Malocclusion, Past Orthodontic Treatment, and Satisfaction with Dental Appearance among Canadian Adults

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ABSTRACT

Objective: To examine whether malocclusion and past orthodontic treatment are associated with satisfaction with dental appearance among Canadian adults.

Methods: Using data from the 2007–09 Canadian Health Measures Survey, this cross-sectional study analyzed information from 2184 respondents (1005 men and 1179 women) aged 20–59 years. The outcome variable was satisfaction with dental appearance. Ordinal logistic regression was used to investigate the relation between satisfaction with dental appearance and 2 independent variables: malocclusion and past orthodontic treatment.

Results: Of the participants, 70% were "very satisfied" or "satisfied" with the appearance of their teeth. The prevalence of malocclusion and past orthodontic treatment was 25% and 20%, respectively. Controlling for the effect of covariates, malocclusion had a significant negative effect on satisfaction with dental appearance ($p = 0.02$), but past orthodontic treatment did not ($p = 0.36$). Satisfaction with dental appearance was greater among those in the higher-income group, never smokers, those with better self-rated health, those with no anterior decayed teeth, and those with no anterior filled teeth.

Conclusion: Past orthodontic treatment was not linked to satisfaction with dental appearance in this sample of Canadian adults. Public health programs and clinicians should focus on addressing esthetic problems by restoring inadequate anterior teeth fillings, restoring anterior tooth decay, and implementing smoking cessation programs before considering orthodontic treatment.

Dental appearance is one of the most important components of facial appearance.[1] Satisfaction with dental appearance improves self-esteem[2] and quality of life,[3] and dental professionals are often responsible for helping patients reach an acceptable level of such satisfaction. People who are dissatisfied with their dental appearance have a greater need for treatment.[2] Thus, satisfaction with dental appearance not only affects the individual but also influences overall use of oral health care services.

Malocclusion is an umbrella term that refers to a set of growth and developmental anomalies that affect jaws and teeth resulting in variations in their position. People with various traits of malocclusion, such as anterior irregularities, maxillary overjet and anterior spacing, report less satisfaction with dental appearance[4,5] as well as masticatory performance.[6] However, these patients seek orthodontic treatment mainly because of dissatisfaction with the appearance of their teeth rather than problems with oral functioning.[7-9] Thus, the success of orthodontic treatment should be evaluated with regard to patients' satisfaction with their dental appearance, and researchers and clinicians should consider patient-centred outcomes in addition to clinically determined criteria in evaluating the results of orthodontic treatment. This is particularly of note with respect to occlusion, as the professional perception of ideal occlusion could vary from that of patients.[10,11] As health services are adapted to meet patients' needs, patients' perceptions of orthodontic treatment cannot be underestimated, as it is the patient who receives treatment and must gain satisfaction from improved esthetics.

Dental professionals are becoming increasingly more aware of the importance of patients' satisfaction with their dental appearance. In a study of orthodontics professionals in Finland, researchers suggested that priority should be given to patients' opinions of dental appearance rather than professional views when assessing treatment outcome.[12] Despite this, a systematic review found that satisfaction with dental appearance following orthodontic treatment has rarely been investigated, particularly among adult populations.[13]

In this study, we use nationally representative data from the 2007–09 Canadian Health Measures Survey,[14] to investigate whether malocclusion and past orthodontic treatment are associated with satisfaction with dental appearance among Canadian adults.

Materials and Methods

Dataset

Data for this study are from the 2007–09 Canadian Health Measures Survey (CHMS). This is the most recent national health survey of the Canadian population that collected data on oral health indicators. The CHMS is a probabilistic, multistage stratified survey of Canadian households. The sampling framework ensures representativeness of the Canadian population, by collecting data from various age–sex groups sampled from several sites across Canada and stratified by region. The CHMS aimed to provide national estimates by collecting data from a number of sites representative of 97% of the population of Canada.

Oral health data were collected using both household interviews and clinical examinations. Seven Canadian Forces dentists were trained, along with 2 back-up dentists/trainers. The instruction was led by a dentist trained to the World Health Organization (WHO) gold standard level and was intended to ensure both inter- and intra-examiner reliability among the survey dentists.[15] Oral health examinations were conducted in accordance with WHO health survey methods. The methods and sampling framework of the CHMS are described by Statistics Canada.[14]

The CHMS collected data from 5604 Canadians aged 6–79 years. In this study, we aimed to study adults aged 20–59 years old ($n = 2433$). (Note: older adults aged 60–79 were not included because the CHMS had not collected data on the status of occlusion among this age group). From this subsample, we excluded edentulous participants ($n = 51$) and those currently receiving orthodontic treatment or had missing values ($n = 198$). Finally, we analyzed the data for 2184 adults aged 20–59 years (1005 men and 1179 women).

Satisfaction with Dental Appearance

The outcome of this study was satisfaction with dental appearance, which was determined through the question: "How satisfied are you with the appearance of your teeth and/or dentures?" Participants reported their satisfaction by selecting 1 of the following answers: very satisfied, satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, and very dissatisfied. For the purpose of data analysis, responses were collapsed into three categories: satisfied (very satisfied/satisfied), neither satisfied nor dissatisfied and dissatisfied (somewhat dissatisfied/very dissatisfied).

Independent Variable

The 2 main independent variables were malocclusion and past orthodontic treatment. Participants were clinically examined to identify malocclusion, which was defined as the presence of at least 1 of the following conditions: (a) anterior cross bite, (b) severe crowding, (c) severe spacing, (d) posterior cross bite, (e) anterior open bite (> 9 mm), (f) excessive overbite (100% or more), (g) excessive overjet (> 9 mm) and (h) midline shift (> 4 mm). With regard to past orthodontic treatment, participants were simply asked whether they had had orthodontic treatment in the past and the answers were recorded as yes or no. Data collection for the oral health components of the CHMS followed the CHMS Dentist's Survey Manual and Coding Criteria, in which additional information is provided on the definition of these variables. (This document is available on request to the corresponding author.)

Control Variables

Five sets of control variables were included in the analyses: sociodemographic factors, health behaviours, dental service utilization, general health and clinical oral health. Sociodemographic factors were sex, age, income and marital status. Indicators of health behaviours were tooth-brushing frequency and smoking. Indicators of dental service utilization consisted of: visiting a dental professional in the past year and having dental insurance. General health was estimated using single-item, self-rated health. Indicators of clinical oral health were having anterior decayed teeth and having anterior filled teeth.

Data Analysis

We undertook a cross-sectional analysis of the CHMS survey data. We analyzed the data for the total adult population (20–59 years), young adults (20–39 years) and adults (40–59 years) separately. This classification for age groups was also adopted by the technical report on the oral health findings of the CHMS published by Health Canada.[16] Bivariate and multivariate analyses were performed taking into account the sample weights, consistent with Statistics Canada's recommendations to provide estimates representative of the Canadian population using STATA 11.1 software (StataCorp LP, College Station, Tex., USA). An ordinal logistic regression model was constructed. According to the approach recommended by Homer and Lemeshow,[17] only variables with a statistical significance of $p < 0.25$ in the bivariate analyses were entered into the model. The significance level was set at $p < 0.05$. Interactions of sex with malocclusion and past orthodontic treatment were tested. Because none of these interactions was significant, a sex-stratified multivariate model was not constructed.

Results

Characteristics of the sample population are shown in **Table 1**: 70% of the participants were satisfied with the appearance of their teeth. On the other hand, 11% were dissatisfied and 19% were neither satisfied nor dissatisfied. The prevalences of malocclusion and past orthodontic treatment were 25% and 20%, respectively.

Satisfaction with dental appearance was examined for a number of variables in the entire population and both age groups (**Table 2**). Bivariate analyses for the entire population showed that satisfaction with dental appearance was significantly higher among those who had received orthodontic treatment in the past ($p = 0.02$) and those with normal occlusion ($p = 0.01$). Further, satisfaction with dental appearance was linked to higher income, brushing teeth twice a day or more, never smoking, visiting dental services in the past year, better self-rated general health, and having no anterior decayed teeth. Age-stratified analysis of the data suggested that some of the variables vary according to age group.

After accounting for other variables, past orthodontic treatment was no longer significantly related to satisfaction with dental appearance for the entire population ($p = 0.36$) (**Table 3**) or for either young adults (20–39 years; $p = 0.39$) or older adults (40–59 years; $p = 0.94$). However, malocclusion had a significant negative effect on satisfaction with dental appearance of the entire population ($p = 0.02$) and young adults (20–39 years; $p = 0.004$), but not older adults (40–59 years; $p = 0.18$). Having no anterior decayed teeth was the strongest determinant of satisfaction with dental appearance for total population, as highlighted by the highest odds ratio (OR = 3.1; 95% CI = 1.93–4.98)

Adjusting for all other variables in the model, for the entire population, satisfaction with dental appearance was greater among the higher income group, never smokers, those with better self-rated health, those with no anterior decayed teeth and those with no anterior filled teeth.

Table 1 Characteristics of adults in a sample from the 2007–09 Canadian Health Measures Survey (*n* = 2184).

Characteristic	All participants (20–59 years) (%)	Young adults (20–39 years) (%)	Older adults (40–59 years) (%)
Sex			
Men	51	51	50
Women	49	49	50
Age			
20–39 years	51	100	0
40–59 years	49	0	100
Income level			
Lower	48	54	40
Higher	52	46	60
Marital status			
Not married	49	62	35
Married	51	38	65
Tooth-brushing frequency			
≤ once a day	26	25	26
≥ twice a day	74	75	74
Smoking			
Ever smoked	50	44	57
Never smoked	50	6	43
Dental visit in the past year			
Yes	73	67	79
No	27	33	21

Characteristic			
Dental insurance			
Yes	71	70	73
No	29	30	27
Self-rated general health			
Good	91	94	88
Poor	9	6	12
Anterior decayed teeth			
No	93	92	94
Yes	7	8	6
Anterior filled teeth			
No	65	81	49
Yes	35	19	51
Past orthodontic treatment			
Yes	20	26	12
No	80	74	88
Malocclusion			
No	75	75	74
Yes	25	25	26
Satisfaction with dental appearance			
Dissatisfied	11	11	10
Neutral	19	20	19
Satisfied	70	69	71

Note: *p* values in bold indicate relations that are statistically significant at *p ≤ 0.05, **p ≤ 0.01 and ***p ≤ 0.001.

Table 2 Satisfaction with dental appearance of adults in a sample from the 2007–09 Canadian Health Measures Survey (*n* = 2184).

Characteristic	All participants (20–59 years)				Young adults (20–39 years)				Older adults (40–59 years)			
	Dissatisfied (%)	Neutral (%)	Satisfied (%)	*p*	Dissatisfied (%)	Neutral (%)	Satisfied (%)	*p*	Dissatisfied (%)	Neutral (%)	Satisfied (%)	*p*
Gender												
Male	10	23	66	0.07	11	25	64	0.07	10	21	69	0.53
Female	11	15	74		12	14	75		11	16	73	
Age												
20–39 years	11	19	69	0.44								
40–59 years	10	19	71									
Income level												
Lower	13	22	64	**0.005****	11	25	64	0.08	16	20	64	**0.004****
Higher	9	16	75		11	14	75		7	18	75	
Marital status												
Not married	12	19	69	0.4	10	19	71	0.32	16	18	66	**0.03***
Married	10	20	71		13	20	67		7	19	73	
Tooth-brushing frequency												
≤ once a day	15	24	61	**0.01****	19	25	57	**0.004****	12	23	66	0.23
≥ twice a day	9	18	73		9	18	74		10	17	73	
Smoking												
Ever smoked	14	22	64	**0.002****	14	24	61	**0.004****	13	20	67	**0.04***
Never smoked	8	16	76		9	16	75		7	17	77	
Dental visit in the past year												
Yes	9	17	74	**0.002****	9	16	74	**0.01****	8	18	74	**0.01****
No	16	24	60		15	26	59		18	21	61	
Dental insurance												
Yes	10	18	71	0.18	11	19	70	0.46	9	18	73	0.17
No	12	22	66		12	21	67		13	22	65	
Self-rated general health												

Good	10	19	72	**< 0.001*****	10	20	70	**0.02***	9	17	74	**0.01****
Poor	21	26	53		24	20	56		20	29	51	
Anterior decayed teeth											
No	9	18	73	**< 0.001*****	8	19	72	**< 0.001*****	10	17	73	**< 0.001*****
Yes	35	29	36		46	23	31		21	38	42	
Anterior filled teeth											
No	10	19	71	0.14	10	19	71	**0.004****	9	19	72	0.57
Yes	13	19	68		17	21	63		11	19	70	
Past orthodontics treatment											
Yes	7	14	79	**0.02***	6	15	79	**0.03***	11	12	77	0.28
No	12	20	68		13	21	66		10	20	70	
Malocclusion											
No	9	18	74	**0.01****	9	18	74	**0.002****	9	17	74	0.14
Yes	16	23	61		18	25	56		14	20	66	

Table 3 Ordinal logistic regression analysis of satisfaction with dental appearance of adults in a sample from the 2007–09 Canadian Health Measures Survey (n = 2184).

Characteristic	All participants (20–59 years)		Young adults (20–39 years)		Older adults (40–59 years)	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Sex						
Female vs. male	1.32 (0.94–1.86)	0.10	1.48 (0.85–2.56)	0.15	1.12 (0.63–1.99)	0.68
Age	1.01 (0.99–1.03)	0.20	1.01 (0.97–1.04)	0.61	1.01 (0.96–1.05)	0.80
Income level						
Higher vs. lower	1.38 (1.02–1.88)	**0.04***	1.26 (0.76–2.09)	0.33	1.4 (0.99–1.98)	0.06
Marital status						
Married vs. not married					1.26 (0.86–1.83)	0.20
Tooth-brushing frequency						
≥ twice a day vs. ≤ once a day	1.15 (0.68–1.95)	0.58	1.46 (0.66–3.2)	0.32		
Smoking						
Never smoked vs. ever smoked	1.7 (1.25–2.31)	**0.003****	1.53 (0.97–2.41)	0.07	1.82 (1.01–3.26)	**0.05***
Dental visit in the past year						
Yes vs. no	1.48 (0.89–2.44)	0.12	1.36 (0.77–2.42)	0.26	1.55 (0.74–3.24)	0.22
Self-rated general health						
Good vs. poor	2.21 (1.31–3.74)	**0.007****	1.91 (0.93–3.89)	0.07	2.42 (1.19–4.92)	**0.02***
Anterior decayed teeth						
No vs. yes	3.1 (1.93–4.98)	**< 0.001*****	3.71 (1.92–7.19)	**0.001*****	2.14 (1.08–4.22)	**0.03***
Anterior filled teeth						
No vs. yes	1.36 (1.03–1.81)	**0.04****	1.51 (1.06–2.16)	**0.03***		
Past orthodontic treatment						
Yes vs. no	1.29 (0.72–2.32)	0.36	1.42 (0.6–3.34)	0.39	0.98 (0.51–1.87)	0.94
Malocclusion						
No vs. yes	1.73 (1.13–2.65)	**0.02***	2.05 (1.34–3.15)	**0.004****	1.52 (0.8–2.88)	0.18
Intercept 1	2.91 (1.32–4.5)	0.002	3.41 (1.38–5.44)	0.003	1.65 (-1.35–4.64)	0.25
Intercept 2	4.27 (2.59–5.95)	0.00	4.84 (2.62–7.05)	0.00	2.96 (-0.18–6.11)	0.06

Note: p values in bold indicate relations that are statistically significant at *p ≤ 0.05, **p ≤ 0.01 and ***p ≤ 0.001.

CI = confidence interval; OR = odd ratio.

Discussion

This study resulted in 2 major findings: malocclusion is negatively related to satisfaction with dental appearance, and past orthodontic treatment is not linked to satisfaction with dental appearance.

Most Canadians aged 20–59 are satisfied with their dental appearance (70%). The prevalence of satisfaction with dental appearance in Canadian adults was slightly lower than that of British adults over 16 years of age (76%)[18] and American adults older than 45 years (76%).[19] Malocclusion was recorded for 1 in 4 people (25%) in this sample of Canadian adults. One in 5 Canadian adults (20%) has received orthodontic treatment in the past, which is comparable to the corresponding prevalence among adults in the United States (20%)[20] and Iceland (21%).[21]

We found that malocclusion is negatively related to satisfaction with dental appearance in accordance with previous reports.[4,5,22] However, this relation varies with age group. Although malocclusion is negatively associated with satisfaction with dental appearance among young adults (20–39 years), among older adults (40–59 years) this relation was not significant. This finding is plausible, as younger people value the esthetic aspects of facial and dental appearance more than older adults.[23,24]

Past orthodontic treatment is not related to satisfaction with dental appearance among Canadian adults, and this applies to both age groups. A number of reports have been published on the results of 17- and 20-year old cohort studies that assessed the long-term benefits of orthodontic treatment up to adulthood. In line with the findings of our work, these studies cast doubts on the long-term benefits of the orthodontic treatment in terms of improving oral health related quality of life, self-esteem and psychological health.[25-28]

The absence of a significant relation between past orthodontic treatment and satisfaction with dental appearance might be due to relapse, which has always been a challenge in determining the long-term results of orthodontic treatment.[29] Some treated patients may not feel satisfied with their appearance during adulthood because of a return to pretreatment conditions. Further, there is a long-standing debate on the detrimental effects on periodontal health of orthodontic treatment.[30-32] For example, a study reported significant attachment loss during orthodontic treatment[33] and some of these changes remained following the removal of the orthodontic appliance.[34] Negative impacts of orthodontic treatment on oral health condition may explain why orthodontic treatment in the long term does not bring psychological benefits.

We also found that satisfaction with dental appearance is negatively affected by lower income, smoking, poor self-rated general health and having anterior decayed or missing teeth. Previously, satisfaction with dental appearance has been linked to clinical conditions, such as the shape and the position of teeth,[35-37] tooth colour,[38] fluorosis,[39] number of missing teeth[4] and having a broken or loose tooth.[19] Smoking has also been linked to lower satisfaction with dental appearance, as tobacco stains on teeth may adversely affect satisfaction.

Satisfaction with dental appearance does not differ according to sex. This finding may imply that men and women value their dental esthetics equally. Although some researchers have not found sex differences in satisfaction with dental appearance,[4] others have reported less satisfaction with dental appearance among women.[19,38]

The findings of this study should be compared cautiously with those of others because of variation in the definition of malocclusion and the measurement of satisfaction with dental appearance. There is no universal agreement on a definition of malocclusion. In the dental literature, malocclusion is often estimated using various occlusal indices, most notably the Dental Aesthetic Index (DAI).[4,40] The DAI takes into account the number of the missing teeth in estimating occlusal abnormality, which was not the case in our study.

This study has some major limitations. For example, we did not know how long after orthodontic treatment the data were collected. It may be that satisfaction with dental appearance varies over time after receiving orthodontic treatment. The low prevalence of some traits of malocclusion in this survey did not allow us to investigate separately the impact of each trait on satisfaction with dental appearance. Using evidence from a national dataset did not allow us to control for several confounding variables, which may cause bias. Regardless, this study is an important addition to the literature, as population-based studies of satisfaction with dental appearance, particularly from a nationally representative sample, are scarce.

The findings of this study suggest that, before considering orthodontic treatment, public health programs and clinicians should focus on addressing esthetic problems by restoring inadequate anterior teeth fillings, treating anterior tooth decay and implementing smoking cessation programs, all of which may play a more significant role in improving people's satisfaction with their dental appearance.

Conclusion

Orthodontic treatment is not related to satisfaction with dental appearance, at least among this sample of Canadian adults. Malocclusion negatively affects satisfaction with dental appearance, but this negative effect is more pronounced among younger adults.

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References

1. Kiekens RM, Maltha JC, van't Hof MA, Kuijpers-Jagtman AM. Objective measures as indicators for facial esthetics in white adolescents. *Angle Orthod.* 2006;76(4):551-6.

2. Badran SA. The effect of malocclusion and self-perceived aesthetics on the self-esteem of a sample of Jordanian adolescents. *Eur J Orthod.* 2010;32(6):638-44.

3. Rodd HD, Marshman Z, Porritt J, Bradbury J, Baker SR. Oral health-related quality of life of children in relation to dental appearance and educational transition. *Br Dent J.* 2011;211(2):E4.

4. Tessarollo FR, Feldens CA, Closs LQ. The impact of malocclusion on adolescents' dissatisfaction with dental appearance and oral functions. *Angle Orthod.* 2012;82(3):403-9.

5. Marques LS, Filogônio CA, Filogônio CB, Pereira LJ, Pordeus IA, Paiva SM, et al. Aesthetic impact of malocclusion in the daily living of Brazilian adolescents. *J Orthod.* 2009;36(3):152-9.

6. Magalhães IB, Pereira LJ, Marques LS, Gameiro GH. The influence of malocclusion on masticatory performance A systematic review. *Angle Orthod.* 2010;80(5):981-7.

7. Wedrychowska-Szulc B, Syryńska M. Patient and parent motivation for orthodontic treatment — a questionnaire study. *Eur J Orthod.* 2010;32(4):447-52.

8. Pabari S, Moles DR, Cunningham SJ. Assessment of motivation and psychological characteristics of adult orthodontic patients. *Am J Orthod Dentofacial Orthop*. 2011;140(6):e263-72.

9. Kiyak HA. Does orthodontic treatment affect patients' quality of life? *J Dent Educ*. 2008;72(8):886-94.

10. Petersen B, Dahlström L. Perception of treatment need among orthodontic patients compared with professionals. *Acta Odontol Scand*. 1998;56(5):299-302.

11. Shue-Te Yeh M, Koochek AR, Vlaskalic V, Boyd R, Richmond S. The relationship of 2 professional occlusal indexes with patients' perceptions of aesthetics, function, speech, and orthodontic treatment need. *Am J Orthod Dentofacial Orthop*. 2000;118(4):421-8.

12. Svedström-Oristo AL, Pietilä T, Pietilä I, Alanen P, Varrela J. Morphological, functional and aesthetic criteria of acceptable mature occlusion. *Eur J Orthod*. 2001;23(4):373-81.

13. Bondemark L, Holm AK, Hansen K, Axelsson S, Mohlin B, Brattstrom V, et al. Long-term stability of orthodontic treatment and patient satisfaction. A systematic review. *Angle Orthod*. 2007;77(1):181-91.

14. Canadian Health Measures Survey, cycle 1. Statistics Canada, Ottawa, Canada. Available: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SurvId=9353&InstaId=10263&SDDS=5071

15. Office of the Chief Dental Officer. Statistics Canada's Canadian Health Measures Survey. *Can J Dent Hyg*. 2007;413:151-3.

16. Health Canada. Report on the Findings of the Oral Health Component of the Canadian Health Measures Survey 2007- 2009. (Accessed 2015 July). Available: http://www.fptdwg.ca/assets/PDF/CHMS/CHMS-E-summ.pdf.

17. Hosmer DW, Lemeshow S. *Applied logistic regression*. 2nd ed. New York: Wiley; 2000.

18. Alkhatib MN, Holt R, Bedi R. Age and perception of dental appearance and tooth colour. *Gerodontology*. 2005;22(1):32-6.

19. Xiaoxian Meng, Gilbert GH, Duncan RP, Heft MW. Satisfaction with dental appearance among diverse groups of dentate adults. *J Aging Health*. 2007;19(5):778-91.

20. Brunelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population, 1988–1991. *J Dent Res*. 1996;75 Spec no:706-13.

21. Jonsson T, Arnlaugsson S, Karlsson KO, Ragnarsson B, Arnarson EO, Magnusson TE. Orthodontic treatment experience and prevalence of malocclusion traits in an Icelandic adult population. *Am J Orthod Dentofacial Orthop*. 2007;131(1):8e11-8.

22. de Paula Júnior DF, Santos NC, da Silva ET, Nunes MD, Leles CR. Psychosocial impact of dental esthetics on quality of life in adolescents. Association with malocclusion, self-image, and oral health-related issues. *Angle Orthod*. 2009;79(6):1188-93.

23. Olsen JA, Inglehart MR. Malocclusions and perceptions of attractiveness, intelligence, and personality, and behavioral intentions. *Am J Orthod Dentofacial Orthop*. 2011;140(5):669-79.

24. Stenvik A, Espeland L, Mathisen A. A longitudinal study on subjective and objective orthodontic treatment need. *Eur J Orthod*. 1997;19(1):85-92.

25. Arrow P, Brennan D, Spencer AJ. Quality of life and psychosocial outcomes after fixed orthodontic treatment: a 17-year observational cohort study. *Community Dent Oral Epidemiol*. 2011;39(6):505-14.

26. Arrow P, Brennan DS, Spencer J. Social acceptability of dental appearance and benefits of fixed orthodontic treatment: a 17-year observational cohort study. *J Public Health Dent*. 2012;72(2):135-42.

27. Kenealy PM, Kingdon A, Richmond S, Shaw WC. The Cardiff dental study: a 20-year critical evaluation of the psychological health gain from orthodontic treatment. *Br J Health Psychol*. 2007;12(Pt 1):17-49.

28. Shaw WC, Richmond S, Kenealy PM, Kingdon A, Worthington H. A 20-year cohort study of health gain from orthodontic treatment: psychological outcome. *Am J Orthod Dentofacial Orthop*. 2007;132(2):146-57.

29. Thilander B. Orthodontic relapse versus natural development. *Am J Orthod Dentofacial Orthop*. 2000;117(5):562-3.

30. Reichert C, Hagner M, Jepsen S, Jäger A. Interfaces between orthodontic and periodontal treatment: their current status. *J Orofac Orthop*. 2011;72(3):165-86.

31. Gkantidis N, Christou P, Topouzelis N. The orthodontic-periodontal interrelationship in integrated treatment challenges: a systematic review. *J Oral Rehabil*. 2010;37(5):377-90.

32. Bollen AM, Cunha-Cruz J, Bakko DW, Huang GJ, Hujoel PP. The effects of orthodontic therapy on periodontal health: a systematic review of controlled evidence. *J Am Dent Assoc*. 2008;139(4):413-22.

33. Janson G, Bombonatti R, Brandão AG, Henriques JF, de Freitas MR. Comparative radiographic evaluation of the alveolar bone crest after orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 2003;124(2):157-64.

34. van Gastel J, Quirynen M, Teughels W, Coucke W, Carels C. Longitudinal changes in microbiology and clinical periodontal parameters after removal of fixed orthodontic appliances. *Eur J Orthod*. 2011;33(1):15-21.

35. Al-Omiri MK, Karasneh JA, Lynch E, Lamey PJ, Clifford TJ. Impacts of missing upper anterior teeth on daily living. *Int Dent J*. 2009;59(3):127-32.

36. Hassel AJ, Wegener I, Rolko C, Nitschke I. Self-rating of satisfaction with dental appearance in an elderly German population. *Int Dent J*. 2008;58(2):98-102.

37. Zagar M, Zlataric DK. Influence of esthetic dental and facial measurements on the Caucasian patients' satisfaction. *J Esthet Restor Dent*. 2011; 23(1): 12-20.

38. Tin-Oo MM, Saddki N, Hassan N. Factors influencing patient satisfaction with dental appearance and treatments they desire to improve aesthetics. *BMC Oral Health*. 2011;11:6.

39. Kavand G, Broffitt B, Levy SM, Warren JJ. Comparison of dental esthetic perceptions of young adolescents and their parents. *J Public Health Dent*. 2012;72(2):164-71.

40. Agou S, Locker D, Muirhead V, Tompson B, Streiner DL. Does psychological well-being influence oral-health-related quality of life reports in children receiving orthodontic treatment? *Am J Orthod Dentofacial Orthop*. 2011 139(3):369-77.