ORIGINAL ARTICLE

# Pretreatment characteristics associated with orthodontic treatment duration

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**Introduction:** Pretreatment characteristics can assist orthodontists in accurately estimating treatment duration. **Methods:** This case-control study identified 400 patients, 9 to 18 years of age. Short treatment duration was 20 months or less, and long treatment duration was 30 months or longer. Potential pretreatment explanatory variables included planned treatment, sociodemographic, behavior, dental, skeletal, and soft-tissue characteristics. Univariable and multivariable logistic regression modeling was used to quantify the association between patient characteristics and treatment duration by reporting the unadjusted odds ratios (OR-crude), the adjusted odds ratios (ORadj), and the 95% confidence intervals (CIs). **Results:** Patients planned as nonextraction (ORadj = 2.3; 95% CI, 1.3-4.2), no deciduous teeth (ORadj = 3.0; 95% CI, 1.5-5.9), less than 80% overbite (ORadj = 2.4; 95% CI, 1.3-4.4), less than 6 mm of maxillary crowding (ORadj = 3.6; 95% CI, 1.7-7.7), and good oral hygiene (ORadj = 3.2; 95% CI, 1.3-1.8) were 2 to 3 times more likely to have short treatments. Patients with decreased lower facial height (ORadj = 3.4; 95% CI, 1.6-7.1), extractions (ORadj = 1.8; 95% CI, 1.0-3.2), deciduous teeth (ORadj = 1.9; 95% CI, 1.0-3.4), poor grades (ORadj = 2.0; 95% CI, 1.1-3.8), excessive overjet (ORadj = 2.3; 95% CI, 1.4-3.8), 80% or more overbite (ORadj = 2.0; 95% CI,1.2-3.6), and 6 mm or more of maxillary crowding (ORadj = 2.6; 95% CI,1.4-4.6) were 2 to 3 times more likely to have long treatments. **Conclusions:** Presence or absence of severe maxillary crowding, deciduous teeth, 80% overbite, and extractions were consistently, inversely, and independently associated with short and long treatment durations. (Am J Orthod Dentofacial Orthop 2010;137:178-86)

Epidemiologic studies that identify independent relationships between pretreatment characteristics and orthodontic treatment duration provide data pertinent for evidence-based orthodontics. This is an important topic for orthodontists because "true and accurate timing estimates" was ranked second to "reduction in treatment fees" as the most common patient recommendation for orthodontists.[1] Furthermore, orthodontists usually have a fixed treatment fee, but have the ability to identify patients who are more likely to have shorter or longer than average treatment times would allow them to adjust fees appropriately.

Previous studies assessed the variations in treatment duration through multiple linear regression analysis of the following potential explanatory variables: extractions, peer assessment rating (PAR) score, oral hygiene during treatment, number of phases of treatment, headgear, age, sex, midline, type of appliances, crowding, Angle classification of molar relationship, pretreatment overbite and overjet, impacted canines, missing teeth, orthognathic surgery, various cephalometric measurements, number of missed appointments, number of broken appliances, total number of office visits, time between appointments, and delivery system (private practice vs graduate orthodontic clinic).[2-10] The resultant multiple linear regression models explained up to 57% of the variation in treatment duration.[2] Although the multiple linear regression models developed in these studies estimate the effect of these variables in explaining the variations in treatment duration, the findings do not assist orthodontists in estimating whether a patient's treatment will be shorter or longer than average. Furthermore, the reported models do not assist the orthodontist in estimating treatment duration because the final models include treatment variables—eg, the number of missed appointments and the frequency of broken appliances—that can only be known after treatment.

The purpose of this study was to estimate, before beginning treatment, which patients are more likely to require a shorter or longer time to complete treatment, by quantifying the association between pretreatment characteristics and short treatment duration (STxD) or long treatment duration (LTxD). To the best of our

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knowledge, all previous studies of orthodontic treatment duration used multiple linear regression modeling to explain the variations in the duration of orthodontic treatment, rather than multiple logistic regression modeling to estimate the direct clinically useful findings regarding how much more likely are patients with certain pretreatment characteristics to have shorter or longer than average treatments. In addition, a patient's probability of having LTxD or STxD was estimated by using the beta coefficients in the corresponding logistic regression model.

## MATERIAL AND METHODS

This case-control study identified 400 orthodontic patients, 9 to18 years old at the start of 1-phase comprehensive treatment in the graduate orthodontic clinic at Case Western Reserve University, Cleveland, Ohio, excluding patients treated in the early treatment clinic. Pretreatment patient records were examined on all consecutively debonded patients during 2003 and 2004, and selected patients debonded during 2005 until a total sample of 400 participants were obtained. Using Epi-Info 6,[11] we estimated that a sample of 390 participants was needed for a statistically significant odds ratio (OR) of 2.0, with alpha = 0.05, and beta = 0.2. This study was approved by the institutional review board of Case Western Reserve University, and all participants signed a consent form allowing the use of their orthodontic records for research. Individual characteristics and treatment plan variables were obtained from the patients' radiographs, study models, photographs, and medical and dental history forms.

Treatment duration was defined as the number of months from the date of bonding or cementation to the date of debonding. The 2 separate and distinct case definitions were LTxD and STxD. An LTxD case was defined as 30 months or longer, and a control was defined as not LTxD (<30 months). This definition of LTxD is consistent with the report that treatment was longer than expected for 20% to 30% of patients in some practices[12] because 26% of the patients in our study were LTxD. Thus, an LTxD patient's treatment took 5 months longer than the average length of 25 months. Similarly, an STxD patient was defined as 20 months or less, based on 5 months shorter than average treatment duration, and a control was defined as not STxD (>20 months).

Data were collected on potential explanatory variables describing the type of planned treatment (extraction, expansion appliance, headgear), sociodemographic variables (age, whether or not puberty was reached, race/ethnicity, sex, parent's marital status and occupation, insurance status), behavioral factors (grades, family's previous orthodontic experience, siblings' missed appointments, siblings' early debond because of lack of compliance or poor oral hygiene, habits, caries experience, initial oral hygiene status), dental variables (deciduous teeth, congenitally missing teeth, impacted teeth, overjet, overbite, coordinated arch form, crowding, crossbite, midline discrepancy, pretreatment PAR (pre-PAR) score provided by 1 outside examiner), skeletal and soft-tissue factors (lip competency, lower anterior facial height, profile, facial plane angle, Y-axis angle, occlusal plane angle, interincisal angle, mandibular incisor to occlusal plane angle, maxillary incisor to A-Point Pgonion plane angle, SNA, SNB, ANB, maxillary incisor to Frankfort horizontal angle [U1-FH], FH-NA angle, maxillary incisor to Nasion A-Point angle [U1-NA], mandibular incisor to NB angle [L1-NB]); and type of appliance. Most of these potential explanatory variables have been investigated in previous studies on orthodontic treatment duration.[2-10] Categorizations of the potential explanatory variables are given in Table I.

The following additional details are provided for potential explanatory variables that were not assessed in previous studies. School grades were dichotomized as good (A or B) or poor (C or D). Pretreatment oral hygiene status was based on the simplified oral hygiene index[13] by using intraoral color photographs. After calibration and standardization, pretreatment oral hygiene status was dichotomized as good, defined as a score of 0 or 1 or less, and poor oral hygiene was defined as a score of 2 or 3. Restorations on permanent teeth were also noted from intraoral photographs.

### Statistical analysis

The hypothesis that at least 1 pretreatment variable is associated with LTxD or STxD was tested by unadjusted or univariable (1 dependent variable and 1 independent variable) and multivariable (1 dependent variable and multiple independent variables) logistic regression modeling. First, the association between patient characteristics and treatment duration was quantified by reporting the unadjusted odds ratios (ORcrude). Next, separate stepwise multivariable logistic regression models for LTxD and STxD quantified the association between LTxD or STxD and the explanatory variables, simultaneously taking into account other significant explanatory variables in the model, by estimating the adjusted odds ratios (ORadj). Statistical significance was determined at $P < 0.05$ by reporting the 95% confidence interval (CI). Analyses were conducted with SAS Systems for Windows (version 9.1, SAS Institute, Cary, NC).

The estimated probability, $\pi(x)$, that a patient with specific pretreatment characteristics (covariates in