



## CLINICAL RESEARCH:

### Oral Care and Lifestyle Habits in Correlation with Glycated Hemoglobin in Type 2 Diabetes Mellitus

Cuidado bucal y hábitos de vida en correlación con la hemoglobina glicosilada en la diabetes mellitus tipo 2

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**ABSTRACT:** Type 2 diabetes mellitus is a multifactorial pathology and a major public health problem. The objectives were to determine the correlation between oral care practices according to glycated hemoglobin and to determine how lifestyle habits correlate with glycated hemoglobin in type 2 diabetes mellitus. An observational and cross-sectional study was carried out through a survey of 420 patients with type 2 diabetes mellitus. The participants were divided into two groups. With glycosylated hemoglobin greater than 7% as uncontrolled type 2 diabetes mellitus and with glycosylated hemoglobin equal to or less than 7% as controlled type 2 diabetes mellitus. It was found that in uncontrolled type 2 diabetes mellitus, 84.5% had bad practices and 90.0% bad lifestyle habits. Patients with uncontrolled type 2 diabetes mellitus who develop poor oral care practices had a mean glycosylated hemoglobin of 9.2%, 95% CI (7.4-11.0). Patients with uncontrolled type 2 diabetes mellitus who develop poor lifestyle habits had a mean glycosylated hemoglobin of 9.2%, 95% CI (7.4-11.0). There is a good and negative correlation between glycated hemoglobin and lifestyle habits ( $Rho=-0.774$  and  $p<0.001$ ). There is a moderate and positive correlation between glycated hemoglobin and oral care practices ( $Rho=0.561$  and  $p<0.001$ ). There is a moderate and negative correlation between oral care practices and lifestyle habits ( $Rho=-0.533$  and  $p<0.001$ ). It was concluded that a person with type 2 diabetes mellitus who maintains good oral care practices may improve their glycated hemoglobin values. The development of good lifestyle habits maintains a normal glycosylated hemoglobin.

**KEYWORDS:** HbA1c; Type 2 diabetes; Public health; Oral hygiene; Lifestyle; Hyperglycemia.



**RESUMEN:** La diabetes mellitus tipo 2 es una patología multifactorial y un importante problema de salud pública. Los objetivos fueron determinar la correlación entre las prácticas de cuidado bucal según la hemoglobina glicosilada y determinar de qué manera se correlacionan los hábitos de vida con la hemoglobina glicosilada en la diabetes mellitus tipo 2. Se realizó un estudio observacional y transversal mediante una encuesta a 420 pacientes con diabetes mellitus tipo 2. Los participantes fueron divididos en dos grupos. Con hemoglobina glicosilada mayor a 7% como diabetes mellitus tipo 2 no controlada y con hemoglobina glicosilada igual o menor a 7% como diabetes mellitus tipo 2 controlada. Se halló que en la diabetes mellitus tipo 2 no controlada 84,5% presentaron malas prácticas y 90,0% malos hábitos de vida. Los pacientes con diabetes mellitus tipo 2 no controlada que desarrollan malas prácticas de cuidado bucal presentaron una hemoglobina glicosilada media del 9,2% IC del 95% (7,4-11,0) %. Los pacientes con diabetes mellitus tipo 2 no controlada que desarrollan malos hábitos de vida presentaron una hemoglobina glicosilada media del 9,2% IC del 95% (7,4-11,0) %. Existe una correlación buena y negativa entre la hemoglobina glicosilada y los hábitos de vida ( $Rho=-0,774$  y  $p<0,001$ ). Existe una correlación moderada y positiva entre la hemoglobina glicosilada y las prácticas de cuidado bucal ( $Rho=0,561$  y  $p<0,001$ ). Existe una correlación moderada y negativa entre las prácticas de cuidado bucal y los hábitos de vida ( $Rho=-0,533$  y  $p<0,001$ ). Se concluyó que la persona con diabetes mellitus tipo 2 que mantiene buenas prácticas de cuidado bucal podría mejorar los valores de su hemoglobina glicosilada. El desarrollo de buenos hábitos de vida mantiene una hemoglobina glicosilada normal.

**PALABRAS CLAVE:** HbA1c; Diabetes tipo 2; Salud pública; Higiene bucal; Estilo de vida, Hiperglucemia.

## INTRODUCTION

Worldwide, the increase in type 2 diabetes mellitus (T2DM) has alarming figures, it is estimated that by 2045 around 629 million people will suffer from T2DM (1). In Latin America alone, around 31.6 million people suffer from T2DM (2). In Peru, approximately 7% suffer from this pathology. This disease is characterized by hyperglycemia that generates multiple complications (3) and a high risk of mortality (4).

The global approach to health policies indicates that oral health promotion should be integrated with general health promotion, since both are linked to lifestyle (5), so changing some risk factors would have a positive impact on a large number of diseases (6), generating healthy lifestyle habits of great importance for public health (7).

Lifestyle habits are related to both personal and sociocultural behaviors (8). A healthy lifestyle includes a balanced diet, good hygiene and physical activity (9). Increased glycemia leads to cardiovascular events with a high percentage of mortality in T2DM (10), and correct glycemic control is necessary to promote a better quality of life and lifestyle (4). Therefore, understanding the extent of hyperglycemia is of great importance for preventive strategies and public health initiatives (11).

Poor oral health as a result of poor hygiene practices can lead to digestive and speech problems, alterations in sleep quality and work performance (12). This leads to oral manifestations typical of T2DM, which often go unnoticed (13). Therefore, the objectives of the study were: to determine the correlation between oral care practices according to glycated hemoglobin

(HbA1c) in T2DM and to determine how lifestyle habits are correlated with HbA1c in T2DM.

## MATERIALS AND METHODS

**Type of study.** Observational, cross-sectional research was carried out through the development of a survey. The research was carried out at the National Hospital P.N.P. Luis N. Saenz (NHPNP-LNS), between the months of September 2023 and February 2024.

The sample consisted of 420 participants between 35 and 74 years of age, of both sexes, who suffered from T2DM, diagnosed by the Endocrinology Service of the NHPNP-LNS. This sample was randomized and calculated with a confidence level of 95.0% and was representative of the study population, considering the proportion of patients cited in the period of execution of the research. Participants were divided into two groups, based on their HbA1c. An HbA1c greater than 7% was considered as uncontrolled T2DM and an HbA1c equal to or less than 7% as controlled T2DM. Each group was made up of 220 patients.

**Selection criteria.** Patients suffering from T2DM with a minimum evolution time of 5 years (14). All participants in a state of pregnancy, with type 1 diabetes, with disabilities such as severe depression, schizophrenia, Down syndrome, autism, motor palsy, as well as all those who submitted the incomplete questionnaire were excluded.

**Instrument.** The study was based on a survey, through a questionnaire. The internal consistency of the questionnaire on oral care practices, lifestyle habits and the measurement instrument used was analyzed, obtaining Cronbach's alpha of 0.871, 0.854 and 0.910 respectively. The questionnaire evaluated oral care practices based on the scale that measures self-perception and self-care habits in patients with diabetes mellitus 2, hypertensive and obese (15). Lifestyle habits in T2DM were

evaluated based on the T2DM lifestyle measurement instrument (16,17). The questionnaire was divided into: sociodemographic data, HbA1c, lifestyle habits and oral care practices.

**Sociodemographic data.** Age, sex, and level of education were recorded. The age was recorded by verifying the identity document. Sex in male and female. The degree of instruction in primary, secondary and higher education.

**Glycosylated hemoglobin.** The HbA1c result presented by each patient was recorded.

**Oral care practices.** Made up of 35 questions, 7 corresponded to the food item, 7 to the hygiene item, 12 to the care item, 4 to the patient's perception of oral symptoms, and 5 to the perception of oral signs. The answers for each item had a score, so 1 point for the answer "always", 2 points for "sometimes" and 3 points for "never". The final sum was classified as good, moderate, bad and very bad oral care practices, if the scores obtained were from 35 to 52, from 53 to 70, from 71 to 87 and from 88 to 105 points respectively (15).

**Lifestyle habits.** It consisted of 25 questions, 9 corresponded to the nutrition item, 3 to the exercise item, 2 to the tobacco item, 2 to the alcohol item, 2 to the information item on diabetes, 3 to the emotions item and 4 to the therapy item. The answers for each item had a score of 0 points for the answer "always", 2 points for "sometimes" and 4 points for "never". The final sum was classified as good, adequate and bad lifestyle habits, if the scores obtained were 60 or less, from 61 to 79, from 80 points or more respectively (16,17).

**Procedure.** Each participant was evaluated by the endocrinologist and referred to the office assigned to carry out the study. They came with their HbA1c results. After accepting and signing the informed consent, the survey was carried out. The patient had a time of 15 minutes to fill out the

questionnaire. No incentives or any type of economic benefit were provided to patients for participating in the research.

**Statistical analysis.** The data were analyzed using the statistical analysis programming language RStudio version R.4.3.2. The responses to the questionnaire were recorded in numerical values, to be replaced as quantitative data and thus perform the statistical analysis. The descriptive analysis calculated the mean and standard deviation for the continuous variables and n (%) for the categorical variables. The Kolmogorov-Smirnov test was used to assess the normality of the distribution of responses. Spearman's correlation coefficient was used for correlations. A significant level of less than 5% ( $p < 0.05$ ) was considered statistically significant for all analyses. The use of two decimal places was standardized in the results.

**Ethical Considerations.** The research was approved by the Ethics Committee of the NHPNP-LNS (02-2023-DIRSAPOLPNP/HN. PNP. LNS/COMETINV) and elaborated under the principles of the Declaration of Helsinki.

## RESULTS

The average age of the participants was  $54.88 \pm 12.87$  years. The level of education showed that 66.1% had studied secondary education, 28.6% higher education and 5.2% primary education. 49.5% of the participants were female.

In uncontrolled T2DM, the mean HbA1c was  $8.63 \pm 0.98\%$ , 90.0% had bad habits and only 10.0% had adequate lifestyle habits, in addition 84.55% presented bad oral care practices, 10.9% very bad oral care practices, and only 4.55% moderate oral care practices. In the controlled T2DM, the mean HbA1c was  $6.67 \pm 0.28\%$ , 100.0% had good lifestyle habits, in addition, 63.18% had

moderate oral care practices and 36.82% had poor oral care practices (Table 1).

Regarding oral care practices, in uncontrolled T2DM 70.5% do not brush their tongue, 58.2% do not floss, 75.0% sometimes brush their teeth when getting up and going to bed, 61.4% do not brush their teeth after meals, likewise, 82.3% need to eat something between meals, 90.0% consume food at any time, 75.9% have not gone to the dentist to have their oral health checked, 76.8% always have bad breath and 52.3% always have bleeding gums (Table 2).

Regarding lifestyle habits, in uncontrolled T2DM, 45.9% add sugar to their foods and drinks, 60.5% always add salt to their meals, 67.7% consume 3 or more breads a day, 75.9% do not exercise for 15 minutes or more per week, 64.5% sometimes consume alcoholic beverages, 60.9% do not attend talks about diabetes or follow a diet for diabetics. 56.8% often neglect to take their medications or apply the insulin necessary for the treatment of their disease (Table 3).

Patients with uncontrolled T2DM who develop poor oral care practices have a mean HbA1c of 9.2%, 95% CI (7.4-11.0), those who perform moderate oral care practices have a mean HbA1c of 8.3%, 95% CI (7.6-8.9). Patients with controlled T2DM who develop poor oral care practices have a mean HbA1c of 6.8% 95% CI (6.5-7.0), and those who perform moderate oral care practices have a mean HbA1c of 6.5% 95% CI (6.0-7.0) (Figure 1).

Patients with uncontrolled T2DM who develop poor lifestyle habits have a mean HbA1c of 9.2% 95% CI (7.4-11.0), those who have adequate lifestyle habits have a mean HbA1c of 7.7% CI of 95% (7.4-8.0). Patients with controlled T2DM who develop adequate lifestyle habits have a mean

HbA1c of 6.6%, 95% CI (6.2-7.0), compared to those who have good lifestyle habits, have a mean HbA1c of 6.5%, 95% CI (6.0-7.0) (Figure 2).

The variables under study did not present a normal distribution. To establish the correlation between variables, Spearman's test was used. It was found that there is a good and negative correlation between HbA1c and lifestyle habits ( $Rho=-0.774$  and  $p<0.001$ ). There is a moderate and positive correlation between HbA1c and oral care

practices ( $Rho=0.561$  and  $p<0.001$ ). There is a moderate and negative correlation between oral care practices and lifestyle habits ( $Rho=-0.533$  and  $p<0.001$ ). Age was also evaluated in relation to the other variables, it was found that age does not show a correlation with HbA1c ( $Rho=-0.101$  and  $p<0.001$ ), age does not show a correlation with oral care practices ( $Rho=-0.024$  and  $p<0.001$ ) and age does not show a correlation with lifestyle habits ( $Rho=-0.036$  and  $p<0.001$ ) (Figure 3).

**Table 1.** Characteristics of patients with type 2 diabetes mellitus.

| Characteristics              |                   | Uncontrolled T2DM | T2DM controlled   | TOTAL             |
|------------------------------|-------------------|-------------------|-------------------|-------------------|
|                              |                   | (n=220)           | (n=220)           | (n=440)           |
| <b>Age</b>                   | Mean $\pm$ SD     | 53.74 $\pm$ 10.36 | 56.03 $\pm$ 14.91 | 54.88 $\pm$ 12.87 |
| <b>HbA1c</b>                 | Mean $\pm$ SD     | 8.63 $\pm$ 0.98   | 6.67 $\pm$ 0.28   | 7.65 $\pm$ 1.22   |
| <b>Level of education</b>    | Primary, n (%)    | 23 (10.5%)        | 0 (0%)            | 23 (5.2%)         |
|                              | Secondary, n (%)  | 112 (50.9%)       | 179 (81.4%)       | 291 (66.1%)       |
|                              | University, n (%) | 85 (38.6%)        | 41 (18.6%)        | 126 (28.6%)       |
| <b>Sex</b>                   | Masculine, n (%)  | 154 (70.0%)       | 69 (30.9%)        | 222 (50.5%)       |
|                              | Femenine, n (%)   | 66 (30.0%)        | 152 (69.1%)       | 218 (49.5%)       |
| <b>Internships oral care</b> | Good              | 0 (0%)            | 0 (0%)            | 0 (0%)            |
|                              | Moderate          | 10 (4.55%)        | 139 (63.18%)      | 149 (33.87%)      |
|                              | Bad               | 186 (84.55%)      | 81 (36.82%)       | 267 (60.68%)      |
|                              | Very bad          | 24 (10.90%)       | 0 (0%)            | 24 (5.45%)        |
| <b>Lifestyle habits</b>      | Good              | 0 (0%)            | 220 (100%)        | 220 (50%)         |
|                              | Moderate          | 22 (10.0%)        | 0 (0%)            | 22 (5.0%)         |
|                              | Bad               | 198 (90.0%)       | 0 (0%)            | 198 (45.0%)       |

SD: standard deviation, n: number of people, HbA1c: Hemoglobin glycosilade.

**Table 2.** Oral care practices in uncontrolled T2DM and controlled T2DM.

| Questions                                        | Uncontrolled T2DM |           |       |       |  | T2DM controlled |           |       |       |  |
|--------------------------------------------------|-------------------|-----------|-------|-------|--|-----------------|-----------|-------|-------|--|
|                                                  | Answers           |           |       |       |  | Answers         |           |       |       |  |
| ORAL HYGIENE                                     | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I use mouthwash?                              | n 5               | 175       | 40    | 220   |  | n 183           | 37        | 0     | 220   |  |
|                                                  | % 2.3%            | 79.5%     | 18.2% | 100%  |  | % 83.2%         | 16.8%     | 0%    | 100%  |  |
| Do I brush my teeth when I get up and go to bed? | n 48              | 165       | 7     | 220   |  | n 210           | 10        | 0     | 220   |  |
|                                                  | % 21.8%           | 75.0%     | 3.2%  | 100%  |  | % 95.5%         | 4.5%      | 0%    | 100%  |  |
| Do I brush my tongue?                            | n 17              | 48        | 155   | 220   |  | n 188           | 29        | 3     | 220   |  |
|                                                  | % 7.7%            | 21.8%     | 70.5% | 100%  |  | % 85.5%         | 13.2%     | 1.4%  | 100%  |  |
| Do I floss?                                      | n 12              | 80        | 128   | 220   |  | n 196           | 21        | 3     | 220   |  |
|                                                  | % 5.5%            | 36.4%     | 58.2% | 100%  |  | % 89.1%         | 9.5%      | 1.4%  | 100%  |  |
| Do you change your toothbrush?                   | n 106             | 114       | 0     | 220   |  | n 220           | 0         | 0     | 220   |  |
|                                                  | % 48.2%           | 51.8%     | 0%    | 100%  |  | % 100%          | 0%        | 0%    | 100%  |  |
| Do I massage my gums?                            | n 12              | 133       | 75    | 220   |  | n 181           | 39        | 0     | 220   |  |
|                                                  | % 5.5%            | 60.5%     | 34.1% | 100%  |  | % 82.3%         | 17.7%     | 0%    | 100%  |  |
| Do I brush my teeth after meals?                 | n 29              | 56        | 135   | 220   |  | n 220           | 0         | 0     | 220   |  |
|                                                  | % 13.2%           | 25.5%     | 61.4% | 100%  |  | % 100%          | 0%        | 0%    | 100%  |  |
| FEEDING                                          | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I usually consume snacks?                     | n 202             | 18        | 0     | 220   |  | n 1             | 11        | 208   | 220   |  |
|                                                  | % 91.8%           | 8.2%      | 0%    | 100%  |  | % 0.5%          | 5.0%      | 94.5% | 100%  |  |
| Do I love eating chocolates?                     | n 198             | 14        | 8     | 220   |  | n 0             | 6         | 214   | 220   |  |
|                                                  | % 90.0%           | 6.4%      | 3.6%  | 100%  |  | % 0%            | 2.7%      | 97.3% | 100%  |  |
| Do I like foods with salt and fat?               | n 149             | 28        | 43    | 220   |  | n 6             | 0         | 214   | 220   |  |
|                                                  | % 67.7%           | 12.7%     | 19.5% | 100%  |  | % 2.7%          | 0%        | 97.3% | 100%  |  |
| Do I need to eat something between meals?        | n 181             | 39        | 0     | 220   |  | n 0             | 15        | 205   | 220   |  |
|                                                  | % 82.3%           | 17.7%     | 0%    | 100%  |  | % 0%            | 6.8%      | 93.2% | 100%  |  |
| Do I drink a lot of water to avoid dryness?      | n 148             | 34        | 38    | 220   |  | n 157           | 6         | 57    | 220   |  |
|                                                  | % 67.3%           | 15.5%     | 17.3% | 100%  |  | % 71.4%         | 2.7%      | 25.9% | 100%  |  |
| Do you always eat at the same time?              | n 0               | 87        | 133   | 220   |  | n 214           | 6         | 0     | 220   |  |
|                                                  | % 0%              | 39.5%     | 60.5% | 100%  |  | % 97.3%         | 2.7%      | 0%    | 100%  |  |
| Do you eat at any time?                          | n 198             | 22        | 0     | 220   |  | n 0             | 0         | 220   | 220   |  |
|                                                  | % 90.0%           | 10.0%     | 0%    | 100%  |  | % 0%            | 0%        | 100%  | 100%  |  |
| CARE                                             | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I check my mouth in the mirror frequently?    | n 15              | 47        | 158   | 220   |  | n 168           | 52        | 0     | 220   |  |
|                                                  | % 6.8%            | 21.4%     | 71.8% | 100%  |  | % 76.4%         | 23.6%     | 0%    | 100%  |  |
| Do I go to the dentist to get checked?           | n 18              | 35        | 167   | 220   |  | n 133           | 87        | 0     | 220   |  |
|                                                  | % 8.2%            | 15.9%     | 75.9% | 100%  |  | % 60.5%         | 39.5%     | 0%    | 100%  |  |
| Do I usually chew gum?                           | n 41              | 115       | 64    | 220   |  | n 1             | 13        | 206   | 220   |  |
|                                                  | % 18.6%           | 52.4%     | 29.1% | 100%  |  | % 0.5%          | 5.9%      | 93.6% | 100%  |  |
| Do I smoke?                                      | n 0               | 156       | 64    | 220   |  | n 0             | 0         | 220   | 220   |  |
|                                                  | % 0%              | 70.9%     | 29.1% | 100%  |  | % 0%            | 0%        | 100%  | 100%  |  |

| Questions                                               | Uncontrolled T2DM |        |           |       |       | T2DM controlled |        |           |        |       |
|---------------------------------------------------------|-------------------|--------|-----------|-------|-------|-----------------|--------|-----------|--------|-------|
|                                                         | Answers           |        |           |       |       | Answers         |        |           |        |       |
| ORAL HYGIENE                                            |                   | Always | Sometimes | Never | Total |                 | Always | Sometimes | Never  | Total |
| Do I use my teeth to peel things?                       | n                 | 0      | 164       | 56    | 220   | n               | 0      | 12        | 208    | 220   |
|                                                         | %                 | 0%     | 74.5%     | 25.5% | 100%  | %               | 0%     | 5.5%      | 94.5%  | 100%  |
| Do I use toothpicks to remove food?                     | n                 | 11     | 145       | 64    | 220   | n               | 0      | 42        | 178    | 220   |
|                                                         | %                 | 5.0%   | 65.9%     | 29.1% | 100%  | %               | 0%     | 19.1%     | 80.9%  | 100%  |
| Do I bite my nails?                                     | n                 | 0      | 168       | 52    | 220   | n               | 0      | 0         | 220    | 220   |
|                                                         | %                 | 0%     | 76.4%     | 23.6% | 100%  | %               | 0%     | 0%        | 100%   | 100%  |
| Do my teeth grind?                                      | n                 | 29     | 108       | 83    | 220   | n               | 0      | 2         | 218    | 220   |
|                                                         | %                 | 13.2%  | 49.1%     | 37.7% | 100%  | %               | 0%     | 0.9%      | 99.1%  | 100%  |
| Do I chew ice?                                          | n                 | 0      | 143       | 77    | 220   | n               | 0      | 12        | 208    | 220   |
|                                                         | %                 | 0%     | 65.0%     | 35.0% | 100%  | %               | 0%     | 5.5%      | 94.5%  | 100%  |
| Do I consume food that is neither too cold nor too hot? | n                 | 0      | 142       | 78    | 220   | n               | 0      | 22        | 198    | 220   |
|                                                         | %                 | 0%     | 64.5%     | 35.5% | 100%  | %               | 0%     | 10.0%     | 90.0%  | 100%  |
| Do I put things in my mouth like a pencil?              | n                 | 0      | 135       | 85    | 220   | n               | 0      | 8         | 212    | 220   |
|                                                         | %                 | 0%     | 61.4%     | 38.6% | 100%  | %               | 0%     | 3.6%      | 96.4%  | 100%  |
| Do my teeth grind when I sleep?                         | n                 | 44     | 120       | 56    | 220   | n               | 0      | 16        | 204    | 220   |
|                                                         | %                 | 20.0%  | 54.5%     | 25.5% | 100%  | %               | 0%     | 7.3%      | 92.70% | 100%  |
| ORAL SYMPTOMS                                           |                   | Always | Sometimes | Never | Total |                 | Always | Sometimes | Never  | Total |
| Do I have a bad taste in my mouth?                      | n                 | 181    | 35        | 4     | 220   | n               | 0      | 21        | 199    | 220   |
|                                                         | %                 | 82.3%  | 15.9%     | 1.8%  | 100%  | %               | 0%     | 9.5%      | 90.5%  | 100%  |
| Do I have bad breath?                                   | n                 | 169    | 43        | 8     | 220   | n               | 0      | 38        | 182    | 220   |
|                                                         | %                 | 76.8%  | 19.5%     | 3.6%  | 100%  | %               | 0%     | 17.3%     | 82.7%  | 100%  |
| Do I have red gums?                                     | n                 | 131    | 89        | 0     | 220   | n               | 0      | 214       | 6      | 220   |
|                                                         | %                 | 59.5%  | 40.5%     | 0%    | 100%  | %               | 0%     | 97.3%     | 2.7%   | 100%  |
| Do I have sensitive teeth?                              | n                 | 120    | 73        | 27    | 220   | n               | 0      | 100       | 120    | 220   |
|                                                         | %                 | 54.5%  | 32.2%     | 12.3% | 100%  | %               | 0%     | 54.5%     | 45.5%  | 100%  |
| ORAL SIGNS                                              |                   | Always | Sometimes | Never | Total |                 | Always | Sometimes | Never  | Total |
| Do my gums bleed?                                       | n                 | 115    | 59        | 46    | 220   | n               | 0      | 83        | 137    | 220   |
|                                                         | %                 | 52.3%  | 26.8%     | 20.9% | 100%  | %               | 0%     | 37.7%     | 62.3%  | 100%  |
| Do I have loose teeth?                                  | n                 | 0      | 128       | 92    | 220   | n               | 0      | 10        | 210    | 220   |
|                                                         | %                 | 0%     | 58.2%     | 41.8% | 100%  | %               | 0%     | 4.5%      | 95.5%  | 100%  |
| Do I have burning mouth?                                | n                 | 86     | 87        | 47    | 220   | n               | 0      | 36        | 184    | 220   |
|                                                         | %                 | 39.1%  | 39.5%     | 21.4% | 100%  | %               | 0%     | 16.4%     | 83.6%  | 100%  |
| Do I have mouth ulcers?                                 | n                 | 112    | 78        | 30    | 220   | n               | 0      | 16        | 204    | 220   |
|                                                         | %                 | 50.9%  | 35.5%     | 13.6% | 100%  | %               | 0%     | 7.3%      | 92.7%  | 100%  |
| Do my gums have pus?                                    | n                 | 15     | 176       | 29    | 220   | n               | 0      | 0         | 220    | 220   |
|                                                         | %                 | 6.8%   | 80.0%     | 13.2% | 100%  | %               | 0%     | 0%        | 0%     | 100%  |

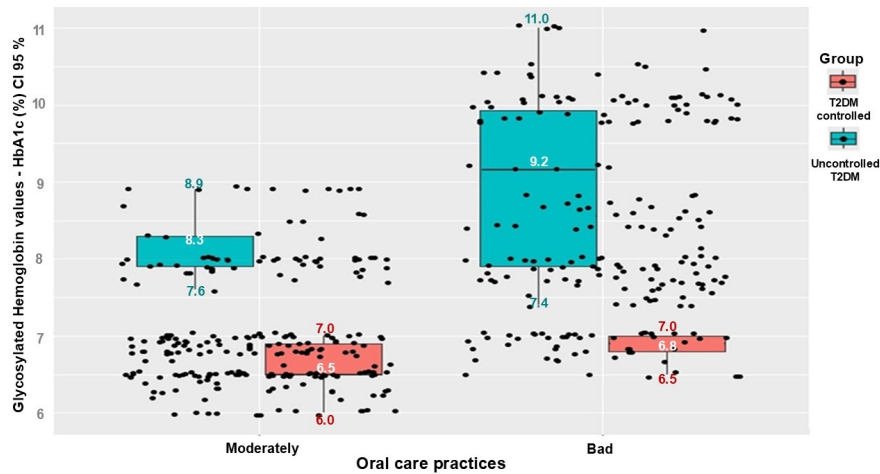


**Table 3.** Lifestyle habits in uncontrolled T2DM and controlled T2DM.

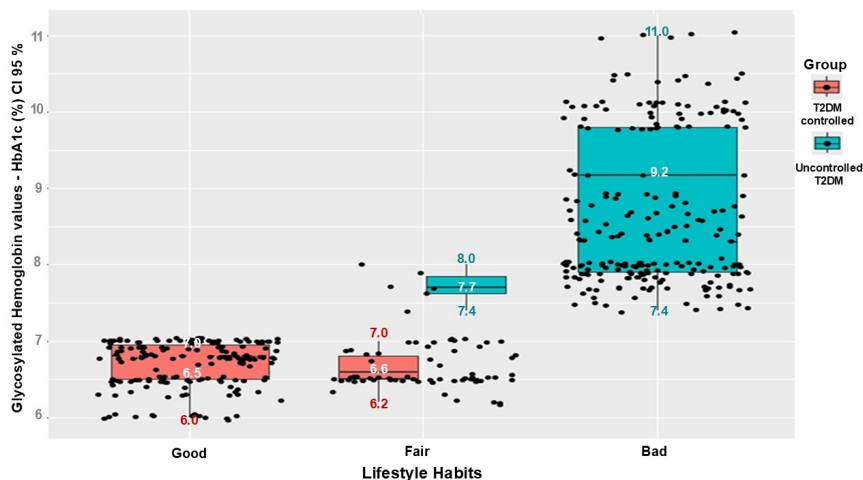
| Questions                                            | Uncontrolled T2DM |                     |                 |              |  | T2DM controlled  |                     |                 |              |  |
|------------------------------------------------------|-------------------|---------------------|-----------------|--------------|--|------------------|---------------------|-----------------|--------------|--|
|                                                      | Answers           |                     |                 |              |  | Answers          |                     |                 |              |  |
|                                                      | Always            | Sometimes           | Never           | Total        |  | Always           | Sometimes           | Never           | Total        |  |
| <b>NUTRITION</b>                                     |                   |                     |                 |              |  |                  |                     |                 |              |  |
| How often do I eat vegetables?                       | n 40              | 180                 | 0               | 220          |  | n 165            | 55                  | 0               | 220          |  |
|                                                      | % 18.2%           | 81.8%               | 0%              | 100%         |  | % 75.0%          | 25.0%               | 0%              | 100%         |  |
| How often do I eat fruit?                            | n 61              | 159                 | 0               | 220          |  | n 155            | 65                  | 0               | 220          |  |
|                                                      | % 27.7%           | 72.3%               | 0%              | 100%         |  | % 70.5%          | 29.5%               | 0%              | 100%         |  |
| Do I add sugar to my food or drinks?                 | n 101             | 104                 | 15              | 220          |  | n 8              | 95                  | 117             | 220          |  |
|                                                      | % 45.9%           | 47.3%               | 6.8%            | 100%         |  | % 3.6%           | 43.2%               | 53.2%           | 100%         |  |
| Do I add salt to my food when I'm eating it?         | n 133             | 55                  | 32              | 220          |  | n 21             | 94                  | 105             | 220          |  |
|                                                      | % 60.5%           | 25.0%               | 14.5%           | 100%         |  | % 9.5%           | 42.7%               | 47.7%           | 100%         |  |
| Do I eat food between meals?                         | n 130             | 90                  | 0               | 220          |  | n 0              | 25                  | 195             | 220          |  |
|                                                      | % 59.1%           | 40.9%               | 0%              | 100%         |  | % 0%             | 11.4%               | 88.6%           | 100%         |  |
| Do I eat food away from home?                        | n 73              | 106                 | 41              | 220          |  | n 0              | 37                  | 183             | 220          |  |
|                                                      | % 33.2%           | 48.2%               | 18.6%           | 100%         |  | % 0%             | 16.8%               | 83.2%           | 100%         |  |
| Do I ask for more to be served when I finish eating? | n 58              | 133                 | 29              | 220          |  | n 0              | 23                  | 197             | 220          |  |
|                                                      | % 26.4%           | 60.0%               | 13.2%           | 100%         |  | % 0%             | 10.5%               | 89.5%           | 100%         |  |
| How many loaves of bread do I eat a day?             | <b>3 or more</b>  | <b>2</b>            | <b>0 a 1</b>    | <b>Total</b> |  | <b>3 or more</b> | <b>2</b>            | <b>0 a 1</b>    | <b>Total</b> |  |
|                                                      | n 149             | 59                  | 12              | 220          |  | n 0              | 70                  | 150             | 220          |  |
|                                                      | % 67.7%           | 26.8%               | 5.5%            | 100%         |  | % 0%             | 31.8%               | 68.2%           | 100%         |  |
| How many fried foods do you eat per day?             | <b>7 or more</b>  | <b>4 a 6</b>        | <b>0 a 3</b>    | <b>Total</b> |  | <b>7 or more</b> | <b>4 a 6</b>        | <b>0 a 3</b>    | <b>Total</b> |  |
|                                                      | n 72              | 148                 | 0               | 220          |  | n 0              | 0                   | 220             | 220          |  |
|                                                      | % 32.7%           | 67.3%               | 0%              | 100%         |  | % 0%             | 0%                  | 100%            | 100%         |  |
| <b>PHYSICAL ACTIVITY</b>                             | <b>Always</b>     | <b>Sometimes</b>    | <b>Never</b>    | <b>Total</b> |  | <b>Always</b>    | <b>Sometimes</b>    | <b>Never</b>    | <b>Total</b> |  |
| Do I keep busy outside of work activities?           | n 16              | 131                 | 73              | 220          |  | n 0              | 33                  | 187             | 220          |  |
|                                                      | % 7.3%            | 59.5%               | 33.2%           | 100%         |  | % 0%             | 15.0%               | 85.0%           | 100%         |  |
| What do I do frequently in my free time?             | <b>get out</b>    | <b>work at home</b> | <b>watch tv</b> | <b>total</b> |  | <b>get out</b>   | <b>work at home</b> | <b>watch tv</b> | <b>total</b> |  |
|                                                      | n 26              | 64                  | 130             | 220          |  | n 135            | 40                  | 45              | 220          |  |
|                                                      | % 11.8%           | 29.1%               | 59.1%           | 100%         |  | % 61.4%          | 18.2%               | 20.5%           | 100%         |  |
| Do I do 15 minutes or more of exercise per week?     | <b>3 or more</b>  | <b>1 a 2</b>        | <b>never</b>    | <b>Total</b> |  | <b>3 or more</b> | <b>1 a 2</b>        | <b>never</b>    | <b>Total</b> |  |
|                                                      | n 0               | 53                  | 167             | 220          |  | n 39             | 152                 | 29              | 220          |  |
|                                                      | % 0%              | 24.1%               | 75.9%           | 100%         |  | % 17.7%          | 69.1%               | 13.2%           | 100%         |  |
| Questions                                            | Uncontrolled T2DM |                     |                 |              |  | T2DM controlled  |                     |                 |              |  |
|                                                      | Answers           |                     |                 |              |  | Answers          |                     |                 |              |  |
|                                                      | Always            | Sometimes           | Never           | Total        |  | Always           | Sometimes           | Never           | Total        |  |
| <b>TOBACCO USE</b>                                   |                   |                     |                 |              |  |                  |                     |                 |              |  |
| Do you smoke?                                        | n 0               | 136                 | 84              | 220          |  | n 0              | 0                   | 220             | 220          |  |
|                                                      | % 0%              | 61.8%               | 38.2%           | 100%         |  | % 0%             | 0%                  | 100%            | 100%         |  |
| How many cigarettes do I smoke a day?                | <b>6 or more</b>  | <b>1 to 5</b>       | <b>none</b>     | <b>Total</b> |  | <b>6 or more</b> | <b>1 to 5</b>       | <b>none</b>     | <b>Total</b> |  |
|                                                      | n 0               | 136                 | 84              | 220          |  | n 0              | 0                   | 220             | 220          |  |
|                                                      | % 0%              | 61.8%               | 38.2%           | 100%         |  | % 0%             | 0%                  | 100%            | 100%         |  |



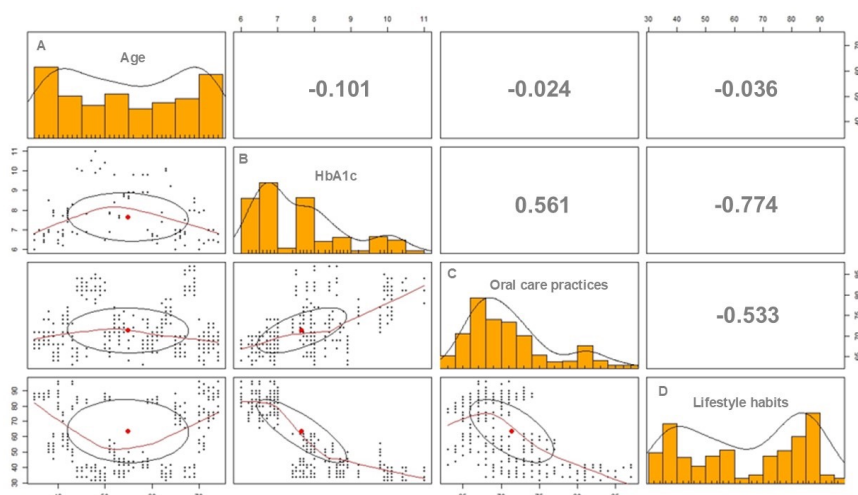
| Questions                                              | Uncontrolled T2DM |           |       |       |  | T2DM controlled |           |       |       |  |
|--------------------------------------------------------|-------------------|-----------|-------|-------|--|-----------------|-----------|-------|-------|--|
|                                                        | Answers           |           |       |       |  | Answers         |           |       |       |  |
| ALCOHOL CONSUMPTION                                    | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I drink alcohol?                                    | n 0               | 142       | 78    | 220   |  | n 0             | 12        | 208   | 220   |  |
|                                                        | % 0%              | 64.5%     | 35.5% | 100%  |  | % 0%            | 5.5%      | 94.5% | 100%  |  |
| How many alcoholic drinks do I drink on each occasion? | 3 or more         | 1 to 2    | none  | Total |  | 3 or more       | 1 to 2    | none  | Total |  |
|                                                        | n 23              | 119       | 78    | 220   |  | n 0             | 12        | 208   | 220   |  |
|                                                        | % 10.5%           | 54.1%     | 35.5% | 100%  |  | % 0%            | 5.5%      | 94.5% | 100%  |  |
| DIABETES INFORMATION                                   | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I try to get information about diabetes?            | n 16              | 181       | 23    | 220   |  | n 220           | 0         | 0     | 220   |  |
|                                                        | % 7.3%            | 82.3%     | 10.5% | 100%  |  | % 100%          | 0%        | 0%    | 100%  |  |
| How many talks about diabetes have I attended?         | 4 or more         | 1 to 3    | none  | Total |  | 4 or more       | 1 to 3    | none  | Total |  |
|                                                        | n 0               | 86        | 134   | 220   |  | n 156           | 64        | 0     | 220   |  |
|                                                        | % 0%              | 39.1%     | 60.9% | 100%  |  | % 70.9%         | 29.1%     | 0%    | 100%  |  |
| EMOTIONS                                               | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I get angry easily?                                 | n 0               | 200       | 20    | 220   |  | n 0             | 146       | 74    | 220   |  |
|                                                        | % 0%              | 90.9%     | 9.1%  | 100%  |  | % 0%            | 66.4%     | 33.6% | 100%  |  |
| Do I feel sad?                                         | n 0               | 174       | 46    | 220   |  | n 0             | 124       | 96    | 220   |  |
|                                                        | % 0%              | 79.1%     | 20.9% | 100%  |  | % 0%            | 56.4%     | 43.6% | 100%  |  |
| Do I have pessimistic thoughts about my future?        | n 0               | 112       | 108   | 220   |  | n 0             | 100       | 120   | 220   |  |
|                                                        | % 0%              | 50.9%     | 49.1% | 100%  |  | % 0%            | 45.5%     | 54.5% | 100%  |  |
| THERAPEUTIC                                            | Always            | Sometimes | Never | Total |  | Always          | Sometimes | Never | Total |  |
| Do I try very hard to get my diabetes under control?   | n 57              | 152       | 11    | 220   |  | n 159           | 61        | 0     | 220   |  |
|                                                        | % 25.9%           | 69.1%     | 5.0%  | 100%  |  | % 72.3%         | 27.7%     | 0%    | 100%  |  |
| Do I follow diets for diabetics?                       | n 0               | 86        | 134   | 220   |  | n 156           | 64        | 0     | 220   |  |
|                                                        | % 0%              | 39.1%     | 60.9% | 100%  |  | % 70.9%         | 29.1%     | 0%    | 100%  |  |
| Do I follow the instructions for my care?              | n 15              | 184       | 21    | 220   |  | n 165           | 55        | 0     | 220   |  |
|                                                        | % 6.8%            | 83.6%     | 9.5%  | 100%  |  | % 75.0%         | 25.0%     | 0%    | 100%  |  |
| Do I forget to take my medication or insulin?          | n 51              | 125       | 44    | 220   |  | n 0             | 48        | 172   | 220   |  |
|                                                        | % 23.2%           | 56.8%     | 20.0% | 100%  |  | % 0%            | 21.8%     | 78.2% | 100%  |  |



**Figure 1.** Dispersion of glycated hemoglobin (HbA1c) values according to oral care practices and patient type. Uncontrolled T2DM (green) who develop poor oral care practices have a mean HbA1c of 9.2% 95% CI (7.4-11.0) %, those who perform moderate oral care practices have a mean HbA1c of 8.3% 95% CI (7.6-8.9) %. Controlled T2DM (red) who develop poor oral care practices have a mean HbA1c of 6.8% 95% CI (6.5-7.0) % and those who perform moderate oral care practices have a mean HbA1c of 6.5 % 95 % CI (6.0-7.0) %.



**Figure 2.** Dispersion of glycated hemoglobin (HbA1c) values according to lifestyle habits and type of patient. Uncontrolled T2DM (green) who develop poor lifestyle habits have a mean HbA1c of 9.2% 95% CI (7.4-11.0) %, those who perform adequate lifestyle habits have a mean HbA1c of 7.7% 95% CI (7.4-8.0) %. Controlled T2DM (red) who develop adequate lifestyle habits have a mean HbA1c of 6.6% 95% CI (6.2-7.0) % compared to those who have good lifestyle habits have a mean HbA1c of 6.5% 95% CI (6.0-7.0) %.



**Figure 3.** Multiple correlations between the variables under study. (A) Correlations of age with: HbA1c (-0.101), oral care practices (-0.024) and lifestyle habits (-0.036). (B) Correlations of HbA1c with oral care practices (0.561) and lifestyle habits (-0.774). (C & D) Correlation between oral care practices and lifestyle habits (-0.533).

## DISCUSSION

The research found that there is a moderate and positive correlation between HbA1c and oral care practices. Therefore, there is a probability that if the patient with uncontrolled T2DM decreases their poor oral care practices, they may decrease their HbA1c values, but if they continue with their poor oral care practices, then their HbA1c values will continue to be elevated. The results indicate that patients with uncontrolled T2DM who maintain poor oral care practices may have an HbA1c between 7.4 and 11.0%. However, HbA1c values tend to decrease to figures between 6.0 and 7.0 %, when good oral care practices are practiced, such as in patients with controlled T2DM. Poor glycemic control is more likely to present periodontal pathology that is increased in extent and severity (18).

The participants in the study responded in many cases that they had bleeding gums, sensitive teeth, red gums as well as the absence or improper use of tooth brushing and flossing. These indicates poor oral care practices, indicates poor oral care practices, which can possibly lead to

poor HbA1c control in T2DM, thus compromising their general health (12). It is therefore important to establish a dental culture based on prevention (19,20,21), carrying out continuous controls of the oral hygiene index in all types of patients (22). It is necessary to consider a correct approach in the use of toothbrushes and floss (23), taking into account the high percentage of patients with uncontrolled T2DM who reported not frequently brushing their teeth and tongue after meals, or when getting up or lying down, causing the presence of dental bacterial plaque and tongue coating, leading to a number of microorganisms that promote the presence of halitosis (24). This is reflected in the increasing number of patients with uncontrolled T2DM, who reported having a bad taste in their mouths and bad breath. This result highlights the importance of promoting adequate control of halitosis from a social and health perspective, as a preventive measure of T2DM.

The study found that there is a good and negative correlation between HbA1c and lifestyle habits. Therefore, there is a probability that if the patient with uncontrolled T2DM develops good lifestyle habits, their HbA1c values may decrease,

but if they maintain poor lifestyle habits, their HbA1c values tend to increase. The results found indicate that the patient with uncontrolled T2DM practices bad lifestyle habits such as eating between meals, especially fried foods, adding sugar and salt in excess to their food, in addition to maintaining a sedentary life, which leads to an alteration in glyce-mic metabolism with an increase in their HbA1c. As known in T2DM, the consumption of fried foods, especially those high in unhealthy fats, are usually high in calories and low in fiber, causing insulin resistance and weight gain (25) and impairing glycemic control (26). In addition, eating between meals, especially processed or carbohydrate-rich foods, can cause hyperglycemia (27). This reinforces the need for personalized educational and support programs on T2DM self-care. These health programs will promote and maintain a global notion of physical exercise, a balanced diet and stress reduction (28). In this way, the manifestations of T2DM in high-risk populations can be prevented or postponed.

Another important finding of the study was that there is a moderate and negative correlation between oral care practices and lifestyle habits, so there is a probability that if a patient with uncontrolled T2DM decreases their poor oral care practices then they can improve their lifestyle habits but if they maintain their poor oral care practices then their lifestyle habits worsen. It is important to always consider the intake of an unhealthy diet (29), as well as the consumption of alcoholic beverages and tobacco (30), as risk factors for the development of oral pathologies, even more so in hyperglycemic events such as T2DM. A diet rich in carbohydrates and refined sugars, together with poor oral hygiene, increase the acidity of the oral environment, making it prone to dental caries and periodontal disease (31).

In this study, elevated HbA1c values were found in uncontrolled T2DM, so it is important to meet the therapeutic objective in these patients

by maintaining good glycemic control, through adequate monitoring of HbA1c, to prevent micro and macrovascular complications (32,33). In addition, many of these patients forget to take their medications or take the insulin prescribed by their treating physician, this bad behavior could lead to poor control of their HbA1c and further increase the problem and complexity of T2DM (34).

The importance of the results obtained to be considered in future research and in public health programs aimed at high-risk populations should be emphasized. Beyond considering as limitations of the research the number of patients with T2DM that make up the study and that the information was obtained from a self-assessment questionnaire that could induce a recall bias on the part of the participant. The importance of this research lies in being one of the few studies that evaluates the correlation between oral health practices and lifestyle habits according to HbA1c in a population suffering from T2DM in Latin America. A relationship that is important because of the diversity of customs that we develop in this part of America unlike the North American, European or Asian population.

## CONCLUSIONS

A person with type 2 diabetes mellitus who maintains good oral care practices may improve their glycosylated hemoglobin values. The development of good lifestyle habits maintains a normal glycosylated hemoglobin. Good oral care practices and good lifestyle habits could avoid possible complications of type 2 diabetes mellitus.

**CONFLICT OF INTEREST:** The authors declare that they have no conflicts of interest with people or institutions related to the results presented in this work.

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**AUTHOR CONTRIBUTION STATEMENT:** Conceptualization and design: J.R.C.C., D.F.L.M., C.B.H. and C.F.M.; Literature review: J.R.C.C., D.F.L.M., C.B.H. and C.F.M.; Methodology and validation: J.R.C.C., D.F.L.M. and R.L.C.G.; Research and data collection: J.R.C.C., D.F.L.M., C.B.H., C.F.M. and R.L.C.G.; Data analysis and interpretation: J.R.C.C., D.F.L.M., R.L.C.G.; Writing draft preparation, revision and editing: J.R.C.C., D.F.L.M., C.B.H., C.F.M. and R.L.C.G.; Project management: J.R.C.C., D.F.L.M., C.B.H. and C.F.M. All authors reviewed and approved the submitted version of the manuscript.

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