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Assessment of the Predictors of Compliance in Orthodontic Patients using the Health Benefit Model

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Abstract

Introduction: Orthodontic treatment success hinges not only on clinical need but also on the patient's subjective perception of that need, which greatly influences compliance and treatment outcomes. This study evaluates the effectiveness of the Health Belief Model (HBM) in predicting compliance among orthodontic patients, aiming to identify the best predictors of compliance to help healthcare professionals design more effective treatment plans.

Methodology: The study involved 65 patients aged 12-18 years undergoing fixed orthodontic therapy. A structured questionnaire based on HBM constructs was distributed to these patients before treatment, with responses scored on a 4-point Likert scale. Patients were observed clinically for one year to assess compliance, categorized into compliant (C1) and non-compliant (C2) groups, and matched to their predicted compliance from the questionnaire.

Results: HBM-based questionnaire effectively predicted compliance, with C1 patients showing more positive perceptions of HBM constructs compared to the C2 group, thus validating HBM's utility in this context. The odds ratio of 2 with a 95% confidence interval highlighted a strong association between predicted and actual compliance. The model summary revealed a high R^2 value of .952, indicating a strong link between compliance and HBM constructs, with cues to action showing the highest correlation.

Conclusion: In conclusion, the study confirms that the Health Belief Model is a valid and reliable tool for predicting patient compliance in orthodontic treatment, aiding orthodontists in improving treatment outcomes through better understanding and addressing patient perceptions.

Key words: Compliance, Health Belief Model, Predictors, Treatment outcome.

Introduction

Orthodontic treatment success hinges not only on objective clinical need but also on the subjective perception of need by the patient. This perception significantly influences patient compliance, which ultimately dictates treatment outcomes.[1] Patient compliance is a critical factor in successful orthodontic treatment, which is directly influenced by the patient's mindset and their understanding of both the dental issues and the proposed solutions.[2] Recognizing this, orthodontists must prioritize understanding their patients' perspectives to ensure seamless treatment planning and execution. During orthodontic treatment, patients need to modify existing behaviors, such as maintaining oral hygiene, wearing removable appliances as instructed, adhering to dietary restrictions to avoid appliance breakage, and keeping scheduled appointments. Failure to comply can compromise even the most meticulously designed treatment plans.[3,4]

Successful orthodontic results depend on evaluating patient compliance. A recent study by Crerand and Da Silveira found that age, diagnosis, and history of behavioral health or social work engagement were all related to

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non-adherence to orthodontic therapy in patients with cleft lip and palate.[5] While individual variations exist, factors like age, gender, socioeconomic status, parental relationships, and psychological aspects are considered potential predictors of compliance. However, accurately assessing patient cooperation before the start of treatment remains a challenge for clinicians. Existing predictive methods, including surveys and subjective measurements, lack the reliability needed for accurate determination of future compliance.[6]

While there isn't a specific tool designed exclusively to predict orthodontic compliance it was decided to choose a Health Belief model (HBM). In order to explain why participants failed in disease prevention and detection, social psychologists Hochbaum, Rosenstock, and others in the U.S. Public Health Service created the Health Belief Model (HBM) in the 1950s.[7] According to the HBM as it relates to oral health education, people are more likely to adopt advised oral health behaviors when they recognize their vulnerability to oral health issues and comprehend how serious they are. The transformation of unhealthy behaviors into healthy ones depends on other components of the Health Belief Model, such as the perceived balance between benefits and barriers, the influence of media or other sources of cues to action, and an individual's self-efficacy, or confidence in their ability to take preventive measures. All of these elements work together to affect a person's desire to modify their lifestyle and take up healthy behaviors.[7] Previous studies have successfully employed the HBM to investigate drug compliance, self-care behaviors in diabetes management and impact of oral health behaviors on regular dental checkups.[8-11] There was only one orthodontic study that was found, and it used the Health Belief Model (HBM) to determine health-related behaviors associated with wearing fashion braces.[12]

Our study assesses the effectiveness of the Health Belief Model (HBM) in predicting patient compliance in orthodontic treatment. The goal is to identify the most significant predictors of compliance by using the HBM based questionnaire, enabling healthcare professionals to understand the factors that influence patient behavior, to enhance the overall success of orthodontic treatment.

Methodology

This is an experimental study conducted from 1st June 2022 to 1st June 2023 in Orthodontic Department of Rawal Institute of health Sciences. Islamabad. The study was approved by the Ethics Board of Rawal College of Dentistry, RIHS. An informed consent was obtained from all the study participants and their guardians. Using convenience sampling, the minimal number of samples needed was determined to be 65 patients, taking into account a 90% test power, a 10% chance of sample loss, and a 95% confidence interval.[13]

$$n = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2(\sigma_1^2 + \sigma_2^2)}{(\mu_2 - \mu_1)^2}$$

One patient was rejected because of incomplete questionnaire so the final sample consisted of 64 patients. All the patients included in this study gave consent to undergo fixed orthodontic therapy at the orthodontic Department of RIHS. The inclusion criteria set was patients between 12-18 years who were planned for extraction or non-extraction orthodontic treatment by fixed mechanotherapy. Patients planned for removable or functional appliances were excluded from the study. Patients above 18 years of age, and those with syndrome or cleft lip and palate conditions were excluded from the study because their compliance is already compromised because of poor health which can introduce bias. Convenience sampling technique was used and all the patients were given a questionnaire designed by the research orthodontists using the Health Benefit Model (Table I). The HBM framework is illustrated in Figure I.[13]

A structured questionnaire with translation in patients 'mother language (Urdu) was developed based on the HBM constructs and divided into six parts. The questions with constructs are shown in Table I. The questionnaire was distributed among the participants by allocating a departmental serial number. All the questions were fully explained by the researcher to the patient and parent. The patients were asked to complete the questionnaire under the supervision of their parents. Prior to the study, all participants were informed that the findings would remain confidential. The purpose of the study was explained to the participants, and informed consent was obtained from all. Serial number, age and gender of the participants were specified in the demographics. All constructs of the model were scored on a 4-point Likert scale (1=not agree, 2=slightly agree, 3=moderately agree, 4=completely agree). The total scores ranged from 1 to 4, with higher scores indicating greater compliance and lower scores indicating lesser compliance with the treatment.

The face and content validity of the questionnaire was confirmed by 4 specialists. The content validity rate and content validity index were finally assessed and corrected until it attained a value of 1. Prior to the survey, a pilot study was executed on 10 patients to examine the eligibility of the questionnaire and also to determine the probable problems with the instrument. The questionnaire reliability was tested using Cronbach's alpha. Its' value for the full questionnaire was .69 and for the constructs (susceptibility, severity, benefits, barriers, cues to action and self-efficacy) of HBM were 0.61, 0.68, 0.72, 0.73, 0.68 and 0.69 respectively. As these values show moderate reliability, confirmatory factor analysis was applied and comparative fit index was found to be 0.95 which is considered acceptable.

All the patients started their orthodontic treatment after filling the questionnaire. They were observed clinically for one year for their behavior during treatment and identified as compliant or noncompliant. Patients with good oral hygiene, regular in appointments and less than two bracket breakages in one year were considered compliant labelled as C1, while patients with two or more breakages, irregular in appointments and showing poor oral hygiene were considered non-compliant and labelled as C2. This clinically assessed compliance was then matched with the predicted compliance of each patient to assess the validity of the HBM questionnaire.

Statistical Analyses: To evaluate the data, IBM SPSS 23 was used to insert the precoded questionnaire. The HBM component scores were calculated. Before analysis, the normality distribution and missing values were examined. To give a summary of each variable, descriptive statistics (numbers, means, and percentages, if appropriate) were used. Multiple regression analysis and a Pearson's correlation coefficient were used to identify relationships between the HBM components and compliance. To ascertain the degree of correlation between an exposure (such as high scores on an HBM questionnaire) and an outcome (such as compliance), the odds ratio and confidence interval were computed.

Result

Out of the total sample of 64 patients 45 were found clinically compliant (C1) while 19 fell in the non-compliant group (C2). Mean age of the C1 and C2 group was 15.99 ± 1.81 and 16.09 ± 2.46 respectively. CI group consisted of 17 (37.7%) males and 28 (62.2%) females while C2 group had 5 (26.3%) males and 14 (73.6%) females (figure II). Frequency of patients along with their responses in percentage according to the HBM questionnaire is shown in Table II. In the C1 group maximum number of patients were found to be moderately or highly compliant and in the C2 group maximum number of patients were slightly compliant or non-

compliant according to the HBM based questionnaire. This reveals that perception of compliant patients (C1) was more positive about constructs as compared to non-compliant (C2) patients indicating the validity of HBM constructs for predicting compliance. In C2 group 100% patients considered inabilty to change their eating habits while 68.3% patients considered inability to change their brushing habits as a biggest barrier in coping with the orthodontic treatment. Odds ratio was found 2 with confidence interval of 95% showing strong association between predicted and clinical compliance.

The value of R2 in model summary (Table III) was found to be .952 which shows a good association between dependent variable (compliance) and the independent variables i-e (questionnaire designed on the basis of HBM). All the independent variables (Table IV) were found highly correlent to the compliance (dependent variable). Cues to action showed the highest correlation of .956 according to which ability to change eating habits, adherance to appointment schedule and following the orthodontic instructions are most effective predictors of compliance. Same results are depicted in Figure III in which all the independent variables are closely hugging the regression line. If the regression residuals are normally distributed, the points fall close to the diagonal line, which represents perfect normality (i.e., observed and expected probabilities are the same).

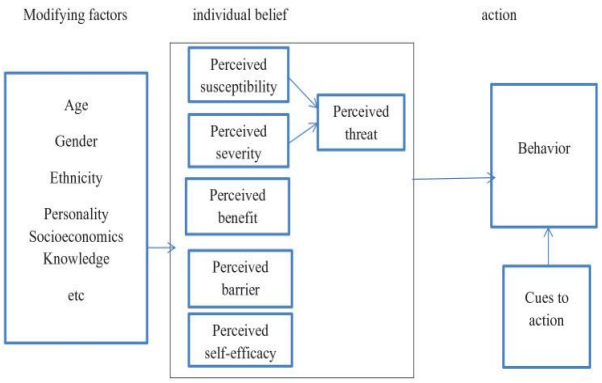

Fig. I: Conceptual Framework of the Health Belief Model

Figure.I adapted from Zewdie etal.[14]

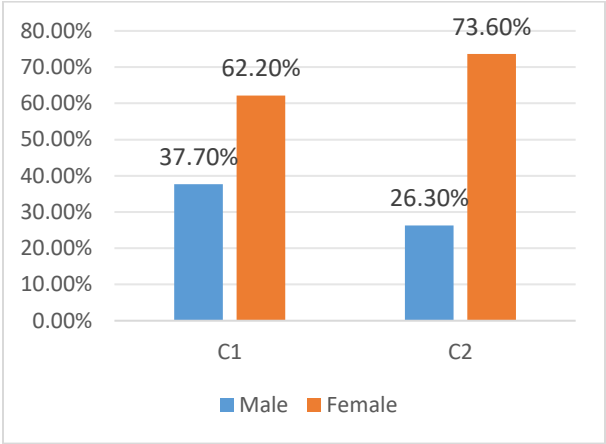

Fig. II: Gender Distribution in C1 and C2 Groups

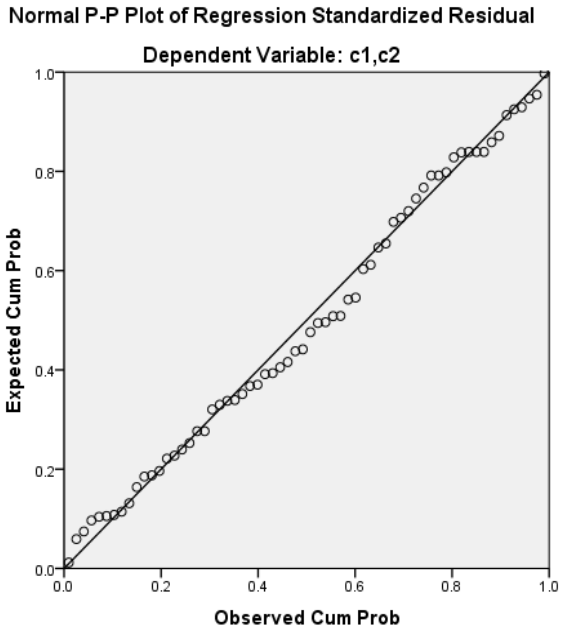

Fig. III:
Observed Cum Prob = The empirical cumulative probability of the observed residuals.

Expected Cum Prob = The theoretical cumulative probability based on a normal distribution.

Construct	Question Designed According To The Construct
Perceived Susceptibility	**Q no1**. On a scale of 1 to 4, how susceptible do you believe you are to dental and oral health issues if you do not undergo orthodontic treatment? آپ کتنے حساس محسوس کرتے ہیں کہ اگر آپ آرتھوڈونٹک علاج نہیں کرواتے تو آپ کو دانتوں اور منہ کی صحت کے مسائل کا سامنا ہو سکتا ہے
Perceived Severity	**Q no2.** How severe do you believe the consequences of not undergoing orthodontic treatment would be for your overall oral health and well-being? آپ کتنی سنگینی محسوس کرتے ہیں کہ آرتھوڈونٹک علاج نہ کروانے کے نتائج آپ فلاحوبہبودکےلیےہونگے کی مجموعی زبانی صحت اور ؟
Perceived Benefits	**Q no 3.**To what extent,you believe your appearance and confidence will improve after completing the orthodontic treatment successfully? آپ کس حد تک یقین رکھتے ہیں کہ آرتھوڈونٹک علاج کامیابی سے مکمل ہونے کے بعد آپ کی ظاہری حالت اور اعتماد میں بہتری آئے گی **Q no4.** To what extent,you believe orthodontic treatment will help in achieving better dental function.? آپ کس حد تک یقین رکھتے ہیں کہ آرتھوڈونٹک علاج بہتر دانتوں کی کارکردگی حاصل کرنے میں مددگار ثابت ہوگا؟ **Q no5.** To what extent,you believe orthodontic treatment will impact on your psychological well-being positively.? آپ کس حد تک یقین رکھتے ہیں کہ آرتھوڈونٹک علاج آپ کی نفسیاتی فلاح و بہبود پر مثبت اثر ڈالے گا؟
Perceived Barriers	**Q no6.** To what extent you will be able to change your brushing habits with orthodontic treatment? آپ کس حد تک یقین رکھتے ہیں کہ آرتھوڈونٹک علاج کے ساتھ آپ اپنی برش کرنے کی عادات کو تبدیل کر سکیں گے؟ **Q no7.** To what extent you will be able to change your eating habits with orthodontic treatment.? آپ کس حد تک یقین رکھتے ہیں کہ آرتھوڈونٹک علاج کے ساتھ آپ اپنی کھانے کی عادات کو تبدیل کر سکیں گے
Cues to Action	**Q no8.** To what extent you will avoid eating hard and sticky food to complete your treatment successfully. آپ کس حد تک یقین رکھتے ہیں کہ آپ اپنے علاج کو کامیابی سے مکمل کرنے کے لیے سخت اور چپکنے والی غذا سے پرہیز کریں گے؟ **Q no9.** To what extent you will avoid missing your orthodontic appointment to adhere to the orthodontic treatment plan? آپ کس حد تک یقین رکھتے ہیں کہ آپ آرتھوڈونٹک علاج کے منصوبے کی پابندی کرنے کے لیے اپنی آرتھوڈونٹک ملاقات کو چھوڑنے سے بچیں گے **Q no10.** To what extent you will listen and follow the instructions of your treating orthodontist? آپ کس حد تک یقین رکھتے ہیں کہ آپ اپنے معالج آرتھوڈونٹسٹ کی ہدایات کو سنیں گے اور ان پر عمل کریں گے
Self-Efficacy	**Q no11.** How confident are you in your ability to comply with the orthodontic treatment plan i-e wearing elastics/functional appliance as directed by the doctor? آپ اپنے آرتھوڈونٹک علاج کے منصوبے پر عمل کرنے کی صلاحیت پر کتنا اعتماد محسوس کرتے ہیں، یعنی جیسا کہ ڈاکٹر کی ہدایت کے مطابق فنکشنل آلات پہننا/الاسٹک **Q no12.** How much maintaining your tooth alignment is highly important and top priority to you?آپ کے لیے اپنے دانتوں کی سیدھ کو برقرار رکھنا کتنا اہم اور اعلیٰ ترجیح ہے

Table I: Questionnaire Based on HBM

Question	Compliance group C1			Non compliance group C2		
	Response	Frequency	percentage	Response	Frequency	%age
Q NO 1	Slightly compliant Medium compliant Highly compliant	1 25 19	2.2% 55.5% 42.2%	Not compliant Slightly compliant Medium compliant	4 14 1	21.0% 73.6% 5.2%
Q NO 2	Slightly compliant Medium compliant Highly compliant	4 29 14	8.8% 64.4% 31.1%	Not compliant Slightly compliant Medium compliant	13 6 0	68.4% 31.% 0%
Q NO 3	Slightly compliant Medium compliant Highly compliant	3 30 12	6.6% 66.6% 26.6%	Not compliant Slightly compliant Medium compliant	10 5 4	52.6% 26.3% 21.0%
Q NO 4	Slightly compliant Medium compliant	2 27	4.4% 60%	Not compliant Slightly compliant	12 7	63.1% 36.8%

	Highly compliant	16	35.5%	Medium compliant	0	0%
Q NO 5	Slightly compliant Medium compliant Highly compliant	2 32 13	4.4% 71.1% 28.8%	Not compliant Slightly compliant Medium compliant	15 4 0	78.9% 21.0% 0%
Q NO 6	Slightly compliant Medium compliant Highly compliant	4 31 10	8.8% 68.8% 22.2%	Not compliant Slightly compliant Moderate compliant	19 0 0	100% 0% 0%
Q NO 7	Non compliant Slightly compliant Medium compliant Highly compliant	10 24 10 1	22.2% 53.3% 22.2% 2.2%	Not compliant Slightly compliant Moderate compliant	13 5 1	68.4% 26.3% 5.2%
Q NO 8	Slightly compliant Moder compliant Highly compliant	1 27 17	2.2% 60% 37.7%	Not compliant Slightly compliant Moder compliant	11 7 1	57.8% 36.8% 5.2%
Q NO 9	Slightly compliant Moder compliant Highly compliant	1 31 13	2.2% 68.8% 28.8%	Not compliant Slightly compliant Moder compliant	14 5 0	73.6% 26.3% 0%
Q NO 10	Slightly compliant Moder compliant Highly compliant	4 28 13	8.8% 62.2% 28.8%	Not compliant Slightly compliant Moder compliant	9 9 1	47.3% 47.3% 5.2%
Q NO 11	Slightly compliant Moder compliant Highly compliant	0 33 12	0% 73.3% 26.6%	Not compliant Slightly compliant Moder compliant	11 8 0	57.8% 42.1% 0%
Q NO 12	Slightly compliant Moder compliant Highly compliant	0 25 20	0% 55.5% 44.4%	Not compliant Slightly compliant Moder compliant	7 10 2	36.8% 52.6% 10.5%

Table II: Frequency of HBM Predicted Compliance In C1 And C2 Group

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1.	.979	.959	.954	.108

Table III: Model Summery

Model	Unstandardized Coefficient		Standardized Coefficient	t	Sig.	95%confidence Interval for B		Correlations		
	B	Std. error	Beta			Lower Bound	Upper Bound	Zero	Partial	Part
		.355	.090	3.958	.000		.176	.535		
Perceived Susceptibility	.032	.027	.057	1.168	.248	-.023	.086	.832	.153	.031
Perceived Severity	.044	.027	.064	1.593	.117	-.011	.098	.749	.206	.043
Perceived Benefits	.028	.014	.116	2.005	.050	.000	.056	.888	.257	.054
Perceived Barriers	-.023	.017	-.063	-1.371	.176	-.058	.011	.746	-.179	-.037
Cues to action	.100	.012	.720	8.374	.000	.076	.124	.970	.743	.226
Self- efficacy	.047	.018	.129	2.686	.009	.012	.082	.844	.335	.072

Table IV: Co-efficient and Correlation

Discussion

In our study female patients showed higher percentage in both C1 and C2 group but this is attributed because of higher number of enrolled female patients in orthodontic outdoor. The disparities in gender representation between compliant and non-compliant orthodontic patient groups merit further study, given the growing acknowledgment of gender-specific methods in dental care. Research indicates that female patients who received orthodontic treatment in their childhood exhibit greater awareness of preventive measures in adulthood, potentially fostering compliant behavior during their formative years.[14] During adolescence, patients frequently seek orthodontic treatment, a period characterized by a psychological shift towards broader resistance to adult guidance.[15]The majority of demographic factors have been found to be unreliable in forecasting patient compliance, and it is probable that variables like age and gender are too rudimentary to serve as a robust predictor in this context, despite potentially providing an initial understanding of the patient's general background and surroundings.[6]

Previous research has highlighted the significance of patient compliance during orthodontic treatment. In fact, a study conducted by Li and Liu et al. (2022) revealed that compliance is a key factor in determining the success of orthodontic treatment. Although some patients are knowledgeable about oral hygiene practices, such as maintaining a healthy diet and dental care during treatment, they struggle to modify their eating habits.[16] In our study 100% patients acknowledged that it would be hard to change my eating habits. The implementation of HBM in our research is consistent with the findings of Goodarzi and Heidarnia (2019), who showed the model's efficiency in forecasting oral health behaviors. However, one limitation of this study is that all participants were female, restricting the generalizability of the results to males.[17] A meta-analysis demonstrated that interventions based on the Health Belief Model (HBM) are effective in enhancing oral health behaviors.[18] Orthodontic compliance with the help of HBM has not been investigated earlier. Our study contributes to the literature by specifically applying the HBM in an orthodontic context, illustrating the model's utility beyond general health behaviors. The six variables of the HBM (susceptibility, severity, benefits, barriers, self-efficacy, and cue to action) provide a comprehensive framework for understanding patient behavior.

Bos et al. discovered that the degree of eye contact between the patient and the parent and the orthodontist was regarded as an indirect measure of compliance since it showed motivation and interest. Clinical signs were also identified as potential measures of compliance, including the number of loose brackets, the look of the braces, and periodontal disease.[19] According to Stefanovic et al., the best predictor of increased compliance was parental judgment of their children's altered emotional well-being, and there were more noncompliant patients than compliant ones (55% vs. 45%).[20]

In contrast our study revealed that the number of compliant patients (45) was higher as compared to noncompliant patients (19) while ability to change eating habits, adherance to appointment schedule and following the orthodontic instructions are the strongest predictors of compliance. Previous research has proved that psychological tests and assessing a patient's academic performance can help forecast their level of compliance. However, it is essential to understand that relationships are a key factor in fostering cooperation .Building a strong bond with patients and their parents is a crucial tool for improving compliance levels and maximizing treatment outcomes and satisfaction.[21]

The findings of our study suggest that orthodontists can use the HBM-based questionnaire to predict patient compliance, which is critical for treatment planning and outcomes. However recent advancements in AI and ML offer clinicians a supplementary tool to aid in predicting and changing patient behavior. Therefore, it is necessary to create high-quality orthodontic applications that incorporate suitable behavior modification strategies in order to increase patients' adherence to treatment.[22] It is important to recognize the limitations of our study, including the small sample size, convenience sampling, and possible reporting bias, even though it offers insightful information. The study variables could be investigated in more varied populations in future research. Additionally, different orthodontic treatment situations can be used to evaluate the HBM's applicability.

Conclusion

In conclusion, our study provides a practical tool for predicting compliance using the Health Belief Model. It emphasizes the importance of compliance and the associated factors which affect the patient compliance during orthodontic treatment. This can benefit many clinicians who can adjust treatment plans to avoid or include orthodontic appliances based on test results, resulting in a more personalized and effective approach to orthodontic care that aligns with the patient-centered care model.

Ethical Approval

The study was approved by the Ethical Review Board of Rawal College of Dentistry, Rawal Institute of Health Sciences, Islamabad.

Disclaimer

No external funding.

Conflict of Interest

It is declared that the authors don't have any conflict of interest.

Authors' Contribution

SN: Conception of study, Data collection, statistical analysis.

HGK: Reference checking and proof reading.

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