Research in Health Science
ISSN 2470-6205 (Print) ISSN 2470-6213 (Online)
Vol. 10, No. 4, 2025
www.scholink.org/ojs/index.php/rhs

Original Paper

Nursing Intervention Models for Improving Oral Hygiene in Adolescent Orthodontic Patients

Fang Guo*, Xiuzhen Rao & Simin Li

Stomatological Hospital, School of Stomatology, Southern Medical University, 366 Jiangnan South Avenue, Haizhu District, Guangzhou 510280, Guangdong Province, China

* Corresponding author, Fang Guo, E-mail: 1135166445@qq.com

Received: July 16, 2025 Accepted: November 20, 2025 Online Published: December 8, 2025

doi:10.22158/rhs.v10n4p131 URL: http://dx.doi.org/10.22158/rhs.v10n4p131

Abstract

Oral hygiene maintenance in adolescent orthodontic patients is a critical factor influencing treatment outcomes and overall oral health. Adolescents undergoing orthodontic treatment often face unique physiological and psychological challenges that can hinder effective oral hygiene practices. This review systematically explores nursing intervention models centered on health education, behavioral motivation, and family involvement to improve oral hygiene behaviors in this population. Current research reveals that conventional approaches frequently overlook the complex interplay of adolescent developmental characteristics and social support systems, leading to suboptimal compliance and increased risk of oral complications. By evaluating various caregiving strategies and their efficacy in promoting sustained oral hygiene, this article aims to establish a comprehensive, evidence-based nursing intervention framework tailored to adolescents receiving orthodontic care. Integrating multidimensional components, including targeted health education programs, behavioral incentive mechanisms, and active family participation, the proposed nursing model addresses existing gaps and enhances patient adherence. The review synthesizes recent empirical findings to provide theoretical foundations and practical guidance for clinicians and nursing professionals, ultimately contributing to improved oral health outcomes and quality of life for adolescent orthodontic patients.

Keywords

adolescents, orthodontic patients, oral hygiene, behavior intervention, nursing model, health education, family involvement

1. Introduction

Orthodontic treatment during adolescence plays a pivotal role in correcting malocclusions and enhancing dental aesthetics and function. However, maintaining optimal oral hygiene throughout orthodontic therapy is crucial, as inadequate oral hygiene can significantly compromise treatment outcomes. Fixed orthodontic appliances, commonly used in adolescents, create additional retentive areas for dental plaque accumulation, increasing the risk of gingival inflammation, white spot lesions (WSLs), and dental caries. These complications not only affect oral health but may also prolong treatment duration and diminish patient satisfaction (Čalušić Šarac, M., Anić Milošević, S., Matošić, Ž., & Lapter Varga, M., 2021; Chauhan, A., Mishra, N., Patil, D., et al., 2024). The importance of oral hygiene maintenance during orthodontic treatment is underscored by evidence showing that many adolescent patients fail to achieve adequate plaque control, resulting in adverse periodontal and enamel changes (Sbricoli, L., Bernardi, L., Ezeddine, F., Bacci, C., & Di Fiore, A., 2022; Almansob, Y. A., Alhammadi, M. S., Luo, X. J., et al., 2021). Therefore, effective oral hygiene behavior intervention is essential to ensure treatment success and prevent complications.

Adolescents undergoing orthodontic treatment represent a unique patient population characterized by ongoing physiological development and evolving psychological and cognitive capacities. This developmental stage influences their health behaviors, including oral hygiene practices. Studies reveal that adolescents often exhibit inconsistent oral hygiene habits, limited knowledge about dental plaque and WSLs, and variable motivation levels during orthodontic therapy (Bilici Geçer, R., & Dursun, D., 2024; Mociu, M., Bartok-Nicolae, C., Raftu, G., Briceag, R., & Caraiane, A., 2024). For instance, a substantial proportion of adolescent orthodontic patients lack awareness of the etiology and prevention of common treatment-related complications, which hampers their adherence to recommended oral hygiene protocols (Bilici Geçer, R., & Dursun, D., 2024). Moreover, psychosocial factors such as fear of dental procedures, peer influence, and self-image concerns can further affect their oral health behaviors (Wai Yan Myint Thu, S., Ngeonwiwatkul, Y., Maneekan, P., & Phuanukoonnon, S., 2020). These developmental and psychosocial characteristics necessitate tailored intervention strategies that address the specific needs and challenges faced by adolescent orthodontic patients.

Traditional nursing and oral health care models during orthodontic treatment have predominantly relied on single-session health education and verbal instructions. However, evidence suggests that such approaches are insufficient to produce sustained behavioral changes in adolescents. For example, routine oral hygiene instructions without reinforcement or engaging educational methods often result in limited improvements in plaque control and gingival health (Deleuse, M., Meiffren, C., Bruwier, A., Maes, N., Le Gall, M., & Charavet, C., 2020; Farhadifard, H., Soheilifar, S., Farhadian, M., Kokabi, H., & Bakhshaei, A., 2020). Additionally, the lack of continuous motivation and personalized feedback contributes to the decline in adherence over time (Deleuse, M., Meiffren, C., Bruwier, A., Maes, N., Le Gall, M., & Charavet, C., 2020). These limitations highlight the need for innovative and multifaceted nursing care models that move beyond conventional health education to incorporate behavioral and

motivational components, thereby fostering long-term oral hygiene compliance.

In response to the shortcomings of traditional care models, recent research advocates for the integration of diversified nursing strategies to enhance oral hygiene behaviors among adolescent orthodontic patients. Multimodal interventions combining health education, behavioral incentives, and family involvement have demonstrated promising results. For instance, educational programs that include hands-on practice coupled with multimedia resources significantly improve oral hygiene knowledge, attitudes, and clinical parameters such as plaque and gingival indices compared to standard verbal instructions (Lin, Q., Zheng, Y., Chen, Y., & Lin, Y., 2025). Similarly, the use of smartphone applications and digital reminders has been explored as a means to motivate adolescents and reinforce proper oral hygiene techniques, although long-term adherence remains a challenge (Deleuse, M., Meiffren, C., Bruwier, A., Maes, N., Le Gall, M., & Charavet, C., 2020; Farhadifard, H., Soheilifar, S., Farhadian, M., Kokabi, H., & Bakhshaei, A., 2020). Furthermore, engaging family members in oral health education and care routines can provide social support and enhance adolescents' motivation to maintain oral hygiene (Sbricoli, L., Bernardi, L., Ezeddine, F., Bacci, C., & Di Fiore, A., 2022). These diversified care strategies underscore the necessity of a comprehensive, patient-centered approach that addresses cognitive, behavioral, and social dimensions of oral hygiene maintenance during orthodontic treatment.

Given the critical role of oral hygiene in orthodontic treatment outcomes and the unique challenges posed by adolescent patients, there is an urgent need to systematically evaluate existing nursing care models and explore pathways for their optimization. This review aims to synthesize current evidence on nursing interventions targeting oral hygiene behaviors in adolescent orthodontic patients, assessing their effectiveness and identifying best practices. By analyzing diverse care approaches—including traditional education, behavioral motivation, technological aids, and family participation—this article seeks to provide a foundation for developing optimized nursing care models tailored to the adolescent orthodontic population. Such models have the potential to enhance oral hygiene compliance, minimize treatment complications, and ultimately improve the quality and efficacy of orthodontic care.

2. Main Body

2.1 Current Status and Influencing Factors of Oral Hygiene Behavior in Adolescent Orthodontic Patients

2.1.1 Characteristics of Oral Hygiene Behavior in Adolescent Orthodontic Patients

Adolescents undergoing orthodontic treatment exhibit distinct oral hygiene behavior characteristics shaped by their developmental stage, psychological state, and the complexity of orthodontic appliances. Their limited self-management abilities and strong dependence on external guidance make them particularly susceptible to peer and environmental influences, which can either positively or negatively affect their oral hygiene routines. Orthodontic appliances, especially fixed devices, introduce mechanical challenges by creating additional plaque retention sites, complicating cleaning procedures

and increasing the risk of plaque accumulation. Studies have shown that while many adolescents maintain routine toothbrushing, the use of adjunctive aids such as dental floss remains low, with only a minority using floss daily despite high motivation from orthodontic professionals (Čalušić Šarac, M., Anić Milošević, S., Matošić, Ž., & Lapter Varga, M., 2021). Psychological factors, including anxiety and shyness, further complicate the establishment of consistent oral hygiene habits. Negative emotions related to orthodontic treatment can reduce motivation and adherence to oral care regimens, thereby exacerbating plaque accumulation and gingival inflammation risks (Bilici Geçer, R., & Dursun, D., 2024). Additionally, the complexity of orthodontic devices demands higher manual dexterity and knowledge, which adolescents may lack, leading to suboptimal cleaning and increased susceptibility to white spot lesions and gingivitis (Petrauskiene, S., Wanczewska, N., Slabsinskiene, E., & Zemgulyte, G., 2019). The interplay of these factors underscores the need for tailored oral hygiene interventions that consider adolescents' developmental and psychological characteristics to enhance compliance and effectiveness.

2.1.2 Major Factors Influencing Oral Hygiene Behavior

Multiple factors at the individual, social, and medical levels influence oral hygiene behaviors in adolescent orthodontic patients. At the individual level, cognitive understanding of oral health, health beliefs, and self-efficacy play pivotal roles. Adolescents with higher oral health literacy and confidence in their ability to perform effective hygiene practices demonstrate better compliance . Conversely, limited knowledge about dental plaque and white spot lesions is prevalent, indicating gaps in awareness that negatively impact behavior (Bilici Geçer, R., & Dursun, D., 2024). Social factors, including family support, peer influence, and cultural background, significantly affect adolescents' oral hygiene practices. Family involvement, especially parental attitudes and behaviors, has been shown to shape adolescents' oral health habits, with positive family dynamics promoting better outcomes (Sivakumar, A., Venkatarayappa, J. G., Tirupati, N., Benedict, C. H., Gunasekaran, V., & Babu, N. K., 2024). Peer influence can either reinforce or undermine oral hygiene routines, given adolescents' heightened sensitivity to social acceptance (Puri, S., Vasthare, R., & Munoli, R., 2019). Cultural norms and socioeconomic status also modulate access to oral hygiene resources and information, influencing behavior patterns (Zheng, M. L., Chen, F., Yu, H., & Zhang, C. Y., 2025). Medical factors encompass the role of healthcare providers and the complexity of orthodontic treatment. The guidance style of orthodontists, including the frequency and method of oral hygiene instruction, directly affects patient adherence. Studies emphasize that detailed, repeated, and multimodal educational interventions, including hands-on training and multimedia tools, significantly improve oral hygiene behaviors (Lin, Q., Zheng, Y., Chen, Y., & Lin, Y., 2025; Scheerman, J. F. M., van Meijel, B., van Empelen, P., et al., 2020). The complexity of the orthodontic appliance itself, such as fixed braces versus clear aligners, can alter the difficulty of maintaining hygiene, with fixed appliances posing greater challenges (Zhang, H., Bi, S., & Zhang, X., 2025). Furthermore, emerging adjuncts like probiotic supplementation are being explored to mitigate inflammation and microbial dysbiosis during treatment (Agossa, K., Dubar,

M., Lemaire, G., et al., 2022). Collectively, these multifactorial influences necessitate comprehensive, individualized approaches to optimize oral hygiene among adolescent orthodontic patients.

2.1.3 Negative Impact of Poor Oral Hygiene on Orthodontic Treatment

Poor oral hygiene in adolescent orthodontic patients leads to a cascade of adverse clinical outcomes that compromise both oral health and orthodontic treatment efficacy. The accumulation of dental plaque fosters the development of caries and gingival inflammation, with increased incidence of white spot lesions (WSLs), dental caries, and gingivitis documented among patients with inadequate hygiene (Chauhan, A., Mishra, N., Patil, D., et al., 2024; Manuelli, M., Marcolina, M., Nardi, N., et al., 2019). These complications not only affect the aesthetic and functional results of orthodontic therapy but also extend treatment duration due to the need for managing these sequelae. WSLs, in particular, represent early enamel demineralization around brackets and are strongly associated with poor plaque control and certain individual risk factors such as taste perception phenotypes (Alanzi, A., Velissariou, M., Al-Melh, M. A., Ferguson, D., & Kavvadia, K., 2019). Gingival inflammation is more prevalent in adolescents compared to adults during orthodontic treatment, especially with fixed appliances, and can be partially mitigated by professional periodontal therapy combined with personalized oral hygiene education (Zhang, H., Bi, S., & Zhang, X., 2025. Furthermore, poor oral hygiene diminishes patient compliance and motivation, negatively influencing the overall treatment experience and outcomes. Patients experiencing discomfort or complications may be less adherent to orthodontic protocols and follow-up visits (Bilici Geçer, R., & Dursun, D., 2024). The presence of mucosal lesions and discomfort caused by appliances can also deter proper cleaning practices (Manuelli, M., Marcolina, M., Nardi, N., et al., 2019). Collectively, these factors underscore the critical importance of maintaining optimal oral hygiene to prevent complications, ensure timely treatment progression, and achieve favorable orthodontic results. Effective educational strategies and regular professional monitoring are essential components to mitigate these risks and enhance treatment success.

2.2 Oral Hygiene Behavior Intervention Nursing Model Construction

The integrated nursing intervention model comprises seven core components that work synergistically to improve oral hygiene behaviors in adolescent orthodontic patients. Table 1 provides a comprehensive overview of these components, detailing the specific strategies, implementation methods, underlying mechanisms, and target outcomes for each element of the model.

Table 1. Core Components of the Integrated Nursing Intervention Model for Oral Hygiene Behavior in Adolescent Orthodontic Patients

Intervention Component	Specific Strategies	Implementation Methods	Expected Mechanisms	Target Outcomes
Health Education Strategies	• Personalized educational content • Multimedia learning tools • Hands-on practice training • Interactive demonstrations • Theory-based instruction	• Video tutorials and animations • Digital games and applications • Practical brushing demonstrations • Visual aids (models, charts) • Group education sessions • One-on-one counseling	• Enhanced knowledge acquisition • Improved risk awareness • Attitude change • Cognitive skill development • Memory retention	• Increased oral hygiene knowledge • Positive attitude formation • Correct technique adoption • Understanding of complications
Behavioral Incentive Mechanisms	• Goal-setting frameworks • Self-monitoring systems • Positive reinforcement • Reward programs • Feedback mechanisms	• Establish quantifiable targets • Daily/weekly tracking logs • Point-based reward systems • Verbal praise and recognition • Progress visualization tools • Achievement certificates	• Intrinsic motivation development • Enhanced self-efficacy • Goal commitment • Self-regulatory capacity • Behavioral reinforcement	• Increased compliance rates • Sustained motivation • Regular oral hygiene practice • Behavioral habit formation
Family Involvement Models	• Parental education programs • Supervision strategies • Social support networks • Collaborative care approach • Home environment optimization	• Family education sessions • Parent-child joint activities • Home monitoring protocols • Family communication training • Environmental modifications • Sibling involvement	• Social support provision • Environmental facilitation • Modeling positive behaviors • Social accountability • Normalization of practices	• Enhanced family support • Consistent home practice • Reduced behavioral barriers • Improved adherence
Digital Health Integration	• Mobile applications • Automated reminders • Tele-monitoring systems	• Smartphone app installation • Daily reminder notifications	• Continuous engagement • Timely behavioral prompts	• Improved short-term compliance • Enhanced accessibility • Timely intervention

	• AI-assisted tools • Digital feedback platforms	• Photo-based progress tracking • Virtual consultations • Gamified learning modules • Real-time feedback systems	• Personalized guidance • Progress visualization • Remote support access	• Increased engagement
Psychological Support	• Motivational interviewing • Cognitive-behavioral techniques • Anxiety reduction strategies • Self-image enhancement • Peer influence management	• Individual counseling sessions • Group therapy discussions • Stress management training • Positive self-talk techniques • Peer support groups • Confidence-building activities	• Reduced dental anxiety • Enhanced self-esteem • Improved emotional regulation • Positive peer influence • Increased self-efficacy	• Reduced psychological barriers • Increased treatment acceptance • Better emotional well-being • Improved cooperation
Clinical Monitoring and Assessment	• Regular clinical examinations • Objective index measurements • Progress documentation • Personalized feedback • Adaptive interventions	• Plaque index assessment • Gingival index evaluation • Professional cleaning sessions • Photographic documentation • Treatment plan adjustments • Quarterly reviews	• Early problem detection • Evidence-based modification • Professional guidance • Accountability reinforcement • Outcome tracking	• Reduced plaque accumulation • Improved gingival health • Prevention of complications • Optimized treatment progress
Continuity of Care	• Structured follow-up protocols • Longitudinal monitoring • Care coordination • Transition support • Long-term maintenance	• Scheduled follow-up appointments • Regular phone/text check-ins • Multi-disciplinary coordination • Post-treatment care plans • Maintenance program enrollment • Alumni support groups	• Sustained behavioral support • Consistent reinforcement • Relationship building • Trust development • Long-term accountability	• Sustained behavioral changes • Long-term habit maintenance • Reduced relapse rates • Continued improvement

2.2.1 Health Education Strategies

Designing personalized health education content tailored to adolescents' cognitive characteristics is essential for effective oral hygiene behavior interventions in orthodontic patients. Adolescents are at a developmental stage where their understanding, motivation, and attention span differ markedly from adults, necessitating educational materials that resonate with their cognitive level and interests. Incorporating multimedia and interactive educational methods, such as videos, animations, and digital games, can significantly enhance learning engagement and memory retention. For instance, mHealth interventions employing mobile applications and audiovisual tools have demonstrated improvements in oral hygiene behaviors among children, although their efficacy in adolescents remains limited, highlighting the need for more adolescent-specific content and delivery modes (Saxena, N., Kaurani, P., Marwah, N., & Kauveettil, V., 2025). Furthermore, theory-based educational interventions, particularly those grounded in the Theory of Planned Behavior (TPB), have shown effectiveness in improving oral hygiene behaviors and related oral health outcomes in young adults, underscoring the importance of integrating behavioral theories into health education (Prihastuti, R., Hinode, D., Fukui, M., Rodis, O. M. M., & Matsuka, Y., 2025). Regular evaluation of educational outcomes is crucial to dynamically adjust intervention strategies, ensuring sustained behavioral improvements. School-based oral health education programs have been found to positively impact plaque reduction, gingivitis prevention, and oral health knowledge, attitudes, and practices, supporting the integration of ongoing assessments and tailored modifications in educational content (Das, H., Janakiram, C., S, V. K., & Karuveettil, V., 2025). Additionally, nurse-led oral hygiene programs have effectively enhanced knowledge, attitudes, and practices among schoolchildren, suggesting the value of professional facilitation and structured program delivery (Mohamed, A. H., Ali, H. M., Berdida, D. J. E., Agunod, C. D., & Santos, A. M., 2025). Overall, health education strategies should be personalized, engaging, theory-driven, and continuously evaluated to optimize oral hygiene interventions for adolescent orthodontic patients.

2.2.2 Behavioral Incentive Mechanisms

Establishing concrete, quantifiable oral hygiene goals is pivotal to fostering self-monitoring and promoting sustained behavioral change among adolescents undergoing orthodontic treatment. Behavioral incentive mechanisms grounded in psychological theories such as the Health Belief Model and Social Cognitive Theory have been shown to facilitate oral hygiene improvements by enhancing motivation and self-efficacy (Vilar Doceda, M., Petit, C., & Huck, O., 2023; Chan, C. C. K., Chan, A. K. Y., Chu, C. H., & Tsang, Y. C., 2023). Positive reinforcement strategies, including reward systems and verbal praise, serve to strengthen the persistence of desirable behaviors. For example, financial and social incentives have been demonstrated to increase cooperative health behaviors, with financial incentives exerting a particularly strong effect (Micheli, L., Stallen, M., & Sanfey, A. G., 2021). However, the design of incentives must consider individual differences in motivation and social context to avoid undermining intrinsic motivation or causing adverse effects. The integration of behavior change theories, such as the Theory of Planned Behavior and Social Cognitive Theory, can guide the

development of effective incentive programs by incorporating goal setting, planning, self-monitoring, and feedback components (Vilar Doceda, M., Petit, C., & Huck, O., 2023; Chan, C. C. K., Chan, A. K. Y., Chu, C. H., & Tsang, Y. C., 2023). Furthermore, interventions embedding motivational interviewing and cognitive-behavioral techniques have yielded improvements in oral hygiene by addressing patients' beliefs and enhancing self-regulatory capacities (Vilar Doceda, M., Petit, C., & Huck, O., 2023). The application of incentive mechanisms should also consider the balance between extrinsic rewards and intrinsic motivation to promote long-term adherence. Research in other behavioral domains suggests that well-calibrated incentive programs that align with users' values and provide meaningful feedback can effectively modify health behaviors (Murray, J. M., French, D. P., Kee, F., Gough, A., Tang, J., & Hunter, R. F., 2020; Yoon, Y. R., & Woolley, K., 2024). In sum, behavioral incentive mechanisms for oral hygiene should be theory-driven, personalized, and incorporate positive reinforcement and self-regulatory strategies to optimize adherence in adolescent orthodontic populations.

2.2.3 Family Involvement Models

Family involvement plays a critical role in shaping and sustaining oral hygiene behaviors among adolescents receiving orthodontic care. Training family members in oral hygiene knowledge enhances their capacity to provide effective support and supervision, thereby strengthening the family's role in promoting healthy behaviors (Smith, S. R., Kroon, J., Schwarzer, R., & Hamilton, K., 2020). Active participation of family members in monitoring and encouraging oral hygiene practices creates a supportive environment conducive to behavior maintenance. Studies indicate that parental attitudes, self-efficacy, and intentions significantly correlate with children's oral hygiene behaviors, emphasizing the importance of family engagement (Smith, S. R., Kroon, J., Schwarzer, R., & Hamilton, K., 2020). Moreover, family dynamics and the home environment substantially influence adolescents' oral health habits, suggesting that interventions should address familial and contextual factors to foster long-term adherence (Xu, X., Zhao, Y., Gu, D., Pei, Y., & Wu, B., 2021). Intergenerational studies also highlight the transmission of health behaviors and attitudes within families, underscoring the need for family-centered approaches in oral hygiene interventions (Greenblatt-Kimron, L., Shrira, A., Rubinstein, T., & Palgi, Y., 2023). Integrating family members into oral hygiene programs not only improves adolescents' knowledge and practices but also mitigates psychological barriers such as social avoidance and low self-efficacy, which are often linked to family environment (Tian, X., Gu, L., Ma, X., et al., 2025). Additionally, family involvement models have demonstrated positive impacts in broader health contexts, including chronic disease management and mental health, reinforcing their applicability to oral health promotion (Yan, T., Hou, Y., & Liang, L., 2023; Watson, L., Link, C., Qi, S., & DeIure, A., 2023). Effective family involvement models should include education, joint participation in hygiene activities, and strategies to cultivate a positive home environment that supports sustained oral hygiene behaviors in adolescent orthodontic patients.

Figure 1 illustrates the conceptual framework of the integrated nursing intervention model, depicting how three core intervention strategies—health education, behavioral incentives, and family

involvement—converge to improve oral hygiene behaviors in adolescent orthodontic patients. The model delineates four underlying mechanistic pathways (cognitive, motivational, behavioral, and social support) through which these interventions exert their effects on patient outcomes. The framework demonstrates that enhanced knowledge, intrinsic motivation development, skill acquisition, and family engagement operate synergistically to promote sustainable behavioral change. Primary outcomes are categorized into clinical improvements (reduced plaque and gingival inflammation), behavioral enhancements (increased compliance and proper technique utilization), and optimized treatment results (shortened duration and improved satisfaction).

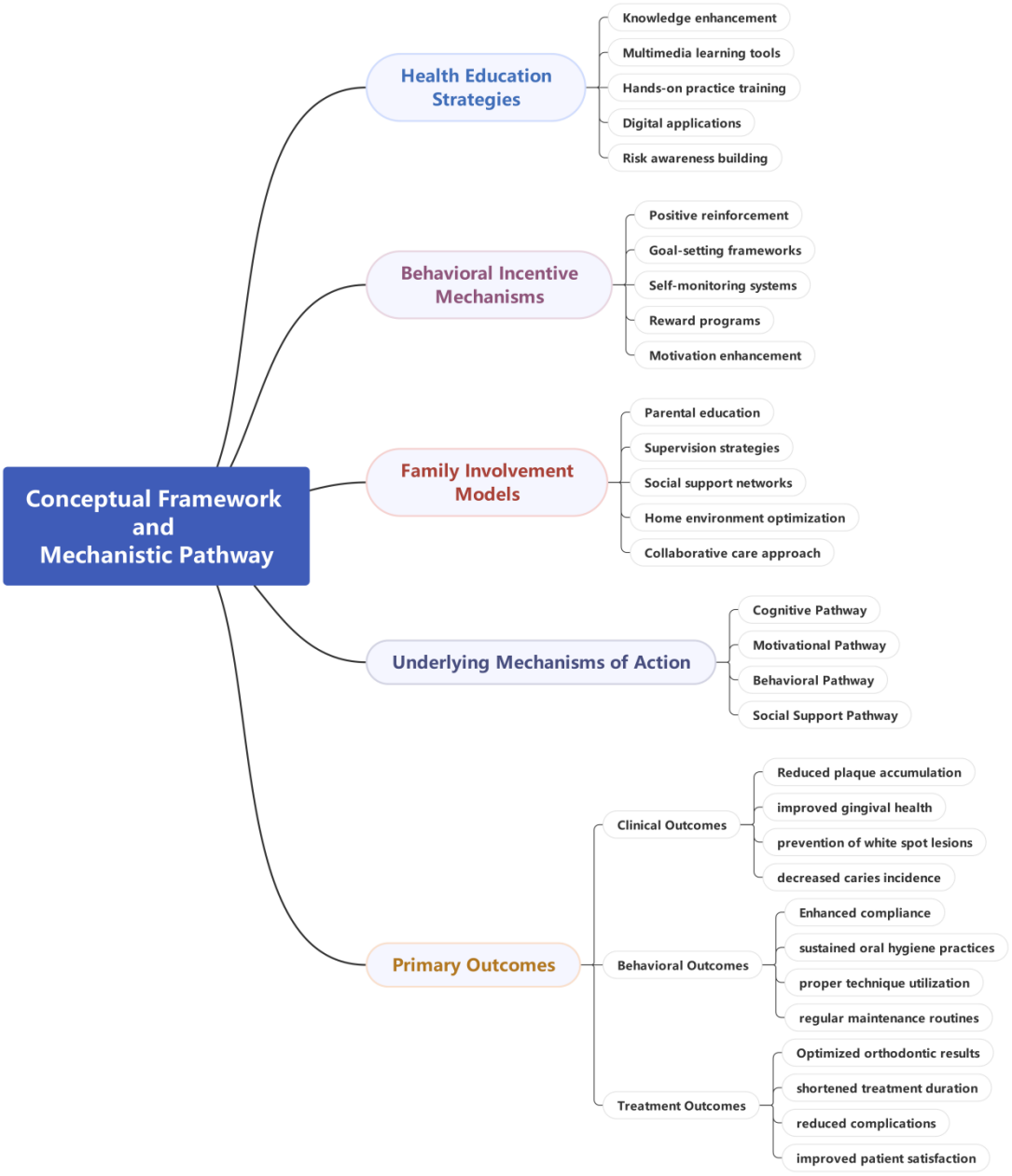

Figure 1. Conceptual Framework and Mechanistic Pathway of the Integrated Nursing Intervention Model for Oral Hygiene Behavior in Adolescent Orthodontic Patients

Figure 2 illustrates the integrated nursing intervention model depicting the interconnected relationships among the three core intervention strategies (health education, behavioral incentives, and family involvement), the four underlying mechanistic pathways, and the three primary outcome domains. The model demonstrates a synergistic framework where intervention components operate through cognitive, motivational, and behavioral pathways to produce clinical improvements, behavioral enhancements, and optimized treatment results. Bidirectional arrows emphasize the dynamic, reciprocal nature of these relationships, highlighting how initial outcomes reinforce continued engagement with intervention strategies and sustain positive behavioral changes.

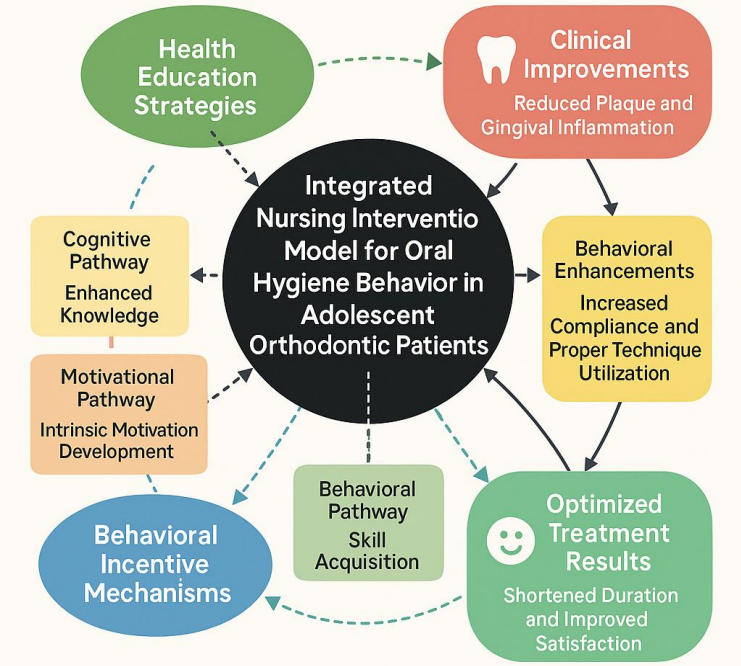

Figure 2. Integrated Nursing Intervention Model for Oral Hygiene Behavior in Adolescent Orthodontic Patients: Pathways and Outcomes

2.3 Clinical Application and Effect Evaluation of Nursing Models

2.3.1 Implementation Process of Nursing Models in Clinical Practice

The implementation of nursing models in clinical practice for adolescent orthodontic patients begins with a comprehensive initial assessment of the patient's oral hygiene status and behavioral habits. This evaluation involves detailed examination of plaque accumulation, gingival health, and patient-reported oral hygiene routines, which serve as baseline indicators for tailoring interventions. Following assessment, an individualized nursing intervention plan is formulated, integrating health education, motivational strategies, and active family involvement. Health education focuses on imparting knowledge about the importance of oral hygiene during orthodontic treatment, potential complications arising from poor care, and practical guidance on maintaining oral cleanliness. Motivation is enhanced through positive reinforcement and goal-setting techniques, encouraging patients to adhere to

recommended behaviors. Family participation is emphasized to provide continuous support and supervision, which is critical in adolescent populations. The nursing model incorporates scheduled regular follow-ups to monitor progress, reassess oral hygiene indices, and adjust care strategies accordingly, ensuring maximal intervention efficacy. This cyclical process facilitates dynamic adaptation to patient needs and promotes sustained behavioral change. Integration of digital tools, such as mobile applications and digital notebooks, has been explored to augment education and follow-up efficiency, demonstrating improved patient engagement and nursing workflow optimization. The structured implementation process underscores a holistic approach, combining clinical assessment, personalized education, motivational support, and family involvement to enhance oral hygiene behaviors in orthodontic adolescents (Shi, L. N., Wang, L., Gao, Y. B., et al., 2025; Lv, S., Ye, X., Wang, Z., et al., 2019; Yuan, X., Zhu, L., Jiang, K., & Chen, J., 2025).

2.3.2 Evaluation Indicators of Nursing Model Effectiveness

Effectiveness of nursing models in orthodontic oral hygiene intervention is primarily evaluated through changes in oral hygiene indices, including plaque index and gingival index, which objectively reflect improvements in oral cleanliness and gingival health. Significant reductions in plaque accumulation and gingival inflammation post-intervention indicate successful behavioral modification and adherence to oral hygiene protocols. Patient compliance with oral hygiene behaviors and self-management capacity are assessed via validated questionnaires and behavioral observations, revealing enhanced knowledge, motivation, and routine maintenance of oral care. Additionally, the incidence of orthodontic treatment complications, such as gingivitis, dental caries, and mucosal lesions, serves as a critical outcome measure, with decreased complication rates signifying improved preventive care. Treatment progress, including orthodontic outcomes and patient satisfaction, is also monitored to evaluate the broader impact of nursing interventions. Advanced evaluation models, such as the Kirkpatrick framework, have been utilized to assess training effectiveness for nursing staff, encompassing reaction, learning, behavior, and results levels, thereby ensuring that nursing competencies translate into improved patient care. The incorporation of AI-assisted closed-loop nursing information systems further enhances the precision and timeliness of quality indicators, contributing to comprehensive effectiveness assessment. Collectively, these multidimensional indicators provide robust evidence of nursing model efficacy in optimizing oral hygiene and orthodontic treatment outcomes (Yuan, X., Zhu, L., Jiang, K., & Chen, J., 2025; Li, Y., Yang, Q., Wang, X., et al., 2024; Yang, M., Zhang, X., Han, R., et al., 2025; Liang, B., Zhang, J., Qu, Z., et al., 2024).

2.3.3 Representative Research Cases and Data Analysis

Recent clinical studies have demonstrated significant improvements in oral hygiene status among adolescent orthodontic patients following nursing model interventions. For example, a randomized controlled trial employing a mobile application-assisted nurse-led management model reported decreased frequency of asthma exacerbations and improved adherence, suggesting the potential of digital tools in enhancing nursing care outcomes, which can be extrapolated to oral hygiene

interventions in orthodontics (Lv, S., Ye, X., Wang, Z., et al., 2019). Comparative analyses of different nursing strategies reveal that continuity of care under integrated healthcare models leads to superior periodontal health, reduced complications, and enhanced self-management and psychological well-being among orthodontic patients, compared to routine care (Li, Q., Wu, R., Du, C., & Miao, Q., 2025). Moreover, studies analyzing the impact of educational models, such as the flipped classroom and role-playing methods, indicate that structured, interactive nursing education significantly elevates nursing students' critical thinking, self-efficacy, and clinical competencies, which are essential for effective patient education and behavioral intervention (Su, X., Ning, H., Zhang, F., Liu, L., Zhang, X., & Xu, H., 2023; Dorri, S., Farahani, M. A., Maserat, E., & Haghani, H., 2019). Variability in nursing model effectiveness across different populations and treatment stages has been noted, emphasizing the need for tailored approaches. For instance, children with neurodevelopmental disabilities or autism spectrum disorders exhibit unique challenges requiring specialized nursing strategies to address oral hygiene behaviors effectively (Véliz Méndez, S., Rotman, M., Hormazábal, F., Sepúlveda, L., Valle, M., & Álvarez, E., 2022; Khalifa, A. B. H., Boukhris, H., Ayari, G., Ksiksi, Y., & Baccouche, C., 2025). Data also suggest that psychosocial factors, such as anxiety and fear related to dental care, influence oral health behaviors, underscoring the importance of integrating psychological support within nursing models (Supriya, Singh, R., & Ahsan, A., 2024). Optimization of nursing models involves leveraging technological advancements, including AI and tele-orthodontics, to improve accessibility, monitoring, and personalized care, thereby enhancing intervention outcomes across diverse clinical contexts (Kavousinejad, S., Ameli-Mazandarani, Z., Behnaz, M., & Ebadifar, A., 2024; Masood, H., Rossouw, P. E., Barmak, A. B., & Malik, S., 2025). These findings collectively advocate for a dynamic, evidence-based nursing model framework that adapts to patient-specific needs, treatment phases, and emerging technologies to maximize oral hygiene behavior modification and orthodontic treatment success.

3. Conclusion

This review demonstrates that integrated nursing intervention models combining health education, behavioral motivation, and family involvement significantly enhance oral hygiene compliance in adolescent orthodontic patients. Traditional single-approach strategies prove insufficient due to the complex psychosocial characteristics of this population. Evidence supports that personalized, multidimensional care frameworks effectively address the unique challenges of maintaining oral hygiene during orthodontic treatment. Future research should focus on optimizing intervention components and exploring long-term sustainability of behavioral changes. Interdisciplinary collaboration remains essential for developing comprehensive care models that improve treatment outcomes and patient quality of life.

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