The association between parent-child relationship and orthodontic compliance with clear aligners among children and adolescents

Zhenrong Yin,[a] Yiliu Zhou,[a] Yuxiang Peng,[a] Chaoran Xue,[a,b,c] Zhihe Zhao,[a,b] Xianglong Han,[a,b] and Peilin Li[a,b,c]
Chengdu, China

Introduction: This study aimed to quantitatively and systematically evaluate the association between parent-child relationship (PCR) and orthodontic compliance with clear aligners (CAs) among children and adolescents. **Methods:** Children and adolescents aged 6-18 years undergoing orthodontic treatment with CAs were included. Parents completed 3 sections of the questionnaire: the sociodemographic section, the previously established Child-Parent Relationship Scale, and the CA compliance section with 8 self-designed compliance indicators. Spearman correlation coefficients and binary logistic regression were used for comprehensive quantitative analysis. **Results:** A total of 124 questionnaires were included and analyzed. No significant differences in CA compliance were found across different sociodemographic characteristics ($P > 0.05$). Among compliance indicators, appointment adherence (4.67 $\pm$ 0.70) and timely aligner change (4.42 $\pm$ 0.83) received the highest scores, whereas chewies usage scored the lowest (3.21 $\pm$ 1.14). Higher closeness and lower conflict demonstrated a statistically significant, but relatively weak correlation with a higher mean compliance score ($P < 0.01$). Significantly more patients with high closeness and low conflict demonstrated better CA compliance, particularly in cleaning aligners and timely aligner change ($P < 0.05$). Participants with high closeness were 2.2 times more likely to achieve better overall compliance, whereas those with high conflict were only 0.3 times as likely as those with low conflict. **Conclusions:** High closeness and low conflict in PCR are associated with better CA compliance among children and adolescents, particularly in cleaning aligners and timely aligner change. Chewies usage showed the lowest compliance and warrants significant improvement. Pretreatment assessment of children's and adolescents' PCR can offer valuable prognostic insights for orthodontic treatment planning and personalized compliance management. (Am J Orthod Dentofacial Orthop 2026;■:■-■)

Malocclusion is a highly prevalent disease and affects approximately 70% of children and adolescents.[1] This population is more susceptible to disruptions in normal jaw growth, masticatory function, and psychosocial development compared with adults.[2] With the increasing demand for esthetic and comfortable orthodontic treatment, clear aligners (CAs) have gained widespread adoption globally,

[a] State Key Laboratory of Oral Diseases & National Center for Stomatology & National Clinical Research Center for Oral Diseases, West China Hospital of Stomatology, Sichuan University, Chengdu, China.
[b] Department of Orthodontics, West China Hospital of Stomatology, Sichuan University, Chengdu, China.
[c] Specialized Department of Pediatric Early Orthodontics, West China Hospital of Stomatology, Sichuan University, Chengdu, China.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
This work was supported by the National Natural Science Foundation of China (62306193) and Sichuan Science and Technology Program (2025ZNSFSC0756 and 2026NSFSC1577).

All procedures were performed in compliance with relevant laws and institutional guidelines and have been approved by the Medical Ethics Committee, West China Stomatological Hospital, Sichuan University, China (approval No. WCHSIRB-D-2025-051; approval date 19 February 2025). Informed consent was obtained for experimentation with human subjects.
Address correspondence to: Peilin Li, Department of Orthodontics, West China Hospital of Stomatology, Sichuan University, No. 14, Block 3, Renmin Road South, Chengdu 610041, China; e-mail, lipeilin@scu.edu.cn.
Submitted, August 2025; revised and accepted, December 2025.
0889-5406

https://doi.org/10.1016/j.ajodo.2025.12.012

particularly among children and adolescents.[3] Early orthodontic intervention with CAs can effectively eliminate adverse oral and systemic factors, optimize dentofacial development, and promote harmonious craniofacial growth and function, while also simplifying the correction of malocclusion in the permanent dentition.[4] Moreover, CAs demonstrate distinct therapeutic advantages, including precise guidance of permanent tooth eruption, prevention of severe malocclusion progression, and facilitation of oral hygiene maintenance.[3,5] The removable nature of CAs necessitates strict daily compliance to achieve optimal outcomes, requiring consistent adherence to treatment protocols, such as adequate wear duration, timely aligner change, and correct chewie usage.[6-8] However, children and adolescents often exhibit limited self-control and cognitive immaturity, which may compromise compliance in CA treatment. These compliance issues may result in prolonged treatment duration, suboptimal clinical outcomes, or even premature treatment discontinuation.[9] Therefore, identifying factors associated with CA compliance in this population is essential for improving both treatment efficacy and patient satisfaction.

Previous studies have shown that pediatric patients' own profiles, such as gender, age, and personality traits, are significantly associated with orthodontic compliance.[10,11] Beyond these innate factors, current studies highlight the crucial role of parental involvement in pediatric patients' compliance during orthodontic treatment, in line with the growing recognition of the bio-psycho-social medical model.[3] Research has established that specific parental behaviors are positively linked to orthodontic compliance, including active motivational support, conscientious supervision, and heightened awareness of their child's emotional well-being alteration.[9,12,13] Furthermore, higher parental education levels show a consistent association with improved orthodontic compliance, potentially attributable to enhanced health literacy and treatment understanding.[11] Clinical observations indicate that patients from supportive family environments frequently demonstrate better persistence through discomfort, whereas those from conflictual parent-child relationship (PCR) backgrounds often exhibit higher noncompliance rates. Nevertheless, the association between PCR and CA compliance among children and adolescents remains underexplored.

This study aims to investigate the association between PCR and the compliance of children and adolescents in CA treatment. To our knowledge, this represents the first attempt to comprehensively and quantitatively evaluate CA compliance and systematically explore the associations between PCR and CA compliance within this population. The findings will provide clinicians with evidence-based insights to enhance compliance management and facilitate more personalized treatment planning for pediatric patients.

MATERIAL AND METHODS

Approval for this study was obtained from the clinical research ethics committee of West China Hospital of Stomatology, Sichuan University, on 19 February 2025 (approval No. WCHSIRB-D-2025-051). All procedures adhered to the relevant guidelines and regulations, including the Declaration of Helsinki. Informed consent was secured from all participants involved in the study.

The sample size was calculated using the G*Power statistical software (version 3.1.9.7; Franz Faul, Universität Kiel, Germany).[14] Correlation analysis calculated that a minimum of 96 subjects were required for the study, based on an alpha of 0.05, a power of 0.85, and a correlation coefficient of 0.3.[15] Considering a potential drop-out rate of 10%, the final estimate of the minimum required sample size was approximately 106 patients.

This study was conducted from February 2025 to April 2025 at the Department of Orthodontics of West China Hospital of Stomatology, Sichuan University. The inclusion criteria were as follows: patients aged 6-18 years who underwent treatment with CAs at the Department of Orthodontics of West China Hospital of Stomatology. Parental consent was secured before study participation, and parents were required to complete the questionnaire. The exclusion criteria were as follows: parents who declined study participation, withheld consent, or failed to complete the questionnaire fully and patients who received fixed aligner treatment or were accompanied by nonparental individuals.

Our questionnaire comprised 3 sections. The first section gathered patients' socio-demographic data. The second section employed the Child-Parent Relationship Scale (CPRS; R Pianta, 1992), a well-established, internationally validated, and widely applied instrument to assess PCR.[16] In this study, the previously translated and validated Chinese version of the CPRS was used,[16] which evaluates 3 dimensions: closeness (10 items), conflict (12 items), and dependence (4 items). Given the low reliability of the dependence dimension in previous studies,[17] only the closeness and conflict dimensions were included in this research. The third section, designed by us based on previous surveys,[10,18] assesses CA compliance across

8 aspects: adequate wear duration, use chewies, wear elastics, maintain oral hygiene, clean aligners, timely change aligners, appointment adherence, and damage or loss of aligners. The second and third sections both used a 5-point Likert scale ranging from never (1 point) to always (5 points). In the third section, after the scoring of the negative item damage or loss of aligners was reversed, the total score ranged 0-40, with higher values denoting better compliance. As only 58 of the 124 children were required to wear elastics, scores for children not wearing elastics ranged 0-35. The mean compliance score was used to reflect overall compliance, with a higher mean score indicating better overall compliance. The questionnaire used in this study is provided in the Supplementary Material.

Before the main survey, the self-designed third section underwent face validation by an experienced orthodontist and was subsequently pilot tested among 30 patients. The reliability of the third part was assessed using Cronbach Alpha, which yielded a value of 0.751, indicating good internal consistency and acceptability for survey instruments.[19]

Statistical analysis

Data analysis was performed using SPSS Statistics (version 27; IBM, Armonk, NY). First, descriptive statistics were used to outline participants' sociodemographic characteristics, PCR, and compliance indicators for CA treatment via text and tables. Given the non-normal distribution of the samples confirmed by the Shapiro-Wilk test, the Mann-Whitney U test and the Kruskal-Wallis H test were applied to compare sociodemographic characteristics and mean compliance score. For PCR, samples were divided into 2 categories based on the median score of each dimension: high closeness or conflict (scores equal to or greater than the median) and low closeness or conflict (scores below the median).[20] Regarding compliance, good compliance for each item was defined as selecting often (4 points) or always (5 points), except for selecting rarely (reversed 4 points) or never (reversed 5 points) for the negative item damage or loss of aligners. Similarly, overall good compliance was defined as having a mean compliance score of $\geq$4, corresponding to selecting the 2 options (4 or 5 points) representing good compliance for each item on average. Spearman rho correlation coefficients were used to measure correlations, Pearson chi-square tests to assess differences in good compliance patient proportion, and binary logistic regression to determine the predictive role of PCR for CA compliance. All variables with P values <0.05 at 95% confidence intervals (CIs) were deemed statistically significant.

RESULTS

A total of 124 children and adolescent participants (53 males and 71 females) were included (Table I). Their ages ranged from 6-18 years, with a mean age of 12.35 years (standard deviation = 2.62). The results showed that 66.90% of the participants were the only child, 75.00% had parents with a college degree as the highest education level, and 83.90% were day scholars (ie, did not board at school on weekdays). No significant differences in CA compliance were found between samples with different sociodemographic characteristics ($P > 0.05$) according to the Mann-Whitney U test and the Kruskal-Wallis H test.

The descriptive data of PCR and compliance demonstrated considerable closeness (40.65 $\pm$ 5.42) and an elevated mean compliance score (3.97 $\pm$ 0.59) of the samples (Table II). The median scores for closeness and conflict were 42.00 and 26.00, respectively. Among compliance indicators, timely change aligners (4.42 $\pm$ 0.83) and appointment adherence (4.67 $\pm$ 0.70) received the highest scores, whereas use chewies (3.21 $\pm$ 1.14) scored lowest.

The heat map demonstrates the Spearman rho correlation coefficients between PCR and compliance indicators (Fig 1). The bottom of the heat map showed the value of the Spearman rho correlation coefficients. Left-sided blue areas denote negative correlations, whereas right-sided red areas denote positive correlations. The color intensity reflects correlation strength, with light and white areas indicating weak or no correlation. Closeness shows a highly significant positive correlation with cleaning aligners and mean compliance score ($P < 0.01$), whereas conflict has a highly significant negative correlation with cleaning aligners, timely changing aligners, and mean compliance score ($P < 0.01$). However, with all correlation coefficients <0.39, this indicates a statistically significant, but relatively weak correlation between the high closeness and low conflict scores in PCR and good compliance for CA treatment.[21]

Figure 2 illustrates the proportion of patients with good compliance across each indicator and overall. Pearson chi-square tests indicated that significantly more patients with high closeness showed good compliance in maintaining oral hygiene, cleaning aligners, and timely changing aligners ($P < 0.05$). Regarding adequate wear duration, 73.44% patients with high closeness showed good compliance, compared with 60.00% of those with low closeness, although not significant ($P = 0.112$) (Fig 2, A). Also, significantly more patients with low conflict showed good compliance in adequate wear duration, using chewies, wearing

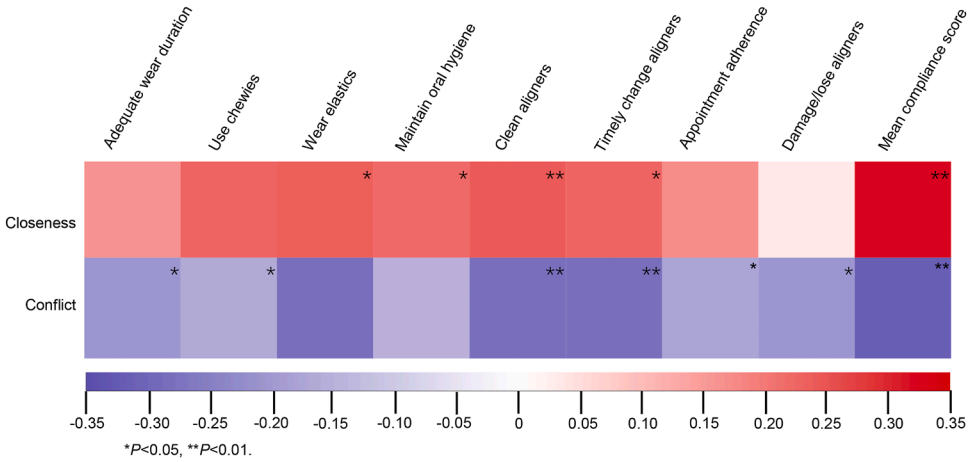

Fig 1. Correlation between PCR and indicators of compliance.

elastics, cleaning aligners, and timely changing aligners ($P < 0.05$). Specifically, 76.67% patients with low conflict showed good compliance in adequate wear duration, compared with 57.81% of those with high conflict. Significantly more patients with high closeness and low conflict demonstrated a higher mean compliance score of ≥4 ($P < 0.01$). These suggest that more patients with high closeness and low conflict in PCR demonstrated good compliance, both in most compliance indicators and in the overall level. Furthermore, regardless of the levels of closeness or conflict, a remarkably high and consistent proportion of patients, exceeding 90% and peaking at 95.31%, demonstrated good compliance in appointment adherence (Fig 2, *B*).

Binary logistic regression analysis further confirmed that closeness and conflict were significant predictors of compliance for CA treatment (Table III). The Hosmer-Lemeshow test ($P = 0.943$) indicated that the predicted probability of the model fitted well with the actual probability. It was found that patients with high closeness were 2.2 times more likely to have a high mean compliance score than those with low closeness (odds ratio = 2.238; 95% CI: 1.051-4.764; $P = 0.037$). Conversely, patients with high conflict were only 0.3 times as likely to have a high mean compliance score as those with low (odds ratio = 0.366; 95% CI: 0.172-0.782; $P = 0.009$). That is to say, patients with high closeness and low conflict are particularly more likely to have good compliance in CA treatment.

DISCUSSION

Strict daily compliance is essential for successful CA treatment in young patients, yet reliable assessment remains a challenge because of the predominantly qualitative nature of existing metrics.[6,18] Our study addresses this gap by introducing a comprehensive, quantitative framework that evaluates 8 key compliance behaviors, which are adequate wear duration, use chewies, wear elastics, maintain oral hygiene, clean aligners, timely change aligners, appointment adherence, and damage or loss of aligners. By employing the CPRS, an internationally validated and widely applied instrument[16] to assess PCR, our study represents the first to systematically examine and confirm the associations between PCR and CA compliance among children and adolescents. Results show that pediatric patients with high closeness and low conflict in PCR tend to exhibit better compliance during CA treatment, both in the most compliance indicators and in the overall level. Thus, assessing PCR via observation, inquiry, or brief questionnaires during orthodontic treatment planning may offer valuable prognostic information. In particular, low closeness or high conflict can serve as a warning that CA treatment may be at an increased risk of poor compliance and suboptimal outcomes, thereby encouraging the need for additional motivational or behavioral management and more careful consideration of tooth movement design. Such a proactive approach could help mitigate various adverse outcomes (eg, treatment prolongation and unsatisfactory outcomes) associated with noncompliance.[9]

This study examined the association between sociodemographic factors and compliance in CA treatment. The results indicated no significant differences in CA compliance across sociodemographic variables, including sex, age, only-child status, parental education, family income, and boarding status. Regarding gender, Al-Abdallah et al[11] found that female patients aged 12-18 years were more compliant during fixed orthodontic treatment. Schäfer et al[22] reported that females aged

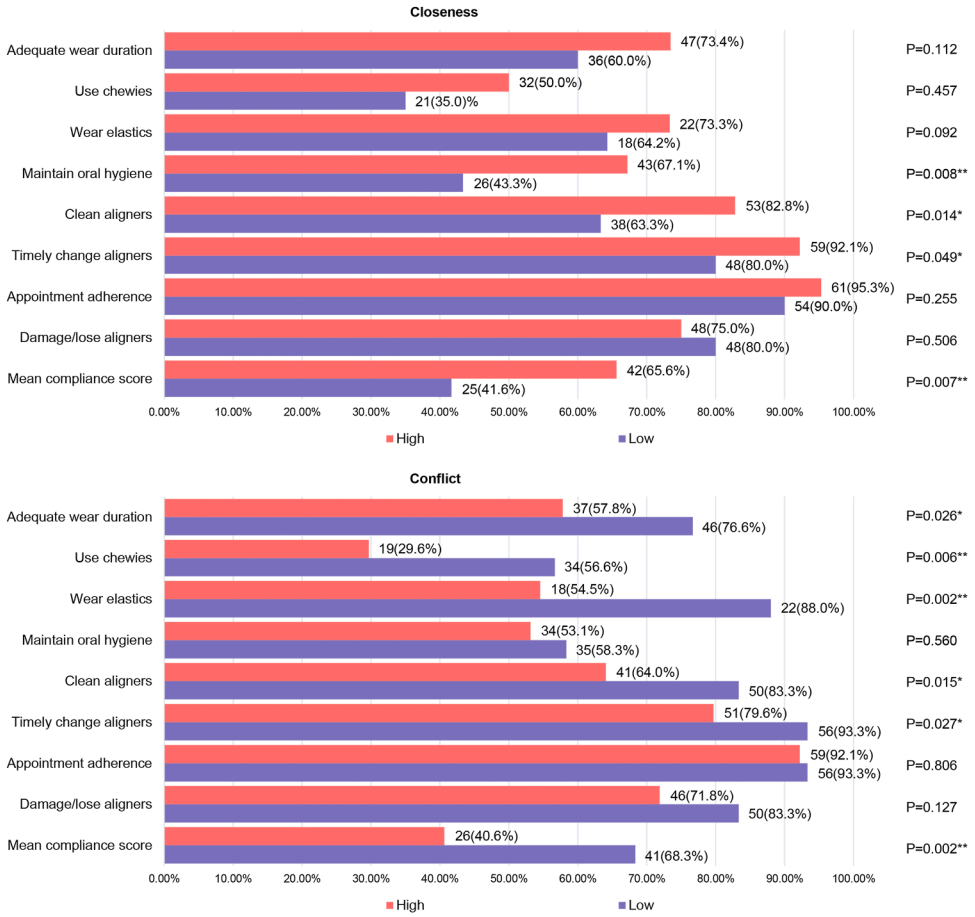

Fig 2. Proportion of good compliance in patients with high or low levels of PCR. **A,** Closeness; **B,** conflict.

7-15 years were more compliant with removable appliances. Consistently, 2 additional studies focusing on children and adolescents under the age of 18 years also reported better compliance with fixed appliances in females.[11,23] Regarding age, studies have reported that orthodontic compliance with removable appliances decreases with age in children and adolescents aged 6-15 years, which may be associated with the onset of puberty.[10,24] Regarding boarding status, previous research indicates that boarding can lead to unstable relationships and reduced attachment among children and adolescents,[25] potentially affecting CA compliance indirectly. The discrepancies between our findings and those of previous studies may stem from differences in the types of orthodontic appliances used, as well as the specific sample characteristics arising from nonrepresentative and convenience sampling. Further research with more diverse, cross-regional samples is needed to confirm the association of gender, age, and boarding status with CA compliance.

Building on previous research,[11,26] we incorporated a broader set of compliance indicators for CA treatment, including adequate wear duration, usage of chewies, wear of elastics, and incidence of aligner damage or loss, to promote a more comprehensive assessment. Adequate aligner wear duration (22 hours daily) is fundamental to maintaining continuous and stable orthodontic forces for efficient tooth movement. Insufficient wear duration disrupts force application, thereby compromising treatment efficiency and prolonging the overall treatment duration.[6] Orthodontic chewies critically enhance aligner-tooth adaptation by eliminating interfacial gaps, thereby optimizing force transmission fidelity. However, our study found that the usage of chewies scored lowest among the 8 indicators, which may result in force decay and an increased risk of tracking failures, consequently necessitating more midcourse corrections. To enhance patient compliance with chewies usage and achieve better treatment outcomes, strategies, such as daily records and timely

Table I. Comparisons between sociodemographic details and mean compliance score

			Mean compliance score		
Variables		*N (%)*	*Median (Q1, Q3)*	*U/H*	*P value*
Sex	Male	53 (42.70)	3.875 (3.535, 4.535)	1946.000*	0.744
	Female	71 (57.30)	4.125 (3.625, 4.428)		
Age	Children (aged 6-11 years)	49 (39.50)	4.000 (3.598, 4.428)	1850.500*	0.947
	Adolescent (aged 12-18 years)	75 (60.50)	4.000 (3.571, 4.428)		
Only child	Yes	83 (66.90)	4.000 (3.626, 4.428)	1570.000*	0.484
	No	41 (33.10)	4.000 (3.464, 4.428)		
Parental educational attainment	Less than high school	9 (7.30)	3.750 (3.500, 4.464)	1.319**	0.517
	College degree (Associate's/bachelor's)	93 (75.00)	4.125 (3.589, 4.428)		
	Graduate degree (Master's/PhD)	22 (17.70)	3.857 (3.611, 4.464)		
Household monthly income	<5000 CNY (<700 USD)	4 (3.20)	4.357 (3.415, 4.669)	0.518**	0.772
	5000-10,000 CNY (700-1400 USD)	33 (26.60)	4.000 (3.464, 4.535)		
	>10,000 CNY (>1400 USD)	87 (70.20)	4.000 (3.625, 4.428)		
Boarding	Yes	20 (16.10)	4.187 (3.339, 4.428)	1013.500*	0.857
	No	104 (83.90)	4.000 (3.625, 4.428)		

Note. Exchange rate: 1 USD = 7.1 CNY (June 2025).
Q1, the first quartile; *Q3*, the third quartile; *UDS*, US dollar; *CNY*, Chinese yuan.
*U, the Mann-Whitney U statistic; **H, the Kruskal-Wallis H statistic.

reminders from parents, could be adopted.[27] Elastics supplement directional forces for complex tooth movements, such as reducing midline deviation and achieving Class I molar relationships.[7,28] Damage or loss of aligners can interrupt the application of orthodontic force, leading to stagnation of tooth movement or even rebound.[29] Our results indicated that for adequate wear duration, usage of chewies, and damage or loss of aligners, no statistically significant associations were found between closeness and any of the 3 compliance indicators. In contrast, conflict demonstrates a significantly negative association with adequate wear duration and chewies usage, as evidenced by both the Spearman rho correlation coefficients and the proportion of patients with good compliance. In addition, regarding the usage of elastics, the results of the correlation analysis and proportion analysis are inconsistent, which may stem from the limited number of patients using elastics (58 of 124). Further research with larger sample sizes is needed to clarify how PCR relates to elastics usage compliance and, consequently, to final treatment outcomes.

Our results suggest that among the compliance indicators, cleaning aligners and timely aligner change show the strongest associations with PCR. Spearman correlation coefficients revealed that cleaning aligners and timely aligner change were statistically significantly, although weakly, positively correlated with closeness and negatively correlated with conflict. Similarly, the proportion of patients with good compliance in these 2 indicators was significantly higher among those with high closeness and low conflict. The findings suggest that enhancing PCR may yield particularly marked effects on these 2 specific compliance behaviors, thereby optimizing treatment outcomes. In addition, closeness exhibited a significant positive association with maintaining oral hygiene, as demonstrated by both Spearman rho correlation coefficients and the proportion of patients with good compliance, whereas conflict showed a marginal association. Maintaining oral hygiene through practices, such as brushing teeth and using dental floss, can prevent the accumulation of dental plaque on the tooth surface.[30] Cleaning the aligners helps prevent the adhesion of harmful bacteria and the formation of plaques, while preserving the transparency and esthetic appeal of the aligners.[31] Given that CAs can cause prolonged plaque retention or even sugary fluid buildup on the tooth surface, which may lead to disastrous consequences,[32] cleaning both teeth and aligners is essential to reduce the risk of oral diseases, including gingivitis, periodontitis, white spot lesions, caries, and halitosis. Timely aligner change prevents material fatigue and ensures proper force application.[33] Recent research shows that a 7-day changing interval for CAs achieves similar clinical accuracy to the conventional 14-day interval regardless of extraction. Delayed aligner change doesn't improve treatment outcomes and instead prolongs the treatment duration.[8,33]

In this study, appointment adherence served as the most consistent and compliant behavior among 8 indicators, with rates exceeding 90% and reaching a peak of

Table II. Descriptive statistics of PCR and compliance indicators

Variables	*Mean (SD)*	*Median (Q1, Q3)*	*Minimum-maximum*
Closeness (10-50)	40.65 (5.42)	42.00 (38.00, 44.00)	14.00-49.00
Conflict (12-60)	27.56 (9.28)	26.00 (20.25, 33.00)	12.00-53.00
Adequate wear duration	3.77 (1.15)	4.00 (3.00, 5.00)	1.00-5.00
Use chewies	3.21 (1.14)	3.00 (2.00, 4.00)	1.00-5.00
Wear elastics	3.97 (0.90)	4.00 (3.00, 5.00)	2.00-5.00
Maintain oral hygiene	3.65 (1.07)	4.00 (3.00, 5.00)	1.00-5.00
Clean aligners	3.94 (0.96)	4.00 (3.00, 5.00)	1.00-5.00
Timely change aligners	4.42 (0.83)	5.00 (4.00, 5.00)	2.00-5.00
Appointment adherence	4.67 (0.70)	5.00 (5.00, 5.00)	1.00-5.00
Damage/loss of aligners	4.15 (1.02)	4.00 (4.00, 5.00)	1.00-5.00
Mean compliance score	3.97 (0.59)	4.00 (3.58, 4.43)	2.13-5.00

SD, standard deviation; *Q1*, the first quartile; *Q3*, the third quartile.

Table III. Binary logistic regression between the PCR and compliance

Variable	*B*	*SE*	*P value*	*OR (95% CI)*
Closeness	0.806	0.386	0.037	2.238 (1.051-4.764)
Conflict	−1.005	0.387	0.009	0.366 (0.172-0.782)
Constant	0.484	0.904	0.592	

Note. Hosmer-Lemeshow X2 = 0.117; *P* value = 0.943>0.05.
B, logistic coefficient; *SE*, standard error.

95.31% across varying PCR level cohorts. Moreover, this high level of adherence showed no significant variation across patients with different levels of PCR. Similarly, other research incorporating appointment adherence as a compliance indicator also found no significant differences among patients with varying economic status, communication strategies, or types of invisible appliance (CAs or lingual braces).[11,34] Better appointment adherence allows the dentist to address orthodontic emergencies and make timely adjustments to the treatment plan to ensure that the orthodontic process stays on track.[35]

Previous studies have shown that parental motivation,[12] higher parental education levels,[11] parental self-efficacy,[13] and a positive orthodontist-patient-parent relationship[36] are associated with children's better cooperation in orthodontic treatment, highlighting parents' crucial role in pediatric orthodontic compliance. Our study on PCR further extends this understanding, particularly regarding CA treatment. These findings collectively suggested that family-centered interventions may be beneficial in promoting orthodontic compliance among children and adolescents. Evidence-based family interventions, such as role-playing exercises and family discussions among parents, have shown efficacy in strengthening PCR.[37] Hence, family psychoeducation and targeted interventions appear to represent promising strategies for supporting compliance during long-term orthodontic treatment and ultimately improving clinical outcomes in children and adolescents.

Though meticulously planned, this research has several limitations. First, the relatively modest correlation coefficients between PCR and CA compliance suggest that other confounding variables, such as oral health–related quality of life and the orthodontist-patient relationship,[38] may also be associated with CA compliance. Therefore, PCR should be considered as a complementary factor, rather than the sole determinant, in predicting CA compliance. Second, the cross-sectional design precludes causal inference; thus, the observed associations should not be interpreted as direct causation. Third, although the CPRS is a widely validated and cross-culturally applied tool,[16] its applicability may be affected by cultural bias and reduced sensitivity in adolescents.[39] Fourth, assessing CA compliance via questionnaires may introduce subject-reported and social desirability biases, as overreporting of appliance wear has been noted in a previous review.[40] Finally, as data were collected from a single-center sample, the generalizability of the findings may be limited. Sociocultural and economic variations across regions could further influence the observed associations. Despite these limitations, this study provides valuable preliminary insights into the relationship between PCR and CA compliance among children and adolescents.

Future multicenter, cross-regional studies with more diverse and representative samples are warranted.

CONCLUSIONS

This study aims to comprehensively and quantitatively evaluate CA compliance and systematically explore its association with PCR among children and adolescents. The results indicate that high closeness and low conflict in PCR are associated with better CA compliance among children and adolescents, particularly regarding cleaning aligners and timely aligner change. Chewies usage showed the lowest compliance and warrants significant improvement. Pretreatment assessment of PCR in children and adolescents may serve as a valuable adjunct for predicting CA compliance and indicating individualized behavioral management, thereby helping to mitigate adverse outcomes associated with noncompliance.

AUTHOR CREDIT STATEMENT

Zhenrong Yin contributed to conceptualization, methodology, formal analysis, investigation, writing-original draft preparation, and writing-reviewing and editing; Yiliu Zhou contributed to methodology, investigation, visualization, and writing-original draft preparation; Yuxiang Peng contributed to investigation, visualization, and writing-original draft preparation; Zhihe Zhao contributed to writing-reviewing and editing; Chaoran Xue contributed to funding acquisition and writing-reviewing and editing; Xianglong Han contributed to writing-reviewing and editing; Peilin Li contributed to conceptualization, methodology, writing-reviewing and editing, project administration, funding acquisition, and supervision. All authors read and approved the final version of this manuscript.

ACKNOWLEDGMENTS

The authors thank Wenyu Zhang, Chao Huang, Peiqi Wang, and Tian Tang for their valuable support and contributions to this study.

SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ajodo.2025.12.012

REFERENCES

1. Göranson E, Sonesson M, Naimi-Akbar A, Dimberg L. Malocclusions and quality of life among adolescents: a systematic review and meta-analysis. Eur J Orthod 2023;45:295-307.
2. Alshammari A, Almotairy N, Kumar A, Grigoriadis A. Effect of malocclusion on jaw motor function and chewing in children: a systematic review. Clin Oral Investig 2022;26:2335-51.
3. Chandra A, Thosar NR, Parakh H. Clear aligners in pediatric dentistry: a scoping review. Cureus 2024;16:e58992.
4. Zhou C, Duan P, He H, Song J, Hu M, Liu Y, et al. Expert consensus on pediatric orthodontic therapies of malocclusions in children. Int J Oral Sci 2024;16:32.
5. Gazzani F, Pavoni C, Loberto S, Caruso S, Cozza P. Severe crowding associated with lower canine premature resorption: interceptive treatment with clear aligners-a pilot study. Children (Basel) 2024;11:451.
6. Cremonini F, Chiusolo G, Pepe F, Lombardo L. Color variation in 3D-printed orthodontic aligners as a compliance indicator: a prospective pilot study. Appl Sci 2025;15:6409.
7. Quinzi V, Conigliaro A, Fani E, Memè L, Fiasca F, Carugo N, et al. Teenage patients with Class II subdivision treated with aligners and elastics: a retrospective study. Medicina (Kaunas) 2024;60:2089.
8. Yu Y, Zhou Y. Evaluation of Invisalign wear protocol on the efficacy of tooth movement in four first-premolar extraction in adolescent patients: a randomised controlled trial. Orthod Craniofac Res 2025;28:466-73.
9. Stefanovic NL, Uhac M, Brumini M, Zigante M, Perkovic V, Spalj S. Predictors of patient compliance during Class II division 1 malocclusion functional orthodontic treatment. Angle Orthod 2021;91:502-8.
10. Torsello F, D'Amico G, Staderini E, Marigo L, Cordaro M, Castagnola R. Factors influencing appliance wearing time during orthodontic treatments: a literature review. Appl Sci 2022;12:7807.
11. Al-Abdallah M, Hamdan M, Dar-Odeh N. Traditional vs digital communication channels for improving compliance with fixed orthodontic treatment. Angle Orthod 2021;91:227-35.
12. Quinzi V, Salvati SE, Pisaneschi A, Palermiti M, Marzo G. Class III malocclusions in deciduous or early mixed dentition: an early orthopaedic treatment. Eur J Paediatr Dent 2023;24:42-4.
13. Santana LG, Gatti-Reis L, Paiva SM, Ramos-Jorge ML, Marques LS. Patient-centered factors associated with orthodontic treatment success: a scoping review. Braz Oral Res 2025;39:e020.
14. Akbeyaz Şivet EA, Sezer B, Atmaca N, Hüseynova N, Kargül B. Evaluation of the effect of dental caries, oral hygiene, and treatment need on oral health-related quality of life among Turkish orphan children and adolescents. BMC Oral Health 2025;25:134.
15. Doughan MB, Khandakji M, Khoury B, Ghafari JG. Assessment of psychosocial parameters in adolescents seeking orthodontic treatment. BMC Oral Health 2024;24:1299.
16. Weng W, Liu M, Wang S, Li X, Zhang J, Fu Y, et al. The impact of lockdown on child adjustment: a propensity score matched analysis. BMC Psychol 2024;12:409.
17. Rinaldi T, Castelli I, Palena N, Greco A, Pianta R, Marchetti A, et al. The representation of child-parent relation: validation of the Italian version of the child-parent relationship scale (CPRS-I). Front Psychol 2023;14:1194644.
18. Timm LH, Farrag G, Baxmann M, Schwendicke F. Factors influencing patient compliance during clear aligner therapy: a retrospective cohort study. J Clin Med 2021;10:3103.
19. Yassir YA, McIntyre GT, Bearn DR. Three questionnaires to assess the perception of fixed orthodontic therapy before, during and after treatment: validity and reliability. Eur J Orthod 2017;39:402-10.
20. Dhanapriyanka M, Silva RR, Warnakulasuriya S, Jayasekara P, De Silva D, Moraes RR, et al. Mapping tobacco use cessation

counselling awareness in dental offices: a cross-country survey. BMC Oral Health 2025;25:265.
21. Schober P, Boer C, Schwarte LA. Correlation coefficients: appropriate use and interpretation. Anesth Analg 2018;126:1763-8.
22. Schäfer K, Ludwig B, Meyer-Gutknecht H, Schott TC. Quantifying patient adherence during active orthodontic treatment with removable appliances using microelectronic wear-time documentation. Eur J Orthod 2015;37:73-80.
23. Bukhari OM, Sohrabi K, Tavares M. Factors affecting patients' adherence to orthodontic appointments. Am J Orthod Dentofacial Orthop 2016;149:319-24.
24. Arreghini A, Trigila S, Lombardo L, Siciliani G. Objective assessment of compliance with intra- and extraoral removable appliances. Angle Orthod 2017;87:88-95.
25. Zhang YY, To SM. Perceived mutual parent–child trust, mobile phone conversations, and development outcomes of boarding school students in china. Child Adolesc Soc Work J 2024;41:441-53.
26. Al Shammary N, Asimakopoulou K, McDonald F, Newton JT, Scambler S. How is adult patient adherence recorded in orthodontists' clinical notes? A mixed-method case-note study. Patient Preference Adherence 2017;11:1807-14.
27. Timm LH, Farrag G, Wolf D, Baxmann M, Schwendicke F. Effect of electronic reminders on patients' compliance during clear aligner treatment: an interrupted time series study. Sci Rep 2022;12:16652.
28. Rongo R, Dianisková S, Spiezia A, Bucci R, Michelotti A, D'Antò V. Class II malocclusion in adult patients: what are the effects of the intermaxillary elastics with clear aligners? A retrospective single center one-group longitudinal study. J Clin Med 2022;11:7333.
29. Chen YS, Mohamed AM, Wang JB, Zheng ZW, Al-balaa M, Yan Y. Risk factors of composite attachment loss in orthodontic patients during orthodontic clear aligner therapy: a prospective study. BioMed Res Int 2021;2021:6620377.
30. Mei L, Kang A, Jin C, Farella M. An orthodontic tooth brushing technique to enhance oral hygiene in patients wearing fixed orthodontic appliances: a randomized controlled trial. Int J Dent Hyg 2023;21:634-40.
31. Alweneen A, Alqahtani N. The effectiveness of different cleaning methods for clear orthodontic aligners: impacts on physical, mechanical, and chemical properties-an in vivo study. Polymers 2025;17:1620.
32. Roberts CA, Varner RE. What is risk management (and why should I care?). Am J Orthod Dentofacial Orthop 2025;167:379-81.
33. Al-Nadawi M, Kravitz ND, Hansa I, Makki L, Ferguson DJ, Vaid NR. Effect of clear aligner wear protocol on the efficacy of tooth movement. Angle Orthod 2021;91:157-63.
34. Alfawzan AA. Evaluation of patient acceptance and compliance with clear aligners vs. lingual braces: a randomized trial. J Pharm Bioallied Sci 2024;16:S546-8.
35. Xiang J, Xin Y, Wang R, Zhou H, Zou Y, Shim S, et al. Appointment impact and orthodontic emergency occurrence during the coronavirus disease 2019 pandemic: a retrospective study. Am J Orthod Dentofacial Orthop 2022;161:e12-9.
36. Yassir YA, McIntyre GT, Bearn DR. The impact of labial fixed appliance orthodontic treatment on patient expectation, experience, and satisfaction: an overview of systematic reviews. Eur J Orthod 2020;42:223-30.
37. Yeo AJ, Halpern LF, Lin B, Riddick L, Sima D, Wohlfahrt KM, et al. Youth temperament moderates associations between parental involvement and pediatric type 1 diabetes treatment outcome. J Pediatr Psychol 2022;47:795-803.
38. El-Huni A, Colonio Salazar FBC, Sharma PK, Fleming PS. Understanding factors influencing compliance with removable functional appliances: a qualitative study. Am J Orthod Dentofacial Orthop 2019;155:173-81.
39. Geng Z, Liu R. The impact of smartphone addiction and negative emotions on parent-child relationships among elementary school students. Front Psychiatry 2025;16:1582741.
40. Al-Moghrabi D, Salazar FC, Pandis N, Fleming PS. Compliance with removable orthodontic appliances and adjuncts: a systematic review and meta-analysis. Am J Orthod Dentofacial Orthop 2017;152:17-32.

SUPPLEMENTARY MATERIAL

The Influence of Parent-Child Relationships on Clear Aligner Compliance

Dear parents:
Hello!
We are researchers from West China Hospital of Stomatology investigating the influence of parent-child relationship on the compliance of children and adolescents in clear aligner treatment. We aim to identify relevant factors affecting treatment compliance for improving treatment outcomes for children and adolescents. We will investigate the basic information about you and your children, the parent-child relationship between you and your children, and the situation regarding your child's cooperation during treatment. This survey has received approval from the ethics committee of the West China Hospital of Stomatology, Sichuan University, ensuring that all data is processed anonymously and stored securely. The information you provide will be kept strictly confidential and used solely for scientific research. Please complete the questionnaire based on the actual situations of both you and your child. We appreciate your support for our research topic. Thank you!

It is expected to take you approximately 5 minutes to complete this questionnaire.
Thank you for your support and cooperation!
Part 1: Survey on Basic Information
1. Your child's sex is (single-choice question)*
- Male
- Female

2. Your child's age is (fill in the blank question)*
3. Your child is the only child (single-choice question)*
- Yes
- No

4. The highest educational attainment of you and your spouse is (single-choice question)*
- Less than high school
- College degree (Associate's/bachelor's)
- Graduate degree (Master's/PhD)

5. Household monthly income is (single-choice question)*
- <700 USD
- 700-1400 USD
- >1400 USD

6. Your child boards at school on weekdays evenings (single-choice question)*
- Yes
- No

Part II: Child-Parent Relationship Scale

7. Please reflect on the degree to which each of the following statements currently applies to your relationship with your child, and make a choice based on the degree of conformity with the actual situation (matrix single-choice questions)*

	Definitely does not apply	*Not really*	*Neutral, not sure*	*Applies somewhat*	*Definitely applies*
1. I share an affectionate, warm relationship with my child.	○	○	○	○	○
2. My child and I always seem to be struggling with each other.	○	○	○	○	○
3. If upset, my child will seek comfort from me.	○	○	○	○	○
4. My child is uncomfortable with physical affection or touch from me.	○	○	○	○	○
5. My child values his or her relationship with me.	○	○	○	○	○
6. My child appears hurt or embarrassed when I correct him or her.	○	○	○	○	○
7. My child does not want to accept help when he or she needs it.	○	○	○	○	○
8. When I praise my child, he or she beams with pride.	○	○	○	○	○
9. My child reacts strongly to separation from me.	○	○	○	○	○
10. My child spontaneously shares information about himself or herself.	○	○	○	○	○
11. My child is overly dependent on me.	○	○	○	○	○
12. My child easily becomes angry at me.	○	○	○	○	○
13. My child tries to please me.	○	○	○	○	○
14. My child feels that I treat him or her unfairly.	○	○	○	○	○
15. My child asks for my help when he or she really does not need help.	○	○	○	○	○
16. It is easy to be in tune with what my child is feeling.	○	○	○	○	○
17. My child sees me as a source of punishment and criticism.	○	○	○	○	○
18. My child expresses hurt or jealousy when I spend time with other children.	○	○	○	○	○
19. My child remains angry or is resistant after being disciplined.	○	○	○	○	○
20. When my child is misbehaving, he or she responds to my look or tone of voice.	○	○	○	○	○
21. Dealing with my child drains my energy.	○	○	○	○	○
22. I've noticed my child copying my behavior or ways of doing things.	○	○	○	○	○
23. When my child is in a bad mood, I know we're in for a long and difficult day.	○	○	○	○	○
24. My child's feelings toward me can be unpredictable or can change suddenly.	○	○	○	○	○
25. Despite my best efforts, I'm uncomfortable with how my child and I get along.	○	○	○	○	○
26. I often think about my child when at work.	○	○	○	○	○
27. My child whines or cries when he or she wants something from me.	○	○	○	○	○
28. My child is sneaky or manipulative with me.	○	○	○	○	○
29. My child openly shares his or her feelings and experiences with me.	○	○	○	○	○
30. My interactions with my child make me feel effective and confident as a parent.	○	○	○	○	○

Part III: Survey on compliance of children and adolescents in clear aligner treatment

8. Your child can wear clear aligners for 20-22 hours a day (single-choice question)*

- Never
- Rarely
- Sometimes
- Often
- Always

9. Your child can use chewies as required (use chewies after putting on aligners each time, and bite until the aligners fit the teeth surface) (single-choice question)*

- Never
- Rarely
- Sometimes
- Often
- Always

10. Does the doctor ask your child to wear elastics? (single-choice question)*
- Yes
- No (Please skip the next question)

11. Your child can wear elastics every day as required (wear them for enough time every day, wear them in the right position, and replace them on time) (single-choice question)
- Never
- Rarely
- Sometimes
- Often
- Always

(Dependent on the first option of the 15th question)

12. Your child can maintain oral hygiene as required (regularly brush teeth, use dental floss, and mouthwash) (single-choice question)*
- Never
- Rarely
- Sometimes
- Often
- Always

13. Your child can clean aligners as required (after each removal, before putting on) (single-choice question)*
- Never
- Rarely
- Sometimes
- Often
- Always

14. Your child can change aligners timely, as required (single-choice question)*
- Never
- Rarely
- Sometimes
- Often
- Always

15. Your child can keep up with follow-up appointments scheduled (single-choice question)*
- Never
- Rarely
- Sometimes
- Often
- Always

16. Your child may damage or lose aligners (single-choice question)*
- Never
- Rarely
- Sometimes
- Often
- Always

Thank you sincerely for your assistance! Your responses will be of great value to our research!

亲子关系对佩戴隐形矫治器依从性的影响

尊敬的家长:
您好!
我们是来自华西口腔医学院的科研人员, 正在面向儿童及青少年正畸患者进行一项关于亲子关系对于佩戴隐形牙套依从性的调查, 旨在于深入研究影响孩子佩戴隐形牙套的相关因素, 从而提高孩子的正畸治疗效果。我们将就您及您的孩子的基本信息、您与孩子之间的亲子关系以及您的孩子佩戴隐形牙套的情况三方面展开调查。此次调查已得到了四川大学华西口腔医院伦理委员会的批准, 并确保所有数据都经过匿名处理和安全存储, 您所提交的资料我们将严格保密, 仅用于科学研究。请您根据您及您的孩子的实际情况填写问卷, 感谢您对本课题的支持,谢谢!
填写此问卷预计需要5分钟左右,
感谢您的支持与配合,谢谢!

第一部分: 基本信息

1. 您的孩子的性别是 (单选题)*
   - ○ 男
   - ○ 女
2. 您的孩子的年龄是: 周岁 (填空题)*
3. 您的孩子是否为独生子女 (单选题)*
   - ○ 是
   - ○ 否
4. 您与您的配偶的最高文化程度是 (单选题)*
   - ○ 高中或以下
   - ○ 大专、本科
   - ○ 硕士或以上
5. 家庭月收入 (单选题)*
   - ○ <5000元
   - ○ 5000-10,000元
   - ○ >10,000元
6. 您的孩子目前是否工作日晚上寄宿在学校 (单选题)*
   - ○ 是
   - ○ 否

第二部分: 家庭关系调查

7. 请根据您目前和您孩子的关系对下列陈述进行判断,根据与实际情况的符合程度做出选择 (矩阵单选题)*

	完全不符	不太符合	不能确定	比较符合	完全符合
1、我和孩子之间的关系亲密而且感情深厚。	•	•	•	•	•
2、孩子和我似乎总是在相互对抗。	•	•	•	•	•
3、如果孩子情绪低落,他(她)会向我寻求安慰。	•	•	•	•	•
4、我跟孩子有一些身体上的接触或亲密动作的时候,他(她)会感到不自在。	•	•	•	•	•
5、孩子珍惜他(她)和我之间的关系。	•	•	•	•	•
6、当我纠正孩子错误的时候,他(她)会伤心或者觉得不好意思。	•	•	•	•	•
7、孩子在需要帮助的时候却不想接受我的帮助。	•	•	•	•	•
8、当我表扬孩子的时候,他(她)会自豪地微笑。	•	•	•	•	•
9、孩子对于和我的分离有强烈的反应。	•	•	•	•	•
10、孩子会很自然地把有关他(她)自己的一些情况分享给我听。	•	•	•	•	•
11、孩子过于依赖我。	•	•	•	•	•
12、孩子容易对我生气。	•	•	•	•	•
13、孩子会努力地去取悦我。	•	•	•	•	•
14、孩子觉得我对他(她)不公平。	•	•	•	•	•
15、孩子在其实并不需要帮助的时候也会向我求助。	•	•	•	•	•
16、体察孩子的感受对我来说是容易的。	•	•	•	•	•
17、孩子把我看成是惩罚和批评的源泉。	•	•	•	•	•
18、当我和其他小孩呆在一起的时候,我的孩子会表现出伤心或嫉妒。	•	•	•	•	•
19、孩子在受到惩罚之后会一直生气或产生抵触情绪。	•	•	•	•	•
20、孩子做了错事的时候,对我的脸色或语气,他(她)能做出相应的回应。	•	•	•	•	•
21、与孩子的相处耗尽了我的精力。	•	•	•	•	•
22、我注意到孩子会模仿我的行为或做事的方式。	•	•	•	•	•
23、当孩子心情不好的时候,我就知道这一天对我们俩来说将会漫长而又难熬。	•	•	•	•	•
24、孩子对我的情绪会突然改变,或者让我难以捉摸。	•	•	•	•	•
25、尽管我尽了最大的努力,可是我对自己和孩子的相处还是感到不舒服。	•	•	•	•	•
26、我常常在工作的时候想起我的孩子。	•	•	•	•	•
27、孩子想从我这儿得到什么东西的时候,他(她)会哼哼唧唧或者哭起来。	•	•	•	•	•
28、孩子会跟我耍花招,或者来操纵我。	•	•	•	•	•
29、孩子会坦诚地与我分享他(她)的心情和体验。	•	•	•	•	•
30、和孩子的相处让我感到自己作为一个母亲/父亲是自信而称职的。	•	•	•	•	•

第三部分: 关于孩子佩戴隐形牙套的依从性调查

8. 您的孩子能做到每天佩戴隐形牙套20-22小时吗 (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

9. 您的孩子能做到按医生的要求使用咬胶吗(每次戴上隐形牙套后使用咬胶,咬至隐形牙套贴合牙面) (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

10. 医生是否要求您的孩子挂橡皮筋 (单选题)*

- ○ 是
- ○ 否(请跳过下一题)

11. 您的孩子能做到按医生的要求每天挂橡皮筋吗(每天挂足够时间,挂在正确的位置,按时更换) (单选题)

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

12. 您的孩子能做到按医生的要求保持口腔卫生吗(每天按时刷牙,并使用牙线、漱口水等清洁口腔) (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

13. 您的孩子能做到按要求清洗隐形牙套吗(每次取下后、戴上前清洗) (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

14. 您的孩子能做到遵医嘱按时更换新的隐形牙套吗 (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

15. 您的孩子能做到在医生规定的时间内及时复诊吗 (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

16. 您的孩子会损坏或丢失隐形牙套吗? (单选题)*

- ○ 从不
- ○ 很少
- ○ 有时
- ○ 经常
- ○ 总是

对于您所提供的帮助,我们表示诚挚的感谢!您的回答将为我们的研究带来极大的助力!