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Technology to support mental health adolescents: a literature review

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ABSTRACT

The increasing prevalence of mental health issues among adolescents highlights a critical public health concern. Adolescents face unique challenges during this developmental phase, including academic pressure, social media influence, and the stigma surrounding mental health, which may hinder their willingness to seek help. This paper aims to explore the role of technology in preventing and addressing mental health challenges among adolescents, focusing on the potential of digital tools to provide accessible and effective support. This study is a literature review using the PRISMA method, covering articles published between 2001 and 2024. A total of 56 relevant articles were retrieved from the Science Direct, Scopus, and Google Scholar databases. This study seeks to analyze technological interventions in mental health care. The primary strategies include examining mobile applications, telehealth services, and other digital platforms that facilitate early detection and the sustainable management of mental health conditions. The review also considers the implications of privacy, data security, and digital literacy in implementing technology. Findings indicate that digital tools can significantly enhance access to mental health resources, enable timely interventions, and reduce the stigma associated with seeking help. A comprehensive approach that combines technological innovation with robust data protection is crucial to improving adolescent mental well-being. By leveraging the power of technology while ensuring personal information security, stakeholders in mental health, technology, and policy can collaborate to create effective, accessible, and safe mental health interventions for young people.

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1. INTRODUCTION

Adolescence showcases a crucial developmental phase, particularly vulnerable mental health susceptibilities amid various social, biological, and environmental factors effects. Grasping technology's prowess, there can be seen accessible, engaging, personalized interventions for youth grappling with mental health. Technology bears potential for a broader audience reach, including remote or underserved terrains, aiding in decreasing the stigma associated with mental health aid-seeking. So, probing this research sphere is foundational for assimilating effective tools, and strategies into current prevention schemes. Investigating techno-mental health interplay, we bolster adolescent emotional well-being and elevate positive mental health results amongst the vulnerable group.

Pertinent to scrutinizing technological advancements for precluding mental health complications among adolescents, the pivotal cognition of inclusive digital health escalates. Emphasized within the scrutiny by [1] the centrality of equity, literacy, and bias addressing in digital health systems is crucial, ensuring universal access, encompassing delicate populations, to requisite resources and data. Additionally, elemental theories alongside models relevant to adolescent risk conduct deliberated in [2] elucidate the intricate liaison amid biological, psychological, and social determinants delineating mental health results in juveniles. Henceforth, the objective of the inquiry navigates to exploit technological progresses to fabricate inclusive as well as accessible mental health deterrence methodologies bespoke to the myriad requisites of adolescents, fortified by an exhaustive comprehension of risk factors conjoined with resilience components within this demography.

This paper aims to highlight the significance of identifying technology-based effective interventions for preventing mental health issues adolescents among. Rise within mental health concerns among this population, innovative technological solutions potential to provide accessible and tailored support. This research explores various technological tools mobile such as applications, online platforms, and wearable devices, that offer valuable resources for early intervention and ongoing mental health management. Examining by effect and feasibility of solutions these, insights gain how technology leveraged can enhance mental well-being and prevent the onset of psychological disorders in adolescents. A thorough analysis of existing studies, trends technology innovation, research seeks to contribute value to the field of mental health promotion and prevention. Additionally, perspectives explore both adolescents' mental health professionals, comprehensive gain impact potential of these technological interventions, understanding [3].

In the inquiry into the tech innovation to halt mental struggle concerns in teens, the fusion of therapy methods has offered encouraging outcomes in cutting down anxiety, chiefly through cognitive behavioural therapy paired with technology [4]. Yet, the extant studies call for incoming advancements to rectify unsolved requirements and hurdles in this field. With focusing on prevention starting from young ages and involving self-help structures and personal tailoring for broad spread, there lies a clamour for automated data harvesting to measure program success. The deliberate weaving of motivation-boosting tactics and protracted assessment of tech-based remedies stands pivotal in confirming constant participation and its effect on teen mental well-being. Consequently, a broad-based approach to tech interventions must put first user-friendliness, result-getting, and lastingness to tackle the mental well-being challenges of teens suitably. This study seeks to find out how technology plays a role in mental well-being problems, especially in adolescents with a focus on the potential of digital devices to provide accessible and effective support.

2. METHOD

This paper is based on a literature review using the preferred reporting items for systematic reviews meta-analyses (PRISMA) method, as shown in Figure 1. The authors searched online in several databases, such as Science Direct, Scopus, and Google Scholar. The search strategy includes the following keywords: technology, innovation, mental health, and adolescents. The search is conducted in English, with no restrictions on the year of publication. The initial search found 496,000 articles related to those keywords. Therefore, at the final stage, only 56 references were selected for this paper with a publication time between 2001-2024.

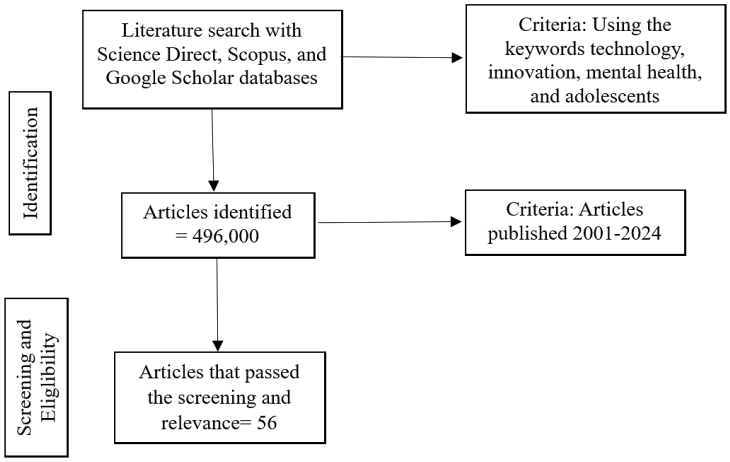

Figure 1. PRISMA flowchart

3. RESULTS AND DISCUSSION

3.1. Current mental health challenges among adolescents

3.1.1. Prevalence of mental health problems

In recent years, there has been an alarming increase in adolescents suffering from mental health problems. Several factors, such as academic pressure, social media usage, and family dynamics, significantly contribute to the rise in mental health issues in this age group. Furthermore, the study in [5] underscores that stigma of mental health surrounding many adolescents hesitate to help with their problem the exacerbating. It is crucial for technological innovations to harness these challenges, address adolescents, and provide tools accessible effectively to prevent, manage, and treat mental health problems. By technology integrating interventions of mental health, the broader population can be reached and alleviate potentially the mental burden of health issues among adolescents.

UNICEF in 2021 reported that the estimated mental disorders in adolescents in the world reached more than 13%, of which 40% were autism and depression. Based on gender, depression, and dysphoria are more common in women, while attention deficit hyperactivity disorder (ADHD) and behavioral disorders are more common among men. This prevalence shows fairly consistent variation [6]. From 2009-2019, the increase in cases of sadness and despair among high school students reached 36.7% from 26.1% originally. This increase is followed by suicide planning and attempts [7]. A meta-analysis of 191 studies involving 1,389,447 participants also found the prevalence of mental problems in children and adolescents under the age of 18. The combined symptoms of depression, anxiety symptoms, and sleep disorders were 31%, 31%, and 42%, respectively, during the COVID-19 pandemic. Although signs of recovery and stabilization are visible, the prevalence of mental health problems is also increasing [8].

The WHO estimates that one in seven children aged 10-19 years is mentally disturbed, which already accounts for 15% of the global disease burden. Anxiety, depression, and behavioral disorders are the main causes of diseases and disabilities in adolescents. Meanwhile, among those aged 15-29, the third highest cause of death is suicide. Failed treatment of mental health conditions can continue into adulthood so it risks interfering with health and even limiting the ability to live life as it should. Some adolescents are at higher risk of experiencing mental disorders due to several things, such as housing conditions, stigma, discrimination, and lack of access to quality health services. In addition, physical, emotional, and social changes also contribute to mental health problems, among them [9].

3.1.2. Factors contributing to mental health issues

A plethora of determinants contribute to the emergence of psychological health complications among adolescents contemporarily. A principal constituent is the amplified ubiquity of social media and technology in their quotidian existence. The relentless exposure to meticulously curated depictions of flawlessness and the incessant impetus to juxtapose themselves with others can engender sensations of inadequacy and diminished self-worth. Concomitantly, cyberbullying has ascended as a pronounced predicament, with adolescents undergoing online harassment that possesses severe ramifications for their psychological well-being. The deficiency of direct interpersonal interactions and substantial connections within a digital milieu can further exacerbate sensations of seclusion and desolation. Moreover, the perpetual stimulation and surfeit of information attributed to technology can culminate in heightened stress and anxiety, adversely influencing the general mental health of adolescents. Addressing these determinants and devising ameliorative strategies to abate their detrimental repercussions is imperative in fostering psychological well-being among the youth.

Basically, mental health disorders can affect anyone even at all stages of the life cycle. However, in those who experience it in childhood, there is a sensitive development. Inappropriate parenting and physical punishment can threaten children's health, while bullying is the main risk of mental health disorders. Not only that, emotional skills, drug use, genetics, poverty, inequality, environmental deprivation, and other social circumstances are also factors that contribute to it. The complex interaction between stress, individual vulnerability, and social and structural conditions determines a person's mental health status [10].

A cross-sectional study of 295 high school students aged 16-18 in Hanoi revealed that mental health problems among them were influenced by certain internal factors, such as low self-esteem, worries about physical appearance, refraining from group participation, not exercising, and the habit of staying up late. In the school environment, mental health is associated with peer influence, public punishment, and teacher reprimands [11]. Another study states that mental health disorders during adolescence can interfere with emotional, cognitive, and behavioral functions, which have an impact on decreasing social interaction and academic achievement. The onset of psychological disorders, depression, and anxiety is also inseparable from the level of stress and the stress reaction pattern itself. Such conditions can interfere with their well-being in adulthood [12].

3.1.3. Impact of untreated mental health problems

The global pandemic has affected older adults significantly in diverse manners, underscoring the necessity for inventive health technology resolutions that target issues like isolation and restricted accessibility to conventional healthcare [13]. A notable element of health technology progression is the deployment of socially assistive robots to aid older adults, which indicates favorable outcomes in facilitating social engagements and bolstering healthy aging while staying in one's own home [13]. Furthermore, the amalgamation of technology, notably video games, holds significant potential in fostering patient wellness and the humanization of hospital environments, particularly among paediatric and adolescent populations undergoing hospitalization. By capitalizing on technological advancements, encompassing mobile health applications and digital therapeutic frameworks, initiatives could be concentrated on the prevention and management of mental health challenges in adolescents, thereby enhancing patient results and overall care quality.

A study revealed that negative stigma against mental health services and treatment is still widespread. As a result, the risk of suicide increased by 4.19 times in cases of untreated depression in adolescence. Adolescents who experience depression will be more irritable, mood swings, anxiety, have decreased appetite, and have decreased academic achievement. Another study also stated that the follow-up results of 1,238 14-year-old adolescents who experienced clinical depression in those who did not access mental health services were 7.38 times more likely to commit suicide. The lack of treatment is motivated by the fact that there are still many negative stigmas on access to mental health services in the community, rejection from parents, and social prejudice [14].

In China, people with schizophrenia only get treatment after a 4-year delay. After being traced, the results showed that the delay caused them to be overweight and lower suicidal ideation. Although the potential for suicide is low, the negative syndrome scale score (PASSN) score is higher. In other words, negative symptoms can appear if you don't get treatment right away. The symptoms in question include emotional apathy, dull affection, wilful activity, spatial disorders, and deep work, to mental disability [15]. Looking at limited access to health care in rural areas, a 2022 Ohio study revealed that low graduation rates among middle school students are underlined as a long-term implication of untreated mental health problems [16].

3.1.4. Barriers to seeking help

Regardless of technological solutions available concerning mental health issues among adolescents, barriers hinder youth from seeking assistance. A prevalent barrier involves stigma surrounding mental health conditions, resulting in embarrassment or ashamed feelings regarding struggles, precipitating reluctance to acquire support. Concurrently, knowledge scarcity associated with resources and ambiguity regarding accessibility potentially prevents adolescents from seeking assistance. Moreover, privacy apprehensions connected to technology utilization mental health support might likewise function as obstructive elements; adolescents exhibit trepidation toward personal information exposure or misuse [17]. Resolving these impediments necessitates awareness elevation regarding mental health services, stigma reduction via education and advocacy, in addition to emphasizing confidentiality alongside data security within technological innovations tailored to adolescent mental well-being support.

In the Philippines, barriers to mental health help are caused by economic conditions and lack of access to services. For those living outside the country, immigration status, lack of health insurance, discrimination, and lack of acculturation of host culture are obstacles for those with mental disorders. These two groups are also hindered by the social stigma that circulates because they are considered incompatible with Asian values that are in certain norms so that mental illness is unacceptable [18]. From the 53 studies identified, four themes of obstacles experienced by adolescents emerged. Internal (individual) factors such as lack of mental health knowledge and lack of perception of seeking help became the first theme. Social factors, namely negative stigma and feelings of past, are the second theme. In the third theme, there is a sense of adolescence about the most important relationship with professionals, including data confidentiality, making it difficult to build trust in new people who were previously unknown. The last theme mentioned that systemic and structural facilitators, such as financial limitations, logistical limitations, and the availability of professional assistance are obstacles for adolescents to seek help related to their mental health disorders [19].

A study in Africa (2023) of several cases found that adolescents' barriers to accessing mental health services varied considerably. The preference for alternative and complementary medicine through the church, rukyah, and so on often leads to misunderstandings about the causes and prognosis of mental health conditions. Just like other studies, negative stigma spread in society, lack of knowledge related to mental health (both in patients and parents), and economic difficulties are also validated as obstacles. Race, a history of suicide attempts, expectations of unavailable health services, fear of treatment, rural housing, and parental denial of children's mental health conditions contribute to adolescents' inhibition of access to services [20].

3.1.5. Need for innovative solutions

In the addressing of the deeply essential neediness for the finding of innovation-type solutions onto the prevention of problematic mental health occurrences seen among youthful adolescents, the complex involving of information and communication technologies (ICTs) do come out as a most potential promising path [21]. Utilizing the deriving knowledge from sources that signifyingly stress the criticality of culturally sensitive and reactionary digital mental health assistances packages, such as AIMhi for youth support, there is possibilities for creating specific interventions targeting riskier elements associated with suicidalities and health degradations in vulnerable populations [21]. Additionally, as pronounced in another sourced reference [22], the mixture of theoretical conceptions and practical models relating to ICT usage within the Satir family therapy perspective gives groundwork for the promoting of technology-enhanced supports for Chinese adolescent groups. Through the drawing of technological potentials aimed at the provision of accessible-immediate connectives, supports, and educative tools, new-age solutions make able the bridging of traditional mental health service gaps to empower said adolescents with proactive well-being managements. This approach of a transformative nature on its own highlights the valuability of embracing and integrating technology advancements for better promotion and health fortifying for adolescents.

Digital innovation in mental health is basically a great opportunity, but challenges are still found when implementing it. Through the consensus development panel approach, the expert panel, international, and cross-disciplinary work together to develop a framework for the concept of digital mental health innovation. However, this approach to intervention must be creative and require change by expanding the role of traditional diagnostic systems. Accessibility and co-design then become essential to sustain innovation to last [23].

In addition to being technology-based, community/community empowerment can also be an innovative solution. Jurisdictions in Canada, through the agreement on the common principal statement on shared health priorities, promote community-based mental health promotion programs as well as early interventions targeting children and adolescents as solution innovations. Barriers related to costs, limitations in seeking help, and long wait times are overcome with the agreement. There is a lot of evidence to find that community-based interventions and specific primary care are effective and even cost-effective, leading to increased access to mental health services [24].

3.2. Role of technology in mental health prevention

The amalgamation of avant-garde health technologies, epitomized by mobile health applications, online interventions, and socially assistive robots, engenders a multitude of benefits in rectifying mental health dilemmas among adolescents. These novelties proffer an array of resolutions to endorse salubrious aging and thwart mental health quandaries, efficaciously bridging lacunae in resources and services for the elderly population. The utilization of smartphone applications to supervise sleep patterns and air quality, as delineated in [13], burgeons well-being and cognitive acuity. Corroboratively, digital therapeutic frameworks, exemplified by the MEDSReM © system for hypertension adherence described in [13], elucidate the augmentation of medication adherence and salutary results. Moreover, socially assistive automatons, as reported in [13] evince the potential to tender cognitive reinforcement and ameliorate indoor air quality regulation for senior adults grappling with chronic afflictions, which might extrapolate to adolescents' advantages. Harnessing these technological strides and deftly engaging stakeholders propitiously, the domain can escalate in averting mental health perturbations among the youth, thereby fostering holistic well-being.

The extent and scope of innovative technological adaptations hold a pivotal influence in curbing mental health complications within adolescent demographics. The prevalent assimilation of smartphones alongside internet applications propels digital mental health initiatives into a realm where they possess the propensity to cater to an expansive subset of young individuals who otherwise lack access to conventional mental health institutions. These pioneering solutions proffer continuous support and resource availability indiscriminately of time and location, effectively surmounting geographical constraints and social prejudices. Nonetheless, prioritizing equitable and inclusive paradigms in the advent and operationalization of such technologies is paramount to guarantee advantageous utilization by adolescents amidst diverse socio-economic tiers and varied backgrounds. Prospective investigative endeavors should concentrate on meticulously appraising the proficiency of these technological interventions in heterogenous cohorts and contexts to enhance their salutary effects on mental health paradigms. Furthermore, synergistic efforts among technology developers, clinical mental health experts, and legislative authorities are indispensable in establishing a resilient framework that augments the distribution and accessibility of these avant-garde solutions.

The practicability along with efficiency of individualized interferences, such as the SMS text communication intervention known as Kirabo situated in Uganda, accentuates the pivotal nature of modifying stratagems to cater to the distinct necessities of teenagers in the sphere of mental health promotion

included with HIV prevention [25]. Through the amalgamation of data-centric methodologies and the exploitation of digital interfaces, interferences are capable of being tailored to extend specialized aid and resources based upon singular behavioral health symptoms coupled with risk determinants. This personalization amplifies involvement and simplifies the attainment of indispensable services inclusive of mental well-being consultation and HIV examinations, ultimately bolstering proactive health-seeking proclivities amidst adolescents [26]. These endeavors exalt the importance of adjusting interferences to harmonize with the variegated experiences and obstacles encountered by young individuals, thereby magnifying the impact along with the efficiency of mental health preventive maneuvers within youthful populations.

3.3. Technological innovations for mental health prevention among adolescents

3.3.1. Telehealth and teletherapy

New-fangled technologies, like telehealth and teletherapy, they got loads of potential in dealing with adolescent mental needs. This remote stuff, give ease, easy access, and more privacy for that seeker mental aid. With videoconferencing, messages, and mobile apps, adolescents can chat with certified mental health experts right from home. Research, it shows that teletherapy, is useful thing in stopping and handling mental issues among adolescent. Plus, telehealth, it can get to adolescents in rural or underserved places where mental resources, they're short. So, using technology in mental health care, we can fill the gap in service access and give quick help to the young ones in need [27].

The outbreak of COVID-19 as a pandemic has distracted all aspects of human life by utilizing technology to interact remotely, including health screening. This makes access to health services more flexible (fewer barriers), affordable prices, and wider service availability. The use of audio-visual technology in telemental health can help psychological interventions or be targeted only with an internet connection without having to meet face-to-face. It has proven to be just as effective for treating mental disorders than direct intervention. However, in its realization, it still needs to be developed so that the provision of long-term health services and future health crises can be prepared [28].

Various studies do contain dominant evidence that technology-based mobile applications and telemental health are quite promising. Statistical analysis shows that technology-based interventions can be a potential treatment option for managing mental health symptoms in adolescents and young adults, especially in rural America [29]. Long before the pandemic, teletherapy was claimed as a form of treatment for mental disorders in children and adolescents, who had a high acceptance rate analyzed from several studies. Teletherapy and telepsychiatry (video-based psychiatric consultations) are also more commonly chosen by their parents than face-to-face/face-to-face treatment. Several surveys in 2021 also reported that satisfaction in service was still dominated by the moderate to good category of teletherapy during COVID-19 [30].

3.3.2. Mobile applications for mental well-being

In so doing, scrutinizing tech-based resolves to alleviate adolescent mental health tribulations, merging mobile apps appears a hopeful path toward fostering mental good-being. Exploiting AI advancements, as accentuated in [31], might overhaul suicide deterrence tactics by bettering risk evaluation and bespoke interventions. Furthermore, mobile health app employment, as explained in [32], offers a shifting methodology to forming sound habits and tackling adolescent mental troubles. By harnessing the omnipresent nature of mobiles in youths' existences, these cutting-edge educative actions propose a forward-looking way to breed positive actions and halt the burgeoning of mental health dilemmas. Merging AI-inspired insights with mobile health apps could lay a foundation for specific interventions that harmonize with adolescents, plausibly molding a scenario wherein tech acts as a revolutionary instrument in protecting young people's mental wellness.

Globally, individuals with mental health disorders are more likely to have access to smartphones than to mental health care. The mechanisms underlying mental health and technology interaction are well understood within the field of human-computer interaction (HCI). This includes predicting how individuals express their mental health issues online and socially through social media analysis and mental health forums. For example, data accuracy from Twitter can predict the likelihood of postpartum depression and major depressive disorder with over 70% accuracy. Reddit, as a social media platform, can also detect changes in users, potentially indicating a shift toward suicidal ideation based on recorded data, or identifying signs of complex mental health disorders such as schizophrenia [33].

Opp is another universal mobile application promoting mental health, especially for teenagers aged 13–19T. This app can be downloaded for free through the Google Play Store and other App Stores. A study in Norway mentions that Opp was created to improve well-being and mental health, increase knowledge about mental health, enhance stress-coping skills, encourage help-seeking behavior, boost self-esteem, improve sleep quality, and reduce mental health issues among its users. Another mobile app, NettOpp, is

designed for teens aged 11–16 who have experienced negative events on social media [34]. The #LIFEGOALS app also provides an option for teens in evidence-based mobile health interventions, featuring activity tracking, self-regulation techniques, gamification elements, a supportive chatbot, and health narrative videos. Although this intervention is not explicitly introduced as a tool for enhancing mental health, the information on lifestyle management benefits can contribute to a healthier mind [35].

3.3.3. Wearable technology for monitoring

Technological progressions have prepared route for creating wearable gadgets which can trace diverse facets of person's health and wellness, also containing mental health aspects. Wearable tech conveying benefit of nonstop and real-time tracking, permitting premature discovery of likely issues like stress, anxiety, or depression. These gadgets capable to log physiological cues such as heart rate variability, sleep patterns, and activity levels, providing useful data for both persons and healthcare operatives. Inspecting has indicated hopeful results in utilizing wearable tech for mental health supervision, with research spotlighting the prospective for prematurely intervention and custom-tailored treatment plans. By fusing wearable tech into preventive tactics for mental health within teenagers, awareness possibly enhanced, timely interventions facilitated, and overall results improved for this vulnerable group [36].

The use of technology can be involved in the approach to mental health in adolescents by providing direct physiological marker information to support self-regulation. This can help users focus on the stress they are experiencing and apply interventions to reduce it [37]. Health monitoring and intervention are potential points offered by mobile apps, especially in adolescents aged 13-18 years. A quantitative study with a survey proved that the level of anxiety and depression in users decreased significantly. The features available in the app help them know more about mental health and improve their emotion management skills [38].

Mood monitoring through tracking symptoms, feelings, and behaviors is a crucial aspect of cognitive behavioral therapy (CBT). This monitoring is useful for identifying triggers, developing coping strategies, adjusting treatments, and helping teenagers better understand their behaviors. CBT is considered a manualized therapy widely accessible to individuals with mental health needs in the UK due to its affordability. Monitoring features are also implemented with remote sensing functions (active and passive) to track various physical and mental conditions, such as sleep patterns, exercise, and mood activity. This feature is a core component in the design of mental health applications. Scientific reviews have shown that self-monitoring acts as a therapeutic intervention by reducing psychological distress, promoting treatment adherence, and supporting teenagers' self-efficacy [39].

3.3.4. Virtual reality therapy

In the sphere where tech innovation lends a hand to thwart mental health woes among the young, virtual reality therapy (VRT) may be a noteworthy instrument. VRT crafts an imitated world plunging individuals into regulated healing instances, presenting an unusual way to treatment. By making a secure spot for folks to face their dread and worry, VRT might be notably useful for healing phobias, post-traumatic stress disorder, and anxiety messes. Moreover, VRT allows for custom-made treatment schemes tuned to personal needs and advance levels, hence boosting therapy success. Study papers have hinted at promising results deploying VRT alongside traditional ways, thereby bettering results for teens facing mental health tribulations. As tech moves ahead, weaving VRT into mental health interventions has a stupendous capacity for transforming treatment strategies and bettering outcomes for youngsters [40].

Mental health is not only about a happy life and healthy growth of individuals but also about improving the relevant national health status. The application of virtual reality (VR) technology in solving adolescent mental health problems at various levels is a strategy that can be pursued like China's. VR has a complex characteristic that blends multimedia, numerical image processing, sensor technology, and computer graphics that emerged in the late 20th century. Its application to science education in China is able to improve the psychological well-being of adolescents through the extraction of color features and gray-level cocurrence matrix, marching cubes algorithms, as well as synthesis. The popularity rate of students increased by 26.9% and the number of students with a subhealthy mentality decreased by 16.9% after receiving science education using VR [41]. VR is also used as an approach in rehabilitation, promotion of emotional well-being in inpatients, and mental health treatment ranging from phobia disorders, post-traumatic stress, and obsessive-compulsive disorder, to autism spectrum disorder (ASD) [42].

Virtual reality is able to make users not lonely (experiencing a sense of presence), being in a place of information, where this situation is a turning point in the relationship between humans and computers. VR therapy is an integrated approach to clinical practice in which the therapist must be able to create a dialogue between traditional psychotherapy and new technologies. Head-mounted display (HMD) is the most widely used VR tool in achieving mediated direct actions. Exploring the process is an interesting part of understanding how the mechanism of change during therapy takes place. The flexibility of VR allows disruptive variables in psychotherapy to be eliminated. A systematic review proves that virtual reality

exposure therapy (VRET) is a valid alternative to in vivo therapy in the treatment of social anxiety disorder in its various forms [43].

3.3.5. Artificial intelligence in mental health care

These progressions in technological advancements have also facilitated the amalgamation of artificial intelligence (AI) within the domain of mental health care, manifesting a potential route for enhancement in early intervention and treatment stratagems for adolescent individuals. AI-driven mechanisms possess the capacity to evaluate extensive datasets to discern patterns and tendencies that may symbolize the incipience of mental health afflictions, thereby allowing healthcare operatives to engage preemptively. For instance, AI computational models can scrutinize social media emissions or digital conduct to ascertain persons susceptible to depressive or anxious states, thereby provisioning prompt assistance and means. Additionally, AI conversational agents can extend uninterrupted support and therapeutic dialogues to individuals, potentially mitigating the stigma affiliated with requisitioning aid and amplifying the accessibility to mental health provisions [44]. By leveraging the capabilities intrinsic to AI, mental health care services can undergo transformation to more adeptly satisfy the requisites of adolescents, culminating in augmented outcomes and welfare.

In some cases, artificial intelligence can distinguish between a diagnosis of a disease and the same symptoms so that it can recommend appropriate treatment. The results of structural MRI scans in bipolar or unipolar depressed patients are identified through imaging features in AI. In addition, methodologies in AI can also decipher patterns from data obtained from a specific (usually long) time span to validate diagnoses based on the evolution of mental health conditions that occur. A study showed that autoencoders (generative tissues) work with fMRI and sMRI data to diagnose attention deficit hyperactivity disorder (ADHD) with an accuracy rate of up to 67% using the input multimode feature [45].

ChatGPT as an emerging AI product also has the potential to support the mental health of children and adolescents in various ways. First, guidance on evidence-based treatments, assessment tools and practices to overcome anxiety, depression, and hyperactivity in ADHD can be easily obtained by health professionals. Second, negative stigma related to mental health is much minimal because ChatGPT does not corner users with poor mental conditions. On the contrary, ChatGPT actually helps teenagers to manage their mental health with a variety of relevant information. Third, this AI can provide direction and support to parents and caregivers to be more skilled in dealing with their children with unhealthy mental conditions. However, ChatGPT also has limitations in diagnosis so that its use is only around prevention and treatment recommendations in general, not specific according to individual needs [46].

3.4. Implementation challenges and ethical considerations

3.4.1. Privacy and data security

In respect to exploiting tech so as to avert mental health dilemmas amidst youths, the pivotal matters of privacy alongside data safeguarding just can't be sidelined. When tech interventions tender hopeful prospects for early spotting and prompt addressing, matters linked to the secrecy and shield of delicate info gotta be meticulously tackled. It's crucial in ensuring juveniles' personal data stays guarded versus unpermitted access or misuse, thus upholding their trust plus engagement with digital mental health solutions. Besides, stern data security arrangements can diminish risks linked to data leaks or misuse. Via embedding sturdy privacy norms plus encryption practices, developers can forge a secure and dependable digital setting favorable to uplifting mental well-being amidst adolescents. So, an all-encompassing method that emphasizes both tech novelty plus data-protection is indispensable in efficaciously confronting mental health hurdles in this susceptible cohort.

Entering the era of information and communication technology (ICT), various tools have been developed to offer mental health services to the public conveniently. Increased access to smartphone applications and remote monitoring systems of the internet of things (IoT) opens up flexible and cost-effective consultation and therapy services to support the treatment of anxiety disorders and depression. Although digital technology in mental health care is increasingly massive, there are challenges in its realization. People may not have enough digital literacy so that their skills in technology access are limited and they are worried if their personal data is disseminated [47]. In this regard, security and privacy are two terms that appear in the use of technology. Privacy refers to a person's right to determine when, where, and how personal information can be accessed and shared by others. Meanwhile, security is interpreted as the level of access to personal information that is restricted and allowed to certain people. Electronic health records need to be secured, one way is to block hackers when they enter the system so that information can be protected [48].

Eighteen studies analyzed in the United States brought up three privacy and security risk factors in telehealth practices. The lack of personal space for vulnerable groups and the difficulty of sharing sensitive

health information are factors that have first been revealed through the lens of the environment. Data security issues, limited internet access, and lack of access to technology are the technological factors found. Operational factors such as reimbursement, refusal of payers, accessibility of technology, and training are all three risks. Some of the efforts that can be made to support best practices are: i) providing a safe environment with guaranteed availability and suitability of patient locations before and during telehealth services, ii) entering personal information only on secure websites with a lock icon in the URL bar when sharing information online, and iii) including telehealth services in privacy and security policies, procedures, workflows, also integrate telemedicine into privacy practice notices [49].

A study analyzed data privacy from 27 mental health apps that ranked top on the Google Play Store. Unnecessary permissions, insecure cryptographic implementations, leaks of personal data and credentials in logs and website requests are important data privacy issues to pay attention to, especially the risks in creating user profiles. Sometimes, the app doesn't provide a secure mechanism for connection, detection, and identification. Sharing data between third parties and in-app advertisers can make it easier to leak data. Negative stigma related to mental illness can occur to users if they violate existing privacy. For example, a user's link to a particular app may reveal the fact that they are experiencing anxiety, depression, or other mental health disorders that make them feel more vulnerable and uncomfortable. Therefore, the development of privacy-friendly applications is very necessary for developers/developers by involving users and health professionals, considering that the data recorded is quite sensitive [50].

3.4.2. Digital divide and accessibility issues

Digital divide stays persist as big barrier mental health resources accessing for adolescents, mostly those marginalized communities from. Internet limited access, digital literacy lacking, and financial limits can more worsen mental health troubles for individuals disadvantaged already. Addressing disparity need interventions tailored sure accessibility equal for all, regardless their tech proficiency or socioeconomic standing. Efforts need made provide support systems that bridge gap between easy digital resources accessors and non-accessors. Initiatives like free or subsidized internet access, digital skills trainings, and culturally aware online support services can alleviate digital divide and make mental health resources more inclusive and accessible for adolescents all.

Health information technology is estimated to be a contributor to minimizing unequal access to health services. However, the long-lasting financial, social, and economic gap has made certain groups also experience a digital divide. Telehealth portals, for example, offer a quick and easy way to access the healthcare system. However, the results tend to be poor due to social factors so that the output of health services is not optimal. Poverty, low literacy, lack of interest or motivation in the use of technology, and lack of technology available for access are factors that affect the digital divide in all countries so that it is considered a global problem. Lack of access to technology can occur due to cost, inadequate broadband access, lack of attention to users with disabilities, as well as low device performance [51].

The shift in human activity patterns due to COVID-19, which is all-digital, has actually created a gap in society. The reason is, not everyone is skilled in accessing technology. In those who are less skilled, the negative impact will be more felt, especially those related to health, well-being, and social support. In some cases, geographical conditions make it difficult for people to access health services and public services from the government to local authorities. People with severe mental health disorders (SMIs) report that the internet is too difficult and complicated to understand before or after the pandemic. A study found that there is a digital gap between the SMI group and the general group (non-SMI) [52].

3.4.3. Regulation and quality control

Quality control also regulation year crucial pieces in ensuring the effectiveness likewise safety with technological interventions targeting the prevention of mental health problems within adolescents. Regulatory entities conduct a fundamental role in supervising the creation and execution of these inventions to maintain alignment with instituted standards and guidelines. Moreover, quality control actions help in recognizing and fixing potential problems or inadequacies in the tech to boost its total efficacy. By following strict regulations together with quality control procedures, developers might instill assurance in both users also healthcare providers regarding the dependability and safety of these digital answers. Via unbroken monitoring also evaluation, regulatory bodies could foster ongoing enhancement and innovation in the mental health tech domain, finally resulting in superior outcomes for adolescent demographics. This focus on regulation also quality control lays emphasis on the necessity of ensuring that these improvements be both evidence-based and ethically minded [53].

Seeing the opportunities for digital technology in mental health interventions is considerable, but some challenges need to be underlined. First, the guarantee of the fulfillment of patient integrity in the development and implementation of technology. Second, increasing the evidence base to support the effectiveness of digital-based clinical studies quickly. Third, the guarantee of data provided between patients,

nurses, and doctors does not threaten privacy or damage public trust. Healthcare institutions then need a framework to evaluate key features of the new technology used including practical benefits, content, safety, cost, and clinical effectiveness [54]. In the United States, the Food and Drug Administration (FDA) together with the Federal Trade Commission (FTC) supervises and regulates applications designed to treat mental health disorders in the early stages before they are consumed by the public. This is intended so that the diagnosis or recommendation provided does not mislead users [55].

A study provides recommendations to present a roadmap of the system requirements and policies needed in digital-based mental health services. This departs from the COVID-19 pandemic which necessitates digital mental health interventions as a routine part of the healthcare system. Training, licensing, safety, privacy, payments, and evaluations are indicators that can help increase the effectiveness of these mental health interventions. Innovative digital practices such as the phased care model and the provision of preventive and self-management services outside of clinical services into the healthcare system are long-term goals that need attention [56].

3.4.4. Ethical use of technology in mental health care

Additionally, imperative attendance at ethical ponderings enveloping technology's utilization in youthful mental health maintenance is paramount. Technological forerunning may amplify resource and support access in mental health realms, yet risks loom requiring meticulous oversight. Privacy, confidentiality anxiety, data security, and algorithmic bias odds stand amongst cardinal ethical predicaments deserving rigorous redress. Thus, demand arises for conjoint efforts of mental health custodians and technology architects to uphold ethics during tech design and enactment within mental health maintenance. Adding to this necessity, acquiring informed consent alongside elucidatory communication with youths on technology employment in their mental therapy remains crucial to preserve trust leaps and transparency chasms within therapeutic ties [57]. Elevating ethical meditations permits technology's boons while preserving adolescent mental wellness aspirations and seeking supportive measures.

One of the technologies that can be used to assess the mental health condition of individuals is virtual reality (VR). This technology elicits psychological and physiological reactions similar to their original (real-world) environment. VR can also expand the range of assessments outside the clinic and laboratory. Immersive VR is used with a head-mounted enclosed device (HMD) that will display a three-dimensional image on the screen so that the individual will be in a virtual environment. This ability to manipulate can improve methodological rigor as well as accurate judgment of individuals. The results of the use of VR so far are divided into three main areas, namely social function, cognition, and symptomatology. Eye gaze, the distance of the individual from the VR avatar, and the recorder's response to simulated social situations become indicators of social functioning. Maze navigation and attention tasks assessed memory and executive function as the first outcomes in the cognition section VR program. Finally, symptoms of mental disorders such as paranoid ideas, delusions, auditory hallucinations, eating disorders, addictions, and phobias are the assessment outputs in the area of symptomatology [58].

In addition to VR, artificial intelligence (AI) chatbots such as ChatGPT can also help psychiatrists in completing medical records, bridging between doctors and patients, perfecting academic writing or presentations, and analyzing research data. However, a psychotherapy system in the use of chatbots must be developed. The incorporation of empathy, emotion recognition, personality recognition, and early detection of mental health warnings are the main points. Practical 'real-world' input integration, a device-friendly AI user and patient-friendly interface must pass through clinically validated algorithms, voice generation modules, as well as emotional discrimination algorithms from facial expressions and other physiological inputs. Although there are opportunities in the field of mental health, it is important to establish generally accepted ChatGPT ethical standards [59].

4. CONCLUSION

To sum up, the use of tech in preventative steps for teen mental health issues shows promising areas for action. Checking out different digital tools like apps, virtual reality stuff, and online therapy platforms, shows big potential to reach more people and give personalized help that's handy and easily available for teens. But even though technology gives many good things, it must be used carefully and properly for it to work well and tackle worries about data privacy and online safety. Also, studies in the future need to look at the long-term results and effectiveness of these tech solutions, using strict study designs and working together with people in the mental health field to make them fit into healthcare systems better. As tech keeps moving forward, it is important to use its power to boost mental health and toughness in teens, helping create a healthier and tougher future generation.

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C : **C**onceptualization
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CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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