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Evaluation of orthodontic treatment need by patient-based methods compared with normative method

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ABSTRACT

Background: A comprehensive system of assessing orthodontic need requires the integration of normative clinical measures with patient-based indicators. This study sought to discover weather an oral health-related quality of life measure or Aesthetic Component of Index of Orthodontic Treatment Need (AC-IOTN) could be used as a predictor of orthodontic treatment need. Factors affecting the judgment of patient and dentist about this need are discussed.

Materials and Methods: Oral examination on 597 Iranian students between 13 years and 18 years was done to reach the grade of Dental Health Component (DHC). The Child Oral Health Impact Profile (COHIP) and AC-IOTN were recorded. The diagnostic values of subjective tests were assessed. Multiple logistic regressions were applied to investigate the role of variables in the persons' perceptions.

Results: Half of the 570 eligible students did not need orthodontic treatment either on professional or self-assessment; 60% of patients with definite need had a distinct impact on their quality of life. The specificity of AC to detect the healthy persons was excellent (0.99) but its sensitivity was low (0.08). COHIP score gave a better sensitivity but its specificity was 50%. Caries experience, quality of life, father's education, and brushing habits were the factors relating to the same judgment of persons and dentists ($P < 0.02$).

Conclusion: Regarding the discrepancies between two assessment methods, present instruments did not meet the predictor's competencies. The patient-based methods could not substitute the professional assessment, but by identification, the persons with higher impacts would benefit the prioritization process.

Key Words: Adolescents, oral health-related quality of life, orthodontic treatment need

INTRODUCTION

Traditionally, the common model of oral health needs assessment depends almost entirely on professional opinions. Normative need assessment refers to the impairments and diseases which expert, administrator or scientist defines as need. In spite of the usefulness of this concept in the estimation of people, procedures, and delivering services costs, it has considerable limitations.[1] A major shortcoming of the normative approach is that it fails to take into account the broader concepts of health as it has been stated by World Health Organization (WHO) in 1948, which have led to incorporate functional, psychological, and social well-being to almost all disciplines of health. More considerably, this method is criticized for unrealistic estimation of need for treatment planning, especially in developing countries with scarce oral health care recourses.[2]

Demand for orthodontic treatment is mostly related

to psychosocial factors like personal concern about appearance.[3] It seems that in most patients, malocclusion is a deviation from a documented average rather than a disease, so distinction between acceptable and unacceptable occlusion is influenced by psychological and social factors.[4] So a person's feelings about his dental appearance should be essential in assessing the need and outcome of orthodontic treatment. On the other hand, deficiencies of normative need assessment are more serious in large-scale population studies and this method leads to a high estimation of treatment needs which is unlikely to be met by decision makers.[5] Therefore, a comprehensive system of assessing orthodontic need requires the integration of normative clinical measures with patient-based indicators of the individual's emotion. The studies of Gherunspong *et al.*, using Oral Impact on Daily Performance (OIDP)[6] and Locker and Jokovic using Oral Health Impact Profile (OHIP-49)[5] indicated that diagnostic values of such measures are not good enough to work as screening tests. But evidently, they identified the individuals with some impacts from their conditions and consequently may conduct us to the sub-groups who could benefit more from dental treatments. Perceived need to dental treatment and Oral Health-Related Quality of Life (OHRQoL) have been utilized as the subjective assessment measures in the literatures, previously.[2,7,8]

Studies suggest that a perceptual oral awareness is developed mostly in adolescence.[9] Teenagers show a perception of dental beauty and orthodontic treatment need particularly attributes to their peers and environments.[9] Child Oral Health Impact Profile (COHIP) is a psychometrically sound instrument intended to measure OHRQoL among school-age children with different oral health conditions. As this instrument emphasizes on the social-emotional and school environment aspects of well-being in details, it seems that it is more appropriate to assess the quality of life in the period of adolescence.[10-12]

The Aesthetic Component of Index of Orthodontic Treatment Need (AC-IOTN) is a standardized rating scale of dental attractiveness. It has been allocated for more than two decades as a tool in patient counseling; assisting subjects to gain a realistic impression of their relative dental attractiveness.[13] Several studies have investigated the relationship between normative need assessors and AC-IOTN for evaluating the patient's perception. The findings support that the perception of orthodontic treatment need is a multi-factorial

process and is influenced by some personal, cultural, and social factors.[9,14,15]

Regarding the fact that adolescents from lower socio-economic levels usually report lower levels of self-perceived health,[16] it seems crucial to consider the role of Socio-Economic Status (SES) to correlate between professionally and self-assessed needs.[15]

In this study, we aimed to compare the diagnostic value of two instruments, COHIP and AC-IOTN, for self-perceived orthodontic need assessment and explore the role of some confounders in the relationship between professional and self-assessed need. The specific objectives of the study are:

- The prevalence of Orthodontic Treatment Need (OTN) in a sample of Iranian adolescents by self-perceived and normative methods.
- The role of variables such as gender, age, SES, health behaviors, and oral health impacts in the similarity of the assessment about the treatment need by individuals and dentists.
- The evaluation of the diagnostic validity of COHIP and self-perceived AC through the analysis of sensitivity, specificity, positive predictive value, and negative predictive value.

MATERIALS AND METHODS

Study population
A cross-sectional survey was conducted in the 13-18-years-old school children in the city of Isfahan, the second most populated city of Iran. Study population consisted of 597 students attending in 20 high schools. The sample size was calculated to be able to detect a difference of two in the score of oral health impacts by 90% power at 5% significance and considered 10% attrition rate. To obtain a representative random sample, a stratified non-proportionate two-stage sampling design was utilized. Divisions of the Ministry of Education and Gender were determined as the variables for stratification. In each district, two boys' and two girls' schools were selected randomly from the electronically registered public schools' list at the pertinent home page (20 schools). Thereafter, 30 eligible students from each school were invited to the study by convenient sampling. The inclusion criteria were the age between 13 years and 18 years and having written parental informed consent. The students who had orthodontic appliances or reported a history of orthodontic treatment were excluded from the main study. The

study was approved by the Human Research Ethics Committee of Shahid Beheshti University of Medical Sciences and Isfahan University of Medical Sciences. Also, legal process in the Bureau of Education, school administrations, and parent's levels were passed.

Data collection

All eligible children have been examined to reach the IOTN.[17] The Dental Health Component (DHC) were recorded in five severity level from one 'no treatment need' to five 'very great need' after the assessments of all occlusion features (overjet, overbite, reverse jet, anterior and posterior crossbite, anterior and lateral open bite, displacement of the teeth, and molar relationship). The final score was based on the most severe trait. Prior to the study, two dentists (Principle Investigators) were trained by a qualified orthodontist in the field of epidemiologic malocclusion studies and calibrated to achieve desirable agreement in the pilot study. According to the Intra-class Correlation Coefficient (ICC), the final inter-examiner reliability of 0.95 was achieved. The intra-examiner reliability by one week interval was above 0.9 in two dentists. AC of the IOTN was accounted by two schemes blindly; self-assessed and professionally-assessed AC score. The participants and dentist, separately, evaluated overall dental attractiveness in according to 10 standard photos ranging from the most attractive (score 1) to the least attractive (score 10) appearance of a person.[18] Ten grade of AC was then transformed into three categories of 'no/slight need': AC = 1-4, 'borderline': AC = 5-7, and 'definite need': AC = 8-10.[19]

The participants were also asked whether they thought they have bad-form or bad-sized teeth or whether the space between their teeth are irregular. This question represented their self-perceived need to orthodontic treatment. The answers were coded in a 5-point Likert scale as "0: Never, 1: Almost never, 2: Sometimes, 3: Fairly often, 4: All the time". Using the cut-off point of three, the responses then dichotomized to frequent or infrequent categories.

To identify the Oral health-related quality of life scores of the sample, the validated Persian COHIP questionnaire was utilized.[12] The instrument consist of 34 items in five subscales including oral health, functional well-being, social-emotional well-being, school environment and self-image which has been developed for school-aged children.[20] Participants describe their past three months experiences in the phrases ranging from 0 'never' to 4 'almost all of the time' (e.g. In the past three months, how often

have you had pain in your teeth?). The total score of COHIP has a range from 0 to 136. Higher COHIP scores reflect more positive OHRQoL, while lower scores reflect lower OHRQoL.

To explore the factors determine the similar assessment of the need to orthodontic treatment by the individual and the dentist, a variable computed to detect the persons who reported the same scores on DHC grade and self-perceived AC grade. The primary grading as" no/slight need, borderline need and definite need" for each index used to create a dichotomous variable entitled "similarity in the judgment". Socioeconomic status was assessed based on the parents' educational levels which were asked in five categories as "illiterate, school without formal qualification, high school with diploma, undergraduate university level, and postgraduate university level". In further analysis, it was transformed into a binary variable as "low: Without academic qualification" and "high: With academic qualification".

Statistical analysis

The Statistical Package for Social Sciences (SPSS) software version 15 was applied to analyze the data. To describe data, mean, standard deviation, proportion, and graphs were used. To investigate the relationship between background variables and the similarity of need treatment evaluation by participants and dentist, multiple logistic regressions was applied. To measure the extent of agreement between subjective indicators and normative index Kappa statistics was calculated. The results at the *P*-value level of 0.05 were considered as significant. To evaluate validity of subjective indicators in identifying those needing orthodontic treatment, sensitivity, specificity, positive predictive value, and negative predictive value were calculated. AC score equal to eight or more, COHIP score below the median (107) or positive response to the teeth irregularity question were considered as patients by a self-assessment instrument.[19] DHC grade of 4 or 5 was the gold standard for professional assessment.

RESULTS

There were 597 students who enrolled in the study. Twenty seven (4.5%) of the students who had a history of previous orthodontic treatment were excluded, so complete data was gained from 570 (95%) students. The mean age was 14.9 ± 1.2 and 52.8% of them were female. According to the DHC grade 4 or 5 as the criteria (gold standard) for need to orthodontic

treatment, 16.4% (*n* = 92) of examined children had definite treatment need. A considerable number of children (90%) perceived to have acceptable anterior teeth or AC grade1-4. Figure 1 shows the distribution of OTN from the perspectives of patient and dentist.

The mean (SD) COHIP score of the population was 103.6 (18). While it showed a range of 15-135, 50% of the participants had a score above 107. The prevalence of participants with at least one frequent impact was 66%, 34%, and 32% in the Oral Health, Social-Emotional, and Self-Image subscales, respectively. There were not any association between gender and age variables with the QoL score (*P* > 0.05), but a gradient was seen in this score with the worsening malocclusion disorders. The COHIP scores in different categories of the study population are brought in Table 1.
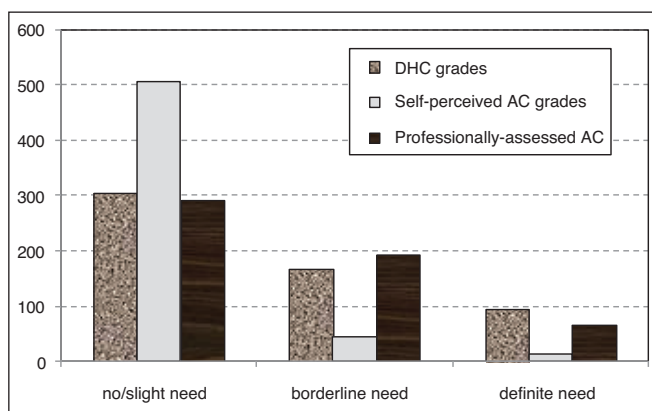

Figure 1: Distribution of IOTN scores in 13-18-year-old school children regarding patient's and dentist's perceptions (*n* = 570)

Twelve persons thought that they are in AC grade of eight and above, while only seven of them had definite normative need. Half of the students did not need orthodontics by perceptional and normative assessment as well. However, 27% with borderline and 13% with definite need to treatment perceived well about themselves. As it is presented in Tables 2 and 3, the distribution of individuals in different categories has significant differences (*P* < 0.001) by changing the indicators of need assessment.

Regarding the AC-IOTN, a comparison between the persons and dentists' evaluation of need showed poor/slight agreement level. Table 4 illustrates the percentage of agreement and the Kappa coefficient (κ) with considering the agreement occurring by chance.

Logistic regression analysis revealed that students with no caries experience, better quality of life, higher father's educational level, and brushing habits are more likely to have judgment comparable with dentists. However, gender, age, and mother's education did not seem to have any role in this decision [Table 5].

The diagnostic power of three subjective indicators with respect to normative need to orthodontics treatment was summarized in Table 6. In this sample, 61% (95% CI = 0.50; 0.71) of all the patients with definite need had a positive impact-related test (sensitivity) and the probability of negative COHIP test result given no disease (specificity) was 50% (95% CI = 0.45; 0.55). Positive predictive value of 20% means that only one-fifth of those who had reported impact on life had need to treatment. Nearly 60% of persons who felt need on

Table 1: Mean and standard deviation (SD) of COHIP scores in 13-18-year-old school children regarding the degree of need to orthodontic treatment and the history of orthodontic treatment (*n*=570)

	DHC grade				History of treatment		
	No/Slight	Borderline	Definite	P_v	Yes	No	P_v
COHIP Mean	105.6	102.4	98	0.002*	108.2	103.4	0.15
SD	16.3	19.6	19.5		16.6	18	

Kruskal-Wallis and Mann-Whitney tests used to compare means, *Significant at the level of 0.05

Table 2: Need to orthodontic treatment on the basis of DHC-IOTN (gold standard) and subjective (self-perceived AC-IOTN) instrument in 13-18-year-old school children (*n*=562) in Isfahan

		DHC grade			
		No/Slight need	Borderline need	Definite need	Total
Self-perceived AC	No/slight need	281 (56%)	151 (29%)	74 (15%)	506
	Borderline need	20 (46%)	13 (29%)	11 (25%)	44
	Definite need	4 (33%)	1 (8%)	7 (53%)	12
	Total (missing=35)	305	165	92	562

Table 3: Frequency of persons with different grades of orthodontic treatment need on the basis of professionally-assessed AC-IOTN and subjective (Self-perceived AC-IOTN) instrument in 13-18-year-old school children (*n*=562) in Isfahan

		Professionally-assessed AC			
		No/Slight need	Borderline need	Definite need	Total
Self-perceived AC	No/slight need	282 (56.7%)	166 (33.4%)	49 (9.9%)	497
	Borderline need	11 (25.6%)	24 (55.8%)	8 (18.6%)	43
	Definite need	0 (0%)	4 (33.3%)	8 (66.7%)	12
	Total (missing=45)	293	194	65	552

Table 4: The agreements between the patients (Self-perceived AC) and dentists (DHC/Normative AC) regarding the judgments about the needs to orthodontic treatment

	Agreement	Expected agreement	K coefficient	Standard error	Z
DHC grade/Self-perceived AC	56.9%	50.8%	0.124	0.023	5.43
Normative AC/Self-perceived AC	53.6%	51.5%	0.042	0.022	1.89

Needs to orthodontic treatment was categorized as no, borderline, and definite need categories. The Kappa statistic used to test the agreement

Table 5: Multiple logistic regression to investigate the influences of the independent variables on the similar judgment in the participant and dentist about treatment need in 13-18-year-old school children in Isfahan

Independent variables	Odds ratio (Adjusted)	95% Confidence interval	*P*-value
Sex			
male	1	0.57-1.14	0.22
female	0.81		
Age group			
13-15 y	1	0.79-1.62	0.48
15-18 y	1.13		
Father education			
Low	1	1.07-1.71	0.02*
high	1.35		
Mother education			
Low	1	0.64-1.09	0.20
high	0.84		
Healthy behaviors			
Brushing twice a day	1	1.07-2.6	0.02*
<twice a day	1.67		
COHIP score			
below median	1	1.08-2.15	0.01*
above median	1.53		
DMFT			
0	1	0.40-0.89	0.01*
≥1	0.60		

*Significant at the level of 0.05

AC score have had real need. It revealed that in our sample the probability of not having the condition is around 85% if the test is negative; either the COHIP or AC or single question is allocated. Regarding a question on the irregular teeth, 88% of persons without malocclusion have been distinguished by a negative response. The strength of AC to detect the healthy ones showed to be excellent, but its low sensitivity disabled the recognition of the persons with serious need.

DISCUSSION

The findings of the present study clearly revealed a considerable difference between subjectively and normatively assessed needs relating to treatment of malocclusions in 13-18-year-old Iranian adolescents. More than half of the students under assessment were defined as healthy by an expert while this rate was 90% when reported by the students themselves. It was in concordance with the previous studies which highlighted disagreement between two kinds of assessment on dento-facial irregularities.[3,7,8,15,21] There was no significant difference in two genders either in their normative need to treatment or in the perception of need to treatment. It was in contrast with some studies which had shown subjective needs for aesthetic-related treatment were more frequent in the females.[8,15,22]

It is well approved that great concerns about appearance is the main factor for motivation to seek orthodontic treatment rather than function or health.[23,24] This is a major worry in the adolescents because of the influences on their communications, and it is suggested that individuals satisfied with their body image tend to have more successful social contacts.[18,25,26] But according to our findings, a considerable proportion of the students with definite need did not expressed any deficiency in their dental

Table 6: Diagnostic validity of subjective indicators in identifying those needing orthodontic treatment in 13-18-year-old school children in Isfahan (*n*=570)

Subjective indicator	Cut-off point	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	LR+	LR−
Self-perceived AC	≥8	0.08	0.99	0.58	0.84	7.15	0.93
COHIP score	≤median	0.61	0.50	0.19	0.86	1.2	0.78
Thought irregular teeth	yes	0.43	0.81	0.31	0.88	2.3	0.7

PPV/NPV: Positive/Negative predictive value; LR: Likelihood ratio

appearance. There may be two explanations; the first one is that the appropriateness of AC index to detect the felt need in this age group is questionable. Teenagers tend to show themselves in a perfect manner and do not tend to be in a flawed state. de Oliveira and Sheiham[27] and Mandall et al.[23] also had concluded that AC was not sufficiently reliable to be used as a consumer measure in child and adolescents. Second is that the DHC takes into account possible occlusal findings that could be functionally detrimental, but are not aesthetically important like posterior crossbite, posterior displacements, or increased overbite.[24,27] Also, it is good to mention that there are cultural and religious norms that play an important role in the mode of self-display in the youth in our country; it could lead to fade the importance of other factors.

While the utilization of quality of life measures has been encouraged in the oral health studies,[28,29] it is emphasized particularly in the orthodontic treatment need assessments, recently.[2,18,22] However, it has been shown that although the clinical condition have a distinct impact on individual's life and the association between malocclusion and QoL was confirmed, there are crucial problems to conjoining the results of these two perspectives. In this study, only 10% of all examined students had criteria of both affected QoL and normative need together. Similar to the finding of the study on Brazilian adolescents,[27] 39% of the patients with grade 4 and 46% of whom with grade 3 of DHC-IOTN did not report considerable impact on their quality of life. Regarding administering a valid questionnaire to quantify the impacts of oral and dental problems on adolescent's daily living, our assumption was that all domains of this instrument (oral health, function, social-emotional, schooling, and self-image) could be affected by malocclusion. Moreover, study of Dunlow indicated that COHIP is sensitive to malocclusion and its subscales have an acceptable concurrency with dento-facial image, social anxiety, and self concept measures.[30] But the present results revealed that this instrument is neither sensitive nor specific enough to detect the

patients with malocclusions as a screening tool. This issue confirmed the previous reports which have mentioned that subjective instruments are not reliable in orthodontic need assessment because of their poor performance to screen clinical diseases.[5,7,25,27]

Regarding the existing discrepancy between two methods of need evaluation, we tried to uncover the variables that played role in the process of judgment by patient's perspective. While some factors such as OHRQoL, dental caries history and father's education increased the chance of same judgment on need, the coefficient of determination which was gained in the fitting models was 0.07. It means that more than 90% of variability of judgment is accounted for the factors other than our tested variables which should be discovered by a qualitative research. In line with the multi-dimensional identity of health, individual's perceptions are the outcomes of complex bio-psychosocial processes and they are affected by various moderating factors such as the person's overall characteristics, living environment, health literacy, and so on.

The main limitation of this study is the conceptual inflictions about the use of generic OHRQoL instrument as measuring tool in OTN. To remove all doubts, the condition-specific instruments should be derived or developed. In addition, it should be thought that the implication of such measures in clinical or patient seeking settings is completely different from public setting. Definition of the minimal clinically importance and cut-off point determination of subjective instruments was another issue in the procedure of need assessment.

CONCLUSION

Despite the advantages of integration of patient-centered outcome measuring, this approach in oral health need assessment needs to further research yet. This study demonstrated that regarding AC as a patient-based outcome, about 50% of the participants had no need on the dentist's and individual's belief. While in

the other 50% with borderline need, the appearance was acceptable. Using COHIP, a high proportion of false positive cases has weakened any decision foundation for treatment; however, individuals with an impact-related need can be prioritized for treatment in program planning. The frequency of definite need to orthodontics has decreased from 16.4% to 10% by application of impact-related need assessment.

REFERENCES

1. Sheiham A, Tsakos G. Oral health needs assessment. In: Pine CM, Harris R, editors. Community Oral Health, 2nd ed. Edinburgh: Quintessence Publishing co; 2007. p. 59-79.
2. Gherunpong S, Tsakos G, Sheiham A. A socio-dental approach to assessing children's orthodontic needs. Eur J Orthod 2006;28:393-9.
3. de Oliveira CM, Sheiham A. Orthodontic treatment and its impact on oral health-related quality of life in Brazilian adolescents. J Orthod 2004;31:20-7.
4. Tsakos G. Combining normative and psychosocial perceptions for assessing orthodontic treatment needs. J Dent Educ 2008;72:876-85.
5. Locker D, Jokovic A. Using subjective oral health status indicators to screen for dental care needs in older adults. Community Dent Oral Epidemiol 1996;24:398-402.
6. Gherunpong S, Sheiham A, Tsakos G. A sociodental approach to assessing children's oral health needs: Integrating an oral health-related quality of life (OHRQoL) measure into oral health service planning. Bull World Health Organ 2006;84:36-42.
7. de Oliveira CM, Sheiham A, Tsakos G, O'Brien KD. Oral health-related quality of life and the IOTN index as predictors of children's perceived needs and acceptance for orthodontic treatment. Br Dent J 2008;204:1-5.
8. Tsakos G, Gherunpong S, Sheiham A. Can oral health-related quality of life measures substitute for normative needs assessments in 11 to 12-year-old children? J Public Health Dent 2006;66:263-8.
9. Mandall NA, McCord JF, Blinkhorn AS, Worthington HV, O'Brien KD. Perceived aesthetic impact of malocclusion and oral self-perceptions in 14-15-year-old Asian and Caucasian children in greater Manchester. Eur J Orthod 2000;22:175-83.
10. Broder HL, Slade G, Caine R, Reisine S. Perceived impact of oral health conditions among minority adolescents. J Public Health Dent 2000;60:189-92.
11. Broder HL, Wilson-Genderson M. Reliability and convergent and discriminant validity of the Child Oral Health Impact Profile (COHIP Child's version). Community Dent Oral Epidemiol 2007;35:20-31.
12. Asgari I, Ahmady AE, Broder H, Eslamipour F, Wilson-Genderson M. Assessing the Oral Health-related Quality of Life in Iranian Adolescents: Validity of the Persian Version of the Child Oral Health Impact Profile (COHIP). Oral Health Prev Dent 2013;2:147-154.
13. Evans R, Shaw W. Preliminary evaluation of an illustrated scale for rating dental attractiveness. Eur J Orthod 1987;9:314-8.
14. Hamdan AM. The relationship between patient, parent and clinician perceived need and normative orthodontic treatment need. Eur J Orthod 2004;26:265-71.
15. Christopherson EA, Briskie D, Inglehart MR. Objective, subjective, and self-assessment of preadolescent orthodontic treatment need — a function of age, gender, and ethnic/racial background? J Public Health Dent 2009;69:9-17.
16. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. Soc Sci Med 2008;66:1429-36.
17. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod 1989;11:309-20.
18. Klages U, Claus N, Wehrbein H, Zentner A. Development of a questionnaire for assessment of the psychosocial impact of dental aesthetics in young adults. Eur J Orthod 2006;28:103-11.
19. Burden DJ, Pine CM, Burnside G. Modified IOTN: An orthodontic treatment need index for use in oral health surveys. Community Dent Oral Epidemiol 2001;29:220-5.
20. Broder HL, McGrath C, Cisneros GJ. Questionnaire development: Face validity and item impact testing of the Child Oral Health Impact Profile. Community Dent Oral Epidemiol 2007;35:8-19.
21. O'Brien K, Wright JL, Conboy F, Macfarlane T, Mandall N. The child perception questionnaire is valid for malocclusions in the United Kingdom. Am J Orthod Dentofacial Orthop 2006;129:536-40.
22. Alkhatib MN, Bedi R, Foster C, Jopanputra P, Allan S. Ethnic variations in orthodontic treatment need in London schoolchildren. BMC Oral Health 2005;5:8-15.
23. Mandall NA, Wright J, Conboy FM, O'Brien KD. The relationship between normative orthodontic treatment need and measures of consumer perception. Community Dent Health 2001;18:3-6.
24. Manzanera D, Montiel-Company JM, Almerich-Silla JM, Gandía JL. Diagnostic agreement in the assessment of orthodontic treatment need using the Dental Aesthetic Index and the Index of OrthodonticTreatment Need. Eur J Orthod 2010;32:193-8.
25. Cunningham SJ, O'Brien C. Quality of life and orthodontics. Semin Orthod 2007;13:96-103.
26. Liu Z, McGrath C, Hägg U. The impact of malocclusion/orthodontic treatment need on the quality of life. A systematic review. Angle Orthod 2009;7:585-91.
27. de Oliveira CM, Sheiham A. The relationship between normative orthodontic treatment need and oral health-related quality of life. Community Dent Oral Epidemiol 2003;31:426-36.
28. Petersen PE. Global policy for improvement of oral health in the 21st century — implications to oral health research of World Health Assembly 2007, World Health Organization. Community Dent Oral Epidemiol 2009;37:1-8.
29. The World Health Organization Quality of Life assessment (WHOQOL): Position paper from the World Health Organization. Soc Sci Med 1995;41:1403-9.
30. Dunlow N, Phillips C, Broder HL. Concurrent validity of the COHIP. Community Dent Oral Epidemiol 2007;35:41-9.