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PAPER

Artificial Intelligence and Mobile Apps Support Intelligent Healthcare Systems for Mental Health Services

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ABSTRACT

Patients and healthcare practitioners have commended the systems' effectiveness, ease, and user-friendliness in several situations. Utilizing cutting-edge ideas and methods from the multidisciplinary domains of electricity, computing, medical engineering, and medicine, mobile healthcare (m-health) technology advances these professions' contributions to healthcare systems. The monitoring and delivery of healthcare interventions are becoming increasingly dependent on mobile phones. Because of their sophisticated processing functions, improved preferences, and wide range of capabilities, they are frequently referred to as pocket computers. Their advanced sensors and intricate software programmers increase the viability and innovation of m-health solutions. To design the m-health application, the design science research methodology (DSRM) framework was used. Additionally, the architecture for connecting the hospital information system and mobile device network together was established. Additionally, a few exemplary intelligent healthcare applications are examined to demonstrate how data analytics and mobile computing can be used to improve the quality of healthcare services.

KEYWORDS

mobile healthcare (m-health), artificial intelligence (AI), mobile apps, mobile healthcare application, mobile device network

1 INTRODUCTION

The art of using mobile-based technology, such as cell phones, PDAs, monitoring of patient devices, and other wireless devices for public and medical health, is known as mobile health. Therefore, using voice communication and short message service (SMS), one of the most valuable features of a mobile phone, is necessary for this operation. Currently, there are about 500 mobile healthcare (m-health) projects underway [1], and there are close to 40,000 mobile applications with a medical focus accessible globally. Certain medical devices based on mobile technology are specifically made to track sleep patterns and measure arterial glucose levels, heart rates, and brain activity. Additionally, it uses increasingly sophisticated functions

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and services including, the Global Positioning System (GPS), third- and fourth-generation mobile-based methods, and the broader General Packet Radio Services.

Artificial intelligence (AI) is a concept that, in terms of clever development, knows no bounds. It includes the capability of computer algorithms to analyze the data without the need for human input. Healthcare systems now have a new level of philosophy thanks to the integration of AI with smart devices. With the development of healthcare systems, people's health has advanced to a new degree. Early disease diagnosis and monitoring are facilitated by AI-enabled devices with sensors [2]. The entire system functions as a robotic nurse for patients, providing consistent care, monitoring, and documentation of the patients' health status.

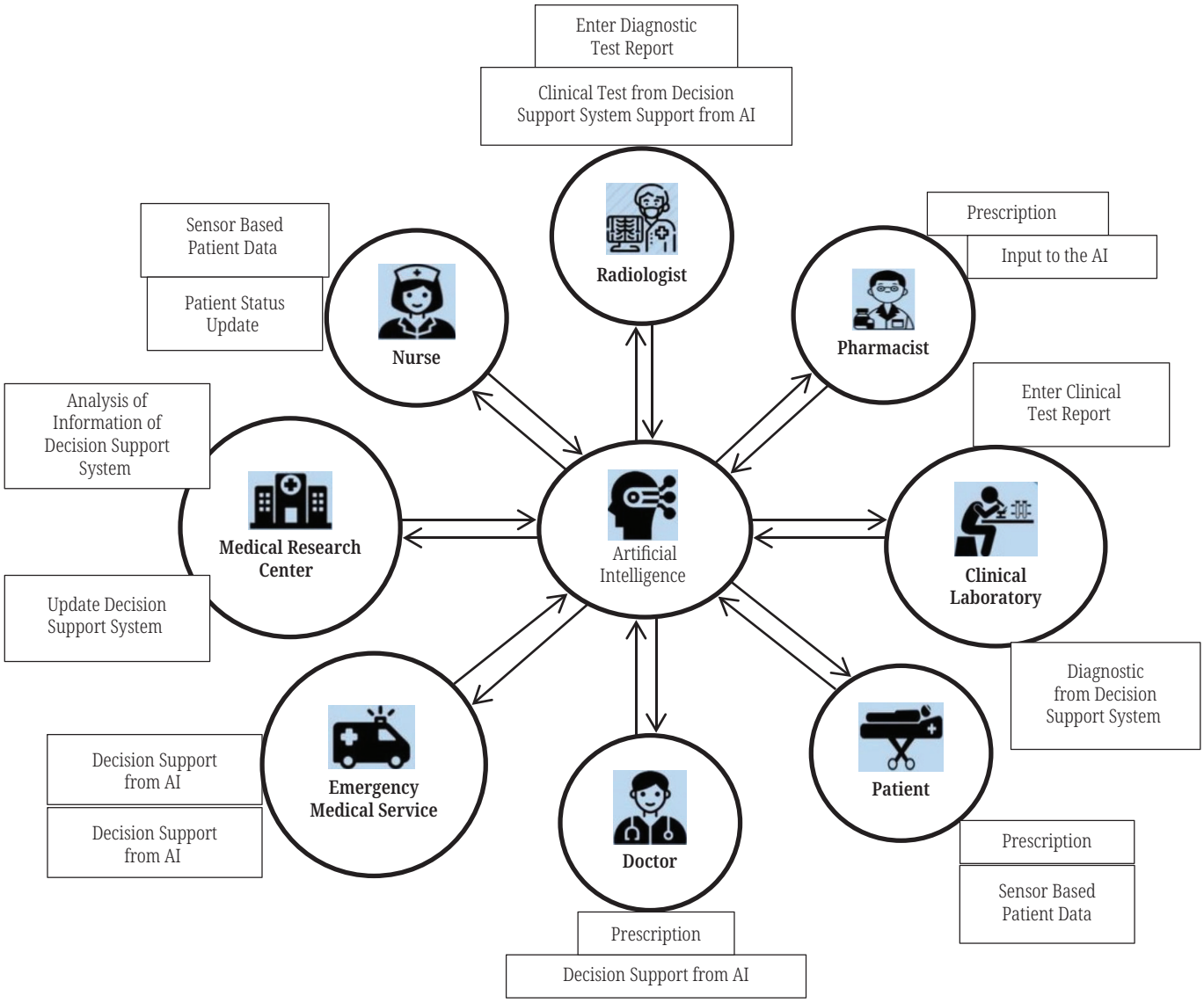

Fig. 1. Artificial intelligence powered smart healthcare

Our general desire is to be healthy, which includes getting sufficient rest, eating a balanced diet, and working out; to function well, which involves avoiding circumstances and ideas that put us at risk of mental health problems such as stress, anxiety, and depression (SAD); and to engage in other behaviors, the majority of which are outlined in the Sustainable Development Goals of the United Nations [3].

A widespread technology can bring about attitude and behavior change in many areas of human life where it is desired. Problems that are addressed by these kinds of behaviors have dramatically increased in the last few decades. The state of mental health is one area where the recent COVID-19 pandemic has had an especially negative impact. Although there has always been a dearth of resources and strong institutional structures in the area of mental wellness, the epidemic brought to light the devastating consequences of decades-long disregard for people's well-being. The social separation that was enforced further crippled the existing systems, breaking the link between individuals and mental health professionals. As a result, decision-makers are looking to technology for assistance in combating a pandemic that affects both the body and the psyche. This work adds a fragment to the systematized effort that is required to uncover the ways in which technology might aid in addressing the current mental health crisis. We conclude this part with a statement outlining our reasons for doing this task and why we think it is necessary.

Many articles on m-health and the use of AI and big data analysis in the healthcare industry have lately been published, either as reviews or suggestions. This document describes the features and uses, the breadth and health subarea, the duration, and the quantity of publications evaluated.

The following research questions are the focus of this review:

- What is m-health, and which sensors have been created for m-health requests?
- What uses and advantages might AI technologies have in m-health?
- What uses and advantages might big data analytics have for mobile health?
- What obstacles exist for m-health organizations looking to implement AI and big data analytics technological advances? And a suggested mobile health paradigm built on big data analytics and artificial intelligence.

This is how the rest of the paper is structured. The purpose and extent of this work, as well as the methodology of systematic reviews and meta-analyses, are presented in Section 2. The definition and graphic of m-health are presented in Section 3 representation in addition to mobile sensors and m-health applications. Section 4 provides an in-depth analysis regarding the use of AI in m-health apps and the metrics for performance assessment employed to assess the caliber of m-healthcare. Section 5 displays the conclusion and upcoming improvements.

2 RELATED WORKS

Artificial intelligence uses algorithms such as DL and ML to quickly diagnose illnesses. This lessens problems and aids in the early diagnosis of illnesses [4]. Clinicians are assisted in the diagnosis and treatment of illnesses using clinical decision support systems, or CDSs. Certain CDSs, such as the medical CDS, help in diagnosis by generating rules either automatically or manually. Based on testing conducted in electronic health records (EMRs), this has proven to be successful. The features from non-contrast imaging have been utilized to create contrast images using more recent deep learning techniques. For this reconstruction, a two-dimensional cycle generative adversarial network (cycleGAN) was employed. By developing and improving this model, the difficulties related to the use of contrasts can be avoided.

Among the many important aspects of smart health monitoring devices are the ability for doctors to remotely check on patients' conditions in real time and the avoidance of needless hospital trips. These gadgets produce data that is safe from attackers.

These devices are a major advancement in the medical industry as they help to alleviate the problem of the high cost of medical care today. IoMTs and SHM will play a continuous part in the overall development and growth as people's expectations and beliefs about the intelligence of devices and digitization grow [5]. As a modern medical device, SHM can be utilized to remotely operate medical facilities in order to save the lives of critically ill patients with heart attacks, asthma attacks, diabetes, etc.

Owing to these practical advantages, it is not unexpected that chatbots have advanced quickly over the previous 20 years and found applications in a wide range of industries, including gaming, entertainment, tourism, automation, and safety [6]. Chatbots have demonstrated a high degree of usefulness in a variety of healthcare components that often need in-person contact. The incorporation of virtual assistants into medical procedures has the potential to improve patient outcomes, streamline operational efficiencies, and save costs due to its capacity for complicated dialogue administration and linguistic adaptability. A web-based self-report study that looked at the opinions of physicians revealed that using healthcare chatbots might help people manage their own health, achieve better behavioral, emotional, and physical results, and most importantly, use them for administrative tasks.

Research on correlations between language/voice characteristics and mental health has emerged as a result of the theory that the language we use and our vocalizations can reveal our psychological states, as well as advancements in the AI domains of natural language processing and sound analysis [7]. Textual content for mental health speech analysis is traditionally derived from transcriptions of clinical interviews and sessions. Internet-based tools like social networking sites, online discussion boards, and messaging apps, however, present abundant new non-clinical written material for this kind of research. Diminished vocabulary, conceptual incoherence, and decreased syntactic complexity—all characteristics of language disturbance—are warning signs of serious mental illness, especially psychosis.

In addition, the worldwide cost of disease 2019 programmer evaluated decades of life lost, years of life with a disability, and years of life with a life expectancy adjusted for disability for 87 risk factors and risk factor combinations. Cigarette usage (15.4% of fatalities) and high diastolic arterial pressure (19% of all fatalities) were the risk variables that contributed to the greatest number of fatalities [8]. The highest levels of ambient particulate matter, alcohol consumption, high BMI, high lower density lipoprotein cholesterol, low intake of whole grains, high sodium intake, and high fasting plasma glucose were also among the top controllable risk variables in adults. Based on these statistics, lifestyle risk factors are important for non-communicable diseases.

In recent years, the sector of healthcare has seen an exponential increase in the quick integration of AI. A number of opportunities have been made available to thousands of women who suffer from different mental health disorders thanks to innovative technologies. Machine learning algorithms have been used in primary care in a number of instances to enhance women's mental health [9]. Suicide prevention, for instance, is a critical public health priority. Nevertheless, little is known about the risk factors for suicidal behavior or thoughts following hospitalization or about an algorithm to distinguish between the risks of suicide attempts and self-harm following post-medical hospitalization in women with depression, bipolar disorder, and ongoing psychosis.

John McCarthy first used the term AI to describe a machine's capacity to mimic or replicate human-like abilities through technology, including thinking, learning, communication, decision-making, adaptability, and sensory perception. As in conversational chatbots, a machine may, for instance [10], deftly control the user's engagement.

Therefore, in situations when resources are limited, chatbots can be utilized to supplement the work of doctors for people who are in need of mental health treatment. But in more recent times, the term AI has come to mean agents or historical calculators that can build prediction models to aid in the making of extremely complicated judgments.

3 METHODS AND MATERIALS

This study thoroughly examines the application of AI in mental health treatment using a narrative review methodology. Papers published in reviewed journals, workshop proceedings, or reliable online databases with an emphasis on the use of AI in mental healthcare were included in the testing and met the requirements for paper selection. This included review papers that offered an overview, evaluation, or synthesis of the body of existing literary works.

Papers that did not fulfill the inclusion criteria, duplicates, publications written in a language other than English, and papers irrelevant to the review topic were all considered exclusion criteria [11]. Three steps made up the screening process: full-text eligibility evaluation, abstract screening, and title screening. Papers that didn't fit the inclusion criteria were disqualified at each level. The objective of the search approach was to locate pertinent articles that were published on "AI in Mental Healthcare" between January 2019 and December 2023. The sources of information included credible internet databases, academic journals, and conference proceedings. Review papers were chosen, and then they were further examined for relevant data, patterns, case studies, and moral issues related to AI in behavioral health treatment.

3.1 Artificial intelligence in mental health history

The mid-20th century, which saw the advent of the calculating era, is when AI first started to be integrated into mental healthcare. At that time, scientists started to imagine that robots could be able to mimic cognitive functions, which paved the way for future developments in this area. Pioneers of AI Allen Newell and Herbert A. Simon set out to create AI models based on human problem-solving in the 1950s and 60s. Their work established the fundamental ideas of symbolic AI, which subsequently proved to be useful in mental health situations for cognitive process simulation. Even though it was primitive by today's standards, this early work on AI set the groundwork for a major confluence of psychiatry and AI.

Joseph Weizenbaum developed one of the first AI applications in psychology by the late 1960s and early 1970s. ELIZA, his program, was a chatbot designed to mimic a Rogerian therapist. Although ELIZA's answers were comparatively straightforward, they might spark text-based discussions amongst users and offer an insight into how technology might facilitate relationships related to mental wellness. Over the years, there has been a gradual increase in the application of AI in mental health treatment. In the 1980s, work on expert systems—rule-based AI systems meant to mimic human expertise—began.

The goal of these systems was to offer recommendations for diagnosis and treatment in a number of psychological areas. Even these early AI systems' capabilities were fairly limited in comparison to those of modern AI; they nonetheless marked a significant breakthrough in the fusion of technology and mental health. Computerized cognitive-behavioral therapy (CBT) programs first appeared in the

late 20th century. The goal of these interactive software programs is to offer therapy solutions based on evidence for common mental health issues. Even if the early attempts were not as sophisticated as modern AI-powered interventions, they did mark a shift in the direction of utilizing technology to improve mental healthcare accessibility.

Artificial intelligence's contribution to mental healthcare has grown significantly as computing power has increased.

In the twenty-first century, AI has advanced several facets of mental healthcare, such as early detection of mental health issues, customized treatment programmers, virtual therapists, teletherapy advancements, and ongoing monitoring. These modern AI uses have an opportunity to completely transform the mental healthcare industry by improving data-driven, efficient, and readily available services [12]. From the early stages of cognitive modeling to the most sophisticated AI-driven treatments available today, the development of AI in mental healthcare is characterized by a number of developmental turning points. This voyage suggests a future in which AI plays a comprehensive role in tackling the worldwide mental health issue, reflecting the ever-growing understanding of technology's ability to assist and promote mental well-being.

3.2 Artificial intelligence's function in diagnostics

Artificial intelligence has proven to be a useful tool for anticipating and detecting mental health issues early on. These technologies are revolutionizing the diagnosis and treatment of mental health issues. They can analyze speech, writing, facial expressions, and electronic health information.

Predictive models are used by AI to improve mental health overall, personalize therapies, and strengthen early intervention [13]. Figure 2 illustrates how AI is used to diagnose mental health issues.

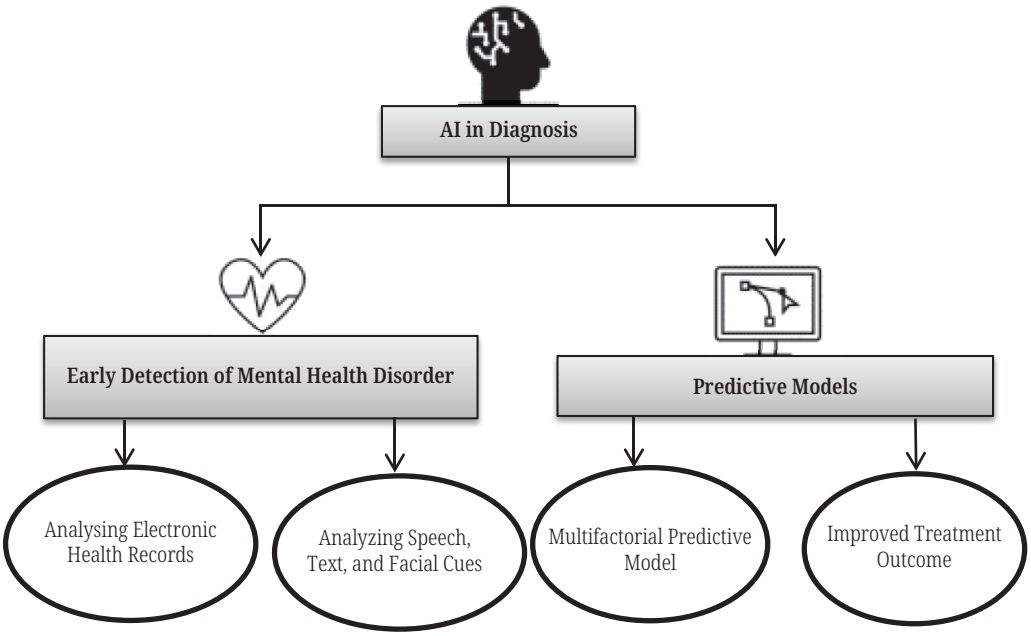

Fig. 2. Artificial intelligence used for diagnosing mental health issues

Early identification of mental health issues. Significant progress has been achieved in the analysis of speech, text, and smiles by AI-driven technologies to spot early indicators of mental health disorders. Through the use of NLP tools, meaningful insights can be gleaned from written or spoken language. Sentiment analysis, for instance, can spot subtle shifts in a person's emotional state by looking at handwritten journals, chat logs, and social media postings. Additionally, voice analysis can identify changes in speech patterns, such as variances in tone, pitch, and rhythm, which may be signs of depression, anxiety, or other mental health issues. When used in conjunction with machine vision, expression analysis can provide information about a person's emotional condition.

3.3 Artificial intelligence in psychiatric hospitals

The research on AI in inpatient mental health units revealed three key themes: evaluation, prognosis, and management.

Identification. Mental health disorder diagnosis is still mostly based on subjective self-reported questionnaires with no objective means of diagnosis, which frequently results in underdiagnosis and misdiagnosis. Poor results and inefficient use of resources are caused by diagnosing issues. Pre-diagnosis [14] and post-diagnosis are the three stages at which AI can be applied to diagnosis.

Early diagnosis. AI has the potential to aid in the pre-diagnosis phase by aiding in patient triage and redirecting patients who do not require actions. ML has been utilized to verify an early psychosis screener, achieving an area under the curve (AUC) of 0.799, which is considered an excellent discriminator when it comes to separating people at moderate risk from those at high risk. Additionally, an assessment system for psychiatric cases has been developed, with a total accuracy in classification of 67%. These investigations need to be validated on large, carefully selected populations because, despite their promise, they have limited generalizability.

Diagnosis peri-diagnostica. AI can support precise patient diagnosis during the peri-diagnosis stage and facilitate the development of new, objective diagnostic techniques. AI may potentially improve our knowledge of illnesses. Using clustering analysis of functional magnetic resonance imaging (fMRI) scans, a recent study identified five psychosis subgroups with "distinctive clinical endorsements and illness courses." Their brain imaging biomarkers achieved a high degree of specificity and sensitivity (72–83%) in multisite and out-of-sample recombination. The study also defined four novel types of depression. Personalized treatments could be administered according to the various subtypes.

Neuroimaging data was the foundation for several studies. By differentiating sick patients from controls and, more recently [15], building prediction models that employed MRI-based multimodal pattern recognition to separate schizophrenia from serious depression, machine learning has advanced our understanding of the brain. In a similar vein, "support vector machines" were employed to study MRIs and separate people with psychosis from normal. While those investigations demonstrated the potential utility of ML for neuroanatomical assessment in ambiguous situations, it is crucial to emphasize that imaging-based research frequently employs inconsistent methodologies and datasets.

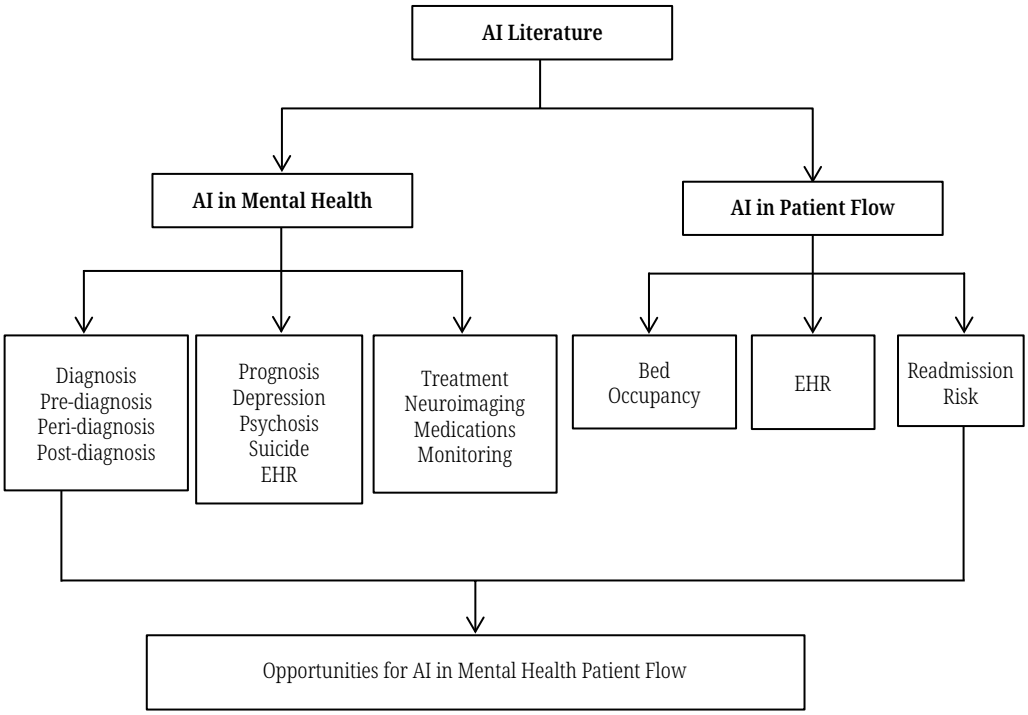

Fig. 3. The above research review's flowchart illustrates its organization

To close the gap between AI in patient flow and mental health, an oral literature analysis was carried out (see Figure 3). For the purpose of finding, evaluating, and reporting themes—patterns found in the literature—a technique called content analysis was used in this review.

4 IMPLEMENTATION AND EXPERIMENTAL RESULTS

The goal of the literature review was to identify the best available research regarding the creation and application of technological options for the care of the elderly. In this paper, we report on how the aging population can be transformed by evolving technological developments and how AI and recognizing patterns may affect the care of older people.

To address the following study issues, we specifically looked at papers about robotic technology, smart home healthcare, and smart distant tracking:

1. Which aging-in-place technology research trends are we currently seeing?
2. How strong is the evidence backing up smart home, mechanically intelligent, and remote monitoring of patient's systems?

In order to address the first query, we identified a broad spectrum of research works that addressed innovative health surveillance and home automation systems, computer science and smart algorithms growth, robotics technologies, and adoption of technology. In response to the second query, the analysis of the papers revealed that the bulk of the publications were subjective and that the majority of studies (75%) had inadequate references without a clear critical evaluation.

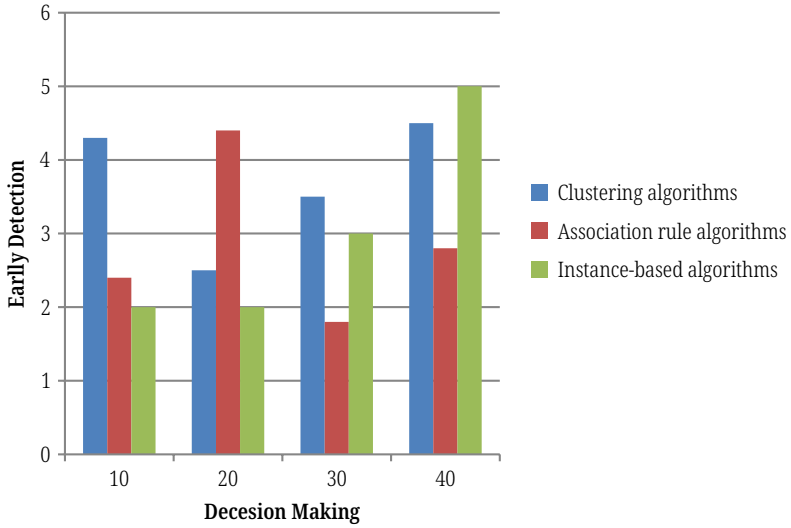

Fig. 4. Techniques of artificial intelligence for self-sufficient living

This analysis of the literature showed that the majority of studies conducted between 2000 and 2010 looked at how older persons perceived technology. There has been a rise in interest in studying monitoring patients and home care technology as a result of the unpredictable rate of change in intelligent assistive technology. Further in-depth study employing sensors, wireless monitoring devices, innovative algorithms, and experimentation or almost experimental research techniques was made possible by the technological acceptance studies. As a result, these studies can be viewed as the beginning of technology research for the elderly population (see Figure 4) [16].

We observed that the number of studies examining the creation of prototype systems, the use of sensors in new intelligent homes, the creation of assistive robots, and the design of new machine learning and AI platforms for assisting elder care increased after 2010. The researchers were able to create complicated AI algorithms, include cutting-edge context gathering techniques, and analyze and automate difficult and demanding jobs thanks to technological breakthroughs. This era, with numerous studies documenting the possible application of robotics technology, reporting promising acceptance rates, and recommending additional experimental studies, might be referred to as the second age of technological study for aging society.

Our research showed that a large number of the studies employed special technology approaches for various senior populations. Research about new technology for Alzheimer's and dementia patients, for instance, was intended for older adults living in nursing facilities, but research supporting an independent way of life was intended for older adults living independently in their own residences.

Additionally, this analysis found other papers regarding cutting-edge new techniques for tracking the health of senior citizens. A large number of these investigations were proof-of-concept systems designed to show that the suggested devices or applications are feasible. Determining the advantages and long-term effects of any invention or experimental device is extremely difficult since some may eventually be widely accepted while others lack sufficient support for deployment. Furthermore, it may be difficult to develop research that validates the rates of technology adoption for senior care by healthcare facilities, nursing facilities, and individual patients. As a result, we advise doing national research to track trends in technology adoption. While this may seem like a lofty goal for one investigator, government and university research institutes can work together to carry out these investigations.

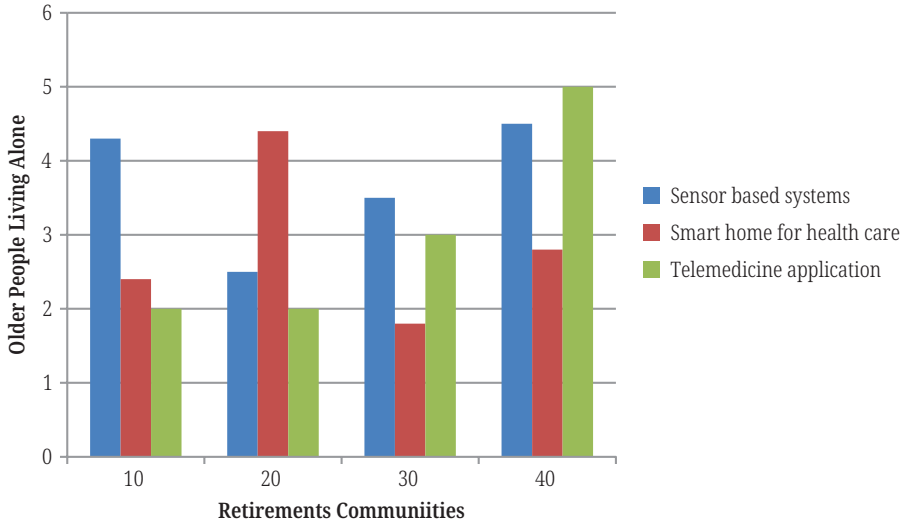

Fig. 5. Technology-based solutions for various aging populations

The ideas and methods used in medical and engineering fields differ when it comes to developments in telecare, residential care, and assisted living facilities. AI algorithms and technology-driven client treatments will likely play a bigger role in the care of the elderly going forward, helping to identify early warning signs and start treatments sooner.

Therefore, we also suggest creating unique smart home applications and sensor-based systems for senior citizens living alone, home service machines and telemedicine applications for senior citizens living with relatives, wearable and remote surveillance devices for senior citizens living in retirement communities, and technologies to help senior citizens suffering from dementia living in residential care homes and assisted living homes (see Figure 5). Any hardware device may contain machine learning and AI, and more research is required to pinpoint the specific technological requirements of an aging society and establish the top objectives for AI research. The outcomes of older patients' medical care and the ability of elderly individuals to live independently will both be enhanced by taking into account the unique needs of various aging populations.

5 CONCLUSION

The difficulties and potential paths in AI for mental healthcare is ever-changing and complex. To fully utilize AI to improve mental healthcare, strong regulatory frameworks, model verification and openness, and continuous development and research are essential. These initiatives will be crucial in influencing the future of mental health therapy and making it more ethical, practical, and accessible for people as AI technologies develop.

According to a review of the literature on AI in mental health, the major goal of AI applications is frequently to enhance patient care quality. AI can also be used to predict clinical results, personalize treatment, and increase diagnostic precision. Predicting unnecessary readmissions, enhancing care effectiveness, optimizing resource allocation, shortening length of stay, and verifying current algorithms for more broad uses were all included in the scientific review on applying AI in patient flow. Studies' generalizability and accuracy differ in both domains. More study is required, with a

particular focus on patient flow in mental health facilities. While this analysis concentrated on hospital-based solutions, it is crucial to emphasize that as medical care will be highly integrated in future generations, community interventions will have a big indirect influence on the movement of inpatient patients.

The experiences of patients may be pleasantly or badly impacted by these possible AI deployments. Further research should examine how patients view the use of AI in healthcare, since patient experience is crucial, particularly when using a patient-centered approach. Especially in the discipline of mental health, addressing queries from patients is essential to the wider adoption of AI in order to preserve patient autonomy over their sensitive data.

There is still a lot to learn about the application of AI in mental health treatment. More research and analysis are needed on crucial issues such as the individual's expertise, clinical importance, and moral considerations.

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