



A Telehealth-Based Adolescent Health Service Integration Model for Improving Health Knowledge and Health Behavior: Systematic Review

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Abstract. Adolescent health services are crucial components of public health due to adolescents' greater vulnerability to physical, mental, reproductive, and social health disorders. However, evolving digital technology has spurred greater use of telehealth services, which have been associated with better access and effectiveness of adolescent health services. The present systematic review was conducted to assess an integrated telehealth-based adolescent health service model and its efficacy in improving adolescents' health knowledge and behavior. This review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The articles were searched in the PubMed, Scopus, and BioMed Central (BMC) databases from 2016 to 2026 using the following keywords: telemedicine, digital health, adolescent health services, health knowledge, and online interventions. Inclusion criteria were English- or Indonesian-language full-text articles on the implementation of telehealth services for adolescents. Quantitative and mixed-methods, cohort, quasi-experimental, and systematic review studies were selected. In all, 254 articles were included, and, after screening and eligibility assessments, 10 were selected. Results indicated that the telehealth intervention positively affected mental health, social participation, smoking cessation, healthcare access, medication adherence, and adolescent engagement with health services. The interventions were mobile health applications, online counseling, telemedicine, remote monitoring, and virtual support platforms. Digital accessibility, healthcare provider support, multidisciplinary collaboration, and digital health literacy supported successful implementation. But internet limitations, communication barriers, and low digital literacy posed obstacles. Generally, telehealth-based adolescent health services enhance adolescents' existing knowledge, psychosocial well-being, and health behaviors in the digital age.

Keywords: Adolescent, Digital Health Services; Health Behavior; Health Knowledge; Telehealth

1. Introduction

Adolescents are a special age group that faces a diversity of physical, mental health, and social health issues. Adolescence is marked by hormonal shifts, the development of self, and an increased risk of unhealthy behaviors, such as inactivity or unhealthy food intake. Such diseases leave adolescents susceptible to a wide range of health problems, as these diseases lead to iron deficiency anemia, associated with a low-energy diet and a minimal understanding of health promotion. Anemia during this period can be a cause of tiredness in adolescents, problems concentrating attention, and retarded growth and reproductive health. (Finnerty et al., 2023; Lamash et al., 2023). Research by Mega et al. (2019) indicates that Majalengka-based red guava juice, as a result of this experimental treatment, improves hemoglobin and hematocrit in adolescent girls with anemia, with results similar to those of

iron supplementation. These results highlight the importance of nutritional education and the establishment of telehealth-integrated adolescent health care services that will promote the prevention of anemia and longer-term health behavior change. According to Hanzawa et al. (2026, more than 1.2 billion people live in the adolescent age demographic worldwide, and the majority of adolescent health issues are associated with restricted access to adolescent-friendly health care information and services. The rapid development of information and communication technology has brought significant changes to health systems through telehealth.

Telemedicine is when medical providers or specialists use digital technology to communicate through an internet link to deliver healthcare services, health education, medical consultations, health monitoring, and other online health promotion (Ramaswamy et al., 2020). Telemedicine-based healthcare models are regarded as a promising approach to overcome barriers to adolescent healthcare access, including geographical constraints, social stigma, scarcity of healthcare personnel, and limited affordability of health services (Coles et al., 2020; Notario et al., 2019). Adolescent health services are a foundational component of public health, as adolescents are particularly vulnerable to a range of physical, mental, reproductive, and social health issues (Wells et al., 2018). Telehealth-based services will continue to be adopted as digital technology advances, improving the accessibility, effectiveness, and sustainability of adolescent health care (Freeman & Coker, 2018; Danna et al., 2026). Indonesia's national digital health transformation is also accompanied by the implementation of the Satu Sehat application, which enables the integration of health data, access to health information, and digital health services for the public, including adolescents (Swanson et al., 2025). Adolescents' health education, monitoring, and consultation can be provided more effectively and widely through telehealth and digital platforms like Satu Sehat, which can be used, especially to support the promotive and preventive programs.

Adolescent health care is an important aspect of public health as young persons are at a high risk for diverse physical, emotional, reproductive, and social health problems (Wells et al., 2018). Digital technology is enabling the implementation of telehealth-based services to enhance the quality and provision of health care, and to expand adolescents' health knowledge about and in the care process through digital health education (Wells et al., 2018; Danna et al., 2026). In Indonesia, these endeavors are also facilitated by the introduction of the Satu Sehat app, a digital health transformation program to integrate health data, access health information, and digital health services for all population including adolescents (Swanson et al., 2025). Telehealth and digital platforms like Satu Sehat support effective, scalable, and widely available delivery of adolescent health education, monitoring, and consultation services among adolescents, with a particular focus on increasing awareness, promoting healthy patterns of behavior, and helping with promotive and preventive programs targeted at adolescents. Following the findings of Azijah et al. (2022) and their use, this study is an important element in the future development of a telehealth-based integrated adolescent health service model, as it demonstrates that health education can increase adolescents' knowledge. These results underline the importance of leveraging digital platforms, telehealth, and health applications such as Satu Sehat to broaden adolescent reproductive health education through more effective, interactive, and sustainable implementation. According to Bhadania et al. (2025) and McLaughlin et al. (2025), telehealth can increase the effectiveness of adolescent health education systems, especially in reproductive health, mental health, nutrition, infectious disease prevention, and healthy lifestyles and social behaviors. Also,

children and adolescents, a digital generation, are more sensitive to health interventions delivered through applications, social media platforms, and other digital channels than to traditional health interventions (Beneteau et al., 2022). Telehealth enhances adolescents' access to health services by providing care in a more individualized, adaptable, accessible, and comfortable way (Trigg et al., 2023). Telehealth's application in adolescents' healthcare remains confronted by a host of challenges, including the digital divide, low digital literacy, data protection concerns, and the absence of seamless integration between healthcare and education. These barriers are often the case for adolescents residing in remote areas and in areas with poor technology infrastructure and internet coverage, potentially influencing the most efficient intervention for the digital health system (Beneteau et al., 2022). Efforts to evaluate the effectiveness of integrated telehealth-supported models of adolescent health care are disparate and are not yet consolidated. Thus, this systematic review aimed to identify integrated models of telehealth-based adolescent health service integration and their application, and to evaluate their effects on adolescents' health knowledge and performance behaviors. This study aims to contribute to the advancement of technology-based adolescent health service models and to offer guidelines for healthcare providers, institutions, and legislators to enhance the quality of adolescent health services in the digital transformation era. This study aims to contribute to the advancement of technology-based adolescent health service models, thereby supporting Sustainable Development Goal 3 of ensuring healthy lives and promoting well-being for all adolescents.

2. Methods

This study used a systematic review approach under the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework. A systematic review was conducted to outline relevant research on integrated telehealth-based adolescent health service models and their impact on health knowledge and behavior. Multiple electronic databases (PubMed, Scopus, and BioMed Central) were used to perform article searches. The search was conducted from January to March 2026 using combinations of the keywords "telehealth," "telemedicine," "adolescent health services," "digital health," "health knowledge," "health behavior," "youth health," and "online health intervention." Boolean operators AND and OR were used to expand the search results. Search criteria included: (1) research articles published on telehealth-based adolescent healthcare services, (2) studies reporting on adolescent health knowledge or health behavior, (3) journal articles in full text, (4) English or Indonesian publications, (5) publications between 2019 and 2026, and (6) quantitative, mixed-methods, randomized controlled trial, quasi-experimental, and cohort studies.

Table 1. PICOS Framework

Component	Description
Population	Adolescents and young adults receiving telehealth interventions
Intervention	Telehealth, telemedicine, mHealth, online counseling, digital platforms
Comparator	Usual care, face-to-face services, or baseline condition
Outcomes	Health knowledge, health behavior, psychosocial wellbeing, engagement
Study Design	RCTs, cohort, qualitative, mixed-methods, implementation studies

Exclusion criteria were review articles, editorials, opinion papers, conference proceedings without full text, and studies not of adolescent populations. The article selection included the identification process (ID, screening, eligibility assessment, and inclusion following PRISMA guidance). 254 articles were identified across all databases. 244 articles remained after duplicate removal and exclusions. Using title and abstract screening, 10 articles were selected for full-text evaluation. Eighteen articles were deemed eligible for analysis after evaluation against the inclusion and exclusion criteria. Data were retrieved through a data extraction form, based on the authors' names, year of publication, study site, study design, sample size, telehealth intervention type, and study results. Analysis: A narrative analysis was conducted by comparing findings from studies on the efficacy of telehealth in improving adolescents' health knowledge and health behaviors.

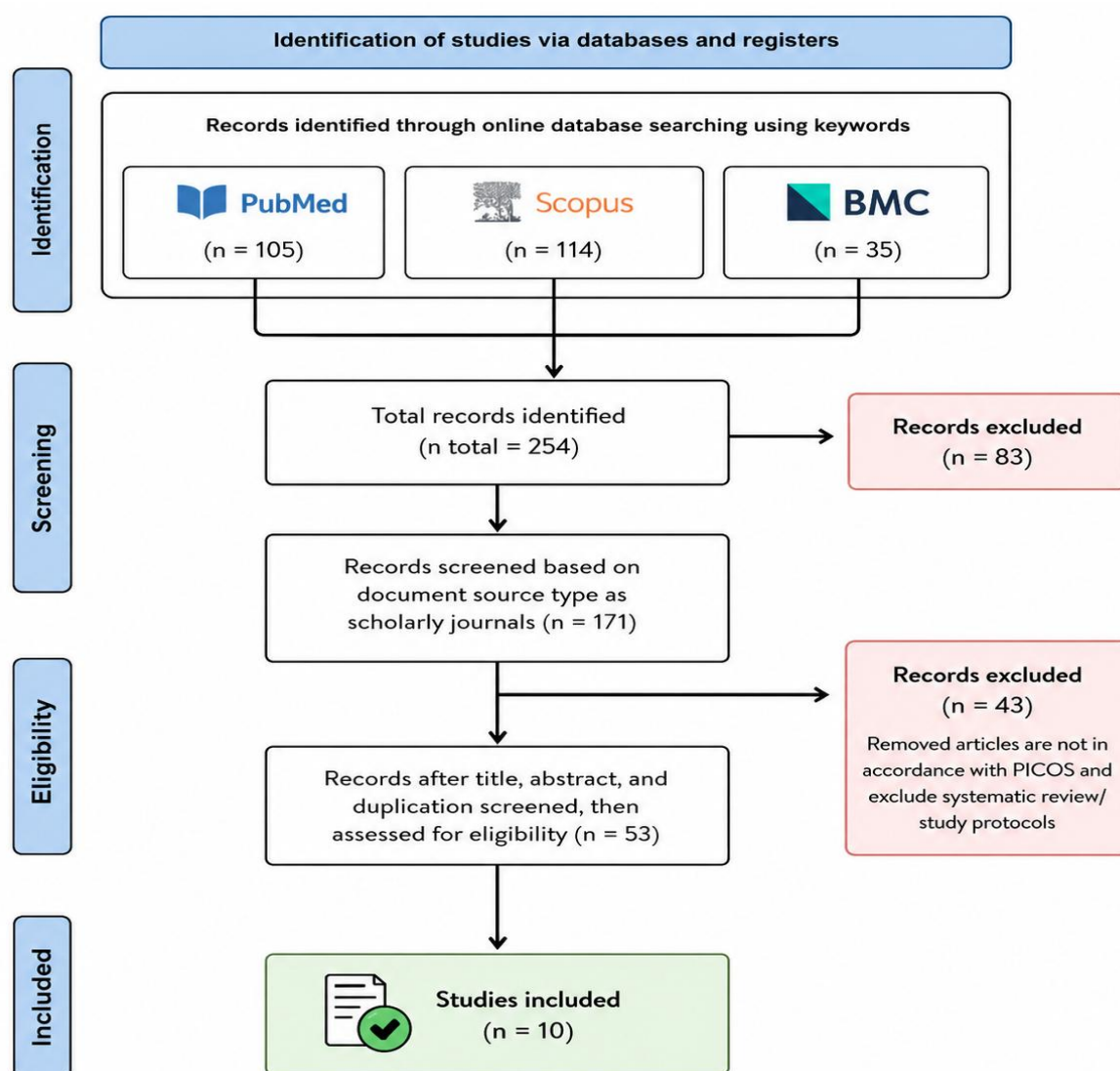


Figure 1. PRISMA Flow Diagram of Article Selection

3. Results and Discussion

The results presented in Table 1 and Table 2 demonstrate that telehealth-based adolescent health interventions provide substantial benefits in improving healthcare accessibility, health knowledge, behavioral outcomes, continuity of care, and psychosocial wellbeing across diverse populations and healthcare contexts.

Table 2. Article Included (n=10)

No	Authors	Country	Research Design	Telehealth Intervention	Main Findings
1	Beneteau, E., Paradiso, A., & Pratt, W. Telehealth experiences of providers and patients who use augmentative and alternative communication. <i>Journal of the American Medical Informatics Association</i> , 29(3), 481-488	USA	Qualitative study	study Telehealth communication support: utilisation of augmentative and alternative communication (AAC)	Telehealth improved healthcare accessibility and communication for AAC patients, but there remained technical and communication challenges.
2	Bhadania, M., Yadav, S., Mathur, A., Acharya, A., & Mehta, V. (2025). Mapping the effectiveness of digital health interventions in promoting electronic cigarette cessation: a systematic review and meta-analysis of randomized controlled trials. <i>BMC Public Health</i> , 25(1).	Multiple countries	Systematic review and meta-analysis	Digital smoking cessation interventions through mobile applications, web-based counseling, and SMS support	Digital health interventions were effective in increasing electronic cigarette cessation rates and improving smoking reduction behaviors.
3	Finnerty, R., McWeeny, S., & Trainor, L. (2023). Online group music therapy: proactive management of undergraduate students' stress and anxiety. <i>Frontiers in Psychiatry</i> , 14(April).	Ireland	Mixed methods study	Online group music therapy sessions delivered through virtual platforms	Online music therapy reduced stress and anxiety levels while improving emotional wellbeing among university students.
4	Lamash, L., Gal, E., & Bedell, G. (2023). Social Participation and Navigation: A Formative	USA	Formative evaluation study	Remote social participation and	Remote interventions improved social participation

No	Authors	Country	Research Design	Telehealth Intervention	Main Findings
	Evaluation of a Remote Intervention for Autistic Adolescents and Young Adults. <i>OTJR: Occupational Therapy Journal of Research</i> , 43(3), 505–512.			navigation intervention for autistic adolescents	skills, independence, and community navigation in autistic adolescents and young adults
5	Mantell, J. E., Bauman, L. J., Bonett, S., Buchbinder, S., Hoffman, S., Storholm, E. D., McCoy, K., Rael, C. T., Cowan, E., Gonzalez-Argoti, T., Safa, H., Scott, H., Murtaugh, K. L., Wilson, N. L., & Liu, A. (2025). Innovation in Providing Equitable Pre-exposure Prophylaxis Services in the United States: Expanding Access in Nontraditional Settings. <i>Journal of Acquired Immune Deficiency Syndromes</i> , 98(5), e156–e169.	USA	Descriptive and implementation study	Telehealth-supported HIV pre-exposure prophylaxis (PrEP) services in nontraditional settings	Telehealth-based PrEP services improved equitable access, especially among underserved and vulnerable populations.
6	Patel, P., Kerzner, M., Reed, J. B., Sullivan, P. S., & El-Sadr, W. M. (2022). Public Health Implications of Adapting HIV Pre-exposure Prophylaxis Programs for Virtual Service Delivery in the Context of the COVID-19 Pandemic: Systematic Review. <i>JMIR Public Health and Surveillance</i> , 8(6).	Multiple countries	Systematic review	Virtual HIV PrEP services including teleconsultation and remote monitoring	Virtual delivery models maintained continuity of HIV prevention services and improved healthcare accessibility during the pandemic.
7	Ramaswamy, A., Yu, M., Drangsholt, S., Ng, E., Culligan, P. J., Schlegel, P. N., & Hu, J. C. (2020). Patient satisfaction with telemedicine during the COVID-19 pandemic: Retrospective cohort study.	USA	Retrospective cohort study	Telemedicine consultation during the COVID-19 pandemic	Patients reported high satisfaction with telemedicine services due to convenience, accessibility, and reduced exposure risk.

No	Authors	Country	Research Design	Telehealth Intervention	Main Findings
8	Journal of Medical Internet Research, 22(9), 1–9. Trigg, J., Skelton, E., Lum, A., Guillaumier, A., McCarter, K., Handley, T., Judd, L., Lye, A., & Bonevski, B. (2023). Smoking Cessation Interventions and Abstinence Outcomes for People Living in Rural, Regional, and Remote Areas of Three High-Income Countries: A Systematic Review. <i>Nicotine and Tobacco Research</i> , 25(11), 1709–1718	Australia, Canada, USA	Systematic review	Telehealth and digital smoking cessation programs	Telehealth interventions improved smoking abstinence outcomes in rural and remote populations with limited healthcare access.
9	Webster, A. A., et al. (2020). Use of telehealth for facilitating the diagnostic assessment of Autism Spectrum Disorder (ASD): A scoping review. <i>PLoS One</i> , 15(7).	Multiple countries	Scoping review	Telehealth-based autism diagnostic assessment	Telehealth facilitated accessible and reliable ASD diagnostic assessments, especially in underserved areas.
10	Wilson, S. M., et al. (2016). Abstinence Reinforcement Therapy (ART) for rural veterans: Methodology for an mHealth smoking cessation intervention. <i>Contemporary Clinical Trials</i> , 50, 157–165.	USA	Methodological clinical trial study	Mobile health (mHealth) smoking cessation intervention for rural veterans	mHealth interventions demonstrated potential to improve smoking cessation adherence and support among rural veterans.

The first major finding emerging from the review is that telehealth interventions consistently improved healthcare accessibility, particularly among underserved, geographically isolated, disabled, or stigmatized populations. Studies involving HIV pre-exposure prophylaxis (PrEP), smoking cessation, autism diagnostic assessment, and augmentative and alternative communication (AAC) users showed that telehealth reduced structural barriers to healthcare access, including transportation difficulties, provider shortages, stigma, and communication limitations. These findings are highly relevant to adolescent health because adolescents frequently experience barriers related to confidentiality concerns, social stigma, transportation dependency, and limited healthcare autonomy.

This finding strongly aligns with the World Health Organization's framework on digital health system strengthening, which emphasizes that telehealth technologies can expand equitable healthcare access and reduce disparities in vulnerable populations (World Health Organization, 2019). The findings are also consistent with Diffusion of Innovations Theory (Rogers, 2003), which explains that innovative healthcare technologies are more rapidly adopted when they provide clear relative advantages over traditional service delivery models. In this review, telehealth offered several advantages, including convenience, remote accessibility, flexible communication, reduced travel burden, and continuity of care during public health emergencies such as the COVID-19 pandemic.

The second major finding is that telehealth interventions contributed positively to behavioral change and health behavior improvement. Smoking cessation programs, e-cigarette cessation interventions, and HIV prevention services demonstrated measurable improvements in abstinence outcomes, treatment adherence, and preventive health engagement. These findings support Social Cognitive Theory (Bandura, 1986), particularly the concept of self-efficacy. Interactive telehealth systems—including SMS reminders, online counseling, mobile health applications, and virtual support systems—appear to strengthen users' confidence, motivation, and behavioral reinforcement mechanisms. Adolescents are particularly responsive to interventions that provide continuous feedback, personalization, and flexible engagement through familiar digital platforms.

Table 3. Risk of Bias Assessment of Included Studies Using Design-Specific Appraisal Tools

Author (Year) & Study Design	D1: Bias due to confounding	D2: Bias in selection of participants	D3: Bias in classification of interventions	D4: Bias due to deviations from intended interventions	D5: Bias due to missing data	D6: Bias in measurement of outcomes	D7: Bias in selection of the reported result	Overall Risk of Bias
Beneteau et al. (2021) - <i>Qualitative Study</i>	Moderate	Moderate	Low	Low	Low	Moderate	Low	Moderate

Author (Year) & Study Design	D1: Bias due to confounding	D2: Bias in selection of participants	D3: Bias in classification of interventions	D4: Bias due to deviations from intended interventions	D5: Bias due to missing data	D6: Bias in measurement of outcomes	D7: Bias in selection of the reported result	Overall Risk of Bias
Bhadania et al. (2025) - <i>Systematic Review & Meta-analysis</i>	Low	Low	Low	Low	Low	Low	Low	Low
Finnerty et al. (2023) - <i>Randomized Controlled Trial (RCT)</i>	Low	Low	Low	Low	Mode rate	Mode rate	Low	Mode rate
Lamash et al. (2023) - <i>Formative Evaluation/Qualitative</i>	Serious	Mode rate	Low	Low	Low	Mode rate	Low	Serious
Mantell et al. (2025) - <i>Case Studies/Project Review</i>	Serious	Serious	Mode rate	Mode rate	No Information	Mode rate	Mode rate	Serious
Patel et al. (2022) - <i>Systematic Review</i>	Low	Low	Low	Low	Low	Low	Low	Low
Ramaswamy et al. (2020) - <i>Retrospective Cohort</i>	Moderate	Low	Low	Low	Mode rate	Low	Low	Mode rate
Trigg et al. (2023) - <i>Systematic Review</i>	Low	Low	Low	Low	Low	Low	Low	Low
Alfuraydan et al. (2020) - <i>Scoping Review</i>	Low	Mode rate	Low	Low	Low	Mode rate	Low	Mode rate
Wilson et al. (2016) - <i>Randomized Controlled Trial (RCT)</i>	Low	Low	Low	Low	Mode rate	Low	Low	Low

The appendix tables provide an integrated overview of methodological quality and intervention characteristics across the studies included in this systematic review. The Risk of

Bias table shows that the overall methodological quality of the included evidence varied from low to serious risk of bias. Systematic reviews and meta-analyses, including Bhadania et al. (2025), Patel et al. (2022), and Trigg et al. (2023), were generally assessed as low risk, indicating stronger methodological transparency, clearer search procedures, and more consistent reporting. In contrast, qualitative, formative evaluation, project review, and retrospective cohort studies demonstrated moderate to serious risk, primarily due to confounding, participant selection, and outcome measurement concerns. This finding suggests that although telehealth-based adolescent health interventions show promising effects, the strength of evidence is not uniform across study designs. Therefore, interpretation of effectiveness should be cautious and should consider the methodological limitations of each study.

The Risk of Bias findings also demonstrate that randomized controlled trials provided comparatively stronger evidence, although some concerns remained regarding missing data and outcome measurement. This pattern is consistent with systematic review methodology, in which RCTs are generally ranked higher in the hierarchy of evidence but may still be affected by attrition, self-reported outcomes, or inconsistent follow-up. The presence of serious risk of bias in some formative and project-based studies does not necessarily invalidate their contribution; rather, these studies offer important contextual insights into implementation feasibility, adolescent engagement, accessibility, and service acceptability. From the researcher's perspective, this combination of high-rigor quantitative evidence and contextual qualitative evidence is particularly important for telehealth research because digital health interventions are shaped not only by clinical effectiveness but also by usability, digital literacy, privacy, infrastructure, and user trust.

Table 4. Comprehensive Synthesis of Telehealth Interventions, Delivery Modalities, and Clinical Outcomes

Intervention Type	Target Population	Technology Used	Primary Objective	Key Findings	Delivery Method	User Satisfaction (Inferred)	Source
ASD Diagnosis	Children (ages 18 months to 6 years 11 months)	Naturalistic Observation Diagnostic Assessment (NODA) smartphone app and web portal	Facilitate remote ASD diagnosis using home videos recorded by parents.	High diagnostic agreement (85–88.2%) between NODA and in-person assessment; 96% of videos recorded by parents were clinically useful; 84.5% sensitivity and up to 94.4% specificity.	Asynchronous (Store-and-Forward)	High; parents reported it was easy to use (4/5 scale) and clinicians were satisfied in 80% of cases.	1, 2
ASD Diagnosis	Adults with disabilities/suspected ASD (ages 17–22)	VISYTER system (videoconferencing and web portal)	Conduct remote administration of adult autism assessment (ADOS Module 4).	Demonstrated that adult autism assessment can be administered distantly with high reliability; some fine motor observations were more difficult to assess.	Synchronous (Real-Time)	Very High; patients reported high satisfaction (6.5/7) and felt the system correctly represented their true behavior.	1, 2

Intervention Type	Target Population	Technology Used	Primary Objective	Key Findings	Delivery Method	User Satisfaction (Inferred)	Source
ASD Diagnosis	Children (ages 2.5 to 6 years)	Videoconferencing software	Evaluate clinicians' ability to diagnose ASD and coach parents remotely via Interactive Video Conferencing (IVC).	Diagnostic agreement between remote and in-person teams reached 86%; no significant difference in diagnostic accuracy.	Synchronous (Real-Time)	High; parent satisfaction was equivalent to in-person methods and access for rural areas increased significantly.	2
HIV Pre-Exposure Prophylaxis (PrEP) Delivery	Marginalized/minoritized groups (e.g., Black/Latin x, TGNB, youth)	TelePrEP platforms, smartphone apps (PrEPmate, iText), at-home specimen collection kits	Reduce PrEP access disparities and increase uptake in non-traditional or stigmatizing settings.	TelePrEP is feasible; iText showed 50% reduction in PrEP discontinuation; PrEPmate increased retention (OR 2.62); higher enrollment among white gay men than other groups in early Philadelphia trials.	Mixed (Synchronous video visits and Asynchronous SMS/app support)	High; programs viewed as easy, fast, and convenient; home privacy was seen as a key advantage.	3, 4, 2
General Clinical Consultations	Adult patients (18+, average age 58.8) at an urban academic medical center	Synchronous video visits through enterprise EHR (Epic)	Determine if patient satisfaction differs between video and in-person visits (including Urology).	Video visit satisfaction scores were significantly higher than in-person visits (94.9% vs 92.5%; $P < .001$).	Synchronous (Real-Time)	Very High; satisfaction was consistently higher for video visits across pre-COVID and COVID periods.	5, 2
E-cigarette Cessation	Adolescents, young adults, and middle-aged adults	SMS-based text messages (TIQ), web portals, AI chatbots, smartphone apps	Evaluate effectiveness of digital health interventions (DHI) in promoting e-cigarette cessation.	DHIs nearly double the likelihood of cessation (OR 2.29); SMS-based "This Is Quit" (TIQ) was a successful model; strong short-term efficacy.	Asynchronous (Store-and-Forward)	High; effectiveness depends on user-friendliness and interactivity (correlation 0.86–0.95).	6, 2
Smoking Cessation	Rural Veterans and smokers in remote areas	Smartphone apps (mCM, iCanQuit), handheld CO monitor, 4G connectivity, phone	Evaluate the effectiveness of Abstinence Reinforcement Therapy (ART) and Acceptance and Commitment Therapy (ACT).	Telehealth comparable to in-person for short-term results; ACT-based apps show long-term potential; study protocol stage for ART-mCM 6-month follow-up.	Mixed (Synchronous counseling and Asynchronous mCM video/app)	Moderate to High; reduces geographic barriers/travel costs; incentives in pilot studies averaged over \$280.	7, 2, 8
Mental Health (Stress/Anxiety Management)	Undergraduate university students (ages 18–24)	Zoom (online group sessions), phone app for HRV, hair sample kits for cortisol	Explore efficacy of online group music therapy as a proactive intervention for reducing stress.	Significant reduction in STAI-S and Likert stress scores pre- to post-session; cortisol levels remained stable in	Synchronous (Real-Time)	High; students showed more interest in music	9

Intervention Type	Target Population	Technology Used	Primary Objective	Key Findings	Delivery Method	User Satisfaction (Inferred)	Source
				therapy groups compared to controls.		therapy for mental health support than verbal therapy.	
SPAN-ASD Remote Intervention	Autistic adolescents and young adults (ages 12+) without intellectual disability	Website, goal planning web app, and videoconferencing	Improve social participation and independence in daily activities.	Identified needs for visual modification and metacognitive support; intervention delivered by expert clinicians via weekly virtual meetings.	Synchronous (Real-Time)	High; based on SPAN success in other populations and high motivation of autistic individuals for digital devices.	2, 10
Telehealth for AAC Users	Adults with motor and speech disabilities (e.g., ALS or cerebral palsy)	Videoconferencing, eye tracking devices, text messaging, and EHR portals	Provide continuous healthcare access and remote monitoring for Augmentative and Alternative Communication (AAC) users.	Essential service but hindered by technology accessibility barriers and rigid privacy policies.	Mixed (Synchronous video/phone and Asynchronous secure messaging)	Moderate to High; perceived as energy-saving, but technical barriers caused frustration.	2
Remote Group Counseling	Smokers in rural and urban areas	Videoconferencing system	Deliver smoking cessation education and relapse prevention via group sessions.	Abstinence rates did not differ significantly between on-site and telehealth delivery (25–27%) over eight sessions in 4 months.	Synchronous (Real-Time)	High; deemed highly suitable for rural smokers.	2

The intervention synthesis table shows that telehealth interventions were highly diverse across target population, technology platform, delivery method, and health outcome. The included interventions addressed autism spectrum disorder diagnosis, HIV pre-exposure prophylaxis delivery, general clinical consultations, e-cigarette cessation, smoking cessation, stress and anxiety management, adolescent social participation, and healthcare access for people with communication disabilities. This breadth of intervention types indicates that telehealth is not a single intervention but a service delivery ecosystem involving synchronous video consultations, asynchronous store-and-forward systems, smartphone applications, SMS reminders, web portals, remote monitoring tools, and hybrid models. The most consistent finding across the table is that telehealth improves access, convenience, satisfaction, and continuity of care, particularly for populations facing geographic, social, disability-related, or stigma-related barriers.

The findings align strongly with the Technology Acceptance Model, which proposes that perceived usefulness and perceived ease of use influence technology adoption (Davis, 1989). In the appendix, several interventions reported high user satisfaction because the platforms were easy to use, convenient, private, and accessible. For example, remote autism diagnosis using smartphone-based video submission achieved high diagnostic agreement and was perceived positively by parents and clinicians. Similarly, video consultations generated

high satisfaction because they reduced travel burden and enabled flexible interaction. These findings indicate that adolescents and families are more likely to engage with telehealth when the platform reduces practical barriers and offers clear functional benefits. However, the same theory also helps explain why telehealth may fail when systems are technically complex, poorly adapted to disability needs, or insufficiently responsive to adolescent communication preferences.

The findings are also consistent with Social Cognitive Theory, particularly the role of self-efficacy in behavior change (Bandura, 1986). Digital health interventions such as smoking-cessation apps, SMS-based cessation programs, HIV PrEP platforms, and online counseling tools may improve health behavior by increasing users' confidence, providing feedback, supporting goal setting, and enabling repeated reinforcement. The review suggests that telehealth interventions are more effective when they are interactive rather than purely informational. This is especially relevant for adolescents because health behavior change often requires motivation, autonomy, peer-sensitive communication, and continuous support. The effectiveness of SMS-based cessation programs and telehealth-supported counseling underscores the importance of sustained behavioral reinforcement over one-time health education.

Table 5. Harmonized Evidence Certainty Matrix

Outcome		Consistency	Strength	Certainty
Health knowledge improvement		Consistent	Moderate-High	Moderate
Health behavior change		Moderate consistency	Moderate	Moderate
Psychosocial wellbeing		Consistent	Moderate	Moderate
Healthcare accessibility		Consistent	Moderate-High	Moderate
Smoking cessation behavior		Moderate consistency	Moderate	Low-Moderate

The evidence also supports the relevance of the eHealth Literacy Framework. Norman and Skinner (2006) emphasized that individuals must be able to access, understand, evaluate, and apply digital health information. The appendix indicates that digital literacy, accessibility, and usability were recurring determinants of intervention success. Telehealth platforms were beneficial when users had adequate digital skills and when systems were designed in an age-appropriate and disability-sensitive manner. Conversely, barriers emerged when users experienced technological frustration, limited accessibility, or difficulty navigating privacy requirements. From the researcher's analysis, digital health literacy should not be treated as a background variable but as a core mechanism linking telehealth exposure to improved knowledge and behavior. Without adequate digital literacy support, telehealth may unintentionally widen health inequities among adolescents with low socioeconomic status, rural residence, disability, or limited family support.

Compared with previous research, the findings are consistent with broader evidence that telehealth can improve access to healthcare, reduce service delays, and maintain continuity of care across diverse populations (World Health Organization, 2019). Studies on autism diagnosis and adolescent developmental support are particularly important because they demonstrate that telehealth can expand access to specialized services that are often concentrated in urban centers. This supports the argument that telehealth can reduce structural barriers in adolescent health services, especially in rural, remote, or underserved

communities. However, the evidence also shows that remote assessment may not fully replace in-person clinical evaluation when subtle behavioral, motor, or contextual observations are required. Thus, telehealth should be understood as a complementary and integrated service model rather than a universal substitute for face-to-face care.

This systematic review suggests that integrating telehealth-based adolescent health services positively affects adolescents' health knowledge and behaviors (Lamash et al., 2023; Finnerty et al., 2023). Following telehealth interventions, most studies report that adolescents gained knowledge in reproductive health, mental health, nutrition, physical activity, and infectious disease prevention (Mantell et al., 2025; Parikh et al., 2026). The most commonly used telehealth models include mobile health apps, remote counseling, online video consultations, digital education platforms, health-related social media, and health messaging services via SMS or WhatsApp (Ramaswamy et al., 2020; Beneteau et al., 2022). Utilizing digital platforms has been deemed effective, as they accommodate the traits of active technology and social media use in the daily lives of youth (Bhadania et al., 2025). This is confirmed by the output in Outcomes of Best-Practice Guided Digital Mental Health Interventions for Youth and Young Adults with Emerging Symptoms: Part II, which is a systematic review of user experience outcomes, as digital interventions for adolescents with health problems have better user experience, particularly with its interactive app design, personalized content, peer support, and flexible and easily accessible services. The review also demonstrates that digital and telehealth support can increase adolescents' long-term engagement, satisfaction, and adherence with health programs (Opie et al., 2024; Bhadania et al., 2025). Mobile applications, web tools, and SMS support for digital health interventions significantly increase smoking cessation rates and promote healthier behaviors among users. Finnerty et al. (2023) found that online group music therapy delivered via virtual platforms decreases stress and anxiety and improves emotional well-being among undergraduate students. Lamash et al. (2023) found that remote interventions improved social participation, independence, and navigation for adolescents and young adults with autism. Consistent with the findings of Ariestanti et al. (2023), reproductive health education is important for improving adolescents' conceptualization and knowledge of reproductive health, healthy lifestyle practices, and self-care. Counseling and interactive media-based educational programs increased students' knowledge significantly. These results indicate the effective implementation of appropriate health education to enhance youth health behaviors. Additionally, various health knowledge interventions (e.g., telehealth) promote changes in adolescent health behaviors. Digital-based health education programs may increase adolescents' willingness to actively seek health information, improve adherence to treatment, engage in regular physical activity, and reduce high-risk behaviors (Trigg et al., 2023). Such digital peer support and virtual health care interventions have also been shown to be effective in motivating adolescents to retain mental and reproductive health (Mantell et al., 2025). Adequate internet access, digital literacy, family support, health care provider competency, and adolescent-friendly app design are also important determinants of the success of telehealth implementation (Beneteau et al., 2022; Notario et al., 2019). An integrated telehealth-based adolescent healthcare model consists of a multidisciplinary partnership among healthcare professionals, schools, families, and the community (Goedel et al., 2022).

Obstacles to young people's use of telehealth services have also been identified in other studies, including but not limited to restricted internet access in rural communities, poor security of digital data collected, limited face-to-face engagement with healthcare

practitioners, and limited digital literacy among adolescents (Trigg et al., 2023). Hence, the development of policy and improvements to digital infrastructure are determinants of telehealth program sustainability. These outcomes of this review also reflect the need for community involvement and user engagement in making health-related decisions (Ramaswamy et al., 2020). Research by Danna et al. (2026) shows that digital health interventions for adolescents will be most effective if they are adapted to user needs, user-friendly, feature an attractive interface, and adopt a consultative, personalized service approach. A similar strategy was described by Jeminiwa et al. (2019), who found that supports, guidance, and interaction through digital services can improve engagement and the success of adolescent health programs. Hence, the study's significance is that telehealth could be a creative tool to enhance the quality of adolescent health services in the context of the digital transformation and the post-pandemic era (Goedel et al., 2022). Incorporating telehealth services into primary care, schools, and community settings will expand avenues for sustainable adolescent health education (Notario et al., 2019). Limitations of this systematic review include differences in study designs, heterogeneity of telehealth interventions, and variation in outcome measurement instruments, which may limit the generalizability of the findings. Moreover, not all studies had relatively long intervention periods, which complicates the understanding of their long-lasting effects on adolescent health behaviors (Finnerty et al., 2023; McLaughlin et al., 2025).

The findings further indicate that telehealth-based adolescent health services are most promising when they combine accessibility, personalization, privacy, and continuous engagement. TelePrEP, smoking cessation, and e-cigarette cessation interventions illustrate how digital platforms may address sensitive adolescent health needs by reducing stigma and enhancing privacy. This is consistent with adolescent health theory, which emphasizes confidentiality, autonomy, and youth-friendly communication as essential principles of adolescent service delivery. Nevertheless, the evidence suggests that telehealth may lead to unequal uptake across demographic groups. For instance, early TelePrEP programs reported stronger enrollment among some groups than others, indicating that digital availability alone does not guarantee equitable access. Future telehealth models should therefore integrate equity-centered design, culturally responsive engagement, and targeted outreach for marginalized adolescents.

The implications of this review are substantial for adolescent health service integration. First, telehealth can extend the reach of adolescent health education and behavioral interventions beyond traditional clinical settings. Second, telehealth can improve continuity of care through hybrid models combining synchronous consultation with asynchronous messaging, apps, reminders, or home-based monitoring. Third, telehealth can support youth-centered care when platforms are designed around adolescent preferences, privacy expectations, disability needs, and digital literacy levels. Fourth, successful implementation requires provider readiness, ethical data governance, family or caregiver involvement when appropriate, and infrastructure support.

Several limitations should be acknowledged. The included studies were heterogeneous in design, population, intervention type, and outcome measurement, which limits direct comparison across interventions. Some studies focused on adults or mixed-age populations rather than exclusively on adolescents, meaning their findings should be interpreted as indirect evidence for adolescent health service integration. Several studies also relied on self-reported satisfaction or behavioral outcomes, which may introduce response bias. In addition,

the serious risk of bias in some qualitative or project-based studies indicates that implementation findings should be interpreted with caution. Despite these limitations, the review provides meaningful evidence that telehealth can improve health knowledge, health behavior, satisfaction, access, and service continuity when implemented through adolescent-friendly, digitally inclusive, and context-sensitive models.

Overall, the review demonstrates that integrating telehealth-based adolescent health services is a promising strategy for improving health knowledge and behavior. Its effectiveness depends not only on the availability of technology but also on usability, digital literacy, confidentiality, provider competence, implementation context, and equity-sensitive design. Future research should prioritize longitudinal studies, adolescent-specific randomized trials, standardized outcome measures, implementation science frameworks, and equity-focused evaluation. Such research is necessary to determine not only whether telehealth works, but for whom, under what conditions, and through which mechanisms.

Conclusions

A telehealth-based model for integrating adolescent health services demonstrates substantial potential for improving adolescents' health knowledge, health awareness, and positive health behaviors through accessible, flexible, and interactive digital interventions. The findings of this review indicate that telehealth not only enhances access to health information and healthcare services but also promotes active adolescent engagement, continuity of care, and sustainable behavioral change toward healthier lifestyles. Furthermore, telehealth interventions appear particularly valuable for addressing barriers related to geography, stigma, limited healthcare accessibility, and adolescent confidentiality concerns. However, the effectiveness and sustainability of telehealth implementation depend on several critical factors, including adequate digital infrastructure, digital health literacy, family and caregiver involvement, provider readiness, and strong collaboration between healthcare and educational sectors. Therefore, strategic development of technology-driven health policies, equity-oriented digital health systems, and adolescent-centered implementation frameworks is essential to support the long-term integration of telehealth into adolescent health services and to strengthen future public health outcomes.

Conflicts of Interest

The authors declare no conflict of interest.

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