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Patient Factors Affecting Compliance with Orthodontic Treatment.

Erin R. Kazmierski-Furno

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PATIENT FACTORS AFFECTING COMPLIANCE WITH ORTHODONTIC TREATMENT

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At the

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APPROVAL PAGE

Master of Dental Science Thesis

PATIENT FACTORS AFFECTING COMPLIANCE WITH ORTHODONTIC TREATMENT

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University of Connecticut
2005
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DEDICATION

This work is dedicated to my family and friends, who gave me strength and helped me believe in myself to go after my dreams.

Without their guidance and support, none of this would have been possible.
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INTRODUCTION

Only one third of today’s population has a normal occlusion (Proffit, 2000). This means that many people could benefit from orthodontic treatment. Maloccluded, protruded, and irregular teeth can 1) impair dentofacial esthetics, mastication, swallowing, and speech, 2) contribute to temporomandibular joint disturbances, and 3) cause periodontal disease, susceptibility to trauma, and even caries. Some of these problems related to malocclusion can prove to be a social handicap (Broder, 2000). People with malocclusion may feel distressed by the way they look or talk.

The preferred time for treatment is during adolescence because the permanent dentition is close to fully erupting, but growth can still be used to the orthodontist’s advantage. Unfortunately patient compliance seems to be the most difficult to attain during adolescence (Bobrow et al, 1985; Johnson et al, 1986; Tattersall and Lowe, 1981). Poor patient compliance, including poor oral hygiene, breakage of the appliances, and missed appointments could lengthen treatment time by months and maybe even years. By improving patient compliance, treatment time might be reduced, the treatment outcome could be improved, and the oral environment could be maintained free of disease. The objective of this study was to determine which patient factors affect compliance. The Theory of Planned Behavior has guided the development of the proposed model to explain patient compliance.
LITERATURE REVIEW

Theoretical Models of Health Behavior

Models of health behavior have been developed to help understand and improve patient compliance. They include: The Health Belief Model, The Theory of Reasoned Action, and Social Learning Theory. These theories have evolved over time and the theoretical constructs overlap to some extent. The theories generally agree that individuals are motivated to maximize gains and minimize losses where they perceive they are in control (Marteau 1995, Inglehart & Tedesco 1995).

The Theory of Planned Behavior

The Theory of Planned Behavior, by Icek Ajzen (1991), is the theory that was chosen for this study because it incorporates the critical elements of other approaches and has been most effective in predicting behaviors through questionnaires. Figure 1 shows a schematic diagram of the theory. It suggests that human action is guided by three kinds of considerations: behavioral beliefs, normative beliefs, and beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors. Behavioral beliefs, which produce a favorable or unfavorable attitude toward behavior, are beliefs about the likely outcomes of the behavior and the evaluations of these outcomes. Normative beliefs, which result in perceived social pressure or subjective norm, are the beliefs about the normative expectations of others and motivation to comply with these expectations. Control beliefs, which give rise to perceived behavioral control, are defined as beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these
factors. All three of these beliefs in combination can lead to a behavioral intention, which predicts the behavior under study. We conducted a partial test of this model by looking at the most proximal values that have the strongest effect on future behavior. These proximal values, which are direct measures, are attitude toward behavior, subjective norm, and perceived behavioral control.

The Theory of Planned Behavior has been applied to the study of compliance with medical regimens (Fortheringham and Sawyer, 1995) such as: adherence to medical regimens by adolescents with cancer (Tamaroff et al, 1992), AIDS prevention programs with high school students (Levy et al, 1995), and exercise adherence (Roach et al, 2003). Armitage et al (2002) showed that the Theory of Planned Behavior was a superior predictor of health-related behavioral intentions, specifically medical screening attendance, than both demographic variables and Multidimensional Health Locus of control.

*Psychological Constructs Related to Health Behaviors: Self-efficacy, Self-Esteem and Locus of Control*

Psychological measures have been used as predictors of health related behavior. Self-efficacy, self esteem, and locus of control are all psychological variables that form beliefs, motivation, expectations, and intentions. Self-efficacy is the belief in one's capabilities to organize and execute the sources of action required to manage prospective situations. Self-concept has 2-dimensions to it, self-esteem and locus of control. Self esteem is defined as a general construct referring to an individuals' perceptions of themselves. Locus of control is described as a domain specific construct referring to an individual's perception of events as determined by his/her own
behaviors, fate, luck or external circumstances. It can be understood as a bipolar construct ranging from external to internal causes. A more internal locus of control can be referred to as “self agency”, “personal control”, self-determination”, etc. Research shows the following trends: males tend to be more internal than females, as people get older they tend to become more internal, and people in higher up organizational structures tend to be more internal (Mamlin, Harris, and Case, 2001). These constructs have been found to be effective in understanding compliance with medical regimens and will be included in this study as enhancement to the Theory of Planned Behavior model.

**Self-efficacy and Compliance with General Health and Oral Health Regimens**

**General Health Regimens:** There is relatively large literature on perceived self-efficacy and compliance with health regimens although relatively few studies have included samples of adolescents. Studies involving adolescents and weight loss have found that as self-efficacy improved, eating habits improved and weight loss increased (Roach et al. 2003). However, another study involving preadolescent girls taking calcium supplements to prevent osteoporosis, found that self-efficacy partially mediated the relationship between family support and calcium intake (Ievers-Landis 2002). That is, participants with high self-efficacy in families with low support had better compliance. This can be explained by the concept as children grow older into adolescence they develop their own behavioral beliefs and self-efficacy and don’t rely on their family support as much with healthcare.

**Oral Health Regimens:** Measures of patient’s perceptions of control during orthodontic treatment have demonstrated strong correlations with cooperation with treatment (Albino 1991 & Tedesco 1985). A study of adults that used the Theory of
Reasoned Action Model including a measure of self-efficacy showed that self-efficacy increased the reliability of predictions of oral health status (Tedesco et al 1993). Another study (Syrjala, 1994) of adolescents showed that tooth brushing self-efficacy and dental visiting self-efficacy was associated with self-reported oral health behavior. Alan et al (1968) found that the more self-controlled patient was more likely to show higher levels of treatment compliance during orthodontic treatment.

**Self-esteem and Compliance with General Health and Oral Health Regimens**

**General Health:** Numerous studies have found a relationship between medication compliance and self-esteem among adolescents. One study found that adolescent females who were compliant with contraceptive measures scored higher on self-concept scales than the noncompliant females (Neel et al, 1985). Studies of teenagers with renal failure and epilepsy found that those with lower rates of medication compliance had a low sense of worth (Korsch et al, 1978) and lower self-esteem (Friedman et al, 1986). While these studies showed a correlation between self-esteem and compliance, other studies suggest that the nature of the illness and treatment may play a role in the relationship between self-esteem and compliance. For example, no relationship between self-esteem and metabolic control was found in a group of adolescents with diabetes (Goldberg et al, 1980) or compliance with wearing the Milwaukee brace among teenagers with scoliosis and (Wickers et al, 1977).

**Oral Health Regimens:** It has been reported that high self esteem is associated with good dental hygiene (Macgregor & Balding 1991). A possible explanation is that people who like and care about the way they look want their teeth to look and feel healthy. Regular and frequent visiting habits and positive attitudes are different ways of
expressing that one cares about one’s teeth, places value upon their health and appearance, believes treatment to conducive to their values and is positively inclined to follow treatment recommendations (Fishbein & Ajzen 1975). Larger scale studies have found correlations between good dental health, proper dental hygiene practice of brushing and flossing. Additionally, high self esteem and fewer health-promoting behaviors and was associated with low self esteem (MacGregor et al. 1994). In 1997, Macgregor, Regis, and Balding found a positive correlation between tooth brushing frequency at ages 12-15 and self esteem. Camner (1994) also found that self confidence was the most important factor predicting dental appointment attendance by patients (Camner et al 1994).

Locus of Control and Compliance with General Health and Oral Health Regimens

General Health Regimens: While there is ample literature on Health Locus of Control and compliance with medical regimens, there is little that focuses on adolescence. A study of adolescent women with AIDS and Health Locus of Control found that the women believed they had control over their health, yet felt powerful others and chance determine their health outcomes (Ragsdale et al, 1995). Another study demonstrated a positive correlation between injured athlete’s internality with compliance with rehabilitation treatment (Murphy et al, 1999). Renal transplant recipients who believed that health outcomes were beyond their control were less compliant with both medications and follow-up physician visits (Frazier et al 1994).

Oral Health Regimens: Studies of oral health regimens are inconsistent. Some have shown internal locus of control to be associated with regular dental visits (Williams, 1972), greater dental compliance (El-Mangourney 1981), consistent flossing
(Bagley and Low, 1992), and improvement with dental hygiene (Galgut et al. 1987) while others have shown no significant relationships (Bailey 1981; Odman 1984). Those with an internal locus of control cooperate better with orthodontic treatment regimens than those with external locus of controls (El-Mangourney, 1981). Another study, found that those who held other people or their orthodontist responsible for the outcome of their treatment were more likely to be viewed as uncooperative (Tedesco et al, 1985).

**Sociodemographic Characteristics**

Sociodemographic characteristics are not part of the Theory of Planned Behavior model, but should be considered and adjusted for in the analysis because of their known relationship to use of dental care, orthodontic services and compliance with health regimens. The characteristics that are assessed in this study are age, socioeconomic status, gender and race/ethnicity.

**Sociodemographic Characteristics and Use of Dental and Orthodontic Services**

The utilization of dental services is not evenly spread over the United States population. Many studies have been conducted to identify the effects of sociodemographic characteristics on utilization of dental care. The profile of the most frequent user of dental services is a white, female, college-educated suburbanite in a higher income bracket, who enjoys good general health and has dental insurance (Burt and Ecklund, 1999). The National Center for Health Statistics has found women report using dental services more than men, the peak age of dental visits have been late teenage years to early adulthood, and that higher socioeconomic status is associated with more use of dental care. It has also been found that 59.3 % of white Americans,
44.5% African-Americans, and 46.4% of Hispanic Americans have reported visiting a
dentist (National Center for Health Statistics, 1989).

Previous studies indicate that decision to begin orthodontic treatment is greater
among females (Banks et al, 1988) and individuals in a higher social class (Jenkins et al,
1984). Burden (1995) found that a subject’s peer group having orthodontic appliances
had more impact on the initiation of treatment than the subject’s gender or social class.

**Sociodemographic Characteristics and Compliance with General Health and Oral
Health Regimen**

Sociodemographic factors, such as age, gender, socioeconomic status and
race/ethnicity, and compliance with health regimens have been studied extensively.
Generally speaking, the older the patient, females, higher socioeconomic status, and
Caucasians have been found to be more compliant with health regimens.

Compliance with oral health regimens has been studied less extensively, but as
would be expected, many of the same relationships exist for oral health as for general
health regimens. Many studies (Macgregor et al, 1997; Tedesco et al. 1992; refs) have
shown a positive correlation between oral hygiene behaviors, dental appointment
keeping, use of head gear and low sugar intake and socioeconomic status. Those in the
highest social classes have the best compliance with recommended regimens. Nanda
(1992) states that higher socioeconomic groups tend to cooperate more with
orthodontics than lower socioeconomic groups because of a difference in values of
facial esthetics. However, others have found that lower middle class patients considered
orthodontic treatment to be more important than the upper middle class patients (Dorsey
and Korabik 1977). Another study found that females from moderate to lower
socioeconomic groups were better orthodontic patients, meaning more compliant (Starnbach and Kaplan 1975).

There have been inconsistent findings for the effects of age on adherence with oral health regimens. Albino, et al., 1991 found no relationship between patient cooperation and duration of treatment may facilitate the effects of personality variables on cooperation (Haynes, 1976, 1979). However, it has also been found that patient cooperation is not due to length of treatment or age of the participants (Albino et al. 1991). Another study found that the younger the patient the less compliant they are with appointment attendance (Camner et al 1994). During adolescence compliance and cooperation seems to be the most difficult to achieve. This is a formative time in which individuals develop values and goal oriented behaviors. Resistance to health care instructions can be due to changes in parental influence, their adult identity emerging, and the importance of peers' opinions (Bobrow et al., 1985). Adolescents also have not realized the consequences that may result from their present behaviors (Freidman and Litt, 1987).

As with age and compliance, there are many inconsistencies with gender and compliance as stated in Litt and Cuskey's (1980) review of general pediatric compliance literature. Some studies found girls to be more compliant than boys, although the differences were not large (Starnbach et al 1975; Kreit et al 1968). Swetlik (1978) found no relationship between gender and compliance with orthodontic care.

Ethnicity and oral health has been studied extensively in the early childhood and adult years, but not as much in the adolescent period. Past studies, have found that adult African-Americans generally have worse oral health and receive less professional health
care than white Americans (Beck & Koch, 1994; Bloom et al, 1992; Brown et al, 1994; Hunt & Silverman, 1987; Jack & Bloom, 1988; Lang et al, 1994 &1995). Other studies have found African-Americans to have more plaque and calculus than whites (Kelly & Harvey, 1979; Hughes et al, 1982). Ronis et al (1998) found that African-Americans were less likely to brush and floss thoroughly, ever have dental check-ups, and have annual check-ups. Another study found that white adults in Maryland and Texas had significantly higher oral hygiene scores than older-aged ethnic minority groups (Davidson et al, 1997). Ismail and Szpunar studied Hispanic health and found that Hispanic adults in the United States had a higher prevalence of gingivitis than non-Hispanic whites (1990). Kiyak et al (2000) studied different ethnic groups and self-efficacy, oral health attitudes, and dental knowledge. They found Asians to feel the least confident to control their oral health and have the least amount of knowledge as opposed to whites who scored highest in self-efficacy and oral health knowledge.

**Dental Knowledge**

Dentists and their staff spend considerable time educating their patients and the public through organized campaigns, school visits, and health fairs about causes of dental diseases and care of teeth and gums. There is little known on the effect of dental or orthodontic knowledge on orthodontic compliance. However, patient management has been found to be greatly enhanced in dentistry, when the patients understand the nature of their condition and the proposed treatment plan (Laskin, 1979). Educating the patient regarding their malocclusion and the means to achieve an acceptable result has been found to be effective in motivating the patient to succeed (Sinha and Nanda, 2000).
GENERAL OBJECTIVES

The topic of compliance with health care regimens is of great interest because it can affect the outcome of medical and dental treatment. Orthodontic treatment outcomes could be improved with increased compliance. Treatment time, caries, gingivitis, white spots/enamel discolorations, could all be decreased with patient compliance. Maintaining oral hygiene by brushing at least twice a day would decrease the chance of caries, gingivitis, white spots, and patient discomfort. Keeping regular appointments would enable the orthodontist to monitor the progress of tooth movement, make the necessary adjustments, and complete treatment in a timely manner. Maintaining the orthodontic appliances without breakage allows treatment to proceed without interruption. Breakage can be described as loosened bands, broken brackets, and broken or bent wires all which effect the way a tooth does or does not move. Breakage is usually caused by eating sticky, chewy, and hard foods. Constant breakage can slow tooth movement or cause undesirable tooth movement thus adding months and years to treatment. Defining factors that affect patient compliance could benefit both the orthodontist and patient. If psychosocial factors that correlated with orthodontic treatment compliance were identified then interventions could be developed to improve preventive behaviors. This study’s purpose was to identify factors that affect patient orthodontic compliance and the difference, if any, between groups by race, sex, age, and socioeconomic status.

HYPOTHESES

The purpose of the study is to identify patient factors that affect compliance with orthodontic treatment. Variables that have been shown to affect medical regimen
compliance include beliefs, attitudes, intentions, motivation, self-efficacy, oral health value, orthodontic and dental knowledge, race, sex, age, and socioeconomic status. This study proposes the following hypotheses:

1. Participants with higher self efficacy will have better compliance with oral hygiene behaviors, appointment keeping and fewer broken appliances compared to those with low self-efficacy.

2. Participants with high socioeconomic status will have better compliance with oral hygiene behaviors, appointment keeping and fewer broken appliances compared to those with higher socioeconomic status.

3. Participants with better dental and orthodontic knowledge will have better compliance with oral hygiene behaviors, appointment keeping and fewer broken appliances compared to those with minimal dental and orthodontic knowledge.

4. Participants with internal locus of control will have better compliance with oral hygiene behaviors, appointment keeping and fewer broken appliances compared to those with external locus of control.

**SPECIFIC AIMS AND OBJECTIVES/IMMEDIATE RESEARCH GOALS**

1. To determine what behavioral beliefs of the patient affect compliance.

2. To determine the affect of dental health knowledge of the patient on compliance.

3. To determine if there is a correlation between sex, race, and age and patient compliance.

4. To determine if there is any difference between state funded and self pay patients and compliance.
METHODS AND MATERIALS

STUDY DESIGN

The study was a longitudinal observational study with repeated measures design. Orthodontic patients between the ages of 10 and 16 years were enrolled in the study. Participants completed questionnaires at entry to the study and received oral examinations at regular visits for one year to obtain oral hygiene and broken appliance data. The questionnaires collected data on psychological variables, dental knowledge and sociodemographic characteristics. Compliance with oral hygiene regimens was assessed by plaque and gingival scores obtained with oral exams. Scores were recorded on clinical exam sheets (Appendix E). Compliance with dietary recommendations about care for brackets was recorded at the oral exams, as well, by the number of broken appliances. The number of broken appointments was recorded.

SAMPLE SELECTION

Participants were recruited from the University of Connecticut Orthodontic clinic. Inclusion criteria were: male or female, between the ages 10-16, any race or ethnicity, and either paid for their braces themselves or by state funding. They must have been in treatment for at least 6 months, but not longer than 2 years. This time range of treatment was selected because any major changes in appliances would have occurred and the patient would have adjusted accordingly. Exclusion criteria were: developmentally disabled and non-English speaking.

PROCEDURE

Participants completed a questionnaire at baseline. Patients were then given instructions on diet and oral hygiene and were given a free toothbrush (Appendix C and
D, respectively). Patients were followed for nine months and data on plaque, gingival inflammation, and breakage of appliance was obtained by one examiner at the subsequent appointments. The patient's chart was not seen by the research examiner thus keeping the examiner blinded to socioeconomic status.

**INDEPENDENT VARIABLES**

The independent variables include: sociodemographic characteristics, orthodontic and dental knowledge, value of oral health and orthodontics, and behavioral beliefs/expectations of the patient. Data on these variables was collected by means of a self-administered questionnaire (see Appendix A and B) at entry to the study.

**Sociodemographic Characteristics:** These variables include the age, gender, race, method of payment for orthodontic care, and family income. The races of the patient were: Caucasian, African-American, Asian, Hispanic, Indian, and other. The method of payment for orthodontic care was either self-pay or state-funded. No patients with private insurance were in the study. The annual family income was divided into categories of less than $24,000, between $25,000 and $49,999, and greater than $50,000.

**Oral Health and Orthodontic Knowledge:** Dental knowledge was assessed by 13 true/false questions. Scores on dental health and orthodontic knowledge were calculated by the number of correct answers to the true/false questions. Questions asked about oral hygiene, dietary guidelines, and appointment attendance.

**Psychological Variables:** These variables were based on the Theory of Planned Behavior and include measures of Intention, Attitude toward behavior, Subjective norm, Perceived Behavioral Control (this captures self-efficacy), and Health Locus of Control.
These predictor variables according to the Theory of Planned Behavior are direct measures.

**Intention:** Intention was measured by 3 questions in reference to brushing and 3 for eating guidelines starting with “1. I will try, 2. I will intend, 3. I plan to” followed by “brush at least twice a day in the next month” or “follow the eating guidelines for the next 2 weeks.” The subject placed an “x” or check in the spot on a unipolar subscale from strongly disagree to strongly agree (1 to 7) to what correlates the most with what they think. An example of this type of question is:

*I plan to brush at least twice a day for the next month.*

**Strongly disagree:** ___: ___: ___: ___: ___: ___: Strongly Agree

**Attitude toward Behavior:** Attitude toward behavior was measured by one question, with 5 parts, which asked the subject to rate on a unipolar subscale (1 to 7) how they feel about brushing and one question regarding following diet guidelines. They marked with an “x” or check on the scale to the adjective which most closely describes how they felt. One side of the scale was a positive adjective and the other a negative one. The questions were:

1. *For me to brush at least twice a day for the next month is or*

2. *For me to follow the eating guidelines for the next 2 weeks is:*

   - harmful: ___: ___: ___: ___: ___: ___: beneficial
   - pleasant: ___: ___: ___: ___: ___: ___: unpleasant
   - good: ___: ___: ___: ___: ___: ___: bad
   - worthless: ___: ___: ___: ___: ___: ___: valuable
   - enjoyable: ___: ___: ___: ___: ___: ___: unenjoyable
Subjective Norm: Subjective norm was measured by 2 questions each for brushing and diet guidelines asking how people who were important to the participant felt about them brushing or people whose opinions they valued would feel about them brushing. The answers also were measured on a unipolar subscale (1 to 7) in which the subject places an “x” or check closer to the statement that they agree most with. An example of this question type is:

*The people in my life whose opinions I value would*

*Avoid sticky, hard, and sugary foods : ___: ___: ___: ___: ___: ___: wouldn't avoid sticky, hard, and sugary foods if they had or have braces.*

*Don't Know*

Perceived Behavioral Control: Perceived behavioral control was measured by 8 questions (4 regarding brushing and 4 regarding the eating guidelines) with unipolar subscales, ranging from 1 to 7, as the answer choice. These questions used the following phrases: 1. For me to brush/ follow eating guidelines in the next month is impossible......possible, 2. If I wanted to I could brush/eat... definitely true vs. false, 3. how much control do you have over brushing/eating.....no control vs. complete control, and 4. It is mostly up to me whether or not I brush....strongly agree vs. strongly disagree.

The following is an example of this type of question:

*For me to avoid sticky, hard, and sugary foods for the next 2 weeks would be*

*Impossible: ___: ___: ___: ___: ___: ___: possible*

Each question of each measure described above can be seen in the questionnaire in the Appendix.
Multidimensional Health Locus of Control: This was measured by how the subject rated their feeling on a belief statement about their dental condition. It was rated on a unipolar subscale of 1 to 6, in which the subject had to circle the number that represented the extent to which they agreed or disagreed with the statement. The numbers were: 1-strongly disagree, 2-moderately disagree, 3-slightly disagree, 4-slightly agree, 5-moderately agree, and 6-strongly agree. There were 4 constructs: internal, chance, doctor, and other people. The possible scores could range from 6-36 for the constructs of internal and chance, which had 6 questions each and 3-18 for doctor and other people, which had 3 questions each. The higher the score for each construct the more the subject believed in that construct’s power of their treatment.

DEPENDENT VARIABLES

The dependent variable was compliance which was operationalized by appointment keeping, oral hygiene, and appliance maintenance. The clinical exam assessed the presence of plaque, gingival inflammation, and breakage of appliance. Data was collected on a clinical assessment form (see Appendix). A checkmark was placed for each tooth for the presence of plaque on the facial gingival third of the teeth (above the bracket up to the gingival margin), gingival inflammation, or broken appliance (wire or bracket broken or loose band). This was chosen instead of the usual plaque indices because most indices include the surfaces that the brackets cover. This technique was quick and decreased difficulty and error that may have been caused by using the other indices. Percentages were tabulated based on the number of teeth present. The percentage formula is as follows:

\[
\frac{\text{# of permanent teeth with plaque present on facial gingival third}}{\text{# of permanent teeth present}} \times 100\%
\]
<table>
<thead>
<tr>
<th>Conditions</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td># of permanent teeth with facial gingival inflammation present</td>
<td>X 100%</td>
</tr>
<tr>
<td># of permanent teeth present</td>
<td></td>
</tr>
<tr>
<td># of permanent teeth with appliance breakage</td>
<td>X 100%</td>
</tr>
<tr>
<td># of permanent teeth present</td>
<td></td>
</tr>
</tbody>
</table>

Appointment keeping was measured by whether the patient attended the scheduled appointment or did not attend the appointment. The usual time intervals between appointments at the University of Connecticut’s Orthodontic Clinic is 4 to 6 weeks. Patients were followed for 9 months therefore the range of visits was anywhere from 1 visit to 7.
STATISTICAL ANALYSIS

Analyses

The analysis begins with a description of the sample, followed by assessment of bivariate relationships and then proceeds to hypotheses testing. Frequency distributions for the dependent and independent variables were generated for descriptive purposes and to assess skewness and the need for variable transformation. Means and standard deviations are presented for continuous variables and percents are used to describe categorical variables. Bivariate relationships between measures of compliance and the independent measures are tested using t-test for continuous variables and Fisher's exact test for categorical variables. Pearson correlations measure the strength of bivariate associations. Logistic regression methods and linear multiple regression methods are used for multivariate analysis assessing the relationships between the cognitive constructs and compliance adjusting for demographic characteristics.
RESULTS

Descriptive characteristics

As previously described, patients were recruited from the University Orthodontic practice. 10 Orthodontic residents referred 110 subjects who were chosen at random to participate in the study. Of the 110 patients 88 completed the questionnaire (80 % response rate). In the event that a question went unanswered it was treated as a missing value in the analyses.

Demographic Characteristics

As shown in Table 1, the participants were at about the age most children undergo orthodontic treatment with mean patient age of 13.1 years and age range of 10 to 16 years. 46.6% of the subjects were female (n=41) and 53.4% were male (n=47). The UCONN Orthodontic program treats a diverse racial patient population which is reflected in our sample, with 63.6% of the participants being white (n=56), 19.3% Hispanic (n=17), 10.2% African-American (n=9), 2.3% Asian (n=2), 1.1% Indian (n=1), and 3.4% other (n=3). African-American, Asian and Indian patients were combined into one category (n=32) for the analysis because of the small numbers in the Asian and Indian groups. Our program also serves a diverse socioeconomic population with about half (54.5%) being self pay (n=48) and 45.5% being state funded (n=40). 27.3% reported family incomes of <$24,000 income group (n=24), 30.7% were in the $25-49,999 group (n=27), and 42% were grouped in the $50,000 + category (n=37).

Psychological Measures

The questionnaire measured five psychological constructs as shown in Figure 1 as they related to eating and brushing. The psychological constructs included Attitude
toward Behavior, Subjective Norms, Perceived Behavioral Control and Intention. Each of these variables had a possible score of 1-7, the higher the score the more positive the result. Lastly, the Multidimensional Health Locus of Control subscale answers ranged from a score of 1 to 6, with 6 being the more positive response. Table 1 shows the mean scores for each scale.

Cronbach’s alpha assessed the internal reliability of psychological scales from the Theory of Planned Behavior and helped to identify the set of items in the scales that exhibited the highest internal reliability. If removing a question would increase the alpha score we did so to improve the reliability. The Attitude Toward Brushing scale had a Cronbach’s alpha was .782 with with 4 items. Similarly to the Attitude Toward Eating scale consisted of 4 items with a Cronbach’s alpha of .779. The Cronbach’s alpha for Subjective norm brushing and eating were respectively .746 and .639. The Cronbach’s alpha for Perceived Behavioral Control with Eating scale was .508 and couldn’t be improved by removing any of the questions. The Cronbach’s alpha for Perceived Behavioral Control with Brushing scale was .612. Lastly, the Cronbach’s alpha for the Eating Intention scale was .715 and the Brushing Intention scale was .947. Although the internal reliability of the Perceived Behavioral Control with Eating scale was relatively low, it was within acceptable limits and the internal reliability of the other scales was quite good.

Participants had relatively positive attitudes towards eating foods that would not harm their brackets with mean scores of 5.4 (sd=1.4) for Attitude towards eating, 5.0 (sd= 1.8) for Subjective norms, 5.9 (sd=1.1) for Perceived Behavioral Control and 5.3 (sd=1.5) for Intention. Scores for brushing were even more favorable with a score 6.0
(sd=1.1) for Attitude towards brushing, 5.6 (sd=1.6) for Subjective Norms, 6.5 (sd=1.0) for Perceived Behavioral Control and 6.4 for Intention.

Participants scored fairly high on the internal subscale of the MHLC with a mean score of 23.1 (sd=5.9), indicating the perceived belief that they have considerable control over their oral health. Lower scores were reported on chance with a mean score of 15.6 (sd=7.1), doctor with a mean score of 15.8 (sd=2.8) and other people (mean = 10; sd=4). **Dental Knowledge**

Data were obtained on level of dental knowledge to adjust for this factor in the analysis. There were 6 number of items for eating, 5 for brushing and 2 for general dental health and each question were true/false statements. The range was 8 correct questions to 13 correct questions. 76% of the subjects had 12 or 13 questions correct. Most participants were fairly knowledgeable as shown in Table 1.

**Measures of Compliance**

There were five measures of compliance, including gingival score, plaque score, combined gingival/plaque score, broken appliance score and appointment keeping. Table 1 presents the mean scores and standard deviations for the compliance measures. Figures 2-4 show the frequency distributions of these scores. The average gingival score measured by the percent of teeth with the presence of gingival inflammation during dental visits was .44 (sd=.23). The average plaque score (measured by the presence of plaque adjacent to the bracket) was .20. The average of both the plaque and gingival scores combined was .32. These values for plaque presence and gingival inflammation were lower, indicating decent oral hygiene compliance, than expected. 64.8% of the patient sample never had a broken orthodontic appliance. 53.4% of the
subjects kept all of their appointments. The figures illustrate the range of scores on these variables showing that scores on the gingival index were almost normally distributed with participants having both very good and very poor gingival health. The other measures of compliance are highly skewed towards the higher end of good compliance.

**Comparison of compliant and non-compliant groups**

Patients were categorized into compliant versus non-compliant depending on their gingival inflammation. Gingival index alone was used rather than gingival and plaque indices because the plaque score was a less reliable measure as most patients brushing their teeth before seeing their doctor. After 7 visits the average of percent of gingival inflammation was calculated into an average gingival score. The range of visits varied from only 1 visit to 7 visits, the mean of visits was 4.4 with a standard deviation of 1.7. The measure was operationalized by dichotomizing the average gingival score on the median (0.44) into low gingival score (compliant group) and high gingival score (non compliant group).

**Demographic Characteristics**

Assessment of baseline characteristics by compliance with oral hygiene behaviors measured by gingival scores is shown in Table 2. The only significant difference between the compliant and non-compliant participants was by age. As might be expected, older children, with a mean age of 13.5 (sd=1.6) had better compliance than younger children, with a mean age of 12.7 (sd=1.2). The two groups were similar on gender, race and socioeconomic status. Although there were more children with family
incomes less than $24,000 who were compliant as compared to children in families with incomes of $50,000 and over, this relationship was not significant.

**Psychological Variables and Compliance**

Table 2 also presents the relationship between attitudes towards brushing, subjective norm brushing, perceived behavioral control brushing and Intention. Attitude toward brushing was significantly related to compliance status. The compliant group had a mean score of 6.2 (sd=.88) and the non-compliant group's score was 5.7 (sd=1.1) indicating that whose with more positive attitudes were more compliant. The other variables were not significantly related to gingival status.

Two subscales in the MHLC, Chance and Other People, were significantly related to gingival status. The mean Chance score for the compliant group was 13.2 (sd=5.9) and the non-compliant group had a mean score of 17.9 (sd =7.4 ) indicating that those who were less compliant had stronger beliefs in the role of chance in their health status compared to the compliant group (p<0.01). The mean for the Other People subscale score was 9.0 (sd=3.7) for the compliant group and the non-compliant group had a mean score of 10.9 (sd=4.1 ; p<0.01). Children in the non-compliant group had stronger beliefs in the influence of others in determining their health status. There were no differences between groups on Internal and Doctor subscales.

As previously discussed, participants were generally fairly knowledgeable about eating and brushing behaviors and general dental health. The more compliant group showed a trend toward better scores.

Assessment of baseline characteristics by broken appliance and broken appointment is shown in Tables 3 and 4, respectively. As shown in Table 3, having a
broken appliance is dichotomized into never having had a broken appliance and one or more broken appliance. None of the demographic factors were related to broken appliances. However, more children in the self-pay group have never had a broken appliance (59.6%) compared to those who had one or more broken appliance (45.2%). This relationship was not significant probably because of insufficient statistical power, but could be a factor for further investigation. None of the psychological variables, dental knowledge, or Health Locus of Control were related to broken appliances.

Table 4 presents the results for broken appointments defined as keeping all appointments (compliant) compared to one or more broken appointments (non-compliant). There were no significant differences between groups on demographic characteristics, although there were more females (56.1%) who had at least one broken appointment compared to those who kept all appointments (38.3% females). The results also show that there was a significant difference between the groups on attitude toward brushing. The group that kept all appointments had an average score of 5.8 (sd=1.1) and the group with at least one broken appointment had an average attitude toward brushing score of 6.2 (sd=1.0 ; p<0.05). This indicates that those who kept all appointments had less positive attitudes towards brushing compared to those who had broken appointments. This is contrary to what would be expected, but these mean differences are relatively small. None of the remaining attitudinal or knowledge variables was significantly related to broken appointments.

**Hypotheses testing**

Multiple regression analysis was performed to assess the relationship between the psychological variables adjusting for demographics. Only the significant
findings are described below and shown in Tables 5-8. The analysis without the demographics variables are presented because including the demographics reduced the power of the overall model and did not have any significant effects on the dependent measures.

Tables 5a and 5b present the results of the multiple regression analysis of the relationship between perceived behavioral control for brushing and eating with the dichotomous gingival index as the dependent measure. Perceived behavioral control for both brushing and eating was significantly related to the gingival index with a regression coefficient of -.057 and -.051, respectively (p<0.05). As expected PBC brushing and PBS eating increases, gingival scores decrease indicating more positive beliefs about brushing and eating properly are associated with better oral hygiene.

Table 6 shows the regression analysis with Attitude Toward Behavior, specifically brushing, and gingival index as the dependent measure. As hypothesized, the Attitude Toward Behavior (brushing) had a significant regression coefficient of -.073 indicating that more positive Attitude Toward Behavior is associated with lower gingival index score (p=.001).

Table 7 shows the regression analysis with multidimensional health locus of control subscales and the gingival index as the dependent measure. As expected, the chance subscale had a significant regression coefficient of .264 indicating that as belief in chance increases, the gingival index increases. That is, those who have stronger beliefs in chance have worse oral hygiene.

Table 8 presents the multiple regression analysis of Multidimensional Health Locus of Control and number of appointments with broken appliances, the dependent
measure. The Internal Subscale had a significant regression coefficient of -.381 (p < 0.05) indicating that, as predicted, the internal score increases, the number of broken appliances decreases. Those who have stronger beliefs in their own ability to control their health status had fewer broken appliances.

Figures 5 and 6 illustrate the relationships among attitude toward behavior, perceived behavioral control, intention, and subjective norm as proposed in the initial conceptual model, Figure 1. All the variables were significantly correlated with each other in reference to brushing (Figure 5) and eating (Figure 6) compliance. As shown in Figure 5 with regard to brushing, the highest correlations are between intention and perceived control (r=0.543), attitude towards behavior and perceived behavioral control (r=0.533) and intention and subjective norm (r=0.520). Somewhat lower associations were observed between intention and attitude towards behavior (r=.475), attitude towards behavior and subjective norm (r=.420) and perceived behavioral control and subjective norm (r=.362). As shown in Figure 6 with regard to dietary compliance, the highest correlations are between intention and perceived control (r=0.629), perceived behavioral control and subjective norm (r=0.590) and attitude towards behavior and intention (r=0.56). Somewhat lower associations were observed between attitude towards behavior and perceived behavioral control (r=.503) and intention and subjective norm (r=.467) and attitude towards behavior and subjective norm (r=.393). These findings provide some support for the validity of these measure as they all are positively correlated, as would be expected, as high values on all these measures were hypothesized to correlate with compliance with oral hygiene behaviors and diet. The findings also provide support for the hypothesis that perceived behavioral control,
attitude toward behavior and subjective norm are significantly associated with intention as propose in Figure 1. However, the high correlations among these variables also indicate that these variables are assessing similar underlying constructs and may have high shared variance in the multivariate model.

This seems to be the case, as Figure 7 shows that only the perceived behavioral control and attitude toward behavior were correlated with gingival compliance and perceived behavioral control was the only measure found to be associated with eating guideline compliance, as seen in Figure 8. For these reasons our path model differs from the Theory of Planned Behavior's path model.
DISCUSSION

The preferred time for orthodontic treatment is during adolescence because the permanent dentition is close to fully erupting, but growth can still be used to the orthodontist’s advantage. Unfortunately patient compliance seems to be the most difficult to attain during adolescence. Poor patient compliance, including poor oral hygiene, breakage of the appliances, and missed appointments could lengthen treatment time by months and maybe even years. By improving patient compliance, treatment time might be reduced, the treatment outcome could be improved, and the oral environment could be maintained free of disease. The objective of this study was to determine which patient factors affect compliance. Questionnaires and clinical exams were utilized to test the hypotheses.

Overall Compliance

Patient compliance in three areas was assessed including oral hygiene, care of appliances and appointment keeping. Compliance with oral hygiene recommendations was operationalized by the gingival score; care of fixed appliances was measured by the number of visits when the patient had a broken appliance; and compliance with scheduled appointments was assessed by having at least one broken appointment. Surprisingly, overall compliance in our sample was better than we had expected. The mean percentage of gingival inflammation for the subjects was only 44.4%, indicating that, on average, only 44.4% of the teeth examined were inflamed. This was surprising because it demonstrated that most of the participants had good oral hygiene habits while most other studies of oral hygiene habits among adolescents are poor.
Participants' care of fixed appliances and appointment keeping was equally
good with a mean percentage of broken appliances being only 0.8%. That is, less than
1% experienced any visits with broken appliances. Further, the mean percentage of
kept appointments was 86.9%. One study found that the younger the patient the less
compliant they were with appointment attendance (Camner et al 1994). We did not find
this association. One possible explanation is that the parent is responsible for driving
the child or setting up their transportation.

**Demographic Characteristics**

Previous studies have not consistently demonstrated significant effects of
sociodemographics variables on compliance with medical regimens. This study
proposed to adjust for age, gender, race/ethnicity, and socioeconomic status when
analyzing the effects of psychological variables on compliance. In this study, age was
significantly related to gingival inflammation meaning older children had better
gingival health and therefore hygiene. However, the other demographic factors
investigated were not related to the measures of assessed in this study.

**Age**

Previous literature on adolescents has been contradictory regarding the
relationship between age and compliance with medical regimens. Litt and Cuskey
(1980) found use of contraception to be positively associated with postmenarchal age
among female adolescents and, as mentioned before, Camner (1994) also found that
older patients had better attendance at dental appointments than younger patients. In
contrast, Allan and Hodgson (1968) and Weiss (1977) found age to be negatively
correlated with compliance with orthodontic treatment, meaning the younger the patient
the more compliant. These results were based on the orthodontist’s rating of perceived compliance rather than clinical measures of plaque scores or gingival inflammation, which are more valid measures of oral hygiene. Others have found no significant association with patient cooperation (Albino et al, 1991). In this study we found a significant positive correlation between age and gingival health.

**Gender**

As with age and compliance, there are many inconsistencies with gender and compliance as stated in Litt and Cuskey’s (1980) review of general pediatric compliance literature. Some studies found girls to be more compliant than boys, although the differences aren’t large (Starnbech et al 1975; Kreit et al 1968). Swetlik (1978) found no relationship between sex and compliance with orthodontic care. As predicted in the hypothesis, we too were unable to demonstrate an association between compliance and gender.

**Socioeconomic Status and Race**

Most of the literature on health disparities studies socioeconomic status and orthodontic compliance rather than ethnicity or race. Nanda (1992) states that higher socioeconomic groups tend to cooperate more than lower socioeconomic groups with orthodontic treatment because of a difference in values of facial esthetics. However, the opposite was found by Starnbach and Kaplan (1975), showing that females from moderate to lower socioeconomic groups were more compliant with orthodontic care. Others also have found that lower middle class patients considered orthodontic treatment to be more important than the upper middle class patients (Dorsey and Korabik 1977). Many studies (Macgregor et al, 1997: Tedesco et al. 1992) have
shown a positive correlation between oral hygiene behaviors, dental appointment keeping, use of head gear and low sugar intake and socioeconomic status. As we hypothesized, there was no significant difference found between patients of higher or lower socioeconomic status, which we measured by level of income and method of payment, with compliance.

As previously noted, relatively few studies specifically state a correlation between race and compliance with orthodontic treatment. Most of the literature concentrates on use of dental services and race. It has been found that 59.3% of white Americans, 44.5% African-Americans, and 46.4% of Hispanic Americans have reported visiting a dentist (National Center for Health Statistics, 1989). Previous literature has also studied correlations of race with oral hygiene, oral health status, and dental knowledge. Many studies, have found that adult African-Americans generally have worse oral health and receive less professional health care than white Americans (Beck & Koch, 1994; Bloom et al, 1992; Brown et al, 1994; Hunt & Silverman, 1987; Jack & Bloom, 1988; Lang et al, 1994 & 1995). Oral hygiene studies found African-Americans to have more plaque and calculus than whites (Kelly & Harvey, 1979; Hughes et al, 1982). Ronis et al (1998) found that African-Americans were less likely to brush and floss thoroughly, ever have dental check-ups, and have annual check-ups. Davidson et al, (1997) found that white adults in Maryland and Texas had significantly higher, more positive, oral hygiene scores than older-aged ethnic minority groups. Ismail and Szpunar studied Hispanic health and found that Hispanic adults in the United States had a higher prevalence of gingivitis than non-Hispanic whites (1990). Various ethnic groups and self-efficacy, oral health attitudes, and dental knowledge were studied by
Kiyak et al (2000). Asians were found to feel the least confident to control their oral health and have the least amount of knowledge in contrast to Caucasians who scored highest in self-efficacy and oral health knowledge. Although previous studies have found correlations between race and oral health, we were unable to correlate race and orthodontic compliance in this study.

**Psychological Variables from the Theory of Planned Behavior**

**Attitude toward Behavior**

We analyzed attitude toward behavior with two specific behaviors, eating and brushing. As predicted by the Theory of Planned Behavior, attitude toward brushing was significantly correlated with compliance, measured by gingival inflammation, and broken appointments. Although the compliant group had a significantly higher score, both the compliant and non-compliant groups in this study tended to have positive attitudes toward brushing. There was not a similar significant correlation with the attitude toward eating. This could be due to the fact that no adolescent has a positive attitude towards limiting candy or soda, etc... Even a compliant child doesn’t enjoy giving up those foods or eating behaviors. Many believe that a patient’s attitude toward orthodontic treatment, and general health-related behavior, influence treatment compliance (Sergl and Zentner, 2000). Health-promoting behaviors may be influenced by patients’ attitudes toward their occlusion, esthetics, and expectations of outcomes of treatment (Clemmer et al, 1979; Fox et al, 1982), although this was not assessed in this study.

**Perceived Behavioral Control**
Perceived Behavioral Control is a measure of self-efficacy. Overall, participants were confident in their ability to brush and follow the dietary guidelines. Tedesco et al (1993), found that patients with high self-efficacy had more predictable positive oral health status. Measures of patient’s perceptions of control during treatment have demonstrated strong correlations with cooperation (Albino 1991 & Tédesco 1985). This study found that perceived behavioral control with eating and brushing was significantly correlated to gingival compliance, which measured oral hygiene. The patients with higher perceived behavioral control scores had lower gingival scores. Therefore similar to the findings of Alan et al (1968), we found that the more self-controlled patient was more likely to show higher levels of treatment compliance.

**Subjective Norm**

Many studies have been conducted to study the effect of parental and peer influence on patient compliance. No conclusive evidence has been found to support this. Mehra et al, (1996) and Folger (1988) found that parental beliefs have been important in studies of patient compliance with orthodontic treatment. In contrast, other studies have found that the patient’s personality is a better predictor of cooperation (Albino, et al 1991).

The effect of peer influence has been frequently studied and found to be important in health-related behaviors of adolescents (Petersen et al, 1997). However, there is little evidence regarding the effect of peers on orthodontic treatment compliance. In this study, we found no significant correlation of subjective norm, which assessed the effect of the patient’s family, peers, and role models, with any of the measures of compliance.
**Intention**

In the Theory of Planned Behavior, a person's intention to engage in a behavior directly determines whether they perform that behavior (Ajzen, 1988). Intention is influenced by 3 factors 1) attitude toward behavior, 2) social influences or subjective norm, and 3) perceived behavioral control. Attitude toward behavior and perceived behavioral control were significantly correlated with oral hygiene, measured by gingival inflammation, but intention was not correlated with this measure of compliance. Thus our path model is different from the Theory of Planned Behavior's model. A model developed from this study will be explained later in this section.

**Multidimensional Health Locus of Control**

Many studies have been conducted to test health locus of control with medical regimen compliance. These findings are similar to those in the Orthodontic literature that those with an internal locus of control cooperate better with orthodontic treatment regimens than those with external locus of controls (El-Mangourney, 1981). Another study, found that those who held other people or their orthodontist responsible for the outcome of their treatment were more likely to be viewed as uncooperative (Tedesco et al, 1985). Findings were similar in this study. Patients who had high scores for chance and other people had a significant correlation with poor oral hygiene compliance.

**Dental Knowledge**

As previously discussed, participants were generally fairly knowledgeable about eating and brushing behaviors and general dental health and the group with better gingival compliance did show a trend with a higher general dental knowledge score. A substantial amount of time is spent educating dental patients and
the public through organized campaigns, school visits, and health fairs. This effort has had some impact, but the amount is unknown. In recent decades, oral health status and views have improved. However, it is unknown if this is due to oral health education or the improvement of living standards and norms of grooming and personal cleanliness (Burt and Eklund, 1999). There is minimal literature studying the effect of dental or orthodontic knowledge on orthodontic compliance. However, when the patients understand the nature of their condition and the proposed treatment plan, patient management has been found to be greatly enhanced in dentistry (Laskin, 1979). Sinha and Nanda, (2000) found that educating the patient regarding their malocclusion and the means to achieve an acceptable result has been effective in motivating the patient to succeed. As we expected, this study found that the higher the general dental knowledge score the lower the gingival score, thus indicating compliance with oral hygiene.

**The Theory of Planned Behavior’s Model and this study’s findings**

The Theory of Planned Behavior involves many psychological variables. As described earlier, the direct measures, attitude toward behavior, subjective norm, and perceived behavioral control all influence intention, which directly determines if a person performs a specific behavior. This theory finds the predictor variables to be the direct measures which included for eating and brushing (attitude toward behavior, subjective norm, perceived behavioral control, and intention) to be correlated to each other as seen in Figures 5 and 6 (p=.01). However, only attitude toward behavior (brushing) and perceived behavioral control (brushing) correlate with or predict oral hygiene compliance as seen in Figure 7 and only perceived behavioral control regarding eating correlates with or predicts oral hygiene compliance as seen in Figure 8. Unlike,
the Theory of Planned Behavior's model we did not find intention to be the direct link to a desired behavior.

**Limitations**

The limitations of this study were sample size and the time frame. A larger sample size would have provided greater power to assess multivariate relationships. The time the patients were followed was short term. A long term study following patients through the course of their entire treatment could further test the Theory of Planned Behavior.

**Future Research**

Personality and psychological variables have been proven to be reliable in predicting compliance with orthodontic treatment. Unlike sociodemographics, these variables can be changed or influenced. Future research needs to be conducted to see what behavioral modification techniques have the best success in changing the variables found to be significant in this study, attitude toward behavior and perceived behavioral control. The orthodontic literature often recommends a reward program to improve patient compliance by patient motivation (Albino, 1991; Gershater, 1968; Kreit et al, 1968; Gross et al, 1985; Sinclair, 1989; Southard et al, 1991). One study using a reward program found that above average complier remained above average throughout the study, below average compliers showed improvement in hygiene scores, but never reached the compliance levels of the above average compliers (Richter et al, 1998). A behavioral modification technique plus a reward system needs to be implicated to achieve not just improved compliance, but more ideal compliance.
CONCLUSIONS

It is apparent that many factors affect patient compliance with orthodontic treatment. Our study has proven sociodemographic generalizations to not hold true. The only demographic variable found to be correlated with compliance was age. The older the patient the more compliant they were. The few studies that do find gender or socioeconomic status to be significant have results that aren’t often replicated in other studies. This study exemplifies the importance of not generalizing when predicting patient compliance. Psychological variable are much more predictive of a patient’s compliance.
Table 1. Assessment of baseline characteristics of patients in compliance study

<table>
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</tr>
<tr>
<td>% Female</td>
<td>46.6</td>
</tr>
<tr>
<td>% White</td>
<td>63.6</td>
</tr>
<tr>
<td>% Self-pay</td>
<td>54.5</td>
</tr>
<tr>
<td>Income</td>
<td></td>
</tr>
<tr>
<td>%&lt;$24,000</td>
<td>27.3</td>
</tr>
<tr>
<td>%$25-49,999</td>
<td>30.7</td>
</tr>
<tr>
<td>%$50,000 +</td>
<td>42.0</td>
</tr>
<tr>
<td>Compliance Measures</td>
<td></td>
</tr>
<tr>
<td>Mean (sd) gingival score</td>
<td>0.44 (0.23)</td>
</tr>
<tr>
<td>Mean (sd) plaque score</td>
<td>0.20 (0.14)</td>
</tr>
<tr>
<td>Average combo of both</td>
<td>0.32 (0.16)</td>
</tr>
<tr>
<td>% never had broken appl</td>
<td>64.8</td>
</tr>
<tr>
<td>% all appointments kept</td>
<td>53.4</td>
</tr>
<tr>
<td>Psychological Variables -Mean (sd)</td>
<td></td>
</tr>
<tr>
<td>Attitude Toward Behavior (eating)</td>
<td>5.4 (1.4)</td>
</tr>
<tr>
<td>Attitude toward Behavior (brushing)</td>
<td>6.0 (1.1)</td>
</tr>
<tr>
<td>Subjective Norm eating</td>
<td>5.0 (1.8)</td>
</tr>
<tr>
<td>Subjective Norm brushing)</td>
<td>5.6 (1.6)</td>
</tr>
<tr>
<td>Perceived Behavioral Control eating</td>
<td>5.9 (1.1)</td>
</tr>
<tr>
<td>Perceived Behavioral Control brushing</td>
<td>6.5 (1.0)</td>
</tr>
<tr>
<td>Intention eating</td>
<td>5.3 (1.5)</td>
</tr>
<tr>
<td>Intention brushing</td>
<td>6.4 (1.1)</td>
</tr>
<tr>
<td>Dental Knowledge Mean(sd)</td>
<td></td>
</tr>
<tr>
<td>Total Number of Correct Questions</td>
<td>11.6 (1.4)</td>
</tr>
<tr>
<td>Correct Eating Questions</td>
<td>5.2 (0.87)</td>
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<tr>
<td>Correct Brush Questions</td>
<td>4.5 (0.77)</td>
</tr>
<tr>
<td>Correct General Dental</td>
<td>1.8 (0.41)</td>
</tr>
<tr>
<td>Multidimensional Health Locus of Control Mean (sd)</td>
<td></td>
</tr>
<tr>
<td>Internal Subscale</td>
<td></td>
</tr>
<tr>
<td>Chance Subscale</td>
<td>23.1 (5.9)</td>
</tr>
<tr>
<td>Doctor Subscale</td>
<td>15.6 (7.1)</td>
</tr>
<tr>
<td>Other people Subscale</td>
<td>15.8 (2.8)</td>
</tr>
<tr>
<td></td>
<td>10.0 (4.0)</td>
</tr>
</tbody>
</table>
Table 2. Assessment of baseline characteristics by oral hygiene compliance, measured by gingival score.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Compliant (Gingival Score &lt;40% (n=44))</th>
<th>Non Compliant (Gingival Score &lt;40% (n=44))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), yrs†</td>
<td>13.5 (1.6)</td>
<td>12.7 (1.2)</td>
</tr>
<tr>
<td>% Female</td>
<td>47.7</td>
<td>45.5</td>
</tr>
<tr>
<td>% White</td>
<td>61.4</td>
<td>65.9</td>
</tr>
<tr>
<td>% Self-Pay</td>
<td>56.8</td>
<td>52.3</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$24,000</td>
<td>31.8</td>
<td>22.7</td>
</tr>
<tr>
<td>$25-49,999</td>
<td>29.5</td>
<td>31.8</td>
</tr>
<tr>
<td>$50,000 +</td>
<td>38.6</td>
<td>45.5</td>
</tr>
<tr>
<td>Psychological Variables-Mean (sd)</td>
<td></td>
<td></td>
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<tr>
<td>Attitude Toward Behavior (eating)</td>
<td>5.5 (1.4)</td>
<td>5.4 (1.4)</td>
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<tr>
<td>Attitude toward Behavior (brushing)</td>
<td>6.2 (0.88)</td>
<td>5.7 (1.1)</td>
</tr>
<tr>
<td>Subjective Norm (eating)</td>
<td>5.1 (1.8)</td>
<td>4.9 (1.8)</td>
</tr>
<tr>
<td>Subjective Norm (brushing)</td>
<td>5.8 (1.7)</td>
<td>5.5 (1.5)</td>
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<tr>
<td>Perceived Behavioral Control (eating)</td>
<td>6.0 (1.0)</td>
<td>5.7 (1.1)</td>
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<tr>
<td>Perceived Behavioral Control (brush)</td>
<td>6.7 (0.72)</td>
<td>6.3 (1.2)</td>
</tr>
<tr>
<td>Intention eating</td>
<td>5.4 (1.5)</td>
<td>5.2 (1.4)</td>
</tr>
<tr>
<td>Intention brushing</td>
<td>6.5 (1.2)</td>
<td>6.3 (1.3)</td>
</tr>
<tr>
<td>Dental Knowledge Mean(sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total correct Number of Questions</td>
<td>11.7 (1.4)</td>
<td>11.4 (1.5)</td>
</tr>
<tr>
<td>Correct Eating Questions</td>
<td>5.3 (0.9)</td>
<td>5.2 (0.9)</td>
</tr>
<tr>
<td>Correct Brush Questions</td>
<td>4.6 (0.7)</td>
<td>4.5 (0.8)</td>
</tr>
<tr>
<td>Correct General Dental††</td>
<td>1.9 (0.4)</td>
<td>1.8 (0.4)</td>
</tr>
<tr>
<td>Multidimensional Health Locus of Control (sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Questions</td>
<td>23.0 (1.6)</td>
<td>23.2 (5.8)</td>
</tr>
<tr>
<td>Chance Questions†</td>
<td>13.2 (5.9)</td>
<td>17.9 (7.4)</td>
</tr>
<tr>
<td>Doctor Questions</td>
<td>16.2 (2.7)</td>
<td>15.5 (2.9)</td>
</tr>
<tr>
<td>Other people Questions†</td>
<td>9.0 (3.7)</td>
<td>10.9 (4.1)</td>
</tr>
</tbody>
</table>

† means are significantly different using a t-test statistic with a \( p \leq 0.05 \)
†† means are significantly different using a t-test statistic with a \( p \leq 0.01 \) indicating a trend.
Table 3. Assessment of baseline characteristics by broken appliance status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Never had B.A. (n=57)</th>
<th>1+ visit w/ B.A (n=31)</th>
</tr>
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<tbody>
<tr>
<td>Age, mean (SD), yrs</td>
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<td>13.0 (1.4)</td>
</tr>
<tr>
<td>% Female</td>
<td>49.1</td>
<td>41.9</td>
</tr>
<tr>
<td>% White</td>
<td>64.9</td>
<td>61.3</td>
</tr>
<tr>
<td>% Self-Pay</td>
<td>59.6</td>
<td>45.2</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$24,000</td>
<td>26.3</td>
<td>29.0</td>
</tr>
<tr>
<td>$25-49,999</td>
<td>29.8</td>
<td>32.3</td>
</tr>
<tr>
<td>$50,000 +</td>
<td>43.9</td>
<td>38.7</td>
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<tr>
<td>Psych variables -Mean (sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude Toward Behavior (eating)</td>
<td>5.5 (1.4)</td>
<td>5.2 (1.4)</td>
</tr>
<tr>
<td>Attitude toward Behavior (brushing)</td>
<td>6.1 (1.0)</td>
<td>5.7 (1.3)</td>
</tr>
<tr>
<td>Subjective Norm (eating)</td>
<td>4.9 (1.8)</td>
<td>5.2 (1.8)</td>
</tr>
<tr>
<td>Subjective Norm (brushing)</td>
<td>5.7 (1.6)</td>
<td>5.6 (1.5)</td>
</tr>
<tr>
<td>Perceived Behavioral Control (eating)</td>
<td>5.8 (1.0)</td>
<td>5.9 (1.1)</td>
</tr>
<tr>
<td>Perceived Behavioral Control (brush)</td>
<td>6.6 (0.8)</td>
<td>6.4 (1.3)</td>
</tr>
<tr>
<td>Intention eating</td>
<td>5.3 (1.5)</td>
<td>5.3 (1.4)</td>
</tr>
<tr>
<td>Intention brushing</td>
<td>6.4 (1.2)</td>
<td>6.3 (1.1)</td>
</tr>
<tr>
<td>Dental Knowledge Mean(sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total correct # of Questions</td>
<td>11.7 (1.3)</td>
<td>11.3 (1.6)</td>
</tr>
<tr>
<td>Correct Eating Questions</td>
<td>5.3 (0.9)</td>
<td>5.0 (0.8)</td>
</tr>
<tr>
<td>Correct Brush Questions</td>
<td>4.6 (0.7)</td>
<td>4.5 (0.9)</td>
</tr>
<tr>
<td>Correct General Dental</td>
<td>1.9 (4.0)</td>
<td>1.8 (0.5)</td>
</tr>
<tr>
<td>Multidimensional Health Locus of Control Mean (sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Questions</td>
<td>23.8 (5.5)</td>
<td>21.8 (6.3)</td>
</tr>
<tr>
<td>Chance Questions</td>
<td>14.7 (6.7)</td>
<td>17.3 (7.6)</td>
</tr>
<tr>
<td>Doctor Questions</td>
<td>16.0 (2.6)</td>
<td>15.5 (3.2)</td>
</tr>
<tr>
<td>Other people Questions</td>
<td>9.5 (4.1)</td>
<td>10.8 (3.7)</td>
</tr>
</tbody>
</table>
Table 4. Assessment of baseline characteristics by broken appointment status

<table>
<thead>
<tr>
<th>Variable</th>
<th>All appointments (n=47)</th>
<th>1+ broken appointment. (n=41)</th>
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<tbody>
<tr>
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<td>13.2 (1.5)</td>
<td>12.9 (1.3)</td>
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<td>% Female</td>
<td>38.3</td>
<td>56.1</td>
</tr>
<tr>
<td>% White</td>
<td>70.2</td>
<td>56.1</td>
</tr>
<tr>
<td>% Self-Pay</td>
<td>57.4</td>
<td>51.2</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$24,000</td>
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</tr>
<tr>
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<td>38.3</td>
<td>22.0</td>
</tr>
<tr>
<td>$50,000 +</td>
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<td>41.5</td>
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<td>Psych variables -Mean (sd)</td>
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<tr>
<td>Attitude Toward Behavior (eating)</td>
<td>5.2 (1.5)</td>
<td>5.6 (1.3)</td>
</tr>
<tr>
<td>Attitude toward Behavior (brushing)</td>
<td>5.8 (1.1)</td>
<td>6.2 (1.0)</td>
</tr>
<tr>
<td>Subjective Norm (eating)</td>
<td>4.9 (2.1)</td>
<td>5.1 (1.5)</td>
</tr>
<tr>
<td>Subjective Norm (brushing)</td>
<td>5.8 (1.5)</td>
<td>5.5 (1.7)</td>
</tr>
<tr>
<td>Perceived Behavioral Control (eating)</td>
<td>5.8 (1.1)</td>
<td>5.8 (1.0)</td>
</tr>
<tr>
<td>(brush)</td>
<td>6.5 (1.1)</td>
<td>6.5 (1.0)</td>
</tr>
<tr>
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<td>5.1 (1.5)</td>
<td>5.6 (1.4)</td>
</tr>
<tr>
<td>Intention eating</td>
<td>6.4 (1.0)</td>
<td>6.4 (1.3)</td>
</tr>
<tr>
<td>Dental Knowledge Mean(sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total correct # of Questions</td>
<td>11.6 (1.5)</td>
<td>11.6 (1.3)</td>
</tr>
<tr>
<td>Correct Eating Questions</td>
<td>5.1 (1.0)</td>
<td>5.3 (0.7)</td>
</tr>
<tr>
<td>Correct Brush Questions</td>
<td>4.6 (0.7)</td>
<td>4.5 (0.8)</td>
</tr>
<tr>
<td>Correct General Dental</td>
<td>1.9 (0.3)</td>
<td>1.8 (0.5)</td>
</tr>
<tr>
<td>Multidimensional Health Locus of Control Mean (sd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Questions</td>
<td>22.4 (5.6)</td>
<td>23.9 (6.1)</td>
</tr>
<tr>
<td>Chance Questions</td>
<td>15.3 (7.1)</td>
<td>15.9 (7.1)</td>
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<tr>
<td>Doctor Questions</td>
<td>16.0 (1.9)</td>
<td>15.5 (3.6)</td>
</tr>
<tr>
<td>Other people Questions</td>
<td>10.4 (4.0)</td>
<td>9.4 (3.9)</td>
</tr>
</tbody>
</table>

*means are significantly different using a t-test statistic with a p ≤05
HYPOTHESES TESTING

Table 5a. Multiple Regression analysis of Perceived Behavioral Control (eating) and Gingival Index

<table>
<thead>
<tr>
<th>Variables</th>
<th>B Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Behavioral Control eating</td>
<td>-.051</td>
</tr>
</tbody>
</table>

$\text{ADJR}^2 = .042, \text{F}(1, 86) = 4.84, p = .031$  
$N < 0.1$  
$* p < .05$  
$** p < .01$  
$*** p < .001$

Table 5b. Multiple Regression analysis of Perceived Behavioral Control (brushing) and Gingival Index

<table>
<thead>
<tr>
<th>Variables</th>
<th>B Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Behavioral Control brushing</td>
<td>-.057</td>
</tr>
</tbody>
</table>

$\text{ADJR}^2 = .051, \text{F}(1, 86) = 5.64, p = .020$  
$N < 0.1$  
$* p < .05$  
$** p < .01$  
$*** p < .001$

Table 6. Multiple Regression analysis of Attitude Toward Behavior (brushing) and Gingival Index

<table>
<thead>
<tr>
<th>Variables</th>
<th>B Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude Toward Behavior brushing</td>
<td>-.073***</td>
</tr>
</tbody>
</table>

$\text{ADJR}^2 = .101, \text{F}(1, 86) = 10.76, p = .001$  
$N < 0.1$  
$* p < .05$  
$** p < .01$  
$*** p < .001$
Table 7. Multiple Regression analysis of Multidimensional Health Locus of Control and Gingival Index

<table>
<thead>
<tr>
<th>Variables</th>
<th>B Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Locus of Control</td>
<td></td>
</tr>
<tr>
<td>Internal Subscale</td>
<td>NS</td>
</tr>
<tr>
<td>Chance Subscale</td>
<td>.264*</td>
</tr>
<tr>
<td>Doctor Subscale</td>
<td>NS</td>
</tr>
<tr>
<td>Other people Subscale</td>
<td>NS</td>
</tr>
</tbody>
</table>

ADJR² = .084, F(4, 74) = 2.85, p = .031
N < .1
*p < .05
**p < .01
***p < .001

Table 8. Multiple Regression analysis of Multidimensional Health Locus of Control and broken appliances

<table>
<thead>
<tr>
<th>Variables</th>
<th>B Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Locus of Control</td>
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</tr>
<tr>
<td>Internal Subscale</td>
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</tr>
<tr>
<td>Chance Subscale</td>
<td>NS</td>
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<td>Doctor Subscale</td>
<td>NS</td>
</tr>
<tr>
<td>Other people Subscale</td>
<td>NS</td>
</tr>
</tbody>
</table>

OR .92, 95% CI .83, 1.00, p = .057
N < .1
*p < .05
**p < .01
***p < .001
Figure 1.

The Theory of Planned Behavior
Figure 2. Frequency Distribution of Gingival Scores

- Mean = 0.444
- Std. Dev. = 0.23491
- N = 88
Figure 3. Frequency Distribution of Broken Appliances

Mean = 0.008
Std. Dev. = 0.01964
N = 88
Figure 4. Frequency Distribution of Percentage of Kept Appointments

Mean = 83.94%
Std. Dev. = 15.968%
N = 88
Figure 7

Path model for brushing

Subjective Norm -> Attitude Toward Behavior
Intention -> Perceived Behavioral Control

Behavior (brushing)

Figure 8

Path model for eating guidelines

Subjective Norm -> Attitude Toward Behavior
Intention -> Perceived Behavioral Control

Behavior (diet)
Appendix A

Patient Questionnaire

1. Sex: ___ Male ___ Female

2. Age: ___

3. Race: ___ Caucasian ___ African American ___ Asian ___ Hispanic ___ Indian ___ Other (please describe on following line) ___

4. How many times a day do you brush your teeth? ___

PLEASE PLACE AN “X” IN THE SPACE THAT CORRESPONDS THE MOST WITH YOUR ANSWER TO THE QUESTION.

5. In the time since you have gotten braces how many days do you brush at least twice a day?
   __ every day
   __ almost every day
   __ most days
   __ on about half of the days
   __ a number of times, but less than half
   __ a few times
   __ never

6. Please estimate how often you have brushed your teeth at least twice daily in the past month
   Never: ___
   Every day: ___

7. I should brush within five minutes of eating.
   ___ True ___ False

8. How much control do you believe you have over following the eating guidelines?
   no control: ___
   complete control: ___

9. Generally speaking, how much do you want to do what your family thinks?
   Not at all: ___
   very much: ___

10. I intend to brush at least twice a day for the next month.
    Strongly disagree: ___
    Strongly agree: ___

11. The food available to me at school and at my house makes it difficult for me to follow the eating guidelines.
    ___ True ___ False
12. Most people who are important to me brush at least twice a day
completely true: _____:____:____:____:____: completely false
_____ Don’t Know

13. It is mostly up to me whether or not to avoid sticky, hard, and sugary foods for the
next 2 weeks.
strongly agree: _____:____:____:____:____: strongly disagree

14. Playing sports after school and on the weekends makes it difficult for me to follow
the brushing and diet guidelines I was given.
___ True ___ False

15. For me to brush at least twice a day in the next month would be
Impossible: _____:____:____:____:____: possible

16. Being in school all day makes brushing and following the eating guidelines difficult
for me.
___ True ___ False

17. If I wanted to I could brush twice a day for the next month
definitely true: _____:____:____:____:____: definitely false

18. My friends and classmates with braces follow the brushing and eating guidelines.
___ True ___ False

19. The people in my life whose opinions I value
Brush twice a day: _____:____:____:____:____: do not brush twice a day
_____ Don’t Know

20. How much control do you believe you have over brushing?
no control: _____:____:____:____:____: complete control

21. My friends would disapprove of me following the eating and brushing guidelines.
___ True ___ False

22. It is mostly up to me whether or not I brush for the next month.
strongly agree: _____:____:____:____:____: strongly disagree

23. Brushing and caring for your teeth and braces will help your treatment in the next
month
extremely unlikely: _____:____:____:____:____: extremely likely

24. I can eat popcorn, nuts, and corn on the cob.
___ True ___ False

25. Caring for your teeth is
extremely bad::: ::::: ::::: ::::: ::::: extremely good

26. I can drink soda because it is low in sugar content.
   ___True ___False

27. I will try to brush at least twice a day for the next month.
   Strongly disagree::: ::::: ::::: ::::: ::::: : Strongly Agree

28. I cannot eat apples or carrots even if they are cut up.
   ___True ___False

29. My family thinks that I
   should::: ::::: ::::: ::::: ::::: : should not brush twice a day for the next month.

30. The more I break things by not following the eating guidelines the longer i may have my braces on.
   ___True ___False

31. Your school placing high demands on your time in the next 2 weeks would make it much more difficult::: ::::: ::::: ::::: : much easier for me to avoid sticky, hard, and sugary foods.

32. Generally speaking, how much do you want to do what your family thinks?
   Not at all::: ::::: ::::: ::::: ::::: : very much

33. Sticky and hard foods can loosen the cement under bands and break or bend the little tubes attached to the bands.
   ___True ___False

34. I plan to brush at least twice a day for the next month.
   Strongly disagree::: ::::: ::::: ::::: ::::: : Strongly Agree

35. The soft white layer of plaque around the braces can cause swollen gums and white spots that scar the teeth.
   ___True ___False

36. I expect that braces will place high demands on my time in the next month.
   strongly agree::: ::::: ::::: ::::: ::::: : strongly disagree

37. My teeth are clean when the brackets and wires are free of food particles and the white soft layer of plaque is no longer there.
   ___True ___False

38. For me to brush at least twice a day for the next month is:
   harmful::: ::::: ::::: ::::: ::::: : beneficial
39. By brushing at least twice a day I can stop white spots from forming on my teeth.  
   ___True   ___False

40. I intend to follow the eating guidelines (no sticky, hard or sugary food) for the next 2 weeks.  
   Strongly disagree: ___:___:___:___:___:___:___: Strongly Agree

41. School placing high demands on my time in the next month would make it much more difficult: ___:___:___:___:___:___: much easier for me to brush and care for your braces in the next month

42. By brushing at least twice a day I am preventing cavities.  
   ___True   ___False

43. How many times in the last 2 weeks have you eaten something hard, sticky, or sugary? ___

44. By following the eating guidelines I can prevent the breakage of my braces and wires.  
   ___True   ___False

45. My family thinks that I should: ___:___:___:___:___:___: should not avoid sticky, hard, and sugary foods for the next 2 weeks.

46. By following the brushing instructions I can stop my gums from getting puffy.  
   ___True   ___False

47. Please estimate how often you have eaten food that is hard, sticky, or sugary in the past 2 weeks  
   Never : ___:___:___:___:___:___: Every day

48. Using fluoride mouthwash can prevent cavities.  
   ___True   ___False

49. I will try to follow the eating guidelines (no sticky, hard or sugary food) for the next 2 weeks.  
   Strongly disagree: ___:___:___:___:___:___: Strongly Agree

50. For me to avoid sticky, hard, and sugary foods for the next 2 weeks is:  
   harmful: ___:___:___:___:___:___: beneficial

51. Avoiding sticky, hard, and sugary foods for the next 2 weeks will help my treatment.

52. The people in my life whose opinions I value would
   Don’t Know

53. For me to avoid sticky, hard, and sugary foods for the next 2 weeks would be

54. If I wanted to I could avoid sticky, hard, and sugary foods for the next 2 weeks.

55. For me to avoiding sticky, hard, and sugary foods for the next 2 weeks is

56. I expect that watching what I eat will place high demands on my time in the next month.

57. I plan to follow the eating guidelines (no sticky, hard or sugary food) for the next 2 weeks.

58. Coming in to see my orthodontist every 4 to 6 weeks isn’t that important.
   True False

59. In the past 2 weeks how often have you eaten food that is sticky, hard, or sugary?
   _ every day
   _ almost every day
   _ most days
   _ on about half of the days
   _ a number of times, but less than half
   _ a few times
   _ never

60. Most people who are important to me would follow the eating guidelines if they had braces.
Don’t Know

INSTRUCTIONS: Each item below is a belief statement about your dental condition with which you may agree or disagree. Beside each statement is a scale which ranges from strongly disagree (1) to strongly agree (6). For each item we would like you to circle the number that represents the extent to which you agree or disagree with that statement. The more you agree with the statement, the higher the number you circle will be. The more you disagree with a statement, the lower the number you will circle. Make sure you circle ONLY ONE number per item. THERE ARE NO WRONG ANSWERS.

1. If my smile or bite worsens, it is my own behavior which determines how soon it will get better.
   - Strongly disagree 1
   - Moderately disagree 2
   - Slightly disagree 3
   - Slightly agree 4
   - Moderately agree 5
   - Strongly agree 6

2. As to my smile and bite, what will be will be.
   - Strongly disagree 1
   - Moderately disagree 2
   - Slightly disagree 3
   - Slightly agree 4
   - Moderately agree 5
   - Strongly agree 6

3. If I see my doctor regularly, I am less likely to have problems with my braces.
   - Strongly disagree 1
   - Moderately disagree 2
   - Slightly disagree 3
   - Slightly agree 4
   - Moderately agree 5
   - Strongly agree 6

4. Most things that happen to affect my braces happen by chance.
   - Strongly disagree 1
   - Moderately disagree 2
   - Slightly disagree 3
   - Slightly agree 4
   - Moderately agree 5
   - Strongly agree 6

5. Whenever my braces have problems, I should consult my doctor.
Strongly disagree 1
Moderately disagree 2
Slightly disagree 3
Slightly agree 4
Moderately agree 5
Strongly agree 6

6. I am directly responsible for your braces breaking or bite or smile worsening.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

7. Other people, besides me, play a big role in whether my bite/smile improves, stays the same, or gets worse.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

8. Whatever goes wrong with my braces is my fault.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

9. Luck plays a big part in determining how my bite/smile improves.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

10. In order for my bite/smile to improve, it is up to other people to see that the right things happen.
    Strongly disagree 1
    Moderately disagree 2
    Slightly disagree 3
    Slightly agree 4
Moderately agree 5
Strongly agree 6

11. Whatever improvement occurs with my smile or bite is largely a matter of good fortune.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

12. The main thing which affects my bite/smile is what I do.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

13. I deserve the credit when my smile/bite are improving and the blame when it gets worse.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

14. Following doctor’s orders exactly is the best way to keep my bite/smile from getting worse.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

15. If my bite/smile worsens, it is a matter of fate.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6
16. If I am lucky, my smile/bite will improve.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

17. If my bite or smile takes a turn for the worse, it is because I haven’t been taking
    proper care of my teeth or braces.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6

18. The type of help I receive from other people, determines how soon your bite/smile
    will improve.
   Strongly disagree 1
   Moderately disagree 2
   Slightly disagree 3
   Slightly agree 4
   Moderately agree 5
   Strongly agree 6
Appendix B

Parent/Guardian Questionnaire

1. Sex: ___Male ___Female

2. Age: ___

3. Race: ___Caucasian ___African American ___Asian ___Hispanic ___Indian ___Other (please describe on following line______________)

4. How many times a day do you brush your teeth? ___

5. How are you paying for braces? ___self pay ___state funding

6. Family income? ___<$15,000 ___$15,000-$24,999 ___$25,000-$34,999 ___$35,000-$49,999 ___$50,000+

7. Occupation?______________________________

8. Spouse’s Occupation (if applicable)?______________________________
Appendix C

Eating Habits
AND ORTHODONTICS

AVOID EATING:

HARD FOODS
STICKY FOODS
FOODS HIGH IN SUGAR CONTENT

A careful orthodontic patient can probably eat almost any food and do no damage to his or her appliance. However, the following three types of food may cause trouble, as may other foods. Use common sense or, if you are in doubt, ask us about some food you enjoy eating.

HARD FOODS may do damage by bending wires, loosening cement under the bands or breaking the little brackets and tubes which are attached.

STICKY FOODS damage appliances by bending wires and pulling cement loose.

FOODS HIGH IN SUGAR CONTENT should be avoided whenever possible. If you do eat any of them, brush your teeth immediately. If not convenient to brush, then always rinse your mouth with clear water after eating very sweet foods such as cake.

DON'T EAT
Popcorn, Nuts, Peanut Brittle
Ice (not even if you’re careful)
Lemons (pure lemon juice can hurt your tooth enamel)
Corn-on-the-cob
Corn chips, crisp tacos
Taffy and Caramels, Gummy Bears, etc.
Lifesavers or other hard candy
Bubble Gum—a thousand times NO!
Pizza Crust (the hard outer edge)

MAYBE
Carrot Sticks (if you cut into carrot curls that are thin)
Apples (cut into wedges; don’t bite)
Hard French Bread (if you take small pieces and are very careful)
Diet Drinks, because they are low in sugar content

Some orthodontists allow sugarless gum (not bubble) if in small amounts. Check with your doctor for approval.
Important TOOTH BRUSHING TIPS

One of the common fears about orthodontics is that the braces may cause decay. Your bands and/or brackets bonded to your teeth cover and protect that portion of your teeth as long as they stay firmly attached.

Either way, your brushing problem is the same. The bands or bonded brackets do make your teeth harder to clean. The brackets, tubes and wires tend to make a little shelf around the outside of the teeth. This shelf makes it harder for your toothbrush to clean the spaces between your gums and the attachments.

Your brackets and your bands may look like these.

If you fail to get the teeth clean and fail to exercise your gums, the gums swell and make it even more difficult to clean.

CONTINUED NEGLECT OF THESE AREAS WILL RESULT IN DECAY

So—WHEN and HOW should you clean your teeth during orthodontic treatment?

WHEN

Within five minutes after you eat. Easy to say but sometimes hard to do! When you're away from home, we suggest you carry a travel type or folding toothbrush with you.

HOW SHOULD YOU CLEAN YOUR TEETH DURING ORTHODONTIC TREATMENT?

1. First, brush back and forth across... between the wires and gums on the upper and lower teeth to loosen the food particles.

2. Next, brush correctly as if you had no braces.

   A. Start on the outside of the uppers with bristles at a 45° angle toward the gum or shelf we have referred to. Scrub with a circular motion, two or three teeth at a time using 10 strokes, and move on.

   B. The same on the inner surfaces of the uppers.

   C. Scrub the chewing surfaces last.

   D. Start on the outside of the lower teeth and repeat this process. Remember, direct the brush at an angle toward the gum or shelf area.

3. Rinse your mouth and toothbrush. LOOK IN A MIRROR to see if you have missed any places. Check the little half-moon spaces of teeth between the bands and gums and the space between the molars and gums. If you see any areas you have missed, clean them now.

   A small pointed brush such as the proximal brush can be helpful cleaning those hard to reach places around your braces.

   A lower toothbrush, such as the INTERPLAINE, is very helpful but it is to be used after brushing. It is not a substitute for brushing, but does help remove food particles that the regular toothbrush can not reach.

   When you have finished brushing, the braces and wires should be free of all food particles and the soft white coating of saliva. The braces should look clean and shiny.

   Flossing between your teeth when full appliances are in place will be different and requires special skills. Ask us for instructions.
Appendix E

PATIENT:

ON TIME: ___  LATE: ___  NO SHOW: ___

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BIBLIOGRAPHY


58. MacGregor I, Balding RD. Toothbrushing in Adolescence. 1994 Exeter: Schools Health Education Unit, University of Exeter.


83. Tedesco LA, Keffner MA, Davis EL, Christersson LA. Self-efficacy and reasoned action: Predicting oral health status and behavior at one, three, and six month intervals. Psychology and Health 1993;8:105-121.


