RELATIONSHIP AMONG METABOLIC CONTROL, ORAL PARAMETERS AND SELF-EFFICACY IN DIABETIC PATIENTS

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ABSTRACT

The aim of the present study was to evaluate the relationship between patients' answers to behavioral questionnaires on diabetes and oral health, oral parameters and metabolic control of diabetes.

A cross-sectional study was conducted on fifty type 2 diabetic subjects selected according to specific criteria, mainly: diagnosis of type 2 diabetes mellitus occurred at least 6 months before the study, presence of ≥5 natural teeth and having at least two recent glycated hemoglobin ($HbA1_c$) measurements. Three questionnaires were administered to the patients after a preliminary testing phase. The questionnaires were: Multidimensional Diabetes Questionnaire (MDQ), organized in three sections; Stress Evaluation Questionnaire for Diabetics, a single questionnaire; and Dental Self-efficacy, organized in three sections. Clinical parameters were O'Leary Plaque Index, and percentage of bleeding on probing. Diabetic metabolic control was calculated using $HbA1_c$ measurements. Reliability of questionnaires was analyzed using Cronbach's α coefficient. Relationship among variables was tested by Pearson Correlation analysis. A p-value <0.05 was significant.

Results: The mean age of the study sample was 52.2 years; 38 individuals were women (77%), and 12 were men (23%). The majority had only completed elementary education (55%). Mean plaque index score was 53.51% (SD 21.6), mean bleeding on probing was 36.33% (SD 23.65). Mean HbA_{1c} value was 9.22% (SD 2.6). Dental self-efficacy for using dental floss and visiting a dentist was low, but it was high for tooth brushing. There was a significant correlation between the MDQ and HbA_{1c}. Percentage of bleeding on probing had a correlation with self-efficacy for dental visits. The MDQ section I had a correlation with O'Leary Plaque Index, sections II and III had a correlation with self-efficacy for tooth brushing, section III had a correlation with self-efficacy for visiting a dentist.

In conclusion, self-efficacy questionnaires for tooth brushing and visiting a dentist had a significant correlation with self-efficacy for diabetes control.

Key words: Behavior, self-efficacy, behavioral research, diabetes mellitus, oral hygiene.

RELACIONES ENTRE CONTROL METABÓLICO, PARÁMETROS CLÍNICOS Y EL MODELO COMPORTAMENTAL DE AUTO-EFICACIA EN PACIENTES DIABÉTICOS TIPO 2.

RESUMEN

El objetivo del presente trabajo fue estudiar la relación entre las respuestas a cuestionarios que evalúan teorías de comportamiento para diabetes y salud oral, parámetros clínicos orales y el control metabólico de la diabetes mellitus tipo 2.

Se realizó un estudio de tipo seccional en una muestra de cincuenta pacientes diabéticos tipo 2 seleccionados de acuerdo a criterios específicos, entre ellos: Diagnóstico de diabetes mellitus tipo 2 ocurrido por lo menos 6 meses antes del inicio del estudio, presencia de por lo menos 5 dientes naturales y poseer dos exámenes de porcentaje de hemoglobina glucolizada obtenidos durante el último año. Después de un proceso de traducción, adaptación y prueba preliminar, los pacientes respondieron tres cuestionarios psicológicos que evalúan patrones de comportamiento específicos, los cuestionarios fueron: Cuestionario de Auto-eficacia Oral, organizado en tres secciones distintas; Cuestionario de Evaluación de Estrés en Diabéticos, compuesto por una sola sección; y Cuestionario Multi-dimensional en Diabetes; organizado en tres secciones. En particular la sección III del Cuestionario Multi-dimensional en Diabetes mide parámetros asociados con auto-eficacia relacionados con la condición diabética. Los parámetros clínicos medidos fueron el Indice de Placa según O´Leary, y el porcentaje de hemorragia al sondaje. El control metabólico de la diabetes fue determinado a través del porcentaje de hemoglobina glucolizada (HbA_{1c}) La confiabilidad de los cuestionarios fue establecida por la prueba del Coeficiente-α de Cronbach. La relación entre las variables se estudió a través del Análisis de Correlación de Pearson. Valor p<0.05.

Resultados: La edad promedio de la muestra del estudio fue de 52.2 años, del total de 50 pacientes 38 individuos (77%) eran mujeres y 12 individuos (23%) eran hombres; la mayoría de los sujetos poseían sólo educación primaria (55%). El promedio del nivel de placa bacteriana era de 53.51% (DE 21.6), el

promedio de porcentaje de hemorragia al sondaje era de 36.33% (DE 23.65). El promedio de los niveles de hemoglobina glucolizada era de 9.22% (DE 2.6), lo cual revela un mal control metabólico de la enfermedad. Los niveles de auto-eficacia oral para la utilización de seda dental y visita al odontólogo fueron bajos, pero la auto-eficacia oral para el cepillado dental fue alta. Se encontró una relación significativa entre los resultados del Cuestionario Multi-dimensional en Diabetes y los niveles de HbA_{1c}. El porcentaje de hemorragia al sondaje se correlacionó con la auto-eficacia oral para visitar de forma regular al odontólogo. El Cuestionario Multi-dimensional en Diabetes, sección I se correlacionó con los valores de Indice de Placa de O'Leary; las secciones II y III se correlacionaron con la auto-eficacia para el cepillado dental, la sección III tuvo una relación significativa con la auto-eficacia para visitar al odontólogo.

Conclusión: Los resultados de los cuestionarios de auto-eficacia oral para el cepillado dental y la visita regular al odontólogo tuvieron una correlación significativa con la sección del Cuestionario Multi-dimensional en Diabetes que mide auto-eficacia para el control de la diabetes.

Palabras clave: Modelo de Auto-eficacia, Investigación Comportamental, Diabetes Mellitus, Higiene Oral.

INTRODUCTION

The prevalence of diabetes mellitus is increasing worldwide, affecting more than 170 million individuals around the world. In developed societies, diabetes mellitus has reached about 6% of the population, but developing countries could account for the greatest future increase in the prevalence of the disease[1, 2]. Approximately 90% of diabetic subjects can be classified as having type 2 diabetes, a disease characterized by insulin resistance and abnormal insulin secretion.

Diabetic subjects present an increased prevalence of periodontal disease. A cross-sectional analysis of 4343 individuals included in the National Health and Nutrition Examination Study III (NHANES III) of U.S.A. calculated a 1.56 adjusted odds ratio for having severe periodontitis in diabetic subjects, this odds ratio increased to 2.90 when subjects with poorly controlled diabetes were separately analyzed[3]. A meta-analysis involving 3500 individuals demonstrated a significant association between diabetes and periodontitis[4]. An epidemiological study on the Pima Indian community, described as having the world's highest incidence of type 2 diabetes mellitus, reported higher prevalence of periodontal disease in diabetics at different age ranges. Differences were greater at younger ages (15-34 years) than at older ages (≥55), where periodontal disease affected the majority of the population independently of diabetic status. Incidence of periodontal disease was approximately three times higher in diabetic subjects at a 2.6-year follow-up[5].

Adherence to medical treatment, defined as the extent to which a person's behavior coincides with medical advice, including medication-taking and lifestyle practices, is an important aspect of treatment for diabetes and periodontal disease. Diabetic subjects are asked to take medication, follow a meal plan, exercise, monitor blood glucose levels and make adjustments to their regimen when warranted[6]. Meanwhile, periodontal patients are asked to perform daily removal of bacterial plaque by tooth brushing and interdental cleaning; it has been established that performance of professional mechanical therapy without proper plaque control does not contribute to improved periodontal status[7, 8].

Several psychological models have been formulated to explain health behavior of patients; they consider a person's knowledge, beliefs, attitudes, feelings, values, psychomotor skills and previous behaviors[9]. Behavioral models applied to oral hygiene practices were summarized in five approaches by Inglehart and Tedesco[10]: self-efficacy theory, health belief model, theory of reasoned action, theory of planned action and relapse prevention model. A Cochrane collaboration systematic review concluded that there is tentative evidence that different psychological approaches can improve oral hygiene behavior of subjects, measured as self-informed tooth brushing and dental floss practices, and plaque and gingival bleeding scores[11].

A research group from Oulu University (Oulu, Finland) has performed an analysis of several psychological model questionnaires related to oral health behavior and metabolic control of diabetes; the models studied included: dental self-efficacy, attributions, self-esteem and the theory of reasoned action[12-15]. The authors suggested that oral health behavior and diabetes self-care have psychological factors in common. In particular, the report of Syrjala et al.[12] focused on the self-efficacy model described by Bandura[16]; according to this model, individuals perform activities with which they feel they can cope and avoid activities they feel they can not manage; thus self-efficacy determines initiation

and persistence with an activity. A dental self-efficacy questionnaire was developed containing seventeen questions, it was tested in a group of 31 non-diabetic patients and 21 diabetic patients before being applied[12] .

The aim of this project was to study the relationship among two behavioral model questionnaires for diabetes and one for oral health, oral clinical parameters and diabetic metabolic control. Behavioral models measure psychological aspects that could influence the performance of daily self-care activities for controlling both diseases.

MATERIALS AND METHODS
Study Design and Patient Population
A cross-sectional study was performed on a sample of fifty type 2 diabetic subjects being treated at the outpatient clinic of the Colombian Diabetic Association (Bogotá, Colombia). Subjects that fulfilled the following inclusion criteria were invited to participate in the study, which included an oral examination, three different survey questionnaires and the collection of metabolic control data.

Inclusion criteria:
- Type 2 diabetes mellitus diagnosis occurred at least six months before the study.
- Presence of at least 5 natural teeth.
- Had at least two measurements of glycated hemoglobin levels obtained during the past year (HbA_{1c}), considering HbA_{1c} examinations are taken at three-month intervals at this diabetes treatment clinic.

Exclusion criteria
- Type 2 diabetes mellitus related to pregnancy, alcoholism or pancreatitis.

The study was approved by the ethical committee of the Dental School, Universidad Nacional de Colombia, and the Colombian Diabetic Association. All subjects signed an informed consent statement prior to inclusion in the study.

Data Collection
Demographic data collected from subjects included: age, gender, marital status and educational level. Educational level was categorized as: elementary education, secondary education, technical qualification and university education.

The O´Leary Plaque Index[17] and percentage of bleeding on periodontal probing were measured in all present teeth at six surfaces per tooth: mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual and distolingual. The O´Leary Plaque Index was chosen as it includes using a disclosing solution for detecting presence/absence of plaque, facilitating the examination procedure. Percentage of bleeding on periodontal probing was determined as gingival bleeding in a period of 10 second after probing.

Diabetic metabolic control was assessed by an average of at least two glycated hemoglobin levels obtained during the previous year under diabetic treatment.

Questionnaires
Three different questionnaires were administered to all patients; assistance was provided to answer any possible doubt regarding questions. A first questionnaire was related to oral health self-efficacy; the other two questionnaires were related to diabetes; one was about cognitive and social factors, and the other was about stress associated with diabetic status. Original English versions of all questionnaires were translated into Spanish by two licensed translators from the Foreign Language Department, School of Social Science, Universidad Nacional de Colombia. Translated versions were refined by two expert associate professors from the Department of Psychology and the Dental School. Questionnaires were evaluated in an independent group of 10 type 2 diabetic subjects; further modifications were performed based on feedback from questionnaire application on patients.

The first questionnaire evaluated was the Dental Self-efficacy Questionnaire (DSelf-efficacyQ) designed by Syrjala et al.[12] which consisted of seventeen questions: five regarding self-efficacy for tooth brushing; five for self-efficacy for approximal cleaning and seven regarding self-efficacy for visiting a dentist. Table 1 provides an example of item questions. Two questions described in the original report related to work interference were eliminated, because of their close similarity to other questions (Table 2). Four possible answer scores were given to questions: completely confident (4 points), fairly confident (3 points), fairly confident not to (2 points) and completely confident not to (1 point).

The second questionnaire was the Multidimensional Diabetic Questionnaire (MDQ) designed by Talbot et al.[18] This questionnaire aims at a comprehensive diabetes behavior evaluation; hence it is

Table 1: Example of item questions.

Dental Self-efficacy Questionnaire

Self-efficacy for tooth brushing
How confident are you that you brush your teeth in the following situations?
When you are on holiday

Self-efficacy for approximal cleaning
How confident are you that you clean your proximal surfaces in the following situations?
When you have a headache or feel ill

Self-efficacy for visiting a dentist
How confident are you that you visit a dentist as often as advised?
When a dentist does not invite you to visit regularly?

Multi-dimensional Diabetes Questionnaire

Section I
General perception of diabetes
How much does your diabetes interfere with your daily activities?
Related social support
To what extent does your spouse (or significant other) support you with your activities?

Section II
Social incentives in relation to self-care activities
My spouse (or significant other):
Encourages me to do exercise

Section III
Self-efficacy
How confident are you in your ability to exercise regularly?
Outcome expectations
How important do you think that measuring your blood sugar is for controlling your diabetes?

Diabetes Stress Questionnaire

I feel worried because of the risk of fainting when my blood sugar is low.
It is difficult to mention my diet requirements when with friends at parties or restaurants.

described as multidimensional. The original MDQ consists of 41 questions organized in three sections; the first section studies general perception of diabetes and related social support and comprises 16 items; the second section focuses on social incentives in relation to self-care activities and comprises 12 items; the third section was designed to assess self-efficacy expectations as well as outcome expectations and comprises 13 items; examples of questions are provided in Table 1.

The patient's answers to the MQD questionnaire sections I and II were scored on a 7-point rating-scale (0 to 6); for the first section, higher scores mean an increased level of perceived interference; for the second section an increased score indicates greater levels of positive and misguided reinforcement behavior. MQD questionnaire section III answers were evaluated on a 0 to 100 point rating scale, meaning 0 feeling "not confident" and 100 feeling "very confident" about performing activities related to diabetic control; thus assessing self-efficacy for diabetic control, or feeling more confident of a positive outcome when performing daily activities for diabetic control. Two questions were eliminated from the questionnaire after expert revision because they were considered redundant (Table 2).

The third questionnaire was the Diabetic Stress Questionnaire (DStressQ), designed by Hershbach et al.[19]. It assesses situations that are sources of stress for diabetic patients using 45 questions. Patients are asked to measure the level of stress that specific situations could cause them on a 5-point rating scale, ranging from "a slight problem" to "a very big problem" (Table 1).

Table 2:

Eliminated question	Reason for elimination
Dental Self-efficacy questionnaire. How confident are you that you brush your teeth in the following situation? When you have/had a lot of work	Similar to: When you are tired in the evening
Dental Self-efficacy questionnaire. How confident are you that you clean your proximal surfaces in the following situations? When you have/had a lot of work	Similar to: When you are tired in the evening
Multidimensional Diabetes Questionnaire To what extent does your diabetes interfere with your ability to participate in social or recreational activities?	Similar to: To what extent does your diabetes decrease your satisfaction or pleasure from social or recreational activities?
Multidimensional Diabetes Questionnaire My spouse (or significant other): Congratulates me when I follow my diet	Similar to: My spouse (or significant other): Congratulates me when I follow my meal schedule

Statistical Analysis

The three questionnaires were evaluated for internal consistency using the Cronbach´s α reliability coefficients. Means and standard deviations were calculated for data description. Correlation among the three types of variables was tested by the Pearson Correlation analysis. A p-value < .05 was considered to indicate significance. SPSS for Windows was used for statistical analysis.

RESULTS

Sample Description

The study population included fifty type 2 diabetic patients with a mean age of 52.2 years, ranging from 25 to 65 years; they were predominantly women, with 38 women and 12 men. Twenty-seven patients had only completed elementary education, 10 had high school education and 13 had technical or university education. More than half of the patients (30) were married; other patients were single, among whom 14 were widowed.

Clinical Parameters

Mean glycated hemoglobin level was 9.22% (SD 2.66), showing a poor metabolic control of diabetes. The O'Leary Plaque Index and percentage of bleeding on probing were equally high with mean values of 53.51% (SD 21.65) and 36.33% (23.65), respectively (Table 3).

Questionnaires

Evaluation of the three questionnaires revealed high Cronbach α reliability coefficients, with values ranging from 0.81 up to 0.97 (Table 4). These high values indicate good intercorrelation among questionnaire items measuring a single defined construct.

Table 3: Description of Clinical Parameters and Questionnaire Results (n=50)

	Mean	Standard Deviation	Minimum	Maximum
HbA_{1c}	9.2	2.66	4.42	15.50
O´Leary Plaque Index	53.51	21.65	7	100
Percentage of Bleeding on Probing	36.33	23.65	0	100
Oral Self-efficacy for Tooth brushing	10.78	3.72	3	15
Oral Self-efficacy for Dental Flossing	5.31	4.34	0	15
Oral Self-efficacy for Visiting a Dentist	7.73	5.74	0	21
Multidimensional Diabetes Questionnaire MDQ (Total score)	61.17	26.33	21	111
Diabetes Stress Questionnaire, DStressQ (Total score)	88.75	33.80	13	171

Table 4: Cronbach α Reliability Coefficient of questionnaires

Questionnaire	Reliability coefficient
Oral Self-efficacy Scale	.93
Tooth brushing Self-efficacy Scale	.94
Dental Floss Self-efficacy Scale	.96
Dental Visiting Self-efficacy Scale	.94
Multidimensional Diabetes Questionnaire Section I	.84
Multidimensional Diabetes Questionnaire Section II	.97
Multidimensional Diabetes Questionnaire Sections I and II	.95
Self-efficacy Section III	.84
Expectations Section III	.90
Self-efficacy and expectations Section III	.81
Stress evaluation	.92

Questionnaire Results

Levels of oral self-efficacy were low, with a mean score of 9.22 (SD 2.66). Results for the other two questionnaires, the MDQ and the DStressQ, showed moderate levels of interference for adherence to diabetic treatment and stress related to daily situations faced by a diabetic patient. The mean MDQ score was 61.17 (SD 26.33); the mean value for the DStressQ was 88.75 (SD 33.80) (Table 3).

Correlation among Variables

Individuals reporting high self-efficacy for tooth brushing also reported high self-efficacy for dental flossing and self-efficacy for visiting a dentist, 0.37 (p<0.01) and 0.30 (p<0.05), respectively. Similar to the previous result, self-efficacy for dental flossing was correlated with self-efficacy for visiting a dentist, with a correlation coefficient 0.52 (p<0.01). Those individuals reporting high self-efficacy for visiting a dentist showed a lower percentage of bleeding on probing with a correlation coefficient of -0.26 (p<0.05); for tooth brushing and dental flossing questionnaire results, there was no correlation with percentage of bleeding on probing. The O'Leary Plaque Index did not significantly correlate with any section of the oral self-efficacy questionnaire.

The total score for the MDQ correlated with HbA_{1c} levels, with a coefficient of 0.29 (p<0.05); on the contrary, the DStressQ did not correlate with HbA_{1c}. The two diabetic questionnaires did not correlate with each other.

Oral and diabetic variables showed four different correlations. Self-efficacy for tooth brushing had a correlation with the MDQ, sections II and III, with correlation coefficients of 0.33 and 0.27 (p<0.05) respectively; in particular section III measures self-efficacy for diabetic control. Similarly self-efficacy for visiting a dentist had a correlation with MDQ section III, with a correlation factor of 0.30 (p<0.05). The O'Leary Plaque Index examination was inversely correlated with the MDQ, section I, correlation factor -0.28 (p<0.05), this meaning lower plaque scores in subjects reporting a higher frequency of positive reinforcement or interference of diabetes with daily activities (Table 5, Table 6).

DISCUSSION

The onset of gingival inflammation is related to inadequate supragingival plaque control; as a result, establishment of optimal self-performed plaque control is an important goal of periodontal therapy[7]. Motivation, knowledge, provision of oral hygiene instructions, type of oral hygiene aids and manual dexterity determine the effectiveness of mechanical plaque control by self-care[20]. Regarding diabetic treatment, individuals are expected to be engaged in a series of self-care activities; adherence to treatment defined as the extent to which a person's behavior coincides with medical advice recognizes personal motivation and knowledge as important factors for performance of self-care activities [5]. Similar behavior that leads to plaque control could lead to adequate diabetic control; this was the reason for analysis of correlations between oral health and diabetic parameters in a small sample of subjects. The present study was designed as a baseline assessment in order to identify significant parameters that could be included in a health promotion program for diabetic patients. Considering an examination time of approximately one hour per patient, which included a full-mouth oral examination and assisted administration of 104 questions, in addition to limited financial funding, a total of 50 patients could be included in the study. In spite of the sample size, significant correlations were found between self-efficacy for oral health and self-efficacy for diabetic control.

Statistical analysis among clinical parameters showed no correlation between HbA_{1c} levels, the O'Leary Plaque Index and Percentage of Bleeding on Probing; all three parameters were elevated in the population studied. Several references have shown increased gingival inflammation in diabetics, in some cases related to poorer metabolic control, compared with control groups [21-24]. Considering that no control group was included, and that the majority of individuals demonstrated equally poor oral conditions and diabetic metabolic control, finding significant correlations could be difficult.

Analysis of the relationship between psychological questionnaires and clinical parameters showed there was a correlation between the MDQ and HbA_{1c} levels; however, there was no correlation between the DStressQ and HbA_{1c}. With regard to the lack of correlation for the sample studied, one must consider difficulties in adapting questionnaires originally developed in samples of diabetic subjects in Finland, Canada and Germany; countries with possible differences in attitudes, beliefs and behavior compared to Colombia. This adaptation process would require further instrument refining and test-

ing, present results could serve as an initial step for future application of questionnaires.

The study by Syrjala et al.[12] using the DSelf-efficacyQ on 149 insulin-dependent subjects reported an inverse correlation between visible plaque index scores and tooth brushing self-efficacy, and the visible plaque index and dental visiting self-efficacy; but not correlation with approximal cleaning self-efficacy. In contrast, our results did not show a correlation between the O'Leary Plaque Index and any of the three components of the DSelf-efficacyQ; a significant inverse correlation was found for percentage of bleeding on probing and self-efficacy for dental visiting. Another finding of Syrjala et al.[12] was that HbA_{1c} was lower in subjects reporting higher self-efficacy for tooth brushing, more frequent tooth brushing reporting and lower visible plaque index; in contrast to the present findings. An interesting finding of the present study was a correlation between self-efficacy for tooth brushing and self-efficacy for diabetic control (MDQ, section III), and between self-efficacy for visiting a dentist and self-efficacy for diabetes control (MDQ, section III); thus showing how self-efficacy behavioral models applied to different diseases could lead to similar scores.

The different results of the present study compared to the study of Syrjala et al.[12] report could be a consequence of very different sample characteristics. In the study by Syrjala et al.[12], the subjects were predominantly type 1 diabetics, in contrast to the subjects of the present sample, who were type 2 diabetics. Moreover, the mean ages for the two study samples were markedly different: 34 years compared to 52 years in our study. Probably related to differences in mean age, subjects in the Finish study had an average of 25 teeth, in contrast to high values of lost teeth in the current study. Education level was different comparing the two samples: in the study by Syrjala et al.[12], most sub-

jects had undergone some form of professional or non-professional education; while in our sample, most subjects had only elementary education. A similarity between both samples was a poor metabolic control of diabetes, for Syrjala et al.[12] mean HbA_{1c} level was 8.5%, for the Colombian Diabetic Association sample mean HbA_{1c} was 9.2%.

The patients who visit the Colombian Diabetic Association can be characterized as belonging to low- to middle-income class, and having a low education level. Many of them visit the Association because they lack coverage from health insurances companies at which regularly employed individuals and their families are registered. Large U.S. epidemiological studies have found that socio-economic status (SES) variables were associated with diabetes[25, 26] and periodontitis[27, 28]. A similar relationship among lower SES, poor diabetic control and worse periodontal condition has been found in developing countries such as Pakistan[29]. Regarding the relationship between the different variables measured in the present sample, the socio-economic status of patients should be considered. Originating from a lower SES, patients in the current study could be prone to more severe periodontal disease and poorer metabolic control than other diabetic subjects with higher SES. Having patients with a wider range of periodontal status and metabolic control, the correlation with behavioral questionnaires answers might differ.

CONCLUSION

The oral health and diabetic behavior questionnaires studied and the clinical parameters showed several correlations; in particular significant correlations were found between self-efficacy for: tooth brushing, visiting a dentist and diabetic control

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