Augmented Reality Technology: A Systematic Review on Gaming Strategy for Medication Adherence

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Abstract

As global health concerns become more complex, technological intervention is needed to achieve the Sustainable Development Goal. This study explores the use of the internet of things (IoT) and augmented reality (AR) applications for medication adherence. IOT devices can collect, transmit, and store up information not including the need for human or computer involvement. It has potential to streamline and improve healthcare. AR, is an advancement in technology which permits patients to interact with virtual objects in a natural way by proactively predicting health conditions, detecting, providing care, and observing patient role while inside and outside the healthcare center. A systematized scoping literature review was conducted on academic databases: Google Scholar, ACM, ScienceDirect, IEEE Xplore, and SpringerLink. The study identified components of IoT, AR, gaming strategy relevant to the healthcare domain and medication adherence. Further discourses applications of AR in the medical disciplines and focus on improving adherence to medication through gaming. The study, point out how AR has enhanced user experience in adherence to medication through gaming. Using AR in health care will provide us with a better understanding of how to deliver health services and how AR technology will be used to enhance global health care in the coming decade.

Keywords: Augmented reality, Gaming, Medication adherence, Internet of things (IoT), Virtual reality

1. Introduction

The Internet of things (IOT) comes after computers, the Internet, and mobile networks as the fourth technology revolution in the global information industry [1]. Numerous devices such as RFIDs and mobile devices can reach out to each other with different inputs. This forms a gigantic network of objects and things that may interact and communicate through the Internet, such as personal computers and global positioning systems. The core of IOT is an expanded Internet-based network [2, 3].An individual can use a computer, a smartphone, a smart band, a wearable, an implantable surgical device, or another device that is connected to the internet to measures health data [3, 4]. Advancing technology is reshaping healthcare, education, and organizational landscapes. The use of technologies like augmented reality provides professionals with technology-enhanced learning opportunities that enhance their ability to learn new concepts through immersive teaching and user experiences. Researchers have shown that augmented reality can increase learner motivation, content knowledge, and critical thinking skills throughout the lifespan. Several tools have been developed as part of this project and have been implemented in a variety of settings throughout healthcare [5, 6].

Artificial intelligence and augment reality (AR) both provide significant technological advancements in recent years that enable virtual environments to be developed or real-world environments to be improved through multiple sensual modes [7, 8]. AR creates a physical boundary to the digital world by adding virtual images to it to improve the way users interact with it by adding virtual images into it. The result is a more intuitive interaction with the digital world. This demonstrates that there are virtual images all over the world that contain knowledge that explains everything about the universe [7, 9]. Objects are exhibited on boards, and information is provided on windows, while photographs can create motion to track the user, all of which has an impact on the individual's experience and mental processes [7]. This technology provides users with real-world experiences such as the Pokémon Go game, Instagram creative filters, Snapchat lenses, and animation on user-generated content [10]. Pokémon Go has demonstrated the growing popularity of augmented reality. In the first month after its debut, millions of people downloaded the game, bringing in a lot of money and attention from all around the world [11].

The medical industry has benefited from the use of augmented reality and artificial intelligence in healthcare. Health check processes, treatment, diagnosis, examinations, and rehabilitation all integrate AR. It's used in heart surgery, spine surgery, neurosurgery, and treating the symptoms of attention deficit hyperactivity disorder (ADHD) in autism patients, among other things [12]. As a result, the quality of treatment provided to patients is improved, the risk is decreased to a minimum, and multitasking is minimized due to surgeons wearing smart glasses and being focused to prevent mistakes [13, 14].

The application of gaming strategy in health-related contexts, such as personal wellness and healthcare, is gaining popularity. Various technology-based innovations have been developed to aid medication adherence and healthy lifestyle choices such as eating patterns, cigarettes, weight maintenance, fitness, and hand hygiene [15, 16]. There is the ability to change obstacles that lead to behavioral changes using gaming approaches, and there are fun engaging practices that motivate users to make the correct choices and activate the proper attitude about their health advantages. Gaming strategy can be used for anything from diagnoses to therapy, from prescriptions to side-effects, medicine adherence challenges to long-term care, as well as instruction and training. For both practitioner and the patient, medication adherence is a monotonous, recurrent, and painful practice. As a result, using gaming techniques, practitioners may effectively participate and collaborate in order to generate a good impact across their activities [15].

AR's use in medication adherence holds a lot of potential for a range of ailments, and it might be a game-changer, especially in situations where medication adherence is low [17]. Nearly half of all prescription medications for chronic conditions are not taken as directed. Treatment noncompliance costs billions of dollars per year all around the world. The American health-care system spends between $100 and $300 billion every year [18]. In this review article, gaming is used to investigate augmented reality (AR) technology as a possible strategy for resolving medicine prescription nonadherence in long-term care. Some components of gaming that contribute to medication adherence would be investigated, as well as health-promoting activities through gaming. The use of gaming techniques may aid in the behavioral transformation of patients. This systematic scoping review intends to answer the research issue of how existing

literature might be used to create a framework for long-term medication adherence through gaming in order to achieve the Sustainable Development Goals (SDG).

2. Evolution of augmented reality in video games

In year 2000, AR knowledge was first used in video games [19]. Out-of-date (non-augmented reality) video games frequently put the player in a first-person perspective of a simulated world [20], whereas Augmented Reality Games (ARG) allow players to focus and relate with improved visuals of real-world conditions [19]. AR Quake, the first outdoor augmented reality game with mega-portable devices, was designed in Wearable Computer Lab in year 2000 by Bruce Thomas. Instead of using a joystick, gamers could walk around and receive augmented graphics based on their physical location using a gyroscope [19]. Around 2010 [21] ARGs spread to mobile phones, and a large quantity of smartphone AR Games swiftly earned worldwide recognition. The game has received over 500,000 downloads and many players from several popular ARGs on the Google App Play Store, including Zombies, Run!, and DJ Rivals [22].

Niantic's introduction of Pokémon GO in 2016 was a watershed moment in the record of AR Games. Pokémon GO is a famous Japanese card and animation game that refers to "pocket monsters." Originally, the Pokémon series comprised of conventional arcades and audiovisual games, which were being displayed on gadgets like the Game Boy. The AR game have now evolved into a mobile-based interactive involvement. Meanwhile previous Pokémon video games included digital fights among Pokémon, Pokémon GO employed augmented reality technology to bring the "Pokémon world" to life. Gamers make use of cellphones to track down, arrest, and catch Pokémon in actual-world settings [23]. PokéStops are real-world sites where players can acquire digital in-game materials or combat many players within individual digital Pokémon in PokéGyms. Pokémon GO became a worldwide success thanks to its unique gaming experience, as well as the popularity and memories linked with the animated series. This game, which was released on July 6, has received 500 (five hundred) million downloads by 15th September, with an average of day-to-day players attaining 20 (twenty) million [23]. According to an online poll conducted by Forbes News, 22 percent of Pokémon GO gamers are in the age range of 13 and 17, while 46 percent is in-between ages of 18 and 29 years. Updates to Pokémon

GO are still being created, and more functionalities are planned to be added as the game grows in popularity [23].

3. Methodology

Systematic reviews are becoming more prominent as a method of summarizing research information ([24, 25]. Its goal is to map the existing literature in a certain subject of interest in terms of volume, nature, and primary research features [26]. A scoping review of a body of literature is especially useful when the topic hasn't been well investigated or is complex or heterogeneous [27]. They are widely used to evaluate the scope, range, and character of research activity in a topic area; determine the value, possible scope, and cost of conducting a complete systematic review; and determine the value, prospective scope, and cost of conducting a full systematic review; synthesize and disseminate research findings, as well as identify research gaps in the literature [25, 26]. A scoping review can be utilized as a standalone project or as a first step to a systematic review since it provides a rigorous and transparent process for mapping study opportunities [26].

Google Scholar, ACM, ScienceDirect, IEEE Xplore, and SpringerLink, were used to conduct a systematic search based on scoping review approaches [25] for literature published between January 2015 and November 2021. Scoping review methods were chosen because of their capacity to investigate broad research issues and evaluate vast volumes of data and research while also serving as a vital first step in synthesizing a big body of work that can be utilized to steer future research [27]. The following categories were used to group search terms: public health, medication adherence, technology and innovation, and gaming using augmented reality. Table 1 lists all the criteria for inclusion and exclusion. A research librarian with competence in the use of literature databases conducted the initial search. Before beginning the search, the search strings were thoroughly tested. A proximity operator, as well as bespoke search phrases for each database, were employed to limit the number of irrelevant hits and improve the accuracy of the searches. After cleansing the original data file, the initial search yielded a total of 5650 studies. There was some screening done to eliminate publications that were not related to the study. Later, articles' eligibility was checked to delete those whose entire text was unavailable and those that were written in

various languages. The data was separated into equal subsets after it was sorted alphabetically by study title. Two more reviewers then sorted each subset independently.

Table 1: Inclusion/Exclusion criteria overview for the study.

Inclusion Criteria	Exclusion Criteria
English Language	Not written in English Language
Peer reviewed original study or review, based on an original data analysis	Focus on health innovations but not on gaming strategy, augmented reality, and medication adherence
Address medication adherence strategy, gaming, augmented reality	Editorial, columns, viewpoints, letters to the editor, opinions, commentary, or similar
Considers health innovations relating to technological intervention	
Promotes healthy behavior strategies	

We limited the article search to English language studies and articles published in peer-reviewed journals. We used the following wide range of search terms related to the study, Augmented reality, Gaming, Medication adherence, Internet of things (IoT), Virtual reality. Relating to the study design, our search terms were qualitative, interview, focus group, questionnaire, observation, study, and research. Studies in this area is very sparse, it is a new study and less experimental studies are found to back up the technological innovations especially in developing nations. Most studies were literature review on strategies that gaming, virtual reality, and augmented reality must impact the world in medication adherence. Figure 1 shows the diagram of the articles used for the review.

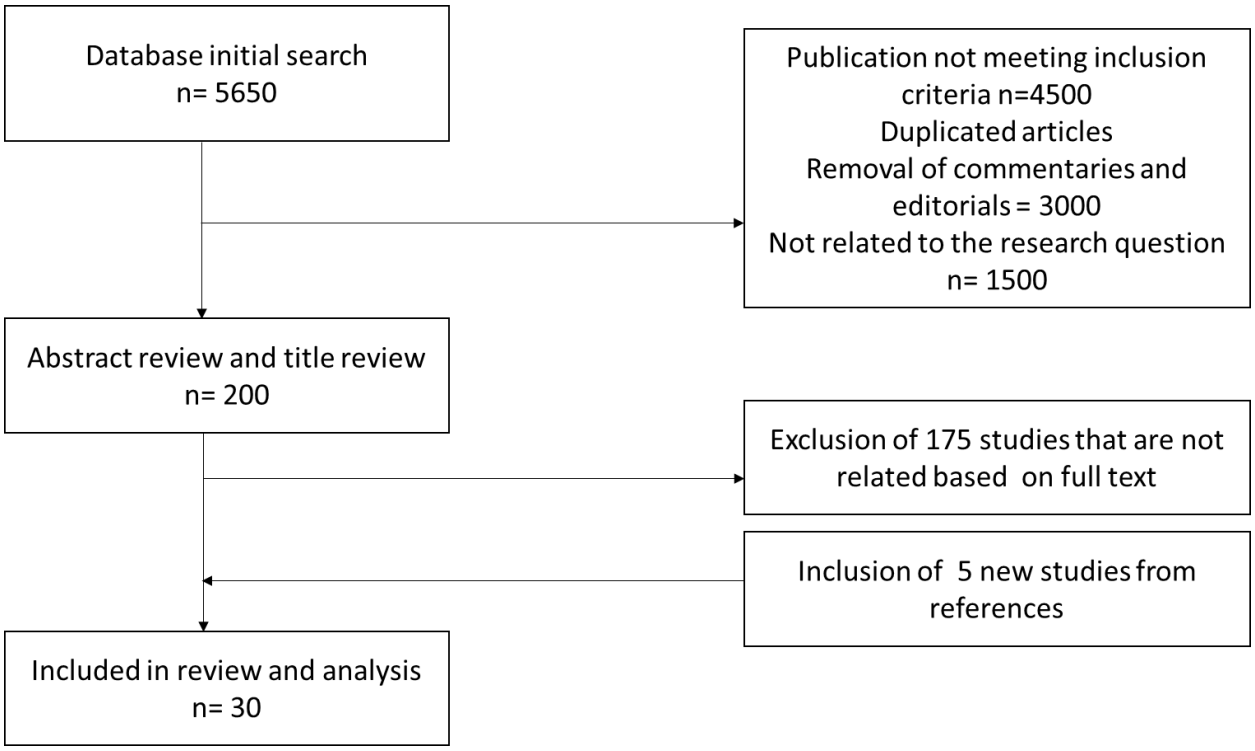

Figure 1 Flow diagram of information from identification to inclusion of studies in this review. Below are the findings from the systemic review.

3.1 AR in Gaming

AR, also known as mixed reality, is an overlay of simulated items onto the actual environment where components are augmented applying sensory inputs, according to Parekh and other researchers [28] gaming has been the principal application of AR since its inception. However, AR will boost healthcare, retailing, industrialization, and estate development industries in the coming decades [28]. Gaming has been the industry leader in the adoption of augmented reality, and as a result, game players have had access to unprecedented levels of innovation, originality, and occurring phenomena in the society. Because of the immersive experience, gamers believe AR-improved games to be of good quality and more exciting because of the attractive feelings being experienced from the technology [29].

This Pokémon Go has risen in popularity primarily to augmented reality animations and games. AR has emerged as the frontrunner in allowing gamers to immerse themselves in a virtual world, such as hunting zombies, monsters, or seizing imaginary objects. Games such as Ingress,

Treaure, Temple, Army of Robots, Hunt, Night Terrors, Sharks in the Park, and many others are popular augmented reality games [7]. Game players are part of the game in the online gaming industry, and the more they want to be a part of it, the better the game experience becomes [7]. In addition, computer games for non-leisure and instructional reasons are preferred over virtual games since they may be customized. The ability to simulate in education, the military, and healthcare could aid in bridging the gap between work, play, and education [8]. Both the real world and computer games (virtual games) offer significant advantages. We can employ AR to improve existing game types and create new ones by combining these qualities. Beyond the refinement of existing game styles and the invention of new ones, AR gaming research provides another purpose, as gaming settings are well adapted for exploratory studies [8, 30].

Many studies have employed game-based approaches (for example, health games, gaming) to keep people engaged in therapy or good practices over time [31-33]. Exergame (or exergaming) as a combination of exertion and video games [34], and serious games aimed at changing behaviors and attitudes more broadly in the domain of healthcare and other fields are two well-known game-based methods [32]. Because of the advancement of mobile technology, it is now possible to build and assess mobile health games that can act without regard to time or space limits [31]. Researchers believe that these approaches can improve clinical outcomes or healthy lifestyles by educating people about health and improving self-efficacy [31-33, 35]. In this study, we examine the effects of Augmented Reality on medication adherence in the real world and in computer games using five criteria: physical, emotional, social, and mental impacts. While real-world and computer games have different strengths in these areas, we discovered that AR techniques can be utilized to create games that combine these qualities.

3.2 Impact of AR games for medication adherence

The impact of AR game would be evaluated in this study to understand the level of medication adherence it can support.

Physical fitness -The physical sense of playing a game, physical abilities a player must utilize, and the game's usage of physical artefacts are all examples of a game's physical element. Paintball, most sporting activities, and skill-based computer games are all examples of physical games. The physical part of computer games is confined to the player's use of interface devices

to play the game. While this does not restrict games that emphasize physical talent, it does limit the kind of physical interactions that can be used. The link between deskbound video gaming and wellbeing hazards such as inadequate cardio-metabolic effects have been proven by a wide body of research (e.g., high adiposity, high body mass index, and weight gain) [36]. AR Games are classified as “active video games” (AVG) since they incorporate physical mobility, which may reduce the health hazards connected with inactive games and probably enhance the gamers health [37]. A survey of 12 Japanese persons indicated that 22 out of 66 exercises contained in two famous AVGs, that is, the Wii Fit Plus, and Wii Sports may be classed as medium intense exercise based on the energy expenditures [38, 39].

In a study of 23 youngsters aged 10 to 13, Lanningham-Foster, Jensen [40] established comparable results. Participants' energy expenditure was measured while playing two AVGs, Wii-Sports Boxing, Dance Dance Revolution (DDR) comparing its vigor expenditure while taking a walk on a routine at three distinct speed limits [40]. The energy expenditure levels were identical between players of DDR and taking a walk on a routine at the maximum measured speed. In comparison to youngsters viewing television at rest, the energetic games exhibited significant increase in a finished ventilation (VO2) and heart rate. Findings like these, highlight the effectiveness of AVGs as efficient mediations for obesity circumvention [40]. ARGs, like AVGs, allow players to exchange idle screen time with an active gameplay and have shown to have positive health benefits. Even though there are only few research on the effect of ARGs on physical activity, Howe and colleagues proposed that variations in physical activities because of engaging Pokémon GO are moderate and not long-lasting [41]. These discoveries, however, are yet to be confirmed by other researchers and are unique to Pokémon GO [42]. Nonetheless, this research implies that ARG creators may have a chance to build ARGs that promote health benefits.

Improved social connection - Though most conventional video games are being played alone, several have substantial social elements, either directly or indirectly, in the gameplay experience. Most youngsters about 76 percent play video games with their friends, either in person or online, according to a 2008 Pew poll of youths in the United States. Furthermore, 65(sixty-five) percent of teens living together play regular video games with others. Only 24 (twenty-four) percent of teenagers say they spend all their time playing video games [43]. Video games might indirectly

act as a basis of shared concern among competitors, inspiring discussions, and forging connections [23].

The way in which users engage with one another is the social side of a game. Collaboration, negotiations, and relationship development are all present. The tabletop role-playing game is a famous example of a social game, but many enormous multiplayer online games also have a significant social component. Social games benefit from computers in a variety of ways. They allow participants to communicate with each other remotely through networking, and they allow for games with far more players than could possibly be organized in a real-world game. They can also provide a persistent gaming world in which players can build reputations and generate wealth, thus building surrogate lives outside of their own real-life struggles. Such a world's politics and economics create a rich and immersive setting for social interaction [30].

Moreover, comparing ARGs to regular video games, could be more friendly and social by nature. Players must engage with their surroundings and frequently run across acquaintances and other participants. For example, Pokémon GO, and many other AR Games have numerous capacities that encourage player participation. PokéStops and PokéGyms serve as gathering points for gamers looking to gather resources. Once they reach a particular level, Pokémon GO team member could participate in one of the three groups. Participants in the same group are urged to collaborate to enhance their Pokémon and obtain or uphold a competitive advantage of PokéGyms [44].

Because players must work with colleagues to succeed in Pokémon GO, the team element adds to the social aspect of the game. Pokémon GO could so perform similarly to multiple players online game with "unions" or groups that enable societal involvement. The social benefits of such online contacts have been shown in previous study. These games establish online "third places" where people can have casual interactions and form relationships [45]. Researchers involving Gentile and colleagues performed series of cumulative, observational, and investigational processes that initiate projected connections among playing cooperative video games and to build social behaviors [46]. According to a 2015 Pew evaluation, developing automated gaming environments can provide more opportunity for youths to form new acquaintances. Fifty-seven percent (57%) of most of youths polled said they have more friends

online through networking with video games and social media apps like Instagram and Facebook, which are the most popular digital platforms for making new acquaintances [47]. Giving to the Essential Facts of 2016 about Computer and Video Game Industry, 53% of all the most regular video gamers polled believe in the fact that video games help them link up with peers [23, 48]. Similarly, the underlying worth of Pokémon GO and other ARGs could be found in the wide interconnections that are formed between people. While such provisional friendships may not be as strong as closer, more deeply personal relationships, they would not be seen to harm the communities and may even have the potential to strengthen it [23].

Mental - Problem solving, logical approach, and thinking are all part of the mental side of a game. Puzzles, resource management games, and strategic games are examples of highly mental games. Complex game models, simulations of real-world systems, and massive volumes of data are all supported by computers, allowing for far more intricate gaming scenarios. AI enables individual engagement against interesting competitors, as well as the design of entities that can help a player learn and deal with difficult scenarios [30]. A self-existence is described as a mental condition in which one perceives one's virtual self as one's true self [49]. Finally, gamers can use computers to help them visualize complex and comprehensive data. Computers essentially improve mental games by allowing for more complicated games and giving AI characters and opponents. Players must resolve all simulations themselves in real-world mental games, therefore the rules are simpler. This does not limit the depth of a real-life mental game, but it does limit the range of possible scenarios. For games that involve spatial reasoning, the actual world is also a good contender. Players can examine objects from various angles while solving the problem utilizing their natural sense of space. Games created for AR will have access to the same simulation and AI resources as games created for other platforms. They will also be able to convey game information in a geographical context, allowing players to properly reason about it [30, 49].

Emotional - Perhaps the most difficult feature of games to comprehend is their emotional component. It reveals how a game influences players' emotion, by the sympathies they show with game players or characters and the emotions are expressed by involvement in the game world. Computer games can create complex graphical and audio environments that elicit strong emotional responses from players by immersing them in the game world through their eyes and

ears. This is best demonstrated by horror games, which can make a player feel nervous after playing. It's also seen in gamers' long-term interest in characters' stories outside of the game. - Once a player develops feelings for a game character, they may bring those feelings into their real lives or creative work. Fan fiction is a clear example of this [30].

Real-world games use less convincing, but more immediate and varied stimuli to engage a player's emotions. By incorporating different lighting conditions, audio effects, and moving pieces, a mental puzzle game (such as travelling through a maze) can be transformed into a significantly more imaginative experience. The theme park ride is a typical type of entertainment that seeks to engage the emotions through real-world experience [30, 50]. Table 2 below shows the relationship between the real world and virtual game experiences.

Table 2– Summary of the real world and virtual game aspects (Adapted from [30].

	Physical	Social	Mental	Emotional
Real world	-May make use of the entire body of the player -The real world could serve as a game setting -Physical artefacts would be significant in the game	- Encourages natural face-to-face interaction	- Players who don't want to figure out complicated rules -Supports spatial reasoning, especially in 3D	- Has the ability to stimulate players' entire range of senses - Capacity to manage the environment is limited.
Virtual world	- Input devices limit physical interaction.	-Intervention reduces communication but other facilities are provided -Enables multiplayer games to be played from afar.	-Assist in the development of complex game models and rules - AI opponents and agents are available.	-The ability to create a variety of virtual worlds and scenarios - Only audio and visual stimulus are allowed.

3.3 Elements of gaming that improves adherence

There are four elements identified from the review that improves adherence to gaming. These are discussed in this section.

Progress paths: Objectives/tasks in games are frequently concise as part of a player's perspective of play. Also essential are clear regulations (i.e., transparency). When progress pathways are employed to speed up game completion, these are readily apparent. The level of complexity or difficulty of the objectives might rise as time progresses, making them simpler for beginner players and more difficult for advanced players, so that everyone is involved (e.g., the state of flow) [16]. Players are encouraged to ascend to higher levels, which encourages them to do so.

Feedback and rewards: providing timely feedback and awards (e.g., points, badges, and ranks) are utilized as markers of achievement and are a crucial aspect for motivation [16]. The prize and feedback provided as part of participating in the game entices players.

Social connection: Game-based interventions, that are complemented by the social networks, Internet, and a variety of mobile applications, improved group technology. As a result, not only does this encourage pleasant engagement and conversation among users, whether they are friends or not, but it also provides fulfilment while helping. Participants are more satisfied and engaged with the gaming solution as a result of this [16].

User interface and user experience: Users' desire for technological facilities are increasing, and this includes aesthetic, interoperability, efficiency, cross-platform, and enjoyment. Recent technological advancements, such as the adoption of "smart" mobile devices with Internet access, cloud-computing, augmented reality, virtual worlds, and sensor-linked databases, encourage the adoption of high-quality game - based techniques [16].

These aspects can also be used in health-related gaming applications. Lenihan stated that when gaming is combined with tactics such as rewards/incentives, computation, mobility, and socialization, better levels of wellbeing can be obtained. Also, socializing is essential for participants to maximize involvement in wellness solutions, as having the opportunity to relate

with providers/caregivers, friends and family would have a good impact on their existence [51]. A variety of prizes and incentives are available, ranging from rebates to assurance payment declines to special offers, and they can inspire as well as boost people' adherence to healthy actions, medication compliance, and/or appropriate vaccinations for the public good. Social mobility is an important technique since it allows a player to take part in his or her interests at any time and from any location. These solutions can give documentation of compliance, progress, and results when combined with applications for the baseline and real-time physical parameter checking and reporting. Computation (i.e., reporting and data analytics) is a necessary necessity for the wellbeing program's management and administration [16, 51].

4. Promotion of healthy behaviors through gaming

Even though Pokémon GO was not marketed as a health app, many studies have found it to be one of the most popular games [52]. In July 2016, Niantic, Inc. released Pokémon GO, a location-based augmented reality gam [53]. The main concept is to use a mobile device's GPS to explore real-world locales while catching new legendary creatures (such as Pokémon) on screen. Niantic, Inc. has added a range of features over the previous three years, including Raid Battles [53] and Adventure Sync [54], which allow users to engage in activities that affect their social and physical health while playing the game [55]. Several research and media coverage on Pokémon GO have underlined that it can improve physical health by boosting time spent outside walking and decreasing time spent sitting, for example [35, 41, 56-62].

ARGs (augmented reality games) can potentially be used to affect the behavior of patients. Currently, Pokémon GO has a partnership with McDonald's in Japan, where all McDonald's locations are selected as PokéGyms or PokéStops, luring players and showcasing the possible impact of the game on customer behavior [63]. The Pokémon GO and many other AR games can be made to encourage healthful habits rather than bad ones, such as eating McDonald's nutrient-poor, calorie-dense fast food. As an alternative, farmer's markets or facilities with out-of-doors exercise kit could be turned to ARG centers of interest. New and old team member should be persuaded to visit these and other areas, increasing their likelihood of purchasing healthful vegetables and fruits or engaging in light physically fit activities. Participation in such healthy practices may be required for advancement in ARGs. Players may, for example, only

level up after walking a specific distance or burning a specific number of calories while having fun. Extrinsic motivation could be utilized to urge patients to participate in eating foods that are good for their health or engage in activities that would help in building healthy behaviors. ARGs are also being employed to advance a patient's emotional well-being. In hospitals, Pokémon GO has been used to bring sick patients off the sick bed and connect with more patients and healthcare workers [64]. While the increased traffic generated by Pokémon GO with attracted attention near healthcare centers may be inconvenient, the emotional advantages to pediatric patients may exceed the hassle. Therefore, AR Games can also be made as a distraction throughout the medical actions such as jabs or blood draws, though to a lesser extent. ARGs, if well-designed, could be a valuable tool for reducing patient stress and anxiety over medication adherence, both minor and major [23, 55].

The game mechanics of a game-based psychological well-being intervention must be properly prepared and linked with the intervention's goals for it to have the desired positive effect. This method necessitates an understanding of a number of game motivators and design principles that contribute to genuinely motivated engagement [65], which can lead to increased intervention adherence. Because video games are such a large genre with so many variations, it's no surprise that there are a plethora of both positive and negative repercussions to playing them [66, 67]. Psychological well-being is one of the beneficial effects. Johnson et al reviewed 200 studies on video games and well-being and concluded that video games can help young people achieve positive emotional states, optimism, energy, resilience, engagement, relationships, sense of competence, self-acceptance, and social connections and functioning [68]. Halbrook, O'Donnell [50] conducted a more recent literature review on the favorable impacts of video games on well-being from both psychological and physical viewpoints. The findings revealed that playing games with social components has a demonstrable favorable impact on psychological well-being. According to the research, playing cooperative games can increase happiness while decreasing aggressiveness among players, but only when the amount of time spent playing is moderate and is largely motivated by social contact [50, 69].

Continual behavior change, motivation, and engagement

Different objective metrics have been used to assess engagement with mHealth apps [70], which should be used in serious gaming research. Much of the research has conflated the effects of psychosocial or other factors on starting to play a game, intensifying, or continuing to play a game, and maintaining behavior change because of game play. Future study should clarify these terms so that interventionists can better affect each behavior. Pokémon Go engagement appears to be influenced by several interconnected aspects. Future research should focus on unifying this method to understanding engagement by combining dimensions and maybe distinguishing whether constructs influence or predict frequency, intensity, duration, and maintenance of engagement individually. Age, gender, social position, ethnic group, and other demographics that determine Pokémon Go gaming play experience may all have experienced influencing factors, necessitating large samples [71]. Users are more engaged by AR than by traditional technologies and, in some cases, pure Virtual Environments. In comparison to standard workstations, Mixed Reality systems provide more control and richness of sensory feedback (e.g., stereoscopic vision, spatial audio), as well as ubiquitous interfaces that increase perceived user control and novelty. Furthermore, the virtual and real-world objects/tools are merged, resulting in seamless focus changes. Finally, when compared to normal workstations and Virtual Environments, AR systems have a better level of social presence due to their strong adherence to real-world regulations and preservation of social protocols [49].

Smartphone applications have been shown to influence health outcomes and behaviors [71], but they are not always enjoyable to use. It is widely assumed that people play games for the purpose of having "fun," also known as enjoyment, pleasure, or playfulness. Something that was enjoyable to use would be used more frequently, intensively, and for a longer period, resulting in a bigger health benefit. With Pokémon Go, this does not appear to be the case. Even though many of the summarized Pokémon Go articles identified fun or enjoyment as a main incentive for participating in Pokémon Go, the definition of fun was not precisely defined [71].

Getting inspired

The promise of augmented reality applications is only hinted at by the strength of extraordinarily complex platforms like Pokémon Go [72]. Developers around the world are now working feverishly to not only imitate Pokémon Go's success in integrating the digital, social, and real

worlds in a game, but also to improve and develop integrative platforms in order to produce fascinating, engaging, and addicting games [73].

Such advancements have the potential to improve health and prevent disease. The creation and application of such integrated apps to critical sectors and people will require more research. These could include people with or at high risk of disease, and they should concentrate on the key design elements that can moderate efficiency in encouraging uptake among older users and crucial outcomes like physical exercise and treatment adherence. Creative projects are now required to not only monitor but also comprehend the results of very complicated activities [69, 73].

The power of social network

Governments, health promoters, and researchers have been attempting to promote regular physical activity for over 50 years, especially among the young and inactive people. Surprisingly, despite decades of investigation, the outcomes have been inconsistent and conflicting. If treatments to encourage healthy habits are to be appealing and successful in fostering long-term behavioral change, they should involve social components, according to Pokémon Go [74]. The speed with which the Pokémon Go app has gained popularity is both promising and alarming. Methods that can capture the uptake and impacts of social dimensions are needed to understand treatments of this type in a comprehensive and sophisticated manner [55, 73]. One of the key principles in distant AR collaboration is the impression of being surrounded by other players. It mostly affects the productivity of collaborative environments, as stated by Sereno et al. This is more relevant to virtual worlds where users are represented by virtual avatars [49].

5. Challenges of using AR

AR, which evolved from virtual reality (VR), is dependent on the expansion of the digital network. The main concerns to augmented reality apps are social criticism, nanotechnology issues, legal problems, bad experience, technological fatigue, and a lack of use cases [75]. The issues are detailed further down.

Technical issues: Many technological issues, such as cost of infrastructure, internet facilities in rural areas, lack of experience, lack of education and awareness among the general public, and poor content, make AR challenging to use and socially desirable [7].

Unavailability of AR devices: Images, screen animations, detectors, graphics, strong internet connectivity, processors, and other equipment all work together to create AR experience. These devices are expensive and difficult to obtain for the public. As a result, augmented reality poses a concern [7].

Public acceptance: Any growing technology must gain public acceptance over time. Similarly, it will take some time for augmented reality to gain widespread acceptance among the public, who will recognize the potential of AR applications. Sectors that invest in AR projects should have a long-term strategy in mind to maximize their return on investment (ROI) [44].

Poor quality of content: Other than the gaming industry, there is no effective AR content in other businesses. The most significant factor for AR's global acceptance issues is its poor quality. Gaming has made tremendous progress, and this issue arises as a result of a scarcity of developers and competence in the field of augmented reality [44].

Uncomfortable architecture: Merging the actual world alongside virtual mechanisms creates a virtual trouble that will become too much to accept in the long term, leading to an increase in health difficulties. Because AR application will be used on a regular basis, it must be acceptable and accessible in order to be valuable [7].

Environment: The lighting and weather conditions have an impact on the AR application's interaction. Outliners and divergences have an impact on the quality of localization, regardless of the algorithm used. Similarly, the environment's color scheme and diversity influence accurate perception and cause substantial problems when describing it [44, 76].

The Study's Added Value

The high number of impacts of augmented reality, virtual reality, and gaming strategy on medication adherence is one of this review's highlights. It outlines the current state of knowledge

about the use of digital technologies to improve medication adherence. The findings point to the need for further research and understanding in health promoting technological strategies, with a focus on patients rather than just health care employees. A discussion of digital technology's multifunctionality also adds value by allowing multiple viewpoints to assess various advancements that have been supplied but have yet to be explored.

6. Conclusion

This study aimed to systematically deliver an overview of the studies published on technology advancement in gaming for medication adherence. The multifunctionality of digital technology is an important finding from the study. Unlike previous single-function solutions, a growing number of digital health technologies now have several roles. Researchers all over the world are working hard to develop better technological solutions to improve the present health-care system. The goal of these technologies is to make a significant difference in the healthcare industry by reducing existing difficulties. The extraordinary ways in which technology has saturated our cultures, society and environment are emphasized by the quick accomplishments made in the modern digital era. The possible impact of AR Games on the lives of patients requiring long-term care is highlighted in this research. The fusion of real-world and virtual aspects opens fascinating brand-new prospects for immersive gaming, improved socializing, and exercise. However, this article also identified several barriers to AR's acceptability in society.

6.1 Theoretical Contributions

The study investigated gaming techniques as a means of advancing digital innovation in terms of medication adherence. The healthcare sector in developing countries is being transformed by technological advancement. For various reasons, this systematic review is thought to contribute significantly to the existing literature. First, it looked at how IoT and augmented reality games could help the healthcare industry. Second, rather than focusing on a single technology, the study examined a variety of information technologies (e.g., IOT, VR and AR). Third, the evaluation includes studies from a variety of locations and numerous researchers. It was discussed what aspects and parts of video games could be employed to improve drug adherence. Fourth, the review's research was published within the last decade (2015–2021), providing a new perspective on the literature.

6.2 Practical Consequences

The study entails many practical ways of assisting patients to adhere to medication over a long period. First, the study differs from others by bringing to limelight various technological innovation that can assist patients in medication adherence. The study identified the used of gaming techniques as discussed by various researchers. Decision makers needs to be aware of many solutions available and make necessary steps for helping patients implement such by playing online games especially in developing nations.

Second, the gap in technological trends in the healthcare sector and adherence to medication is reviewed. The use of virtual reality (VR), internet of things (IOT) and augmented reality are discussed for decision makers to make use of IT solutions to solve the problem of nonadherence to medication. The VR and AR are used to build games that players feel integrated with the situations that seems like real world environment. These could help patents develop mental health, have physical fitness by moving around, build a strong social network that will help in their behavior change towards their medication adherence.

Third, we believe that the findings will aid policymakers in examining current data confidentiality and privacy legislation and practices. These regulations should also be stated and made public. To improve acceptability through improving levels of trust and anxiety, end-users must be educated and aware of their roles and responsibilities.

Fourth, the findings and the challenges serve as lessons for IT companies and healthcare organizations on what needs to be improved upon. As a result, this review can aid in the improvement of currently deployed solutions and the consideration of future technology advancements to make them more user-friendly and inventive. End-users can receive the most benefits from information technology solutions by using them with less effort and without worry of making mistakes.

Fifth, the review addressed gaps in the literature on technology acceptability by focusing on implementation locations. In underdeveloped countries, it has been noticed that the implementation of Internet of Things, virtual reality, and augmented reality applications receives

insufficient attention. As a result, IT companies should focus on Arab and African countries, as these countries have the capacity to deploy new information technology in the healthcare sector.

Finally, the outcomes of this study could help professionals, practitioners, and academics in the gaming and augmented reality fields have a better understanding of one another. There is a need for greater awareness of these technological developments, as well as their benefits to medication adherence and as a foundation for future research on medication adherence.

6.3 Limitations and Future Work

This systematic review was limited to particular digital libraries and databases to collect the research studies (i.e., Google Scholar, ACM, ScienceDirect, IEEE Xplore, and SpringerLink). Therefore, these digital libraries might not provide a complete picture for all studies published on healthcare technologies in IOT, VR, and AR for gaming. Future research may extend this review by including studies from other digital libraries, such as CINAHL, IEEE Xplore, Cochrane, and PubMed.

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