Original Article

Adherence in adult orthodontic settings: Understanding orthodontists' predictors

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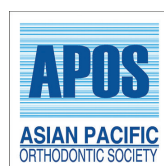
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ABSTRACT

Objectives: The objective of this study was to delve into predictors of adherence in adult orthodontic patients as stated by orthodontists in Saudi Arabia.

Material and Methods: Ninety-one orthodontists from Saudi Arabia completed a questionnaire in relation to the importance and frequency of use of predictors of adherence. In this cross-sectional quantitative and exploratory study, orthodontists were requested to rate the predictors of adherence on a five-point Likert scale. The questionnaire in this study was categorized into four sections such as (1) evaluation – their opinion on the importance of predictor in the assessment of patient adherence, (2) application – scope of use of each predictor in the assessment of adherence in the routine practice, (3) open-ended questions to amass information about other apparent predictors of adherence, and (4) demographics.

Results: Mixed and variable responses were obtained in terms of the importance and extent of application of predictors in assessing patient adherence. The survey revealed the most important predictors for adherence that included patient's adherence to appointments and their cooperation in handling dental appliances, and maintenance of oral hygiene. However, in actual practice, orthodontists were frequently implementing factors such as the patient to keep appointments, the patient is observed to be involved in treatment, and the patient is observed to be enthusiastic about treatment. Through the open-ended questions, multiple factors were reported that need to be explored further. However, the remaining factors reported for adherence portrayed varied patterns.

Conclusion: Predictors of adherence were reported with varying extent of consistency among orthodontists in Saudi Arabia. However, adherence to appointment, co-operation in handling of appliances, and oral hygiene emerged as the most significant factors by the orthodontists for adherence in cases of adult patients.

Keywords: Adherence, Predictors, Adult orthodontic, Treatment

INTRODUCTION

Orthodontic treatment is a way of straightening or moving teeth, to improve the appearance of the teeth and how they work. Orthodontic treatment necessitates several disciplinary activities and restrictions such as attending appointments, daily practice of good oral hygiene, and dietary restrictions. Different samples of orthodontic appliances are used to correct malocclusion, retrain muscles, and effect on growth (Elhussein and Sandler, 2018).[1]

Psychological and behavioral aspects of patients play a significant role in non-adherence; it is crucial that patients must change their behavior and cooperate with clinicians/orthodontists to ensure positive outcomes of the treatment. The behavior of patients in the clinic is regarded as "compliance;" however, recently, it is termed as "adherence" (Tervonen *et al.*, 2011).[2]

Orthodontists believe that factors such as personality traits, motivation for treatment, maintenance of oral hygiene, and communication between orthodontist and patient contribute to adherence (Eppright *et al.*, 2014; Schäfer *et al.*, 2015; Zotti *et al.*, 2016).[3-5] Poor adherence to orthodontic treatment leads a patient to several complications corresponding to decalcifications of the teeth, uncorrected malocclusion, negative psychological and social outcomes attributable to the appearance of their teeth and mouth, a prolonged course of treatment, premature treatment termination, wasted family and provider resources (Apajalahti and Peltola, 2007; Skidmore *et al.*, 2006).[6,7] Adherence to orthodontic treatment is essential to ensure the patient's ultimate positive treatment outcome; since it depends on timing and completion of the orthodontic treatment. However, the previous research demonstrated that data related to adherence to orthodontic treatment are not encouraging; since, treatment termination reported in 43–50% patients due to poor adherence to treatment (Mandall *et al.*, 2008; Martin *et al.*, 2017).[8,9]

It can be argued that non-adherence is not only related to attendance but also to several other factors. Since, poor adherence or non-adherence to the orthodontic treatment usually reflects in the form of poor oral hygiene, broken appliances, patients' ability to cope with the experience of pain and discomfort during treatment, and non-compliance with wear of prescribed elastics or removable appliances (Crerand *et al.*, 2019).[10] It can be argued that non-adherence to the orthodontic treatment is not uniform throughout all the situations; rather, it can be situational-based. Patients might exhibit adherence based on the anticipated outcome. In some instances, patients might be adherent; however, in other instances, they might be non-adherent. Patients might follow appointments on a regular basis; however, they might not wear the appliances during the treatment duration. Hence, clinicians should always be alerted to fluctuations and prepared to take corrective actions. Accurate predictions by the orthodontists regarding the adherence by patients are crucial in executing corrective strategy. Hence, it is essential to understand the orthodontist's predictors regarding adherence (Al Shammary *et al.*, 2017).[11] Further, these predictors can be implemented in a calibrated manner based on their importance for the measurement of patient adherence in the orthodontic setting. Several direct and indirect methods are available for estimating a patient's adherence to the orthodontic setting. However, these methods are associated with limitations such as variable reliability and applicability due to variable orthodontic settings (Bos *et al.*, 2007; Cole, 2002).[12,13]

The previous research demonstrated orthodontists' interpretation of adherence of patients in the orthodontic setting which explored factors such as oral hygiene and appointment keeping as the indicators of adherence. However, these indicators cannot be generalized because these studies were conducted on the young population with a small number of participants. In the previous studies, either open- or closed-type questions were asked of the orthodontists (Bos *et al.*, 2007; Al Shammary *et al.*, 2015).[12,14] Moreover, studies evaluating orthodontist's predictors of adherence to orthodontic treatment in Kingdom of Saudi Arabia (KSA) were not conducted.

This study aims to explore the predictors of orthodontists for adherence of adult patients in the orthodontic settings. Attention is given to rank these predictors in terms of importance and frequency of actual use, as stated by the orthodontist.

MATERIAL AND METHODS

Type of study

This is a cross-sectional quantitative and exploratory survey to explore predictors of adherence which were informed in the previous research (Bos *et al.*, 2007; Al Shammary *et al.*, 2015).[12,14] Both open- and closed-ended questions are incorporated in this research.

Sample/participants

Attending level orthodontists, treating adult patients, in the KSA who could complete the survey in English were selected for participation in the study. On obtaining Institutional Review Board (IRB) approval (Reference No H-2020-004), participants were recruited by sending a short email. Participants were self-screened for eligibility. Participants were provided with the IRB-approved study information sheet detailing the benefits and risks of participation. Moreover, participants were informed about the anonymity and confidentiality of participation. The rights of human participation were protected, and study approval was taken from the Institutional Research Ethics Committee of Hail University. Participants were recruited through sending a short email. In accordance with Dillman, agreed details of the frequency of contact were sent to the orthodontists through email. For those participants with non-responsiveness, two subsequent emails were sent as reminders. Ninety-one orthodontists (48% of female and 52% of male) were recruited in this study. Participants with experience of more than 1 month (5%), 1–2 years (19%), 3–4 years (28%), and >5 years (48%) were recruited in this study.

Materials

The survey questionnaire developed for this study was constructed by the researchers. Questions were developed based on experience in the orthodontist setting and an extensive literature review related to orthodontic adherence. The survey questions were mainly divided into four sections, requesting participants to rate predictors of adherence: (1) Evaluation – how important they perceive the predictor was

to measure patient adherence, (2) application – the level up to which they implemented each predictor to measure adherence in their daily practice, (3) open-ended questions to amass adherence predictors which they understood were worth and were also requested to rate them with respect to their importance and frequency of use, and (4) demographics, including gender and years in practice with adults. The questions in section 1 were answered on a five-point Likert scale (with 1 rated as not at all important and 5 rated as extremely important). The questions in section 2 were responded on a five-point Likert scale (with 1 rated as predictor with never applicable for adherence and 5 rated as predictor which is always applicable in daily practice). In part 3, participants were invited to answer the open-ended questions to propose other predictors of adherence. Moreover, orthodontists were requested to rate these predictors based on the importance and applicability on a five-point Likert scale. The overall scale was found to be highly reliable (24 items; alpha 5.83), whereas Cronbach's alphas for the 12 important and 12 use items were 0.5 and 0.87, respectively.

Data analysis

Descriptive analysis in terms of frequencies, central tendency, and dispersion measures was performed for each of the questions in the list, and two scales that are based on importance and frequency (applicability). Additional predictors that emerged from the open-ended questions were coded and organized under individual categories, and a similar descriptive analysis was reported. Further, a descriptive analysis of two scales was performed that comprise a whole list of predictors from the original list and those added from the participants.

RESULTS

Predictors based on important while assessment of adherence in adult patients

Participants rated 12 factors on the five-point Likert scale. Higher importance to the factor is reported in terms of higher scores. The mean and standard deviation (SD) of each factor are shown in [Table 1].

Table 1: Mean Importance Ratings for Each Factor.

Sr. No	Factor	Frequency of responses (%)					Mean	SD
		Extremely unimportant	Very unimportant	Neither unimportant nor important	Very important	Extremely important		
1	The patient keeps appointments			6.00 (3)	30.00 (15)	64.00 (32)	4.58	0.61
2	The patient is pleasant to the clinic staff		6.12 (3)	22.45 (11)	42.86 (21)	28.57 (14)	3.91	0.89
3	The patient has distorted or damaged wires and/or loose bands			12.24 (6)	42.86 (21)	46.94 (23)	4.37	0.66
4	The patient is observed to be involved in treatment.		4.17 (2)	16.67 (8)	45.83 (22)	35.42 (17)	4.11	0.82
5	The patient speaks of personal problems or demonstrates such problems	6.25 (3)	25.00 (12)	33.33 (16)	25.00 (12)	12.50 (6)	3.14	1.08
6	The patient is observed to be enthusiastic about treatment		2.08 (1)	14.58 (7)	43.75 (21)	39.58 (19)	4.22	0.76
7	The patient cooperates with the use of removable dental appliances (such as retainers) and/or elastics.	2.08 (1)		4.17 (2)	20.83 (10)	72.92 (35)	4.63	0.75
8	The patient complains about treatment procedures (i.e., procedures performed by the orthodontist)		10.42 (5)	27.08 (13)	54.17 (26)	10.42 (5)	3.65	0.78
9	The patient maintains excellent oral hygiene.			4.17 (2)	14.58 (7)	81.25 (39)	4.77	0.51
10	The patient complains about having to wear braces	2.08 (1)	6.25 (3)	25.00 (12)	50.00 (24)	16.67 (8)	3.74	0.88
11	The patient has a negative view or perception of their malocclusion		12.50 (6)	25.00 (12)	50.00 (24)	12.50 (6)	3.64	0.86
12	The patient thinks that facial esthetics are important		2.04 (1)	22.45 (11)	51.02 (25)	28.57 (14)	4.05	0.76

Responses from *N*=91 Orthodontists; SD: Standard deviation

The cutoff score was fixed at 4.5 out of 5. Based on this cutoff score, the following were the three factors with the highest importance, "The patient maintains excellent oral hygiene (score 4.77)," "The patient cooperates with the use of removable dental appliances (such as retainers) and/or elastics (score 4.63)," and "The patient keeps appointments (score 4.58)." The factor with the lowest score was "The patient speaks of personal problems or demonstrates such problems (score 3.14)." From the results, it can be argued that most of the factors scored intermediate scores; these are neither on the higher side nor the lower side. It is likely; since most of the orthodontists did not rate these factors as either extremely important or extremely unimportant.

The factors with the highest rating were also not rated in a uniform manner by all the participants. Few of the participant's ratings demonstrated deviation from the majority of the participant's ratings for highly scored factors. About 4%, 4%, and 6% of participants rated "Neither Unimportant nor Important" for factors such as "The patient maintains excellent oral hygiene," "The patient cooperates with the use of removable dental appliances (such as retainers) and/or elastics," and "The patient keeps appointments," respectively. However, it can be argued that the number of participants with a rating "Neither Unimportant nor Important" was very low. None of the participants rated "Very Unimportant" or "Extremely Unimportant" for factors that scored above 4.5. However, participants demonstrated varied responses to the factor with the lowest score, "The patient speaks of personal

problems or demonstrates such problems;" since 12% of the participants rated this factor as extremely important. Predictors based on frequency of use while assessing adherence of adult patients in their daily practice

Participants rated 12 factors on the five-point Likert scale. High score indicates a high frequency of use and low score indicates a low frequency of use. The mean and SD of each factor are shown in [Table 2].

None of the factors demonstrated a score above the cutoff value (4.5). Hence, factors with a score of more than 4 were considered as high scoring. Four factors were rated with high frequency such as "The patient keeps appointments (score 4.36)," "The patient is observed to be involved in treatment (score 4.16)," "The patient is pleasant to the clinic staff (score 4.11)," and "The patient is observed to be enthusiastic about treatment (score 4.10)." Four factors were rated below the lower cutoff value of 3.5 such as "The patient speaks of personal problems or demonstrates such problems (score 3.38)," "The patient has a negative view or perception of their malocclusion (score 3.38)," "The patient complains about treatment procedures (i.e., procedures performed by the orthodontist) (score 3.3)," and "The patient complains about having to wear braces (score 3.08)." Even though four factors were rated with high frequency, there was no agreement among all the participants. For the factor, "The patient keeps appointments," around 5% of participants rated it sometimes. Moreover, participants rated rarely and never for factors,

Table 2: Mean and SD frequency of use of each factor.

Sr. No.			Factor			Frequency of Use (%)		
		Never	Rarely	Some times	Most of the time	Always	Mean	SD
1	The patient keeps appointments			5.71 (2)	62.86 (22)	34.29 (12)	4.31	0.53
2	The patient is pleasant to the clinic staff	2.86 (1)	5.71 (2)	20.00 (7)	51.43 (18)	28.57 (10)	4.11	0.71
3	The patient has distorted or damaged wires and/or loose bands		22.86 (8)	31.43 (11)	25.71 (9)	22.86 (8)	3.51	1.05
4	The patient is observed to be involved in treatment.		2.86 (1)	22.86 (8)	34.29 (12)	42.86 (15)	4.16	0.84
5	The patient speaks of personal problems or demonstrates such problems	2.86 (1)	25.71 (9)	34.29 (12)	20.00 (7)	22.86 (8)	3.38	1.12
6	The patient is observed to be enthusiastic about treatment	2.86 (1)		8.57 (3)	71.43 (25)	20.00 (7)	4.1	0.56
7	The patient cooperates with the use of removable dental appliances (such as retainers) and/or elastics.		11.43 (4)	25.71 (9)	37.14 (13)	28.57 (10)	3.83	0.95
8	The patient complains about treatment procedures (i.e., procedures performed by the orthodontist)	2.86 (1)	25.71 (9)	37.14 (13)	22.86 (8)	17.14 (6)	3.3	1.06
9	The patient maintains excellent oral hygiene	2.86 (1)	8.57 (3)	34.29 (12)	28.57 (10)	34.29 (12)	3.85	0.99
10	The patient complains about having to wear braces	2.86 (1)	28.57 (10)	42.86 (15)	22.86 (8)	8.57 (3)	3.08	0.94
11	The patient has a negative view or perception of their malocclusion.	5.71 (2)	8.57 (3)	48.57 (17)	34.29 (12)	8.57 (3)	3.38	0.83
12	The patient thinks that facial esthetics are important	5.71 (2)	11.43 (4)	31.43 (11)	25.71 (9)	28.57 (10)	3.63	1.10

Responses from *N*=91 Orthodontists; SD: Standard deviation

"The patient is observed to be involved in treatment (rarely 3%)," "The patient is pleasant to the clinic staff (rarely 6% and never 3%)," and "The patient is observed to be enthusiastic about treatment (never 3%)."

Predictors based on open-ended questions

Orthodontists expressed factors such as oral hygiene, cost, patient-related factors, time, integrative and cooperative approach in treatment, and other factors, in relation to the adherence in the orthodontic setting factor are presented in [Table 3]. The most important identified factors for adherence, according to orthodontists, were "oral hygiene" (M = 4.5; SD = 1.0), "integrative and cooperative approach in treatment," (M = 4.5; SD = 0.5) and "other factors" (M = 4.5; SD = 1.1). Least important identified factor for adherence, according to orthodontists, was, "time" (M = 3.8; SD = 1.0). The most frequently used factors used by orthodontists to asses "adherence were oral hygiene" (M = 4.3; SD = 1.0) and "patient-related factors" (M = 4.3; SD = 1.0). Less frequently employed factor by orthodontists was "time" (M = 3.5; SD = 0.6).

Table 3: Mean and SD of group of adherence factors which were newly added by the orthodontists.

Adherence Factors	Importance		Frequency	
	Mean	SD	Mean	SD
Oral hygiene (4)	4.5	1	4.3	1
Oral hygiene				
Maintaining Oral Hygiene from the patient				
Oral hygiene				
Oral hygiene				
Cost (3)	4.3	0.6	4	1
Cost				
Cost				
The price of adjustment				
Patient related factors (7)	4.4	0.5	4.3	1
Internal motivation				
Showing in clinic on emergencies				
Treatment progress				
Educating the patient about his malocclusion and treatment options				
Interest of the patient in the treatment				
Transportation to the clinic for female patients				
Calling to ask about abnormalities with teeth during treatment				
Time (4)	3.8	1.0	3.5	0.6
Time of treatment available in the clinic no evening time				
Time				
Tolerance to long treatment duration 2 years				
Continuing the treatment				
Integrative and cooperative approach in treatment (8)	4.5	0.5	3.8	1.4
Trusting the orthodontist				
Cooperation of the patient				
Willing to change the Treatment plan if necessary				
Relation with there orthodontist				
Involving patient in their treatment objectives				
Good contact between patient and doctor				
Friendly environment				
Going by the rules				
Other factors (8)	4.5	1.1	3.9	1.2
Accepting new modules to help achieving good results such as mini-implants, forces, etc				
Visibility of brackets some prefer none bracket or lingual				
Damage				
Clean of the clinic				
Realistic expectations				
Proper sterilization				
Behavior				
Being professional				

SD: Standard deviation

DISCUSSION

In this study, a survey was conducted to understand adherence predictors in orthodontic settings in terms of its importance and frequency of use in daily practice. In addition to these question-based factors, other relevant factors were extracted through presenting open-ended questions to the participants.

The majority (71%) of the orthodontists reported treatment termination in <10% of cases and 29% of orthodontists reported treatment termination in 11–30% of patients due to poor adherence to the treatment (Crerand *et al.*, 2019).[10] Mehra *et al.* (1998)[15] reported that 95% of orthodontists reported treatment termination in <5% of the patients, while 5% of orthodontists reported treatment termination in 5–10% of the patients. Adherence to treatment is a crucial factor in cases of prolonged treatment. However, there is no consensus to define prolonged treatment in an orthodontic setting. In some cases, minimum 3 months of treatment and in a few cases, 1-year treatment, beyond the agreed on end of treatment is considered as prolonged treatment. Research demonstrated that family domain and health-care system factors also significantly influence adherence. In the family domain, factors such as family members' mental health, treatment motivation, supervision of care by the family members, coping skills, and awareness of the treatment plan have a substantial impact on adherence. Hence, it is essential to target interventions to family members' motivation and behavior. Motivation by family members can be exemplified by monitoring oral hygiene of patients by the family members. Health-care system-related factors include communication between the patient and health-care providers which promotes change in the behavior of patient and the family members. Health-care system-related factor targets orthodontic education program and dietary instructions (Wysocka *et al.*, 2014; Crerand *et al.*, 2019).[16,10]

In the present study, three factors were rated with the highest importance which includes, "The patient maintains excellent oral hygiene," "The patient cooperates with the use of removable dental appliances (such as retainers) and/or elastics," and "The patient keeps appointments." However, a minimal number of participants did not give importance to these factors. These insignificant numbers of participants would not affect the outcome of the study; however, it is worthwhile to assess the reason behind not giving importance to these factors by these small number of participants. It is obligatory that orthodontists should practice the factors of adherence to which they give more importance. However, in actual practice, these orthodontists practice only one factor, "The patient keeps appointments." It can be argued that participants gave the least importance to this factor out of the three factors with more importance. Nevertheless, orthodontists implemented this factor more frequently in comparison to any other factor. From the obtained results, it can be argued that there was partial agreement between the importance and practice of orthodontists in assessing patient

adherence. Orthodontists practiced only one factor in assessing patient adherence; though, the other two factors are also deemed important. Some of the findings from this study were consistent with factors reported in the previous studies. Mehra *et al.* (1998) and Slakter *et al.*, (1980)[15,17] reported factors such as maintaining regular appointments, good oral hygiene, and adequate use of appliances, as relevant factors for the adherence of patients in orthodontic settings.

For few of the factors studied in this study, there was no agreement between the level of importance and its implementation in actual clinical practice. For factors such as "The patient has distorted or damaged wires and/or loose bands" and "The patient maintains excellent oral hygiene," orthodontists mentioned neither "Not so important" nor "Not at all important." However, a realistic number of participants employed it rarely in actual practice. Orthodontists demonstrated a positive correlation among factors with the lowest importance and least employed in the actual practice. Orthodontists demonstrated the lowest scores in terms of both importance and frequency for factors such as, "The patient speaks of personal problems or demonstrates such problems," "The patient complains about treatment procedures (i.e., procedures performed by the orthodontist)," "The patient complains about having to wear braces," and "The patient has a negative view or perception of their malocclusion." It reflects, orthodontists are not willing to implement the adherence factor in actual practice, if they do not feel it as important factor. Out of these four factors, Slakter *et al.* (1980),[17] stated "The patient speaks of personal problems or demonstrates such problems" as adequate measure of adherence in orthodontic setting.

Through open-ended questions, different predictors of adherence were explored, which include oral hygiene, cost, patient-related factors, time, and integrative and cooperative approach in treatment. These predictors comprise different factors which were coded under respective predictors. Among these, "oral hygiene" and "integrative and cooperative approach in treatment" were stated as the most important factors by the orthodontists. Moreover, "oral hygiene" and "patient-related factors" were more frequently employed adherence measures by the orthodontists. There was not much difference between "oral hygiene" and "patient-related factors" in terms of its importance. Hence, these two factors can be considered as most acceptable predictors stated by the orthodontists through the open-ended questions. The previous research also demonstrated that "oral hygiene" and "keeping appointments" are most important predictors for patient adherence; however, these were not most frequently used by the orthodontists (Martin *et al.*, 2005; Brattström *et al.*, 1991).[18,19] However, authors argued that the lack of evidence for the frequent use of these predictors might be due to improper record keeping of these predictors during actual practice. Most of the predictors reported during open questions were stated for the 1st time in adult's orthodontic

setting. Hence, its importance and frequency of use should be revalidated in a study comprising structured questions.

Limitations

The current study lacks patient-reported data. It would be advisable to integrate the data obtained from the orthodontists with the data obtained from the patients to ensure the validity of the outcome. Orthodontists responded differently for the same predictor which might be due to different working environments or hospital settings for the orthodontists. Hence, to assess an accurate measure of adherence, it would be advisable to conduct a study of orthodontists from a similar type of hospital setting. In a similar fashion to other studies which include non-probabilistic samples, this study also offers an opportunity for further research. It would be advisable to validate the outcome of this study in a randomly selected larger population.

CONCLUSION

"The patient maintains excellent oral hygiene" was regarded as the most important predictor by the orthodontists. "The patient keeps appointments" was regarded as the most frequently used predictor by orthodontists. In open-ended questions, orthodontists highlighted "Oral hygiene" and "Integrative and cooperative approach in treatment" as the most important predictors for adherence in an orthodontic setting. Furthermore, "Oral hygiene" and "Patient-related factors" were reported as the most frequently used predictors through the open-ended questions.

Ethical approval

The author(s) declare that they have taken the ethical approval from IRB (Reference No H-2020-004).

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Elhussein M, Sandler J. Fixed versus removable appliances - Which one to choose? Dent Update 2018;45:874-81.
2. Tervonen MM, Pirttiniemi P, Lahti S. Development of a measure for orthodontists to evaluate patient compliance. Am J Orthod Dentofacial Orthop 2011;139:791-6.
3. Eppright M, Shroff B, Best AM, Barcoma E, Lindauer SJ. Influence of active reminders on oral hygiene compliance in orthodontic patients. Angle Orthod 2014;84:208-13.
4. 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.
5. Zotti F, Dalessandri D, Salgarello S, Piancino M, Bonetti S, Visconti L, *et al.* Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. Angle Orthod 2016;86:101-7.
6. Apajalahti S, Peltola JS. Apical root resorption after orthodontic treatment -- a retrospective study. Eur J Orthod 2007;29:408-12.
7. Skidmore KJ, Brook KJ, Thomson WM, Harding WJ. Factors influencing treatment time in orthodontic patients. Am J Orthod Dentofacial Orthop 2006;129:230-8.
8. Mandall NA, Matthew S, Fox D, Wright J, Conboy FM, O'Brien KD. Prediction of compliance and completion of orthodontic treatment: are quality of life measures important? Eur J Orthod 2008;30:40-5.
9. Martin CA, Dieringer BM, McNeil DW. Orthodontic treatment completion and discontinuation in a rural sample from North Central Appalachia in the USA. Front Public Health 2017;5:171.
10. Crerand CE, Kapa HM, Litteral J, Da Silveira AC, Markey MK. Adherence to orthodontic treatment in youth with craniofacial conditions: A survey of US orthodontists. Cleft Palate Craniofac J 2019;56:1322-32.
11. 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 Prefer Adherence 2017;11:1807-14.
12. Bos A, Kleverlaan CJ, Hoogstraten J, Prahl-Andersen B, Kuitert R. Comparing subjective and objective measures of headgear compliance. Am J Orthod Dentofacial Orthop 2007;132:801-5.
13. Cole WA. Accuracy of patient reporting as an indication of headgear compliance. Am J Orthod Dentofacial Orthop 2002;121:419-23.
14. Al Shammary N, Newton JT, McDonald F, Scambler S, Asimakopoulou K. Adherence in orthodontic settings: Understanding practitioner views in a UK sample. Angle Orthod 2015;85:826-32.

15. Mehra T, Nanda RS, Sinha PK. Orthodontists' assessment and management of patient compliance. Angle Orthod 1998;68:115-22.
16. Wysocka M, Cudzilo D, Beata K, Kopczynski P. Eating habits of patients with cleft lip and palate treated with fixed appliances. Dev Period Med 2014;18:93-101.
17. Slakter MJ, Albino JE, Fox RN, Lewis EA. Reliability and stability of the orthodontic Patient Cooperation Scale. Am J Orthod 1980;78:559-63.
18. Martin LR, Williams SL, Haskard KB, Dimatteo MR. The challenge of patient adherence. Ther Clin Risk Manag 2005;1:189-99.
19. Brattström V, Ingelsson M, Aberg E. Treatment co-operation in orthodontic patients. Br J Orthod 1991;18:37-42.