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Digital and Behavioral Approaches to Improve Adherence in Orthodontic Treatment

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ABSTRACT: Orthodontic treatment outcomes are heavily influenced by patient compliance, yet ensuring consistent adherence remains a challenge. This narrative review aims to synthesize the effectiveness of educational strategies spanning digital, behavioral, and audiovisual approaches in enhancing compliance among orthodontic patients. A comprehensive literature search was conducted across PubMed, Scopus, Google Scholar, and Web of Science, focusing on studies published between 2013 and 2024. Inclusion criteria targeted peer reviewed articles assessing interventions such as mobile apps, motivational interviewing, audiovisual instruction, and culturally tailored communication. Results indicate that mobile applications and SMS reminders substantially improve adherence by enhancing patient engagement and reducing treatment complications. Audiovisual tools surpass traditional instruction methods by improving knowledge retention and facilitating long term behavioral change. Behavioral techniques, especially motivational interviewing, empower patients through collaborative communication, fostering treatment ownership. Psychological traits such as self-efficacy and social support also emerged as significant predictors of adherence. Despite these positive trends, systemic barriers such as healthcare inequities, clinician training deficits, and limited digital access persist. Addressing these challenges requires policy level action and targeted research. Future studies should prioritize longitudinal designs and include underrepresented populations to ensure generalizability. By integrating personalized education and digital platforms, orthodontic practices can enhance compliance and achieve more favorable treatment outcomes.

Keywords: Orthodontic Compliance, Patient Education, Digital Health, Motivational Interviewing, Tele Orthodontics, Behavioral Intervention, Audiovisual Learning.

INTRODUCTION

Orthodontic treatment has undergone a significant transformation in recent years, driven by technological advances, evolving patient expectations, and a broader understanding of behavioral science in healthcare. Patient compliance, defined as the extent to which a patient correctly follows

prescribed orthodontic treatment protocols, remains a pivotal determinant of treatment success. Despite the evolution in appliances and digital monitoring tools, ensuring consistent patient adherence remains a central challenge in orthodontic practice (Mohanty et al., 2024; Yassir et al., 2019).

The integration of digital technologies such as telemedicine and mobile health applications has been proposed as a key facilitator of improved compliance. Tele orthodontics, in particular, enables remote consultations and monitoring, thereby increasing accessibility and patient engagement (Almoammar, 2024). Studies have shown that reminder systems embedded in mobile apps can enhance compliance, especially among adolescents (Farhadifard et al., 2020; Zotti et al., 2016). Concurrently, the advent of clear aligner therapy has improved adherence rates due to its aesthetic appeal and reduced discomfort, which align with the preferences of image conscious patients (Dipalma et al., 2025; Karalikkattil et al., 2024).

Empirical evidence underscores the complexity of the factors influencing patient compliance. Psychological, social, and educational barriers significantly hinder adherence, particularly in patients using removable appliances. A survey conducted by Lim et al. (2023) identified a lack of understanding about the consequences of non-compliance as a primary reason for poor adherence (Lim et al., 2023). These insights are supported by Cannatà et al. (2024), who emphasized that non-compliance often leads to treatment delays and suboptimal results (Cannatà et al., 2024). Additionally, psychological conditions such as dental anxiety have been implicated in decreased cooperation (Naseri et al., 2020).

Several studies have evaluated the role of education in promoting orthodontic compliance. Visual, verbal, and digital educational interventions have demonstrated promising results in improving patient understanding and cooperation (Tadin et al., 2024; Yassir et al., 2019). Motivational interviewing has been particularly effective in addressing emotional and cognitive barriers to adherence (Ludovichetti et al., 2025). Discepoli et al. (2020) showed that behavior change techniques integrated into digital education significantly influence patient behavior, further emphasizing the importance of psychologically informed educational strategies(Discepoli et al., 2020).

Traditional methods such as brochures and in office discussions remain essential. Sivakumar et al. (2021) observed that such methods are particularly effective when used in tandem with modern tools. Moreover, involving family members in the educational process has been shown to enhance patient accountability and compliance (Al-Abdallah et al., 2021). These findings collectively suggest that a balanced approach combining new technologies with fundamental educational strategies offers the most robust outcomes.

Despite the potential of these educational interventions, numerous challenges persist. One of the key obstacles is the variability in patient responsiveness. Communication protocols may not always resonate with all demographic groups, particularly when they fail to consider socio economic status, cultural context, or age related cognitive development (Hussein & Ismail, 2023; Jedliński et al., 2021). Additionally, follow up mechanisms such as SMS reminders can lose effectiveness over time if not personalized and consistently reinforced (Higgins et al., 2023).

Non-compliance among adolescents, who constitute a substantial portion of orthodontic patients, remains notably high. Timm et al. (2021) reported that 81.6% of adolescents failed to adhere to prescribed retainer wear schedules (Timm et al., 2021). Ong et al. (2023) found that actual wear times for removable devices were significantly lower than recommended, a trend corroborated by microsensor data (Nahajowski et al., 2022; Ong-Artborirak et al., 2023). Age related factors also influence compliance, with younger patients demonstrating lower adherence due to lower maturity and greater susceptibility to peer influence (Barbosa et al., 2018).

The literature indicates critical gaps that warrant further investigation. Longitudinal studies assessing the sustained impact of educational strategies are scarce (Timm et al., 2021). Additionally, current educational interventions often lack customization and fail to address individual patient motivations, cultural perspectives, and psychological profiles ((Li et al., 2024; Ludovichetti et al., 2025). Furthermore, much of the research relies on self-reported data, which may not accurately reflect actual compliance behaviors (Crerand et al., 2019; Levrini et al., 2022).

The primary aim of this review is to examine educational approaches used to enhance compliance in orthodontic treatment, with particular focus on behavioral, psychological, and technological interventions. It also seeks to evaluate the effectiveness of these strategies based on empirical evidence, highlighting what works and where improvements are needed. This review will also explore how patient centered communication, motivational frameworks, and digital innovations contribute to improved adherence.

The scope of this review is both thematic and demographic. It centers on adolescent orthodontic patients, a group particularly prone to non-compliance, and explores interventions applied in diverse geographical contexts. While most of the literature originates from high income countries, this review also includes emerging studies from lower resource settings to provide a global perspective. By addressing the multifactorial dimensions of compliance and emphasizing the role of targeted educational interventions, this review aims to inform future strategies for enhancing treatment outcomes in orthodontics.

METHOD

This study employed a narrative review approach to examine educational interventions designed to improve patient compliance in orthodontic treatment. A comprehensive literature search was conducted across major academic databases, including PubMed, Scopus, Google Scholar, the Cochrane Library, and Web of Science. The search targeted studies published primarily between 2013 and 2024 to ensure the inclusion of contemporary findings that reflect current clinical and technological advancements.

The search strategy was constructed using predefined keywords and Boolean operators to optimize the precision and breadth of the results. Keywords included "orthodontic compliance," "patient education," "behavioral compliance," "educational interventions in orthodontics," and "adherence to

orthodontic treatment." These were combined using Boolean operators such as AND, OR, and NOT to filter and refine the results. For instance, a typical search string employed was ("orthodontic compliance" OR "patient adherence") AND ("patient education" OR "educational interventions") AND ("behavioral compliance" OR "adherence strategies"). Filters were applied to restrict results to peer reviewed articles, particularly randomized controlled trials, systematic reviews, and relevant cohort or qualitative studies.

Inclusion criteria comprised peer reviewed studies and reviews that empirically or theoretically evaluated the impact of educational strategies on orthodontic compliance. Studies not published in English, lacking empirical evidence, or not subjected to peer review were excluded. The initial screening involved reviewing titles and abstracts, followed by full text evaluation to assess relevance and methodological rigor.

To ensure reliability, a multi stage screening process was implemented. Four independent reviewers assessed the articles for alignment with the inclusion criteria. Key themes were synthesized to identify recurrent patterns in how educational strategies influence patient compliance. The findings provide insights into the efficacy of behavioral, psychological, and technological approaches in fostering adherence within orthodontic contexts.

RESULTS AND DISCUSSION

Digital Educational Tools and Mobile Interventions

The implementation of digital educational tools and mobile interventions has shown consistent promise in enhancing patient compliance during orthodontic treatment. Mobile applications and messaging platforms such as SMS and WeChat have emerged as effective mechanisms for delivering timely reminders and oral hygiene instructions. Ross et al. (2018) demonstrated that increased frequency of SMS reminders significantly improved adolescent patients' oral hygiene adherence (Ross et al., 2018). Almoammar (2024) corroborated these findings by illustrating that tele orthodontics, inclusive of digital communication and monitoring tools, strengthens adherence through consistent interaction and support (Almoammar, 2024).

Leone et al. (2018) reported that text based reminders notably improved the use of intermaxillary elastics among Class II malocclusion patients, while Farhadifard et al. (2020) highlighted the efficacy of mobile apps like Brush DJ in reinforcing routine hygiene practices for those using removable appliances (Farhadifard et al., 2020; Leone et al., 2018). These apps simplify the dissemination of instructional content and reminders, facilitating improved behavioral outcomes.

Clinical outcomes have also reflected the positive influence of these technologies. Zotti et al. (2016) found that digital interventions not only increased adherence but also decreased plaque accumulation and caries development (Zotti et al., 2016). Cozzani et al. (2016) noted that post treatment digital communication significantly reduced orthodontic emergencies (Cozzani et al., 2016). Similarly, Aljabaa

et al. (2016) revealed that patients using messaging apps experienced shorter overall treatment durations, implying enhanced efficiency and responsiveness in patient care (Aljabaa et al., 2016).

Audiovisual Learning and Knowledge Retention

Audiovisual (AV) educational materials have outperformed traditional verbal and written instructions in improving knowledge retention and patient cooperation. Jassim et al. (2024) demonstrated that AV reminders through smartphone apps increased oral hygiene adherence via more engaging delivery (Jassim et al., 2024). Almoammar (2024) further supported that AV materials in tele orthodontic settings improved patient understanding and cooperation (Almoammar, 2024).

Karalikkattil et al. (2024) showed that AV strategies enhanced cognitive processing and information retention, particularly in adolescent populations who may struggle with complex instructions (Karalikkattil et al., 2024). Studies by Zotti et al. (2019) and Jedliński et al. (2021) confirmed that patients educated via AV tools maintained better compliance with retainer usage over time (Jedliński et al., 2021; Zotti et al., 2019).

Umeh et al. (2021) established that multimedia education facilitated long term behavioral change, with patients adhering more reliably to appliance usage protocols. The findings from these studies affirm that multimedia learning supports not only initial understanding but also sustained engagement and compliance.

Behavioral and Psychological Education

Behavioral interventions such as motivational interviewing (MI) have proven effective in orthodontic practice. MI enhances patient motivation and compliance by fostering an empathetic dialogue between provider and patient. Almoammar (2024) showed that patients who received supportive communication via MI in tele orthodontic contexts displayed increased cooperation (Almoammar, 2024).

The application of MI techniques through reflective listening and collaborative goal setting encourages patients to take ownership of their treatment journey (Cozzani et al., 2016). Timm et al. (2021) emphasized the psychological benefits of MI in fostering autonomy, leading to improved compliance (Timm et al., 2021).

Patients' psychological traits also significantly influence adherence. Traits such as low self-efficacy, high anxiety, and external locus of control correlate with lower compliance ((Lim et al., 2023; Zotti et al., 2016). Naseri et al. (2020) and Sockalingam et al. (2020) linked reduced appliance usage to low psychological readiness (Sockalingam et al., 2020). Umeh et al. (2021) stressed that social support networks family and clinician encouragement play a crucial role in sustaining behavioral changes (Umeh et al., 2021).

Age and educational background are also determinants. Younger adolescents often show inconsistent compliance due to peer influence and cognitive development, while older patients demonstrate improved motivation related to aesthetic outcomes (Levrini et al., 2022).

Clinical Communication and Doctor Patient Relationships

Effective communication is central to patient satisfaction and compliance. Motivational interviewing remains a highly effective communication tool, promoting rapport and engagement (Almoammar, 2024). The use of tele orthodontic systems has improved real time interaction and allowed orthodontists to respond promptly to patient concerns, as noted by Almoammar (2024) and Zotti et al. (2016) (Almoammar, 2024; Zotti et al., 2016).

Psychological strategies like cognitive restructuring help alleviate anxiety, allowing patients to better engage with treatment protocols (Cozzani et al., 2016). Creating a supportive and interactive environment encourages cooperative behavior and enhances the overall treatment experience.

Dental education has increasingly emphasized communication skills. Programs now include training in MI, cultural competence, and the use of digital communication. Stonehouse Smith et al. (2022) and Levrini et al. (2022) documented that students trained in these methods were better prepared for remote consultations (Levrini et al., 2022; Stonehouse-Smith et al., 2022). Clinical audits and evaluations further ensure that communication training remains effective and aligned with patient expectations (Sivakumar et al., 2021).

Sociodemographic Influences and Customization

Patient demographics significantly impact treatment adherence. Lim et al. (2023) reported that adolescents, influenced by peers and psychosocial development, are less compliant than adults (Lim et al., 2023). Al Moghrabi et al. (2019) found that female patients often exhibit better compliance than males, attributed to differing behavioral and emotional responses .

Higher education and socioeconomic status correlate with better adherence due to improved health literacy and resource access (Ludovichetti et al., 2025). Conversely, patients from lower income backgrounds face systemic barriers, limiting treatment continuity.

Educational content must be adapted to suit varying literacy levels and cultural backgrounds. Visual aids, interactive tools, and simple language enhance understanding among low literacy groups (Nahajowski et al., 2022). Almoammar (2024) emphasized that tele orthodontics facilitates personalized education, enabling real time clarification (Almoammar, 2024).

Cultural sensitivity is essential for ensuring engagement. Levrini et al. (2022) and Gandhi et al. (2017) stressed that communication strategies must respect cultural values and beliefs (Gandhi et al., 2017;

Levrini et al., 2022). Digital platforms allow orthodontists to deliver customized content that resonates across diverse populations (Favero et al., 2024).

Tele Orthodontics and Remote Monitoring

Tele orthodontics significantly improves adherence and follow up participation. Almoammar (2024) found that remote monitoring reduced appointment non-attendance and increased treatment continuity (Almoammar, 2024). Wafaie et al. (2023) noted that sensor based tele monitoring tools elevated oral hygiene adherence during treatment (Wafaie et al., 2023).

The flexibility of remote platforms enables real time interaction and immediate feedback, strengthening the patient clinician relationship. Sabbagh et al. (2023) highlighted a shift to telephone consultations during the COVID 19 pandemic, which improved participation rates (Sabbagh et al., 2023).

Patients generally respond positively to remote education. Aljabaa et al. (2016) revealed that formats featuring visual and interactive content were more effective than traditional materials (Aljabaa et al., 2016). Wafaie et al. (2023) and Crerand et al. (2019) affirmed that access to digital content fosters confidence in managing orthodontic responsibilities (Wafaie et al., 2023).

Nevertheless, digital engagement varies. Younger users are typically more tech savvy, whereas older patients may need tailored support. Content diversity infographics, videos, interactive apps ensures accessibility and comprehension across age groups (Favero et al., 2024).

Remote education tools must align with cultural values to improve adherence. Crerand et al. (2019) recommended family inclusive education for pediatric populations (Crerand et al., 2019). Tailoring digital platforms to reflect community norms ensures cultural congruence and enhances engagement.

In conclusion, the evidence highlights that digital tools, AV materials, behavioral interventions, communication strategies, and tele orthodontics play significant roles in improving compliance. Sociodemographic and psychological factors shape responsiveness, emphasizing the need for personalized, culturally sensitive education. As orthodontic practices evolve, these findings offer actionable insights into optimizing treatment adherence and outcomes.

The findings of this review reinforce the growing consensus that educational interventions, especially those mediated through digital and behavioral platforms, substantially improve patient compliance in orthodontic care. When compared with earlier studies, this review highlights a consistent alignment with previous research. The integration of tele orthodontic platforms, for example, mirrors outcomes reported by Wafaie et al. (2023), where increased appointment adherence and engagement were observed through remote monitoring and communication (Wafaie et al., 2023). Similarly, Almoammar (2024) underscored the value of remote access in promoting a more responsive and timely interaction between orthodontists and their patients, which positively influenced treatment adherence

(Almoammar, 2024). These studies validate the effectiveness of technology driven communication tools in optimizing patient behavior.

This review also confirms that audiovisual educational tools play an instrumental role in improving knowledge retention and enhancing adherence. The superiority of audiovisual formats over traditional verbal or written instruction lies in their ability to engage multiple sensory pathways, thereby facilitating deeper cognitive processing. Although earlier studies, such as those by Karalikkattil et al. (2024), alluded to this advantage, our synthesis supports the assertion by presenting empirical outcomes from interventions utilizing video based and app mediated education (Karalikkattil et al., 2024). Furthermore, the deployment of motivational interviewing techniques aligns with established behavioral psychology literature. This method fosters a patient centered dialogue that encourages autonomy and engagement, principles that have long been recognized in healthcare as central to behavioral change and compliance. While some cited research did not always explicitly measure MI outcomes, the prevailing literature supports its role as a best practice in encouraging orthodontic cooperation.

Despite promising results, this review also highlights the persistent presence of systemic barriers that obstruct the widespread implementation of effective educational interventions. One of the foremost barriers is limited access to healthcare among socio economically disadvantaged groups. Studies such as those cited by Zotti et al. (2016) and Umeh et al. confirm that financial constraints and restricted access to healthcare infrastructure compromise patients' ability to maintain regular treatment schedules or access continuous educational resources (Zotti et al., 2016). This systemic inequity necessitates institutional responses that focus on creating scalable and inclusive educational strategies tailored for resource limited populations.

Another significant barrier is the insufficient clinician training in effective communication techniques. While dental curricula increasingly incorporate soft skills and patient engagement modules, evidence indicates that training is often generalized and lacks focus on nuanced communication styles needed for culturally and demographically diverse patient populations. Yassir et al. (2019) and related studies have shown that patients from varying educational backgrounds require differentiated communication strategies to ensure understanding and cooperation (Yassir et al., 2019). This issue becomes particularly urgent in the context of adolescent orthodontic patients, who may require age appropriate, psychologically informed communication approaches.

Furthermore, digital inequality acts as a bottleneck for the implementation of remote education and tele orthodontic platforms. While digital apps and messaging systems demonstrate high efficacy in improving compliance, not all patients possess the devices, connectivity, or digital literacy required to access and benefit from these tools. Li et al. (2024) and others emphasize that digital exclusion remains prevalent, particularly in rural areas or among older adults (Li et al., 2024). Thus, technology based interventions must be accompanied by parallel efforts to ensure digital inclusivity, such as providing accessible platforms, offline capabilities, or clinician led digital onboarding.

The analysis of audiovisual education also reveals broader implications for policy and practice. Given their efficacy, there is a strong rationale for standardizing the use of multimedia tools in patient onboarding and follow up sessions. However, implementation should be sensitive to factors such as learning preferences, language barriers, and disability accommodations. While the adoption of AV tools enhances cognitive retention, their utility can be maximized only when they are part of a broader, integrated communication plan tailored to individual patient profiles.

Behavioral and psychological education strategies, particularly those rooted in motivational interviewing, appear to exert a substantial influence on compliance behaviors. The findings support earlier hypotheses that patient autonomy, emotional validation, and trust are key levers in promoting behavioral change. This is particularly relevant in orthodontics, where treatment duration and complexity often demand prolonged patient cooperation. When practitioners adopt a supportive, collaborative communication style, they empower patients to take ownership of their treatment journey, leading to measurable improvements in adherence.

It is also evident that psychological traits such as self-efficacy, anxiety, and perceived locus of control substantially mediate patient behavior. Adolescents with low self-efficacy, for instance, have consistently demonstrated lower adherence to orthodontic instructions. These insights suggest that pre-treatment psychological assessments could be used to identify patients at risk of non-compliance and guide the application of tailored behavioral interventions. Such an approach would allow for the customization of educational content and support mechanisms, enhancing the overall effectiveness of the intervention.

Doctor patient communication remains a cornerstone of effective orthodontic care. The growing body of evidence affirms that open, empathetic, and culturally competent communication fosters patient satisfaction and cooperation. Tele orthodontic technologies, in particular, facilitate this dynamic by allowing frequent and responsive interactions. Moreover, dental education programs have begun incorporating modules on interpersonal communication and digital consultation skills, equipping future clinicians with tools to meet the demands of modern, tech mediated orthodontic practices. These shifts indicate a positive trend in curriculum evolution, though more structured and immersive training models are needed to achieve consistent competency across institutions.

While this review provides a comprehensive synthesis of current literature, several limitations must be acknowledged. First, the majority of included studies were concentrated in high income countries, which may limit the generalizability of findings to low resource settings. The geographic skew may overlook contextual variables affecting compliance, such as cultural norms or healthcare infrastructure disparities. Second, many studies relied on self-reported compliance measures, which are susceptible to bias and inaccuracies. The absence of standardized metrics for evaluating adherence complicates the comparison of outcomes across studies. Finally, the heterogeneity in study design, intervention format, and sample characteristics introduces variability that may affect the robustness of aggregated conclusions.

Future research should aim to bridge these gaps by prioritizing longitudinal studies that evaluate the sustained effects of educational interventions on compliance. Investigations should also consider incorporating objective measures, such as microsensors or digital tracking, to validate patient reported outcomes. Additionally, there is a need for greater representation of diverse populations in orthodontic research, particularly from under resourced and non-Western regions. Policymakers and educators should collaborate to standardize communication and education protocols while making digital resources universally accessible. Lastly, integrating psychological assessments into routine orthodontic intake procedures could pave the way for personalized compliance strategies, enhancing both clinical outcomes and patient experiences.

CONCLUSION

This narrative review highlights the critical role of educational interventions in improving patient compliance in orthodontic treatment. The synthesis of findings from digital platforms, audiovisual resources, motivational interviewing techniques, and culturally responsive communication underscores that multimodal, tailored education strategies significantly enhance adherence to treatment protocols. Mobile applications and SMS based reminders were shown to improve clinical outcomes by reducing appliance breakage and promoting oral hygiene. Likewise, audiovisual education demonstrated superiority over traditional formats in promoting knowledge retention and long term compliance.

Behavioral approaches such as motivational interviewing and psychological profiling further enriched the understanding of factors influencing adherence, particularly among adolescents. However, systemic barriers including limited healthcare access, insufficient clinician training, and digital inequality continue to impede widespread implementation. Policy level interventions such as expanding telehealth services, incorporating behavioral science into dental education, and ensuring equitable access to digital tools are essential.

To address existing gaps, future research should focus on longitudinal designs, objective measurement of compliance, and inclusion of diverse patient populations. Moreover, integrating personalized digital education and psychological assessments into routine practice represents a strategic response to current challenges. Emphasizing the synergistic use of educational technologies, clinician communication skills, and behavioral frameworks will be pivotal in driving patient centered orthodontic care forward.

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