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Algorithmic Fairness and Internet of Things (IoT)-Based Personalization in Artificial Intelligence-Driven Healthcare Marketing: Implications for Patient Experience and Choice

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Abstract

With the acceleration of digital transformation, the integration of artificial intelligence (AI) and Internet of Things (IoT) systems into marketing processes within the healthcare sector is increasing. While this transformation offers significant opportunities to personalize healthcare services, enhance the patient experience, and align with patient preferences, it also raises critical issues such as algorithmic fairness, data privacy, and ethical risks. In particular, AI-powered marketing algorithms that provide personalized health recommendations by analyzing patient data can improve patient satisfaction and adherence to services. However, algorithmic biases, the risk of discrimination, and the lack of transparency in decision-making mechanisms present significant challenges. This project aims to examine the effects of algorithmic fairness and IoT-based personalization on patient experience and choice in AI-driven marketing within the healthcare sector. The research analyzes the role of AI-powered marketing applications in shaping patient perception, trust, satisfaction, and preference behaviors, while also addressing the moderating effect of algorithmic fairness in these relationships. The findings are expected to contribute to the development of ethical, fair, and patient-centered digital health marketing strategies.

Keywords

Artificial Intelligence, Algorithmic Justice, Internet of Things (IoT), Healthcare Marketing, Personalization, Patient Experience, Patient Selection

1. Introduction

Artificial intelligence (AI) and the Internet of Things (IoT) have emerged as transformative technologies in modern marketing, offering unprecedented capabilities in customer personalization, automation, and data-driven decision-making [1]. AI facilitates adaptive marketing through machine learning algorithms, predictive analytics, and automation tools that tailor consumer interactions and streamline operations [2]. Simultaneously, IoT enhances real-time data collection, enabling businesses to monitor consumer behavior, optimize supply chains, and deliver contextually responsive marketing interventions [3] [4]. Despite these advances, integrating AI and IoT into marketing strategies remains fraught with complex challenges [5]. Issues such as data privacy, algorithmic bias, and consumer autonomy continue to raise ethical concerns, while practical implementation is often hindered by high costs, fragmented infrastructure, a shortage of skilled professionals, and cultural resistance to automation [6] [7]. Furthermore, although many studies highlight the advantages of AI and IoT separately, few offer an integrated perspective on how these technologies can synergize to revolutionize marketing practices [8]. Unanswered questions remain about how businesses can achieve a balanced, ethical, and scalable integration of AI and IoT that creates value without undermining trust [9]. The integration of AI with IoT represents a significant advancement in the healthcare sector, effectively bridging the gap between the digital and physical worlds [10]. AI algorithms embedded in IoT sensors improve production processes and quality control, leading to increased overall productivity [11]. Healthcare has become one of the sectors most rapidly and comprehensively impacted by digitalization [12]. Advanced technologies such as AI and IoT are driving radical changes not only in diagnostic and treatment processes but also in the marketing, delivery, and patient interaction methods of healthcare services [13]. In particular, personalized healthcare marketing enables more accurate analysis of patient expectations and the development of service designs tailored to individual needs [14]. However, the intensive use of patient data by AI-based marketing algorithms raises issues of algorithmic justice and ethical responsibility [15]. Biases arising in algorithmic decision-making can lead to the exclusion or misdirection of certain patient groups [16], posing a significant risk that directly affects patient experience and healthcare choices [17]. In this context, addressing the effects of AI-driven marketing in healthcare on patient experience and choice within the framework of algorithmic justice and IoT-based personalization is of great academic and practical importance. Shankar *et al*. [18] aim to contribute to the literature and assist practitioners by examining the role of these technologies in healthcare marketing from a multidimensional perspective [19].

2. Digital Transformation and Artificial Intelligence in the Healthcare Sector

2.1. The Evolution of Digitalization in the Healthcare Sector

Digitalization means the conversion of information or data into a digital form.

More simply, it involves converting information traditionally found in analog formats such as paper or physical models into a digital, mobile, smartwatch, and computer-readable format. Once converted to digital format, the information can be processed by computers, stored more efficiently, easily transmitted using software, and analyzed. It also helps to make life easier, as it does for many of us [20]. Digital health is transforming medicine and healthcare practices. The field is growing rapidly; the development of new technologies is facilitating medical research and personalized medicine [21]. Digital health has revolutionized the delivery of healthcare services. It is changing the way we diagnose, treat, manage, and prevent health problems [22]. This is a multifaceted discipline involving many stakeholders, including clinicians and researchers with expertise in diverse fields such as healthcare, public health, data technologies, health informatics, and biomedical engineering [23]. Therefore, it is not surprising that current research trends in digital health are diverse and wide-ranging. Examples include advancements in artificial intelligence leading to improvements in diagnosis and drug development, mobile health applications supporting mental health, wearable devices to assess athletic performance or musculoskeletal dysfunction, various digital health solutions to support the elderly and those with chronic diseases, virtual medical education, and remote healthcare services [24]. Digital technology is also a significant factor in shifting the focus of healthcare from healthcare professionals to a patient-centered approach [25]. Many digital health tools, particularly wearable devices and mobile health applications, prioritize patients [26]. Digital transformation is a frequently used term in the healthcare sector. Before examining its impact on the sector, we must ask this question: What does digital mean in the healthcare sector? At its core, digital healthcare involves the use of technology to improve patient care [23]. This encompasses everything from electronic medical records to track patient data to telemedicine services that connect patients with doctors [21]. By leveraging digital tools, healthcare providers can improve the quality of care and patient outcomes [22]. Additionally, digital healthcare can reduce costs by increasing efficiency and improving communication between providers and patients [25]. As the healthcare sector evolves, digital transformation will play a crucial role in shaping future care [21].

Healthcare organizations face increasing pressure to improve patient outcomes while keeping costs under control. Many are turning to digital technology to support their transformation efforts. Digital technology helps healthcare organizations achieve their goals in various ways [26]:

1) Increasing patient engagement: Digital technology increases patient engagement by providing easy access to health information and eliminating the need for paper records (also known as digitalization) [21].

2) Better decision-making: It improves clinical decision-making processes by providing physicians with access to real-time data and information [22].

3) Automation and coordination: Digital technology reduces costs by automating administrative tasks through Robotic Process Automation (RPA) and improv-

ing coordination among care team members [23].

In conclusion, digital technology is an important tool for healthcare organizations to improve the quality and efficiency of care [27].

To strengthen accountability in the proposed framework, we explicitly assign roles and responsibilities: hospitals/brands oversee patient-facing communication and ensure ethical use of personalization, platform providers manage secure data integration and enforce technical safeguards, and model developers maintain algorithmic integrity and monitor for biases. Concrete management mechanisms—such as Data Protection Impact Assessments (DPIAs), model cards, bias audits, and patient appeal channels—are integrated to ensure transparency and oversight. Each mechanism directly supports patient-centered outcomes: DPIAs and bias audits enhance trust, model cards improve satisfaction by clarifying recommendation logic, and appeal channels empower patients to influence decisions, reinforcing autonomy and choice.

2.2. Digital Technology in Healthcare Services

Digital transformation involves using technology to create new or improved business processes, products, or services. Successful digital transformation helps organizations become more efficient and agile, and better meet customer needs. The healthcare sector is particularly well-suited to digital transformation due to its reliance on complex processes and data. By digitizing processes and facilitating access to information, healthcare organizations can improve patient care and outcomes while reducing costs. Furthermore, digital transformation can create opportunities to deliver new care, such as telemedicine. As the healthcare sector continues to evolve, digital transformation will become increasingly important for remaining competitive. Digital transformation in the healthcare sector has provided many benefits, such as the ability to collect and store large amounts of data. However, it has also created new challenges regarding data privacy and security. Since healthcare data is extremely sensitive, its protection is vital. One of the biggest challenges is that healthcare data is often stored on various devices and systems, complicating unified security strategies. Additionally, data sharing between different parties creates potential security vulnerabilities. These challenges are further amplified by the constantly evolving healthcare sector [28]. New technologies and trends are constantly emerging, making it difficult to keep up with best practices. As a result, protecting health data is a complex and ever-changing challenge. To realize the benefits of digital transformation, healthcare organizations need to seamlessly share data across digital platforms. Unfortunately, many systems still use legacy systems that are incompatible with new ones. This leads to data silos, hindering a holistic view of patients' health. This can result in incorrect care decisions and wasted resources [29]. Healthcare organizations should invest in interoperability solutions to overcome these challenges, eliminate data silos, and provide a unified view of patients' health status. By doing so, they will be able to better guide digital transformation and fully benefit from new technologies. Data

silos pose a significant challenge in modern healthcare. A data silo is a collection of isolated data that hinders a complete picture of a patient's health status and makes it difficult to coordinate care among healthcare providers. Digital transformation helps to solve this problem by creating a more connected healthcare system, but many silos still persist and prevent us from reaping all the benefits of digital transformation. Overcoming data silo challenges is crucial to fully leveraging digital health technologies [30]. The healthcare sector is undergoing a digital transformation as patients and healthcare providers increasingly utilize digital tools and services. This shift stems from the need for more convenient, accessible, and personalized care, and is increasing the demand for new service delivery methods, such as digital healthcare services, which enhance the patient experience. Digital healthcare services are becoming increasingly widespread due to their advantages over traditional care models. Often more convenient and accessible, these services are tailored to individual patient needs and can improve outcomes by providing real-time data and feedback [31]. With the development of the healthcare sector, digital healthcare services will play an increasingly important role in meeting the needs of both patients and healthcare providers.

2.3. Artificial Intelligence Applications in Healthcare

The healthcare sector is broadly open to new technologies, including artificial intelligence, which is called the stethoscope of modern medicine. Today, the application of technology in healthcare is inevitable, and there are several ways in which artificial intelligence can improve modern medical practice. Artificial intelligence is not a single technology, but a collection of technologies directly related to healthcare. Based on existing data, artificial intelligence technology performs tasks by mimicking human intelligence. Computer algorithms use raw data and recognize patterns. Independent of human input, artificial intelligence technologies acquire knowledge. Artificial intelligence algorithms are able to analyze image data that humans cannot see. Artificial intelligence surpasses human performance in many aspects. Artificial intelligence primarily automates repetitive and data-driven tasks such as pattern recognition, data analysis, and medical diagnosis. Recent advances in technological maturity, such as ultra-fast computing, have facilitated the application of artificial intelligence in modern healthcare systems, therefore expectations for AI-based systems are very high. Artificial intelligence applications are used to assist medical professionals in clinical settings [32]. Particularly in the last 15 years, title generation and image recognition techniques have paved the way for the use of artificial intelligence technologies in modern medicine, including in general practice. As you might expect, AI-based systems can improve patient care in many ways. Furthermore, AI systems can transform administrative processes and potentially reduce the workload of healthcare professionals. As AI reduces the workload of general practitioners, healthcare personnel can spend more time with patients, speed up processes, reduce waiting times, and improve early diagnosis. Life sciences companies are significantly using AI tech-

nologies in many areas, including drug discovery. Efficient drug design can be achieved through the intensive use of AI-based techniques that enable the analysis of specific structural interactions. Based on structural databases, the analysis of molecular interactions and correlations can facilitate new drug design. In this context, demonstrating the binding between molecules using AI technologies can predict the *in vitro* activity of that molecule, thus greatly simplifying the development process and reducing costs [33]. In recent years, artificial intelligence (AI) has been applied to diagnosis in secondary care. AI can utilize filtering methods to gather small pieces of information that help in making predictions. AI as a digital doctor raises the question of whether AI will replace doctors; this could lead to a loss of trust in clinicians and delay the implementation of AI-based systems in modern medicine. The large number of patients with different illnesses makes it challenging for general practitioners to examine patients under time pressure; this is a major cause of misdiagnosis frequently seen in family medicine. However, general practitioners are expected to become better diagnostic specialists. In particular, those at risk of pre-diabetes, cardiovascular disease, cancer, or mental health issues are expected to be diagnosed earlier in general practice. Given the shortage of doctors in primary care, it is not surprising that working under such high patient volume and time pressure increases stress for general practitioners and affects the quality of primary care. Therefore, workloads need to be redistributed to focus on patient care. From this perspective, artificial intelligence (AI) has the potential to significantly assist in many tasks and can be a powerful tool for general practitioners to manage this large workload. By automating routine tasks, AI can help reduce the administrative burden on doctors [34]. AI has been proposed to improve diagnostic accuracy and efficiency and potentially pave the way for optimal treatment. AI-powered advancements in health information technologies, such as clinical decision support systems (CDSS), can assist doctors in decision-making. Patients in need of medical care go to their family physicians for help. Therefore, family physicians are the first point of medical contact for patients in primary care, which places a significant burden on GPs. Consequently, general practitioners are expected to make accurate diagnoses and manage treatment plans. Furthermore, family physicians are expected to provide preventive care. All this workload leads to diagnostic uncertainty under time pressure. Family physicians are responsible for making the initial diagnosis, which is critical for appropriate care. Misdiagnosis has a significant impact on the quality of primary care. In particular, misdiagnosis of illness and injury can lead to unnecessary hospitalizations or preventable deaths. Similarly, AI-based models can predict who needs hospitalization and prevents deaths due to misdiagnosis. As you can imagine, misdiagnosis is one of the main reasons for increased healthcare costs. Innovative, reliable, and rapid decision-making approaches can prevent these risks in GP care. AI-based technologies can detect anomalies that the human eye might miss. AI-based systems for disease diagnosis are now much more advanced. They can surpass doctors in detecting breast, brain, skin, and bowel cancers, as well as

heart arrhythmia disorders. This can increase the accuracy of diagnosis in primary care by reducing the need for unnecessary referrals [35].

2.3.1. The Use of Artificial Intelligence in Chronic Disease Management

The burden of chronic diseases is increasing worldwide, reducing quality of life and raising the cost of healthcare. Chronic diseases, and especially their management, significantly increase healthcare costs. Patients with chronic diseases expect their doctors to communicate clearly and treat them like human caregivers. In this context, artificial intelligence (AI) is being proposed to optimize healthcare services and reduce costs. Doctors can use AI to reduce their workload. AI-based tools are being evaluated for future real-world medical assistance. Thanks to recent advances in AI, patients with chronic diseases can utilize AI-based applications for complex situations. In particular, AI-prepared home-based systems, such as precise treatment algorithms for cardiovascular diseases and real-time smartphone-based assessments for diabetics, offer doctors more personalized and precise treatment options.

2.3.2. Application of Artificial Intelligence in Diabetes Management

Diabetes affects millions of people worldwide. AI-powered systems play a significant role in diabetes management by improving patient care, diagnosis, and treatment. AI algorithms are known for analyzing health records, laboratory results, and patient data to predict individuals at risk of developing prediabetes or diabetes. Furthermore, AI-based continuous glucose monitoring systems alert patients to manage their blood sugar levels more effectively. Similarly, AI can optimize insulin doses by analyzing glucose levels, leading to more personalized and accurate treatment plans. AI can also offer personalized diet and exercise recommendations to help people with diabetes manage their condition effectively and become healthier. Additionally, AI-based applications can remind patients to take their medications and enable healthcare providers to track patient progress and treatment plans without face-to-face visits [36]. AI-based systems have also been widely used to monitor the retina as a platform for disease screening or as an auxiliary tool in clinical practice. Managing retinal diseases requires multiple follow-up visits, which is a time-consuming and resource-intensive process. Given the significant number of diabetic retinopathy patients, retinopathy screening is strongly recommended and can prevent blindness by ensuring timely referral and treatment. AI-powered home monitoring systems can be a solution for monitoring patients with retinal disease; in the long term, they can effectively and efficiently reduce time and costs. Measurements taken at home between appointments (e.g., blood pressure and glucose) can be recorded and shared with healthcare professionals in the general practitioner's office. AI-based models can detect changes in the retina before symptoms appear, allowing for immediate intervention to prevent vision loss and thus long-term vision impairment. For example, a newly diagnosed patient can be referred to as an ophthalmologist by a local family physician. Retina Specialist can then schedule a follow-up visit that can improve long-

term visual outcomes [37].

2.3.3. Application of Artificial Intelligence in Cardiovascular Diseases

Cardiovascular diseases, the leading cause of death, are increasing worldwide. In today's world, prevention and early diagnosis of cardiovascular diseases are critically important. However, managing the disease after diagnosis is extremely important and is one of the biggest challenges for doctors. It is well known that clinical care currently faces specific challenges such as cost reduction in prevention and treatment, low cost-effectiveness, high readmission and mortality rates, and inadequate patient care. Advanced AI-based data analysis systems are increasingly being used to help develop successful cardiovascular treatments. The field of cardiovascular medicine is undergoing a transformation towards personalized medicine. AI is being used in cardiovascular medicine to improve the quality of patient care; this is expected to reduce readmission and mortality rates. The potential for AI applications in cardiovascular diseases is enormous, and the use of AI in this field will enable individuals with cardiovascular problems to effectively manage their conditions [38]. Algorithms can identify patients at risk of heart attack; they can detect situations where early treatment would benefit the patient. For example, electronic health records and medical images derived from patient data can be analyzed by AI-powered systems to predict the risk of cardiovascular disease. This AI-powered prediction can help identify high-risk individuals and enable early intervention. It also assists doctors in interpreting heart imaging, enabling more accurate and efficient detection of abnormalities in other scans such as echocardiograms, angiograms, and MRI scans. AI-powered mobile applications and wearable devices can continuously monitor vital signs and provide real-time patient data, which is particularly beneficial for individuals with chronic heart conditions. Furthermore, AI-tracked systems can detect arrhythmias by capturing variable heartbeat lengths [39]. Similarly, automated electrocardiography interpretation software can accurately detect atrial fibrillation. Additionally, AI-powered virtual rehabilitation systems can offer personalized exercise and diet recommendations to aid in the recovery and management of cardiovascular diseases. In general, AI-powered applications in cardiovascular diseases aim to improve early diagnosis, treatment, and patient management, ultimately leading to better outcomes and lower healthcare costs. Traditional monitoring of patients with cardiovascular disease is often insufficient to detect early signs of the disease in a timely manner. However, AI-based technologies offer the opportunity for widespread adoption of solutions that can detect early signs of heart palpitations, enabling timely intervention.

2.3.4. Application of Artificial Intelligence in the Management of Arterial Hypertension

Arterial hypertension (AH) is the largest contributor to the global burden of cardiovascular disease. Current treatment for AH largely focuses on regulating vascular resistance. There has been no significant change in the pharmacological

management of AH over the last 20 years. Since the causes of hypertension are diverse, its treatment requires new approaches. Known methods for monitoring blood pressure are invasive manometric measurements using an arterial line or non-invasive oscillometric techniques using an inflatable cuff. Notably, the invasive measurement method carries an increased risk of complications. Therefore, blood pressure monitoring methods are widely used and need to be optimized. The best blood pressure control can be achieved by optimizing pharmacological treatment, a challenging task for healthcare professionals. The rate of blood pressure control is unsatisfactory and cannot be effectively implemented worldwide. In this context, the use of artificial intelligence-based systems to prevent, monitor, and treat hypertension is well-known. The inclusion of artificial intelligence techniques in hypertension management can help improve patient care from diagnosis to therapy. In conclusion, the use of artificial intelligence systems to monitor blood pressure in clinical practice can become more effective and efficient [37]. Since the onset of hypertension is variable, and it can be symptomatic or non-symptomatic, it is not always possible to predict or detect this condition. AI has the potential to increase efficiency, and the application of artificial intelligence can be beneficial in predicting the risk of patients developing hypertension. The best-known example of artificial intelligence for hypertension diagnosis is 24-hour blood pressure monitoring. By taking direct and repeated blood pressure measurements at intervals, AI-driven software can detect and even classify hypertension with a relatively simple algorithm. Figure 1 illustrates the proposed conceptual model, showing how IoT-based personalization influences patient experience and, in turn, patient choice, while perceived algorithmic fairness acts as a moderator and key boundary conditions and confounding factors (e.g., health literacy, disease severity, digital access, prior provider relationships, and insurance constraints) are incorporated to account for realistic patient heterogeneity.

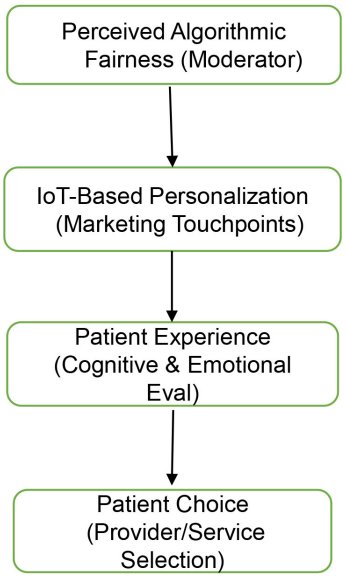

Figure 1. Updated conceptual model.

Moderators/Boundary Conditions:

- Health Literacy.
- Disease Severity.
- Prior Provider Relationship.
- Digital Access/Competency.
- Insurance/Financial Constraints.

Control/Confounding Variables:

- Age, Gender, Socioeconomic Status (optional).

Explanation

1) IoT-Based Personalization: Personalized messages, recommendations, and digital health communications across marketing touchpoints.

2) Patient Experience: Reflects the patient's cognitive and emotional evaluation of personalized interactions.

3) Patient Choice: Behavioral outcome, including provider or service selection.

4) Perceived Algorithmic Fairness: Acts as a moderator; strengthens or weakens the effect of personalization on patient experience.

5) Boundary Conditions/Moderators: Factors like health literacy, disease severity, digital access, prior provider relationships, and insurance constraints can amplify or reduce the effects of personalization.

6) Control/Confounding Variables: Demographics and socioeconomic status can be controlled for to ensure more accurate and testable relationships.

2.4. Advantages and Risks of Artificial Intelligence in Healthcare

Healthcare professionals spend 25% - 30% of their working time on administrative and regulatory activities. Furthermore, AI-powered decision support systems can offer suggestions and recommendations to cardiology professionals based on a patient's medical history, symptoms, and test results. In this way, AI can provide healthcare providers with a second opinion, reducing diagnostic errors caused by human oversight. AI-powered systems help medical professionals by freeing up time for more demanding tasks; AI can foster a more vital doctor-patient relationship, particularly important in primary care, enabling doctors to provide more holistic and individualized treatments. AI can optimize healthcare professionals' workload through scheduling and triage, allowing doctors to focus on more complex cases. By identifying high-risk patients who require more attention, AI-based systems enable doctors to intervene early. By treating high-risk patients identified by AI-powered systems quickly and appropriately, doctors can reduce patient risk and save more lives. This can help clinicians identify high-risk patients and intervene at the right time to prevent adverse outcomes. Furthermore, better risk assessment and intervention by GPs using AI-powered systems can prevent unnecessary expenses [39]. Eliminating certain administrative tasks, such as appointment scheduling and the separation of administrative staff, can free up time to focus on more critical tasks, such as communicating with patients. Appointment scheduling, care management, communication, teleconsultation, health advice sys-

tems, resource management, and user interaction with electronic medical records have been identified as the most common problems in general practitioner practices. Artificial intelligence is increasingly being used by GPs to overcome these problems. Disease diagnosis is the most common application of AI-based systems in modern medicine. AI algorithms can help general practitioners diagnose various medical conditions by analyzing patient data such as medical history, test results, and symptoms. AI systems are trained on very large medical datasets, including patient records, medical images (such as X-rays and MRI), and even genomic information. This data is used to create a comprehensive dataset for analysis. For example, patients' electronic health records, such as medical history, test results, and treatment information, can be analyzed by AI systems. Electronically recorded X-rays, Magnetic Resonance Imaging (MRI), and Computed Tomography (CT) scans can aid in the diagnosis of diseases or conditions. Artificial intelligence algorithms can detect anomalies, identify patterns, and reveal potential problems for further investigation. Therefore, the collection of recorded data is valuable for the diagnosis and monitoring of health conditions. While the application of AI-assisted systems in primary care and diagnosis is important and valuable, the widespread adoption of AI techniques presents several challenges. One challenge is the lack of trust among doctors in AI-assisted systems. Overcoming this lack of trust requires specific tasks to balance the doctor's reliance on AI-assisted systems. Building trust in such a system is essential for its adoption and use. Furthermore, it cannot be ignored that the use of AI systems may involve certain risks if doctors place unquestioning trust in the recommendations and results of these systems. The need for AI systems to access the large amounts of data stored in electronic patient records raises questions about how privacy will be ensured. The storage of data, the processing of signals, and the transmission and dispatch of results can pose certain security risks. Data security systems should protect data; however, data breaches can occur. Ensuring confidentiality in GP applications using AI systems is complex and ongoing. It is also important to note that remote monitoring devices and reprogramming capabilities can be vulnerable to cybersecurity threats, and even proprietary programming and communication protocols can be hacked [38]. AI-based algorithms can be affected by inconsistent quality studies that produce databases requiring optimization. Furthermore, the implementation of comprehensive data protection measures is essential. Even if family physicians keep data anonymized, the risk of individual profiles being tracked always exists. While AI-powered technologies can support clinical decision-making processes, trained medical professionals should not be replaced by AI-enabled systems. In particular, trained medical professionals will always be needed to diagnose complex medical conditions. The nuances of a patient's physical examination findings and medical history can always be evaluated by a physician who can better understand the data. Therefore, trained medical professionals are needed to make an accurate diagnosis. It should also be noted that artificial intelligence systems are not free from technical problems.

3. Artificial Intelligence Marketing in the Healthcare Sector

3.1. The Concept of Health Marketing

As we grapple with how best to communicate with the public and improve health, the principles of commercial marketing are an underutilized resource. The science and practice of health marketing draw heavily on a variety of interrelated and often overlapping disciplines and models. Market research, marketing strategy, and public relations allow for a customer-centric approach and an emphasis on strategic planning and dissemination. Health communication, risk communication, and health promotion provide a theoretical and practical foundation for message development, design, and delivery. Health marketing also draws on various disciplines such as relationship management, social marketing, mass and conversational communication, public affairs and journalism, health education, instructional design, sociology and psychology, and the creation of audio, video, and multimedia products. Almost all of the aforementioned fundamentals of health marketing emphasize the core importance of target audience engagement, a creative aesthetic, and comprehensive formative evaluation [28].

3.2. AI-Based Marketing Approaches

Artificial intelligence (AI) has emerged as a transformative technology in the contemporary marketing environment. AI is a field of study that enables computers to simulate human-like thinking, learning, and decision-making abilities. This technology allows systems to learn, solve problems, and adapt to environmental changes in a manner similar to human intelligence. The historical evolution of AI has been marked by the development of subfields such as deep learning, machine learning, and natural language processing (NLP). Today, these technologies play a critical role in data analytics, image processing, and autonomous systems. In marketing, it is effective in creating competitive advantages by transforming customer experiences. AI has significantly impacted and revolutionized the core components of product, price, place, and promotion (4P) marketing. For example, mechanistic AI is widely used in inventory management and logistics, while thought AI develops personalized product and service recommendations through advanced data analytics. Furthermore, conscious AI adds unique value to customer relationship management by interpreting and responding to consumers' emotional states. One of the prominent applications of artificial intelligence in marketing is dynamic pricing strategy, which adjusts prices in real-time according to consumer demand and market conditions. AI also provides measurable benefits in predicting customer behavior and designing targeted campaigns. Furthermore, NLP technologies such as chatbots and voice assistants enhance customer experiences by offering efficient and interactive communication tools. However, the widespread adoption of AI in marketing is not without challenges. The broad use of the technology raises critical concerns regarding consumer privacy and ethical responsibilities. In particular, the literature highlights the "privacy-personalization paradox" as a significant obstacle to the integration of AI in marketing [40]. E-

commerce refers to the buying and selling of goods and services through electronic means, especially over the internet. In this model, sellers offer their products and services to customers through their own websites or various online platforms; transactions are carried out digitally without the need for physical stores. This digital approach enables small, medium, and large-scale businesses to expand their operational scope, access new markets, diversify product options, and grow their customer bases. In recent years, the impact of artificial intelligence (AI) technologies on marketing processes in the e-commerce ecosystem has increased significantly, leading to important transformations in the field. Systematic literature reviews reveal that AI applications in marketing mainly revolve around three main themes: prediction, personalization strategies, and automation. By increasing operational efficiency in areas such as targeted advertising, customer segmentation, content curation, and campaign analysis, AI significantly contributes to the overall effectiveness and accuracy of marketing activities. Furthermore, AI-powered chatbots are frequently highlighted in the literature as enabling real-time customer interaction, increasing customer satisfaction, and strengthening brand loyalty [41]. In today's digital environment, artificial intelligence (AI) is driving fundamental transformations in the marketing discipline, particularly paving the way for the development of next-generation strategies in email marketing. Going beyond traditional demographic segmentation and basic customer grouping methods, AI technologies now utilize advanced techniques such as natural language processing (NLP), machine learning, and predictive analytics to perform in-depth analysis of customer data, enabling dynamic and real-time targeting. In this context, AI-powered applications allow for the creation and timely delivery of personalized content, taking into account individual customer behaviors, interests, and interaction patterns.

3.3. Personalized Health Marketing

The term "personalized healthcare" traditionally refers to testing disease-related biomarkers and providing targeted treatment protocols. However, today its meaning has broadened to include personalized, evidence-based, and technology-supported healthcare solutions and instant access to vital health information for each individual. This includes early detection and accurate diagnosis, individualized care, rapid and affordable access to the most appropriate care, remote care and monitoring (e.g., telemedicine), and highly relevant digital content [28]. Developing a robust follow-up care plan (e.g., ensuring patients take their medications as prescribed, adhere to rehabilitation and physical therapy plans, monitor their symptoms remotely, and schedule timely follow-up appointments) can reduce unnecessary healthcare expenses and rehospitalization experiences. Healthcare consumers are more likely to return to a hospital or healthcare facility for additional care when follow-up care is absent or fails (due to lack of access, lack of health literacy, or other factors). However, even for a single patient, meaningful patient interaction is very time-consuming. Therefore, leveraging technology to automate post-hospitalization patient interaction as much as possible is vital. Automation

not only helps improve patient satisfaction and, in some cases, patient outcomes, but also reduces the follow-up burden for your staff.

3.4. Algorithmic Marketing and Decision-Making Mechanisms

One of the most important advantages offered by artificial intelligence is the concept of hyper-personalization, which goes beyond addressing the customer by name. This includes optimizing content, offers, and timing tailored specifically to each individual. Furthermore, AI's sentiment analysis capabilities help align marketing content with consumer expectations, thereby improving customer experience and contributing to strengthening brand loyalty. AI-powered dynamic segmentation reveals hidden patterns in customer data, enabling the creation of more meaningful and up-to-date segments and providing flexible responses to changes in the customer journey. Additionally, AI algorithms continuously monitor and optimize campaign performance in real-time, increasing marketing efficiency and maximizing customer engagement. Automated re-engagement campaigns also play a critical role in preventing customer churn and ensuring the sustainability of customer loyalty [41]. However, alongside the effectiveness of AI-based marketing strategies, ethical and legal responsibilities also come to the forefront. Data privacy, algorithmic transparency, and user consent are critical elements, particularly in terms of compliance with regulations such as the General Data Protection Regulation (GDPR). Therefore, ensuring transparency in data collection and usage processes is essential for maintaining user trust and building sustainable customer relationships.

3.5. Data-Driven Marketing Strategies in the Healthcare Sector

Healthcare technology marketing presents unique challenges that differ significantly from other sectors. The complexity of medical products, the tight regulatory environment, and the diverse needs of healthcare providers create hurdles that many sales organizations cannot overcome. In this rapidly evolving environment where technology is vital in improving patient care and operational efficiency, adopting innovative marketing strategies that effectively communicate the value of these advanced solutions is essential. Innovative marketing in healthcare technology requires adopting strategies that meet the evolving and complex needs of buyers and reshaping the purchasing process to focus on holistic solutions that address the organization's challenges. This approach involves continuously testing concepts with buyers through various channels and formats to create a feedback loop that allows marketers to refine their strategies in real time. By fostering a continuous learning process, marketers can become more responsive to buyer needs and ensure their solutions are aligned with the broader goals and challenges of the entire organization, rather than simply promoting isolated point solutions. What is meant here is going beyond traditional advertising and using strategies like social media, personalized emails, and interactive websites that promote products, services, and overall brand messaging. The goal is to reach the right audience

and show them how technology can solve their problems. This type of marketing is important because it helps healthcare providers stay informed about the latest developments, trends, and opportunities, ultimately improving patient care. Some of the most important areas of innovation are using large datasets to understand trends and achieve better alignment within a business and across departments. Data-driven campaigns are crucial in innovative marketing. These campaigns use real data to make decisions. For example, data can show which doctors are most likely to use new medical software. With this information, marketers can create tailored messages that directly address the needs and preferences of these doctors. This makes marketing more effective and ensures that the right people are informed about the technology. Instead of simply continuing to sell individual solutions, vendors need to understand these opportunities from a holistic perspective [28].

4. Algorithmic Justice and the Ethical Dimension

4.1. The Concept of Algorithmic Justice

The increasing evidence of unintended harmful social consequences of automated algorithmic decision-making (AADM) processes, powered by artificial intelligence and big data, in transformative services (e.g., social welfare services) is alarming. The algorithmic harm experienced by individuals, communities, and society in general includes new claims of injustice and disputes that go beyond social justice issues [42]. In today's world, artificial intelligence systems are being used to decide who gets hired, the quality of medical treatment we receive, and whether we will be considered suspects in police investigations. While these tools hold great promise, they can harm vulnerable and marginalized people and threaten civil rights. Uncontrolled, unregulated, and sometimes unwanted artificial intelligence systems can exacerbate racism, sexism, discrimination against people with disabilities, and other forms of discrimination. Courts worldwide are drawn to the alluring promise that algorithms can replace human judgment with mathematical precision, providing objective, unbiased justice. However, the vision of algorithmic neutrality represents one of the most dangerous myths in contemporary criminal justice.

4.2. Algorithmic Bias in the Healthcare Sector

Artificial intelligence (AI) has astonishing potential to assist clinical decision-making processes and revolutionize the healthcare field. A significant open problem that AI must address before being integrated into clinical routines is algorithmic bias. Most AI algorithms require large datasets to learn from, but various groups of the human population have long been underrepresented or misrepresented in existing biomedical datasets [43]. Bias in the medical field can be examined from three perspectives: data-driven, algorithmic, and human-induced. Biases in AI algorithms used in healthcare can have catastrophic consequences by

spreading deeply rooted social biases. This can lead to misdiagnosis of specific patient groups, such as gender and ethnic minorities, who are underrepresented in existing datasets, and further exacerbate inequalities. Artificial intelligence promises to progressively benefit public health by offering data-driven approaches to support clinical decision-making and public health policy formulation. Deep neural networks have made significant advances in medical imaging and precision medicine. Unlike more "traditional" machine learning approaches, deep neural networks propagate an input signal by passing it through multiple transformation layers. This results in the extraction of more complex information patterns from the input signal than simpler techniques typically can reveal. As the amount of data in the biomedical field continues to increase, the use of deep learning has also increased significantly, as deep neural networks are particularly powerful at extracting information from large datasets [42].

4.3. Transparency and Accountability in Artificial Intelligence Systems

The possibility of AI-based clinical tools harming patients through their decisions is an issue that current accountability and safety practices worldwide have yet to address. We focus on two aspects of clinical AI used for decision-making: moral responsibility for harm to patients and safety assurance to protect patients from such harm. AI-based tools challenge standard clinical practices in terms of accountability and safety assurance. Human clinicians and safety engineers have less control over the decisions made by AI systems and less knowledge and understanding of exactly how AI systems arrive at their decisions [44]. Many AI systems used in healthcare, including the system we describe in this article, are assistive systems. In such cases, human clinicians make the final decision on whether or not to act on the system's recommendations. In terms of this final decision or choice, human clinicians meet the control and epistemic conditions mentioned earlier. However, this final choice is only half the picture: The clinician cannot directly alter the system's internal decision-making process once it has begun, nor can they be certain that the software will deliver results that reflect their own clinical intentions. The clinician also has epistemic uncertainty about how the recommendation was reached. Furthermore, the choice to implement the recommendations will be influenced by broader structural and organizational factors such as the clinician's workload and the development of reliance on automation. Security assurance is about demonstrating confidence in the security of a system. Security assurance is typically communicated through a security status document written by the developers of the technology or service, presenting a logical argument supported by a set of evidence. The security status explains why a system is acceptably safe to operate as intended in a defined environment [45].

To date, the combination of high risk of harm and stringent regulations has limited the scope and authority of digital health interventions. Therefore, the transfer of clinical decision-making processes from clinicians to digital systems

has remained limited. Critical software functions are tightly defined to ensure the software exhibits predictable behavior; For example, in robot-assisted surgery where infusion pumps or pacemakers are controlled, or where instruments are directly controlled by clinical professionals. These limitations have been necessary to ensure that qualified clinicians can interpret dynamically complex variables related to patients and the clinical and social context. Artificial intelligence systems have shown the potential to improve clinicians' interpretive ability and subsequent decision-making. However, the potential benefits of this ability are balanced by the widening of accountability gaps and the added risk of negative side effects inherent in healthcare interventions. In essence, the increasing scope and authority of digital health systems challenges existing safety assurance practices and clinical accountability models. These safety assurance and ethical responsibility challenges explain some of the reasons why safety-critical sectors, such as aviation and nuclear energy, are hesitant to evaluate AI applications.

4.4. Data Privacy and Patient Rights

Data privacy in healthcare requires the protection of sensitive patient information, including medical records, personal identifiers, and other health-related data, against unauthorized access, misuse, or disclosure. To clarify, "personal data" refers to any information that can identify an individual (such as names, addresses, and contact information), while "medical data" specifically concerns information generated during the delivery of healthcare services, such as diagnoses, treatment records, and clinical outcomes. Although these categories often overlap, medical data is closely linked to patient care and is subject to additional ethical and professional safeguards enforced by ethical codes of healthcare providers [44]. The World Health Organization (WHO) defines the confidentiality of health data as the implementation of measures that guarantee the confidentiality, integrity, and accessibility of patient information. The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines personal data as any information that directly or indirectly identifies an individual, and emphasizes the secure collection, use, storage, and transmission of such data.

4.5. Ethical AI Design and Regulations

Artificial intelligence (AI) is transforming healthcare by improving diagnosis, personalizing medicine, and increasing surgical precision. However, its integration into healthcare systems presents significant ethical and legal challenges. This review addresses fundamental ethical principles such as autonomy, benevolence, non-maleficence, justice, transparency, and accountability, highlighting their importance in AI-driven decision-making processes. Legal challenges are also addressed, including data privacy and security, liability arising from AI errors, regulatory approval processes, intellectual property, and cross-border regulations. As AI systems become increasingly autonomous, issues of accountability and justice must be carefully considered, particularly given the potential for biased algorithms

to exacerbate inequalities in healthcare. This article highlights the importance of multidisciplinary collaboration among technology experts, healthcare providers, legal experts, and policymakers to create adaptable, globally compatible frameworks. Public engagement is emphasized as essential to foster trust and ensure ethical AI adoption. As AI technologies advance rapidly, a flexible regulatory environment that evolves with innovation is critical. Aligning AI innovation with ethical and legal requirements will lead to a safer and fairer healthcare system for all [42]. Artificial intelligence (AI) is poised to revolutionize healthcare, transforming the landscape of medical practice and patient care in ways once unimaginable. AI's potential to improve diagnostic accuracy, optimize treatment plans, streamline healthcare operations, and improve patient outcomes has garnered significant interest from medical professionals, researchers, and policymakers. With its ability to analyze vast amounts of data, detect hidden patterns, and provide real-time insights, AI has the power to redefine how healthcare is delivered worldwide. One of the most significant applications of AI in healthcare is in diagnosis, where machine learning algorithms are used to interpret medical data such as medical imaging, laboratory results, and patient histories more efficiently and accurately than traditional methods. AI's ability to process medical images such as X-rays, magnetic resonance imaging (MRI), and computed tomography (CT) scans holds promise in detecting diseases such as cancer, cardiovascular diseases, and neurological disorders, often earlier than human clinicians. AI-powered diagnostic systems enable healthcare providers to catch diseases at their earliest stages, when treatment is most effective, by analyzing patterns in large datasets that would otherwise go unnoticed [43]. The field of personalized medicine can significantly benefit from advancements in AI. By integrating data from diverse sources such as genetic profiles, lifestyle habits, environmental factors, and clinical history, AI systems can provide individualized treatment plans tailored to each patient's specific needs. This shift towards precision medicine has the potential to optimize treatment effectiveness and minimize the side effects of treatments. For example, AI can predict how a patient might respond to a particular drug based on their genetic markers, thus ensuring the right treatment is applied to the right patient at the right time. This approach not only improves outcomes but also leads to more efficient healthcare delivery by reducing unnecessary treatments and hospitalizations. AI is also revolutionizing robotic surgery, where advanced algorithms and machine learning provide surgeons with tools that increase precision, minimize human error, and improve the overall surgical experience. These systems can also provide surgeons with real-time feedback and predictive analytics, helping them optimize their decisions during procedures and ultimately improve patient safety. In medical imaging, AI is making significant strides by enabling faster and more accurate interpretation of diagnostic images. Artificial intelligence tools can now detect subtle anomalies in scans that might go unnoticed by human clinicians, making them an invaluable resource for identifying early signs of disease. This capability is particularly critical in fields like oncology, where early

diagnosis can significantly improve survival rates. Furthermore, the ability of AI to learn from diverse datasets and continuously refine its models will ensure that its diagnostic capabilities become increasingly reliable and accurate over time [44].

5. Internet of Things (IoT) and Personalization in Patient Experience Choice Behavior

5.1. The Concept of the Internet of Things (IoT)

The Internet of Things (IoT) refers to a network of physical devices, vehicles, household appliances, and other physical objects equipped with sensors, software, and network connectivity, enabling data collection and sharing [34]. IoT devices (also known as "smart objects") can range from simple "smart home" devices like smart thermostats to wearable devices such as smart watches and RFID-enabled clothing, complex industrial machinery, and transportation systems. Technology experts even envision fully "smart cities" based on IoT technologies. The Internet of Things (IoT) enables these smart devices to communicate with each other and with other internet-connected devices. Devices such as smartphones and gateways form a vast network of interconnected devices capable of exchanging data and autonomously performing various tasks [33]. Developing secure IoT hardware and software is one step toward overcoming this challenge. However, it is equally important that IoT devices in the healthcare sector are properly managed to prevent data from unmonitored devices from falling into the wrong hands. For example, a patient monitoring device with an outdated software or firmware version, or a device that is not properly deactivated when no longer needed, can offer attackers an opportunity to infiltrate a network or steal protected health information. Proper discovery and classification of all IoT devices in a healthcare provider's network helps protect against this risk. Once IoT device networks are properly identified, classified, regulated, and secured, administrators can monitor device behavior to identify anomalies, conduct risk assessments, and separate vulnerable devices from critical ones.

5.2. IoT Applications in the Healthcare Sector

Internet of Things (IoT) devices offer a range of new opportunities for healthcare professionals to monitor patients and for patients to monitor themselves. Therefore, the diversity of wearable IoT devices presents a range of benefits and challenges for both healthcare providers and patients [28].

5.2.1. Heart Rate Monitoring

Like blood sugar measurement, heart rate monitoring can be challenging, even for patients in healthcare settings. Periodic heart rate checks do not protect against rapid fluctuations in heart rate, and traditional continuous heart monitoring devices used in hospitals require patients to remain constantly connected to wired devices, restricting their mobility. Today, various small IoT devices are available.

They can be used for heart rate monitoring, allowing patients to move as they wish while guaranteeing continuous monitoring of their hearts. While achieving ultra-accurate results still poses a challenge, most modern devices can offer accuracy rates of approximately 90% or higher.

5.2.2. Remote Patient Monitoring Systems

Remote patient monitoring is the most common application area of IoT devices in healthcare. IoT devices can automatically collect health measurements such as heart rate, blood pressure, body temperature, and more, even though patients are not physically present in a healthcare facility; this eliminates the need for patients to go to healthcare facilities or collect data themselves. When an IoT device collects patient data, it transmits this data to a software application that can be viewed by healthcare professionals and/or patients. Algorithms can be used to analyze the data in order to make treatment recommendations or generate alerts. For example, an IoT sensor that detects an unusually low heart rate in a patient can generate an alert for healthcare professionals to intervene [46]. One of the biggest challenges with remote patient monitoring devices is ensuring that the highly personal data collected by these IoT devices remains secure and confidential.

5.3. IoT-Powered Data Collection Processes

The Internet of Things (IoT), distinguished by its ability to provide real-time monitoring, faster diagnosis, and efficient resource management in healthcare settings, has become popular in the healthcare ecosystem. Over time, this technology is expected to continue expanding due to the increasing demand for personalization and remote monitoring. Among other technologies serving the healthcare sector, including the Internet of Things (IoT), is artificial intelligence (AI), which enables automation and efficient diagnoses. In addition, other emerging technologies such as augmented reality (AR), virtual reality, and blockchain are also making significant contributions to revolutionizing the healthcare sector. After artificial intelligence, the Internet of Things (IoT) is the most widely used technology in the healthcare sector because it strengthens the connection between healthcare providers and patients by enabling the visualization of data in real time. This makes healthcare services more personalized and more responsive to patient needs. In the healthcare sector, the Internet of Things (IoT) can ultimately improve patient care by facilitating data collection, health tracking, and data access. This significantly reduces the burden on healthcare providers by enabling them to monitor their patients' health status remotely [47].

5.4. IoT and Artificial Intelligence Integration

The healthcare sector is experiencing the most significant digital transformation of recent decades. Hospitals, MedTech companies, and innovators in the digital health field are increasingly turning to artificial intelligence (AI) and the Internet of Things (IoT) to create smarter, more connected, and more predictive care systems. Services that were previously reactive and appointment-focused are becom-

ing proactive, continuous, and personalized, supported by smart medical devices and real-time patient data. The Internet of Things (IoT) in healthcare refers to a network of interconnected medical devices, sensors, wearable technologies, and monitoring systems that collect and share patient data in real time. These devices range from consumer wearables such as smartwatches with electrocardiography (ECG) capabilities to advanced clinical technologies such as smart infusion pumps or connected glucose monitors. In healthcare, artificial intelligence uses machine learning, deep learning, predictive analytics, natural language processing (NLP), and computer vision to analyze medical data and automate decision-making processes. Artificial intelligence can interpret patterns, diagnose conditions, predict risks, and optimize clinical workflows [31]. AI and Internet of Things (IoT) systems in the healthcare sector are based on a multi-layered architecture that connects medical devices, communication networks, cloud platforms, analytics engines, and clinical applications. AI acts as the "brain" of modern healthcare systems, transforming raw data into actionable information. Using techniques such as machine learning, deep learning, natural language processing, and computer vision, AI can interpret patient data, identify anomalies, and support clinicians in decision-making processes. Increased patient recovery: Continuous monitoring enables early diagnosis and faster intervention.

- *Higher Diagnostic Accuracy*: AI analyzes large datasets to identify patterns invisible to the human eye.
- *Reduced Healthcare Costs*: Predictive analytics reduce emergency room visits, readmissions, and unnecessary hospital stays.
- *Operational Efficiency*: Smart hospitals automate administrative and clinical workflows.
- *Personalized Care:* Artificial intelligence tailors' treatment to the individual based on individual patient data.
- *Scalability and Remote Care Service:* IoT devices enable healthcare services to extend beyond hospital walls, providing care in homes and rural areas [32].

5.5. Designing a Personalized Healthcare Experience

Patient experiences play a crucial role in healthcare, as they have a profound impact on patient engagement, satisfaction, and loyalty. In today's digital age, patients expect their interactions with healthcare providers to be tailored to their unique needs and preferences, and personalized experiences are vital for building trust, improving outcomes, and increasing patient satisfaction. Shaping patient experiences requires healthcare organizations to consider several key elements. First and foremost, it is necessary to collect and integrate comprehensive patient data to create a holistic perspective on each individual. By combining data from various sources, such as electronic health records, patient surveys, and digital interactions, healthcare providers can gain valuable insights into patients' needs, preferences, and behaviors. Segmentation strategies based on patient profiles, medical history, and preferences are crucial for delivering the right message to the

right patient at the right time. Healthcare organizations can deliver personalized messages, customized recommendations, and customized treatment plans by segmenting patients into relevant categories. Personalization of messaging and content is another important aspect of these use cases. Patients want information tailored to their specific circumstances, treatment plans, and health goals. Healthcare providers can increase patient engagement and encourage individuals to take an active role in their health journey by tailoring content to patients' needs and concerns [34]. Real-time personalization is vital for providing patients with relevant information and support. Healthcare organizations can proactively engage with patients, provide timely reminders, and offer support at critical moments by leveraging real-time data and behavioral triggers. This personalized approach helps patients feel valued, encourages adherence to treatment plans, and improves overall health outcomes.

5.6. The Concept of Patient Experience

Patient experience encompasses all interactions of patients with the healthcare system, including their health plans and the care they receive from doctors, nurses, and staff in hospitals, doctor's offices, and other healthcare facilities. As an integral component of quality healthcare, patient experience includes aspects of healthcare delivery that patients highly value when seeking and receiving care; these include timely appointments, easy access to information, and good communication with clinicians and staff. Understanding patient experience is a crucial step toward patient-centered care. A common misconception is that patient experience and patient satisfaction are the same thing. However, they are different. Patient satisfaction evaluates patients' expectations and whether those expectations are met. Patient experience, on the other hand, addresses whether or how often various aspects of care (e.g., clear communication with healthcare professionals) occur. By examining the various aspects of patient experience, the degree to which patients receive care that respects and is responsive to their individual preferences, needs, and values can be determined. Evaluating patient experience along with other components such as the effectiveness and safety of care is crucial to providing a complete picture of healthcare quality [33].

5.7. Digital Patient Journey

The digital patient journey begins at a point that can be roughly defined as the digital front door. The digital front door is a group of digital touchpoints representing the first few steps in a patient's healthcare journey. The digital front door can consist of anything from social media posts and advertisements, to your portal/website, call center communications, self-scheduling tools, and more. By examining the patient journey starting from the digital entrance, you can gain a deeper understanding of how each patient interacts with your organization and track how the experience evolves from that point. Who visits your healthcare organization? Who doesn't? What are the reasons why your patients prefer you over

your competitors? What factors bring them back as repeat service users? All of these questions can help your organization identify barriers in the patient journey that hinder patient engagement. Outdated appointment scheduling platforms, lack of digital communication tools, and more can hinder the patient journey and prevent your healthcare organization from acquiring new patients and retaining existing ones. First, there's the awareness stage where a person realizes they or someone they care about needs help. At this stage, they will have already absorbed some information through some form of digital interaction and will have an idea of the options available to them [32]. Then they will move on to the search stage of the journey. At this stage, the individual actively searches online for healthcare providers who can help with their ailment or provide general advice. Predictive modeling is a digital tool you can use to better target your marketing and capture patients at this stage. In the pre-care stage, the patient has chosen a healthcare provider and begun the initial consultation. This is a very sensitive stage of the process because patients are highly likely to seek second or more opinions and have a high potential to switch healthcare providers. Customer relationship management (CRM) technology can be used here to better personalize care and reduce the likelihood of this happening. Point-of-care is the stage where testing and referrals continue. Keeping referrals within your healthcare network and removing barriers in care coordination processes will maximize your chances of retaining patients at this stage. Post-treatment care refers to the point where treatment is completed or ongoing care is put in order. The focus here is on quality outcomes and patient satisfaction; this completes the patient journey and ensures your healthcare network is the first place they will turn to for future issues.

5.8. The Impact of Personalization on Patient Satisfaction

Personalization in healthcare helps provide clear and immediate value to the patient. It is a clear driver of improving the quality of care. Personalization helps healthcare professionals interact with patients with contextual and relevant information specific to their condition, interests, and preferences. It enables them to deliver the right warning with the right message at the right time. They can send timely reminders, help individuals follow their personalized treatment plans, and guide them to relevant resources, enabling them to learn about future healthcare management tools. A proactive and context-driven approach to managing and monitoring health conditions provides clear and immediate value and builds stronger relationships between healthcare providers and patients.

5.9. The Impact of Perceived Algorithmic Justice on Patient Trust

In healthcare, the development and implementation of insufficiently equitable AI systems can undermine the delivery of equitable care. Evaluations of AI models stratified among subpopulations have revealed inequalities in how patients are diagnosed, treated, and billed for healthcare costs [30]. With the proliferation of AI algorithms in healthcare, ethical concerns regarding the disproportionate impact

of models on underrepresented communities are also increasing. Audit studies have shown that AI algorithms can discover misleading causal structures in data associated with protected identity states. These correlations mean that some AI algorithms may use protected identity states as a shortcut to predict health outcomes. For example, in pathology images, the density of hematoxylin and eosin (H&E) stains can predict ethnicity in the Cancer Genome Atlas (TCGA) due to hospital-specific image acquisition protocols. Despite significant differences in performance, there is a lack of regulation on how AI models should be trained and evaluated across diverse and protected subgroups. With the increasing number of algorithms receiving approval from the United States Food and Drug Administration (FDA) as AI-based medical devices (AI-SaMD), AI is poised to permeate routine clinical care in the next decade, replacing or aiding human interpretation in disease diagnosis and prognosis, and predicting treatment responses. However, if left unchecked, algorithms can exacerbate existing health disparities that have already impacted disadvantaged subpopulations. Inequalities in healthcare can lead to disparities in healthcare quality, access to healthcare, and health outcomes among patient subgroups. These disparities are deeply influenced by both historical and current socioeconomic inequalities. While often assessed through observable group-level characteristics such as race, gender, age, and ethnicity, the sources of these inequalities encompass a broader range of observable and latent risk factors, including body mass index, education, type of insurance, geography, and genetics. As formalized by the United States Department of Health and Human Services, most of these factors are identified in five areas of social determinants of health: economic stability, access to and quality of education, access to and quality of healthcare, neighborhood and built environment, and social and community context. These factors are often linked to differing health outcomes and distrust of the health system [29].

5.10. The Impact of Artificial Intelligence and IoT on Patient Selection Behavior

This technological convergence enables predictive healthcare by analyzing large amounts of patient data and identifying potential health risks before they become critical. Early intervention capabilities, supported by AI algorithms, allow healthcare professionals to intervene proactively rather than reactively by detecting subtle changes in patient conditions. As a result, it creates a more personalized patient care approach that tailors treatment plans according to individual patient responses and health patterns. The Internet of Things (IoMT) represents a healthcare-specific ecosystem where medical equipment, wearable IoT devices, and health monitoring systems communicate seamlessly. This interconnected network extends beyond traditional clinical settings, creating a comprehensive view of patient health that reaches into patients' daily lives, enabling continuous monitoring and more informed clinical decisions. Internet of Things (IoT) technology in the healthcare sector encompasses a vast network of connected medical devices that

continuously collect and transmit health data. These devices range from advanced medical equipment in hospitals to simple wearable sensors used by patients at home. Smart beds equipped with weight sensors monitor patient movement and vital signs, while advanced monitoring equipment tracks everything from blood pressure and heart rate to glucose levels and oxygen saturation. The communication infrastructure supporting these healthcare IoT devices relies on a variety of networking technologies, including WiFi, Bluetooth, and increasingly 5G networks. This connectivity enables real-time data transmission between devices, healthcare providers, and central monitoring systems. The choice of communication protocol typically depends on factors such as data transmission requirements, device power consumption, and the specific healthcare environment. Data collection capabilities have expanded significantly with modern IoT devices. Continuous glucose monitors provide real-time blood sugar measurements to diabetic patients and healthcare professionals, while smart inhalers track medication regimens for asthma patients. Cardiac monitors can detect irregular heartbeats and automatically alert healthcare professionals, while sleep sensors collect comprehensive data on patients' resting patterns and respiratory irregularities. Integration with electronic health records and hospital management systems ensures that data collected from IoT devices becomes part of the patient's comprehensive medical record. This integration eliminates data silos and provides healthcare providers with a complete picture of the patient's health, combining traditional clinical observations with continuous real-time monitoring data [27]. The technological infrastructure supporting the Internet of Things (IoT) in the healthcare sector requires strong network capacity, reliable connectivity, and advanced data management capabilities. Healthcare organizations must ensure that their networks can handle continuous data streams from multiple connected devices while maintaining the security and privacy standards required to protect patient data. Artificial intelligence acts as an analytical engine, transforming raw data from IoT devices into meaningful health insights. Machine learning algorithms analyze patterns gathered from IoT data that are impossible for human observers to detect, identifying subtle correlations between various health metrics and potential medical conditions. These artificial intelligence systems continuously learn from new data, improving their accuracy and predictive capabilities over time. AI-powered predictive analytics enable early diagnosis and risk assessment of diseases by analyzing trends in patient data collected through IoT devices. For example, AI algorithms can analyze heart rate variability patterns from wearable devices to predict potential cardiac events before traditional symptoms appear. Similarly, AI-integrated respiratory monitoring devices can detect early signs of pneumonia or other lung diseases [20]. Natural language processing represents another important application of AI in IoT systems in the healthcare field. This technology provides automated clinical documentation by processing voice recordings from healthcare professionals and converting them into structured electronic health records. The

technology also facilitates the automated analysis of patient communications and feedback, helping healthcare providers identify potential problems or concerns that might otherwise go unnoticed. Deep learning applications in medical imaging and diagnostic support represent some of the most advanced use cases of artificial intelligence technologies in healthcare. These systems can analyze radiology images, pathology slides, and other medical images with an accuracy often exceeding human performance. When combined with Internet of Things (IoT) enabled imaging equipment, these AI systems can improve diagnostic accuracy and shorten interpretation time by providing real-time diagnostic support to healthcare professionals. The integration of AI with Internet of Things (IoT) data creates a continuous learning system where every patient interaction and health outcome contributes to the improvement of algorithms. This ongoing research and algorithm development enables AI systems to become increasingly accurate in predicting health risks and recommending treatment approaches based on individual patient characteristics and historical health data [34].

6. Conceptual Framework and Proposed Model of AI-Driven Healthcare Marketing

In recent years, artificial intelligence and Internet of Things (IoT) technologies have significantly transformed the way healthcare organizations interact with patients across digital and physical service environments [12] [48]. Particularly within healthcare marketing, these technologies enable highly personalized communication, service recommendations, and health-related information delivery across multiple touchpoints such as mobile health applications, wearable devices, hospital websites, and automated communication systems [8] [2]. However, the effectiveness of such technologically mediated interactions depends not only on the degree of personalization but also on how patients perceive the fairness of algorithmic decisions that shape these interactions [49] [50]. Building on this premise, the present study proposes a conceptual framework that integrates IoT-based personalization, perceived algorithmic fairness, patient experience, and patient choice within the context of AI-driven healthcare marketing.

6.1. IoT-Based Personalization in Healthcare Marketing Touchpoints

IoT technologies facilitate the continuous collection of patient-related data through interconnected devices such as wearable health trackers, smart monitoring systems, and mobile health platforms [51] [52]. From a marketing perspective, these data streams allow healthcare providers to tailor service messages, preventive health reminders, appointment scheduling suggestions, and treatment recommendations according to individual patient characteristics and behavioral patterns [53]. Such personalization occurs at several marketing touchpoints, including targeted notifications in mobile applications, personalized email communications, patient portals, and automated service interfaces. IoT-enabled personaliza-

tion therefore represents a strategic mechanism through which healthcare organizations can deliver relevant and timely information that aligns with patients' needs and expectations. When effectively implemented, these personalized interactions may strengthen patients' perceptions that healthcare providers understand their individual circumstances, thereby improving the overall service encounter [2]. In this study, IoT-based personalization is conceptualized as the extent to which AI-supported healthcare marketing systems tailor communication, service information, and engagement strategies based on data generated through interconnected digital health devices.

6.2. Perceived Algorithmic Fairness as a Moderating Mechanism

While personalization enhances relevance, it also raises concerns regarding transparency, bias, and equity in algorithmic decision-making [49] [52]. Patients increasingly recognize that many digital healthcare interactions are guided by automated algorithms that process personal data and generate service recommendations. Consequently, perceptions of algorithmic fairness become an important factor shaping how patients evaluate personalized healthcare communications [50].

Perceived algorithmic fairness refers to the degree to which individuals believe that algorithm-driven decisions are unbiased, transparent, and applied consistently across users [54]. In healthcare marketing environments, this perception may influence whether patients view personalized recommendations as supportive guidance or as intrusive or discriminatory interventions. If patients perceive algorithmic processes as fair and trustworthy, they are more likely to interpret personalized communications positively. Conversely, doubts about fairness may weaken the effectiveness of personalization and reduce patient trust in digital healthcare services [49].

Based on this reasoning, perceived algorithmic fairness is proposed as a moderating mechanism within the conceptual model. Specifically, the positive influence of IoT-based personalization on patient experience is expected to be stronger when patients believe that the algorithms governing personalized recommendations operate in a fair and equitable manner.

6.3. Patient Experience in AI-Enabled Healthcare Interactions

Patient experience represents the overall cognitive and emotional evaluation of interactions with healthcare service providers [55]. In digitally mediated environments, patient experience is increasingly shaped by the quality of technology-enabled touchpoints, including user interface design, responsiveness of communication systems, relevance of information provided, and perceived empathy conveyed through digital channels [56].

IoT-driven personalization can contribute to improved patient experience by delivering context-sensitive information and timely health guidance. For example, wearable devices may trigger reminders for preventive screenings, medication adherence notifications, or personalized wellness suggestions. Such interactions can

create a perception that healthcare providers are attentive and proactive in addressing patient needs. In this conceptual model, patient experience functions as an intermediate outcome reflecting how patients interpret personalized marketing interactions facilitated by AI and IoT technologies.

6.4. Patient Choice as a Behavioral Outcome

Patient choice refers to the behavioral decision regarding the selection of healthcare providers, services, or treatment options. In competitive healthcare markets, patient choice is influenced by multiple informational and experiential factors, including perceived service quality, trust in healthcare providers, and prior interaction experiences [57].

Positive patient experiences resulting from effective personalization strategies may strengthen patients' willingness to engage with specific healthcare institutions or digital health platforms. For instance, patients who perceive personalized health communication as helpful and relevant may be more inclined to schedule appointments, use digital consultation services, or continue interacting with the same healthcare provider. Therefore, patient experience is proposed to positively influence patient choice within the model.

6.5. Proposed Conceptual Relationships

Drawing on the preceding theoretical arguments, the conceptual framework proposes a directional relationship in which IoT-based personalization positively influences patient experience across healthcare marketing touchpoints. Patient experience, in turn, is expected to influence patient choice by shaping patients' evaluations of healthcare providers and their service offerings. Furthermore, perceived algorithmic fairness is introduced as a moderating factor that strengthens or weakens the relationship between IoT-based personalization and patient experience. In summary, the model suggests that personalized healthcare marketing strategies powered by IoT technologies can enhance patient experience and ultimately influence patient choice. However, the effectiveness of these strategies depends on patients' perceptions that the underlying algorithmic systems operate fairly and transparently. **Figure 2** illustrates the proposed conceptual model, highlighting the relationships among IoT-based personalization, perceived algorithmic fairness, patient experience, and patient choice within AI-driven healthcare marketing environments.

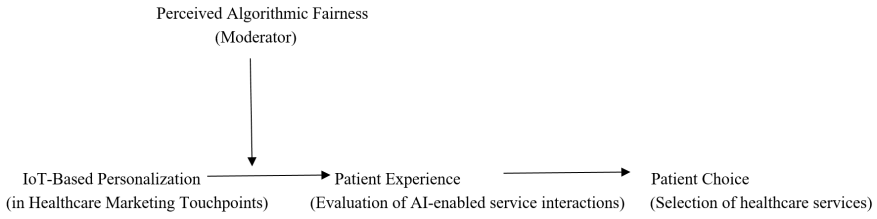

Figure 2. Conceptual model of the study.

7. Operationalizing Algorithmic Fairness in AI-Driven Healthcare Marketing

To clarify the concept of algorithmic fairness within the context of AI-driven healthcare marketing, this study adopts a perceived fairness perspective rather than purely technical fairness metrics. While algorithmic fairness in computer science is often evaluated through formal statistical criteria such as demographic parity, equal opportunity, or calibration, marketing and service research typically examine fairness through the lens of user perceptions and service justice frameworks. This approach is particularly relevant in healthcare marketing, where patients evaluate algorithm-driven recommendations not only based on their outcomes but also on how fair, transparent, and understandable these systems appear. Accordingly, the present study conceptualizes algorithmic fairness through the perspective of perceived procedural and interactional fairness in algorithm-mediated service interactions. Procedural fairness refers to the perceived fairness of the processes through which algorithmic decisions are generated, including the transparency, neutrality, and consistency of automated systems. Interactional fairness reflects how respectfully and clearly algorithmic systems communicate recommendations and explanations to users. In AI-enabled healthcare marketing environments, these dimensions shape whether patients interpret personalized recommendations as supportive guidance or as intrusive or biased interventions. Within this conceptual framework, perceived algorithmic fairness is operationalized as a multidimensional construct reflecting patients' evaluations of how fairly algorithm-driven personalization systems operate across healthcare marketing touchpoints. Building on prior research in algorithmic governance and service fairness, four key perceptual dimensions are proposed: transparency, impartiality, explainability, and contestability. Transparency refers to the extent to which patients believe that the functioning of algorithmic systems is visible and understandable. In healthcare marketing platforms, transparency may involve providing clear information about how personal data are used to generate personalized recommendations. Impartiality reflects the perception that algorithmic systems treat users consistently and without discriminatory bias. Patients may evaluate whether recommendations appear equally appropriate across different users or demographic groups. Explainability captures the degree to which algorithmic decisions can be interpreted or justified. In digital healthcare platforms, explainability may be conveyed through brief explanations accompanying automated recommendations or health alerts. Contestability refers to the perceived ability of users to question, challenge, or override algorithmic recommendations when necessary. Providing options for human consultation or alternative decision pathways can enhance perceptions of contestability. If empirically measured in future studies, perceived algorithmic fairness may be operationalized using survey-based perceptual items. Example scale items could include statements such as:

- "The system clearly explains how personalized recommendations are generated." (Transparency)

- "The algorithm treats patients fairly regardless of their background." (Impartiality)
- "I can understand why the system suggests certain healthcare services." (Explainability)
- "Patients have the opportunity to question or review algorithmic recommendations." (Contestability)

Specifically, when patients perceive algorithmic systems as transparent, unbiased, explainable, and contestable, personalized healthcare communications are more likely to enhance patient experience and subsequently influence patient choice.

8. IoT-Based Personalization Data Flows in Healthcare Marketing

IoT-enabled personalization in healthcare marketing relies on continuous data streams generated by interconnected digital health devices and platforms. These data flows allow healthcare organizations to better understand patient behaviors, preferences, and health-related needs, thereby enabling personalized communication and service recommendations across marketing touchpoints [51] [52]. To operationalize IoT-based personalization within healthcare marketing environments, it is important to clarify the types of devices involved, the categories of data collected, the frequency of data generation, and the integration of these data streams with healthcare information systems such as Customer Relationship Management (CRM) and Electronic Health Records (EHR) [8] [10]. From a technological perspective, several categories of IoT devices contribute to these data flows. Wearable health devices, such as smartwatches and fitness trackers, generate physiological and activity-related data including heart rate, sleep patterns, physical activity levels, and daily movement indicators [48]. Home-based monitoring devices, such as connected blood pressure monitors, glucometers, and smart weight scales, produce periodic clinical measurements that may inform preventive health communication [58]. Mobile health applications also function as important data sources by capturing behavioral data, appointment interactions, symptom reporting, and patient engagement metrics [12]. In addition, hospital-connected IoT systems, including remote monitoring platforms and patient portal interfaces, provide interaction data related to appointment scheduling, service inquiries, and digital communication with healthcare providers. These devices generate different categories of data that support personalization processes. Physiological data describe patients' biometric or health-related indicators, behavioral data reflect daily habits or lifestyle patterns, and interaction data capture patients' digital engagement with healthcare platforms [58]. The frequency of these data flows varies depending on the device type and platform design. Wearable devices may produce continuous or near-real-time data streams, while home monitoring devices typically generate periodic measurements. Interaction data from digital platforms are usually event-driven and recorded when patients engage with specific services or communication channels. For personalization to occur within healthcare market-

ing systems, these IoT-generated data streams are typically integrated into organizational information infrastructures. CRM systems store and analyze patient interaction histories, communication preferences, and engagement patterns, allowing healthcare providers to tailor messages, reminders, and service offers [8]. EHR systems, in contrast, contain clinical and diagnostic information related to patients' medical histories and treatment processes [10]. While IoT data may be linked to both infrastructures, the functional role of these systems differs substantially depending on the intended use of the data. A critical distinction must therefore be made between marketing-oriented personalization and clinical decision support systems (CDSS). Marketing-oriented personalization uses patient-generated data primarily to enhance communication relevance, improve service engagement, and provide informational recommendations such as preventive screening reminders, appointment suggestions, or wellness program invitations [2]. These recommendations aim to support patient engagement and service accessibility rather than to guide clinical diagnosis or treatment decisions. Clinical decision support systems, on the other hand, analyze medical data to assist healthcare professionals in diagnostic reasoning, treatment planning, and clinical risk assessment [12]. The present conceptual framework focuses specifically on personalization mechanisms within healthcare marketing touchpoints and does not address algorithmic decision-making related to medical treatment.

Consent and Engagement across the Patient Journey

The use of IoT-generated data in healthcare marketing also requires careful consideration of patient consent and participation throughout the patient journey. Within digital healthcare ecosystems, patient interactions typically occur across three main stages: the digital entry point, the point of care, and the post-care phase [56]. At the digital entry point, patients often engage with healthcare providers through websites, mobile applications, or wearable device platforms. At this stage, explicit consent mechanisms are typically implemented to inform patients about data collection practices and the potential use of their data for personalized communication [52]. During the point-of-care stage, patient engagement occurs through clinical encounters or digitally supported service interactions, such as telehealth consultations or hospital-based digital systems. At this stage, patients may receive personalized service information or reminders based on previously collected data, provided that appropriate consent has been obtained. The post-care phase represents an additional opportunity for personalized engagement through follow-up communication, wellness guidance, or preventive health reminders delivered via digital platforms. Importantly, maintaining patient trust requires that healthcare organizations clearly communicate how data are used across these stages and allow patients to review, modify, or withdraw their participation in personalized digital services [49]. By incorporating transparent consent and engagement practices throughout the patient journey, healthcare organizations can balance personalization benefits with ethical considerations related to data governance and patient autonomy.

9. Conclusion and Recommendations

This conceptual study investigates the effects of algorithmic fairness and IoT-based personalization on patient experience and preference in AI-powered marketing applications in the healthcare sector. This conceptual assessment demonstrates that personalized service delivery in digital health marketing can contribute to patient satisfaction and trust, playing a significant role in improving the overall patient experience. The evaluations within the conceptual framework are consistent with the existing literature, which shows that AI-powered systems improve perceived service quality in healthcare. However, it is also emphasized that algorithmic fairness is a critical determinant of patient experience and preference behavior. When algorithms are perceived as lacking transparency, impartiality, and fairness, patient trust decreases, leading to negative perceptions of the service even with high levels of personalization. This underlines the need to evaluate AI systems not only in terms of technical accuracy but also within ethical and fairness frameworks. IoT-based personalization applications have the potential to provide solutions tailored to individual needs by analyzing patient behavior more accurately. However, the extensive data usage inherent in these technologies makes data security and privacy perceptions an integral part of the patient experience. Conceptual assessments show that increasing concerns about data privacy can negatively impact patient preference behavior. Therefore, this study, emphasizing the delicate balance between technological benefits and ethical risks, adopts a holistic framework to examine the combined effects of algorithmic fairness and IoT-based personalization in AI marketing in healthcare on patient experience and preference. The study found that AI and IoT-powered personalized marketing applications improve patient experience, increase satisfaction and trust, and significantly influence patient preferences. However, when algorithmic fairness is not ensured, these technologies fail to produce the expected positive effects; instead, they can negatively impact preference behavior by undermining patient trust. Therefore, the success of digital marketing strategies in healthcare depends not only on technological advancement but also on adherence to ethical principles, transparency, and fairness. In this context, to sustain a patient-centered healthcare approach, AI systems must be designed with an ethical, fair, and human-centered perspective. The study highlights the potential of technological innovations in healthcare marketing to improve patient experience, while also demonstrating that this potential can only be realized within a trust-based digital ecosystem.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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