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Relationship between gut microbiota and glycemic control in type 2 diabetes mellitus: Perception and habits in adults / Relación entre la microbiota intestinal y el control glucémico en la Diabetes mellitus tipo 2: Percepción y hábitos en adultos

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ABSTRACT

Introduction: type 2 diabetes mellitus (T2DM) is a chronic disease of increasing prevalence, associated not only with endocrine factors but also with imbalances in the gut microbiota, influenced by modern dietary and lifestyle habits. Intestinal dysbiosis may induce low-grade chronic inflammation and contribute to the development of insulin resistance and metabolic disturbances.
Method: an observational, descriptive, and cross-sectional study was conducted in an academic setting, based on a structured questionnaire administered to adult individuals. Knowledge, dietary practices, and habits related to gut microbiota and T2DM were assessed.
Results: among the most relevant findings, 18,1 % of participants reported not knowing the relationship between gut microbiota and type 2 diabetes; 62,5 % stated they regularly consume ultra-processed foods, and 61 % presented intestinal disorders.
Conclusions: a low level of awareness regarding the role of gut microbiota in T2DM was identified, along with a high prevalence of unhealthy habits. These findings highlight the need to implement educational strategies within primary health care to promote gut health and prevent chronic metabolic diseases.

Keywords: Microbiota; Diabetes Mellitus; Type 2; Diet; Dysbiosis.

RESUMEN

Introducción: la diabetes mellitus tipo 2 (DM2) es una enfermedad crónica de creciente prevalencia, vinculada no solo a factores endocrinos, sino también a desequilibrios en la microbiota intestinal, influenciados por hábitos alimentarios y de vida modernos. La disbiosis intestinal puede inducir inflamación crónica de bajo grado y contribuir al desarrollo de resistencia a la insulina y alteraciones metabólicas.
Método: estudio observacional, descriptivo y transversal realizado en ámbito académico, basado en un cuestionario estructurado dirigido a personas adultas. Se relevaron conocimientos, conductas alimentarias y hábitos relacionados con la microbiota intestinal y la DM2.
Resultados: entre los resultados más relevantes se observó que 18,1 % de los participantes no conoce la relación de la microbiota con la DM2, 62,5 % afirmó consumir ultraprocesados regularmente y 61 % presenta alteraciones intestinales.
Conclusiones: existe una baja conciencia sobre el papel de la microbiota en la DM2, junto con una alta prevalencia de hábitos no saludables. Estos resultados evidencian la necesidad de implementar estrategias educativas desde la atención primaria que promuevan la salud intestinal y prevengan enfermedades metabólicas crónicas.

Palabras clave: Microbiota; Diabetes Mellitus; Type 2; Diet; Disbiosis.

INTRODUCTION

T2DM is a chronic disease characterized primarily by insulin resistance and a progressive decline in pancreatic beta-cell secretion, leading to sustained hyperglycemia. For a long time, the focus was almost exclusively on endocrine and metabolic aspects. Still, in recent years, the role of the gut microbiota as a key factor in this process has begun to be recognized.

The gut microbiota regulates much of innate and adaptive immunity, influences local and systemic responses, and therefore also contributes to the chronic inflammation associated with T2DM. Cell recognition receptors of innate immune system cells, such as Toll-like receptors (TLRs), are activated by microbial or diet-derived stimuli (proteins or lipids) and signal immune system cells to respond appropriately. And after this activation, they interact with different proteins that activate transcription of various factors and the synthesis of multiple cytokines and immune mediators of inflammation.

In this regard, it has been shown that lipopolysaccharide (LPS) derived from the cell membrane of gram-negative bacteria in the gut microbiota, as well as saturated fatty acids in the diet, can act as ligands for toll-like receptor 4 (TLR4) and toll-like receptor 2 (TRL2), which stimulate the release of endogenous inflammatory cytokines, such as tumor necrosis factor (TNF-a), interleukin 6 (IL-6), and other pro-inflammatory cytokines related to the induction of insulin resistance.[1]

According to the latest 2019 report prepared for PAHO by Dr. Carlos Monteiro and colleagues, Argentina ranks third in ultra-processed food consumption in Latin America, behind only Chile and Mexico. This eating pattern has a significant impact on the population's gut microbiota, promoting a dysbiotic, pro-inflammatory profile, altering intestinal permeability, and contributing to a state of low-grade chronic inflammation, or "meta-inflammation," a key factor in the development of chronic diseases prevalent in the country.[2]

The microbiota consists mainly of two phylotypes of bacteria, Firmicutes and Bacteroidetes (the latter accounting for 90 % of the gut microbiota). The former include a large number of genera, the most important being Lactobacillus and Clostridium.[3] In a human experiment, before the start of a low-calorie diet, obese participants had an abundance of Firmicutes and reduced levels of Bacteroidetes, compared with lean participants. These studies confirm observations in animals, suggesting that alterations in intestinal microbial composition are associated with obesity and, consequently, with T2DM, and that the Firmicutes/Bacteroidetes ratio increases as the disease progresses and glycemic control deteriorates.[4,5]

On the other hand, several bacteria have been shown to protect against diabetes by reducing proinflammatory markers and maintaining intestinal barrier integrity. For example, the bacteria Lactobacillus fermentum, plantarum, and casei, Roseburia intestinalis, Akkermansia muciniphila, and Bacteroides fragilis improve glucose metabolism and insulin sensitivity by suppressing proinflammatory cytokines, which is why it is essential to maintain intestinal eubiosis through a healthy diet. Studies have shown that prebiotics and probiotics are potential modulators of obesity and its comorbidities.[6]

The beneficial effects of prebiotics, in general, include stimulating beneficial bacteria such as Bifidobacterium, improving barrier function, modulating lipid metabolism, possibly by inhibiting lipogenic enzymes, and subsequently decreasing lipoprotein synthesis.[7,8]

Various studies have shown that the gut microbiota plays a key role in glycemic control, influencing glucose homeostasis and insulin resistance in key organs such as the liver, muscle, and adipose tissue. Taken together, these findings highlight the ability of certain gut bacteria to modulate the metabolic response, opening new therapeutic avenues for the treatment of T2DM.[9]

Prediabetes is also a pathological condition in which blood glucose levels are higher than usual but lower than the thresholds for diabetes. Compared to people with normal glucose regulation, the most significant characteristic of the gut microbiota in patients with prediabetes was the decreased abundance of the Clostridium genus and A. muciniphila.

It was also observed that there was no significant difference in microbial gene expression between individuals with T2DM, prediabetes, and individuals with standard glucose tolerance without prior treatment.[10]

In addition, not only does food influence the microbiota, but other factors, such as alcohol consumption, smoking, physical exercise, how much you sleep, and whether you experience stress, among many others, can also promote dysbiosis and contribute to the onset of T2DM.

For example, studies have shown that people who smoke have less diversity of gut bacteria compared to non-smokers. In these cases, certain groups considered harmful, such as Shigella, Paraprevotella, Burkholderia, Sutterella, and Megamonas, increase, along with a greater presence of passive bacteria in the intestine.[11,12]

Chronic stress is another factor related to obesity and can affect the microbiota in different ways: it alters cognitive functions such as self-control, can lead to overeating (especially foods high in sugar or fat), reduces physical activity levels, and shortens sleep time. In addition, it activates the hypothalamic-pituitary-adrenal axis, causing hormonal and neurological changes that also impact the gut.[13,14]

Given this scenario, the present study aims to analyze the relationship between modern eating habits and lifestyle and the modulation of the gut microbiota to demonstrate how everyday decisions—specifically, a diet rich in ultra-processed foods, a sedentary lifestyle, smoking, chronic stress, and lack of sleep—affect the composition of the gut microbiota. The hypothesis is that these factors promote a dysbiotic microbiota, characterized by lower bacterial diversity and increased production of pro-inflammatory metabolites, which alters the patient's metabolic homeostasis and increases the risk of developing chronic diseases such as type 2 diabetes.

METHOD

This study is an observational, descriptive, cross-sectional investigation conducted in an academic setting using a structured questionnaire. The study focused on observing and analyzing variables related to adults' knowledge and habits, without directly intervening with the participants.

Table 1. Survey variables

No.	Variable	Measure	Measurement scale
1	Age	18–30 / 31–45 / 46–60 / over 60	Ordinal
2	Gender	Male / Female	Nominal
3	Metabolic conditions present	Prediabetes / Type 2 diabetes / Overweight / Obesity / None	Nominal (multiple)
4	Diagnosis of intestinal disease	Yes / No	Nominal
5	Previous intestinal or bariatric surgery	Yes / No	Nominal
6	Chronic use of antibiotics	Yes / No	Nominal
7	Knowledge about microbiota and its relationship with type 2 diabetes	Yes / No	Nominal
8	Awareness of foods that are beneficial for microbiota	Yes / No	Nominal
9	Diet recommended by a professional	Yes / No	Nominal
10	Regular consumption of ultra-processed foods	Yes / No	Nominal
11	Regular consumption of foods with prebiotics	Yes / No	Nominal
12	Regular consumption of fermented foods or probiotic supplements	Yes / No	Nominal
13	Regular consumption of alcohol (≥ 1 time per week)	Yes / No	Nominal
14	Smoking	Yes / No	Nominal
15	Physical activity ≥ 150 minutes per week	Yes / No	Nominal
16	Frequent stress	Yes / No	Nominal
17	Sufficient sleep (≥ 7 hours per night)	Yes / No	Nominal
18	Frequent intestinal discomfort (gas, bloating, etc.)	Yes / No	Nominal

Data collection instrument

A Google Forms survey with 18 multiple-choice questions was used as the tool. The objective was to analyze participants' knowledge and habits related to gut microbiota, the prevalence of metabolic diseases, and lifestyle factors.

Data analysis plan

Descriptive statistics were used to analyze the collected data. Qualitative variables were expressed in absolute frequencies and percentages. The results were represented using tables and graphs that allowed us to identify general trends in the surveyed population.

Resources needed

- Computer with internet access.
- Questionnaire created in Google Forms.

RESULTS

General information

The results were obtained through a virtual, anonymous survey of 105 people using the

Google Forms platform. Different profiles and habits were analyzed through 18 questions. Regarding respondents' ages, 43,8 % were between 31 and 35 years old, 33,3 % were between 18 and 30, 14,3 % were between 46 and 60, and 8,6 % were over 60. In terms of gender, 61,9 % were female, and 38,1 % were male. In terms of health conditions, 11,9 % were diagnosed with pre-diabetes, 10,9 % with type 2 diabetes, 35,6 % were overweight, 14,9 % were obese, and 43,6 % claimed to have none of the above conditions.

In addition, of the 105 people surveyed, 11,4 % had some form of intestinal disease, 5 % had undergone intestinal surgery, and 5,7 % were chronic users of antibiotics.

Food awareness

As mentioned above, the microbiota is directly associated with T2DM, as is what we consume, which is why in this section we analyze what respondents think about the issue: 18,1 % said they knew what the gut microbiota was and how it was related to type 2 diabetes (Question 7), 43,8 % said they were aware of what to eat (Question 8), and 20 % followed a diet recommended by a health professional (Question 9).

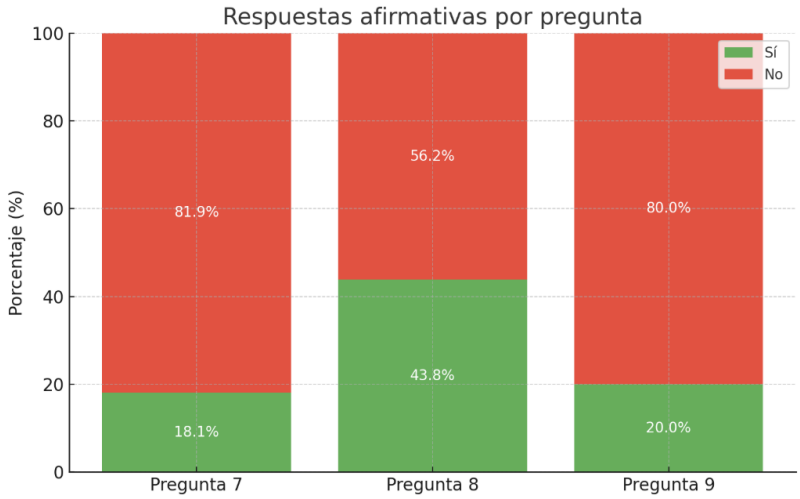

Figure 1. Comparison of knowledge and habits

General habits

When asked about their diet, 62,5 % said they consume ultra-processed foods regularly (Question 10), 51,4 % said they consume probiotics regularly (Question 11), and 29,5 % said they consume probiotic-rich foods regularly (Question 12).

Regarding alcohol and tobacco consumption, 44,8 % said they consume alcohol regularly (at least once a week) (Question 13). Meanwhile, 29,5 % said they are regular tobacco smokers (they smoke every day or almost every day) (Question 14).

Regarding physical exercise, 35,2 % said they engage in at least 150 minutes of moderate physical activity per week (e.g., brisk walking, cycling, jogging, gymnastics, yoga) (Question 15).

From a psychosocial perspective, 82,9 % reported experiencing stress regularly (Question

16), and 35,2 % reported getting enough sleep each night (at least 7 hours) (Question 17).

When asked about intestinal disorders, 61 % reported experiencing one or more symptoms, including bloating, gas, changes in bowel habits, or abdominal pain (Question 18).

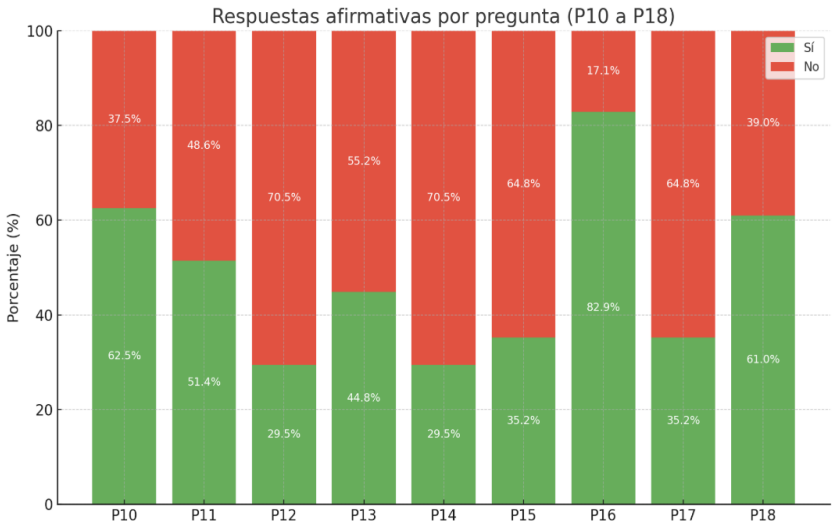

Figure 2. Level of knowledge about Microbiota and Professional Advice

DISCUSSION

The results of this study show that 11,9 % of respondents had been diagnosed with prediabetes and 10,9 % with T2DM, while obesity (35,6 %) and overweight (14,9 %) together accounted for 50,5 % of the sample. These percentages are high, given that only 18,1 % reported awareness of the relationship between gut microbiota and T2DM, suggesting a lack of knowledge or an underestimation of their own health status.

Another relevant aspect is that although 18,1 % of participants stated that they knew what the gut microbiota was and its relationship with DM2, 43,8 % indicated that they were aware of what foods they should consume. This discrepancy confirms that most people have a general idea of healthy eating but lack specific information about the pathophysiological mechanisms involved, such as intestinal dysbiosis and chronic inflammation, and their roles in insulin resistance.

In terms of habits, 62,5 % of respondents reported regular consumption of ultra-processed foods, 44,8 % reported regular alcohol consumption, and 29,5 % reported tobacco use. Only 35,2 % get sufficient physical activity (at least 150 minutes per week). In addition, 87 % of participants reported suffering from chronic stress, and 64,8 % from a lack of adequate sleep (less than 7 hours). All these factors are negative modulators of the gut microbiota and contribute to metabolic dysfunction.

More than half of the respondents (61 %) reported frequent intestinal discomfort, including abdominal pain, gas, or changes in bowel movements.

This data is particularly striking, as it tangibly reflects the impact of the aforementioned

negative habits on digestive health. The high prevalence of these symptoms is consistent with intestinal dysbiosis.

Many of the participants may be experiencing early clinical manifestations of a microbial imbalance that, in the long term, contributes to the development of metabolic diseases and systemic inflammatory disorders such as T2DM.

CONCLUSIONS

The study has shown that although there is some general awareness of eating habits, specific knowledge about the gut microbiota in the genesis and maintenance of T2D is very limited. This lack of information, coupled with the high prevalence of, for example, overweight, obesity, sedentary lifestyles, consumption of ultra-processed foods, and chronic stress, confirms the prevalence of metabolic diseases that could be prevented with better comprehensive health education.

Finally, the research showed the need for educational programs and actions in primary health care aimed at disseminating the importance of habits and their relationship with the gut microbiota in the prevention of metabolic diseases and dysfunctions, promoting regular physical activity, healthy dietary patterns, and addressing psychosocial determinants such as stress and lack of adequate rest. In this way, it would be possible to improve understanding of the interactions among diet, gut health, and metabolic risk, thereby reducing the number of preventable chronic diseases and promoting the quality of life of the population.

BIBLIOGRAPHIC REFERENCES

1. González H, Velásquez D. La microbiota intestinal y su rol en la diabetes. Rev Fac Med. 2015;38(2):102-10.

2. Ferraris J. Cambios en la microbiota por ultraprocesados: obesidad, cáncer y muerte prematura. Rev Med. 2023;130(4):278-85.

3. Gutiérrez M, López M. De la flora intestinal al microbioma. Nutr Hosp. 2018;35(1):22-30.

4. De Moreno de LeBlanc A, Perdigón G. La microbiota intestinal humana y el metabolismo corporal: implicaciones con la obesidad y la diabetes. Rev Argent Microbiol. 2013;45(2):85-93.

5. Araya J, Labbé R. Microbiota intestinal: rol en obesidad. Rev Chil Nutr. 2011;38(2):200-8.

6. Muñoz R, Castro C. Microbiota intestinal, metabolismo y balance calórico. Rev Chil Nutr. 2011;38(4):450-8.

7. Ahmad A, Yang W, Chen G, et al. Gut microbiota and complications of type 2 diabetes. Int J Mol Sci. 2021;22(1):1-18.

8. Li X, Watanabe K, Kimura I. Diet, gut microbiota, and obesity: links with host genetics and epigenetics and potential applications. Biochem Biophys Res Commun. 2019;500(1):22-8.

9. Gurung M, Li Z, You H, et al. Role of gut microbiota in type 2 diabetes pathophysiology. EBioMedicine. 2020;51:102590.

10. Arora T, Bäckhed F. Gut microbiota: an important player in type 2 diabetes mellitus. Nat Rev Endocrinol. 2022;18(3):133-48.

11. Li F, Wang M, Wang J, et al. Características de los microorganismos intestinales en pacientes de mediana edad y ancianos: efectos del tabaquismo. Aging. 2022;14(2):889-902.

12. Mailing LJ, Allen JM, Buford TW, Fields CJ, Woods JA. Efecto de la intensidad y la duración del ejercicio sobre la microbiota intestinal en humanos: una revisión sistemática. Int J Environ Res Public Health. 2022;19(9):9518.

13. Sominsky L, Spencer SJ. Estrés y obesidad. Obes Rev. 2014;15(10):832-40.

14. Benedict C, Vogel H, Jonas W, et al. Sleep deprivation and gut microbiota dysbiosis: current insights and implications. Mol Metab. 2023;70:101624.

FINANCING

None.

CONFLICT OF INTEREST

None.

AUTHORSHIP CONTRIBUTION

Conceptualization: Mylena Souza Freitas, Facundo Correa.
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Formal analysis: Mylena Souza Freitas, Facundo Correa.
Drafting - original draft: Mylena Souza Freitas, Facundo Correa.
Writing - proofreading and editing: Mylena Souza Freitas, Facundo Correa.