RGCS REVISTA GREGORIANA DE CIENCIAS DE LA SALUD

ISSN 3028-8940

ORIGINAL ARTICLE

JULY-DECEMBER 2025;2(2):44-58
https://doi.org/10.36097/rgcs.v2i2.3188

CC BY NC SA

Risk factors associated with type II diabetes mellitus in the Miraflores community in Ecuador

Factores de riesgo asociados a la diabetes mellitus tipo II en la comunidad de Miraflores en Ecuador

Jefferson J. Gutiérrez[1]*, Joseph J. Castro[1], Vicente A. Franco[1]
Irene N. Panta[1], Lester W. Loor[1], María A. Rivadeneira[2]

[1]*Departamento de Nutrición Clínica, Hospital General Santo Domingo, Ecuador.*
[2]*Centro de Salud Olmedo, Ministerio de Salud Pública, Manabí, Ecuador.*

**Corresponding author*

Reception: 09-05-2025 *Acceptance:* 16-07-2025 *Publication:* 31-07-2025

ABSTRACT

Type 2 diabetes mellitus (T2DM) is an increasingly prevalent public health problem, particularly in rural communities where social and economic determinants affect disease management. This study aimed to identify risk factors associated with T2DM in the community of Miraflores, located in the 24 de Mayo canton of Ecuador. A descriptive and cross-sectional study was conducted with a random sample of 60 individuals diagnosed with the disease, using a structured survey to assess their knowledge of the disease, eating habits, physical activity, family history, tobacco and alcohol use, and access to health services. The results revealed limited understanding of the disease, a diet high in high-glycemic index carbohydrates, low frequency of physical activity, and economic constraints that limited access to healthy foods and glucose monitoring. A total of 78.3% reported a family history of T2DM, and more than 50% reported regular tobacco or alcohol use. It is concluded that T2DM in this community is the result of an interaction among genetic, behavioral, and environmental factors, highlighting the need for educational interventions, improved access to metabolic monitoring, and enhanced living conditions to mitigate its impact.

Keywords: type 2 diabetes mellitus, risk factors, nutrition, physical activity, rural health.

RESUMEN

La diabetes mellitus tipo 2 (DMT2I) constituye un problema creciente de salud pública, especialmente en comunidades rurales donde los determinantes sociales y económicos condicionan su manejo. Este estudio tuvo como objetivo identificar los factores de riesgo asociados a la DMT2 en la comunidad de Miraflores, cantón 24 de Mayo, Ecuador. Se realizó un estudio descriptivo y transversal en una muestra aleatoria de 60 personas diagnosticadas, mediante una encuesta estructurada que abordó conocimientos sobre la enfermedad, hábitos alimentarios, actividad física, antecedentes familiares, consumo de tabaco y alcohol, y acceso a servicios de salud. Los resultados evidenciaron un conocimiento limitado sobre la enfermedad, una dieta rica en carbohidratos de alta carga glucémica, baja frecuencia de actividad física y restricciones económicas para el acceso a alimentos saludables y monitoreo glicémico. El 78.3% reportó antecedentes familiares de DMT2, y más del 50% refirió consumo habitual de tabaco o alcohol. Se concluye que la DMT2 en esta comunidad responde a una interacción de factores genéticos, conductuales y estructurales, lo que resalta la necesidad de intervenciones educativas, acceso a monitoreo metabólico y mejora en las condiciones de vida para reducir su impacto.

Palabras clave: diabetes mellitus tipo 2, factores de riesgo, alimentación, actividad física, salud rural.

Cite as: Gutiérrez, J. J., Castro, J. J., Franco, V. A., Panta, I. N., Loor, L. W., & Rivadeneira, M. A. (2025). Risk factors associated with type II diabetes mellitus in the Miraflores community in Ecuador. *Revista Gregoriana de Ciencias de la Salud*, *2*(2), 44-58. https://doi.org/10.36097/rgcs.v2i2.3188

© Author(s) 2025

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic disease characterized by elevated blood glucose levels resulting from insulin resistance, inadequate insulin production, or both. Globally, it affects more than 422 million people, with a growing incidence in low- and middle-income countries (Miksi, 2022). In Ecuador, the National Health and Nutrition Survey (ENSANUT) reported that approximately 1.7% of the population between 20 and 59 years of age suffers from this disease. This figure increases to one in ten by age 50 (Villegas, 2020).

The determination of risk factors is a typical example of clinical research; these factors are not necessarily causal, but identifying them allows correlations to be made and probabilities to be measured (Enríquez-Navascués & Aguirre-Allende, 2022). Among the highlighted factors, obesity, sedentary lifestyle, and an inadequate diet are the main ones (Zavala-Hoppe et al., 2024). It has been documented that nutritional status significantly influences the quality of life in vulnerable populations, underscoring the importance of ensuring food security and providing structured nutritional education (Angulo et al., 2024). The accumulation of intramyocellular lipids and defective phosphorylation of the insulin receptor inhibit GLUT-4 translocation, thereby affecting insulin signaling and promoting insulin resistance (Fernández et al., 2022). Endothelial dysfunction induced by AGEs alters nitric oxide production, contributing to cardiovascular risk (Vallejo, 2022).

The 24 de Mayo canton, located in the province of Manabí, has a population of approximately 31,000 inhabitants (Moreira-Saltos & Zambrano-Cedeño, 2024). It is a rural canton where the main economic activities are agriculture and livestock. Cattle production is used to obtain milk, but pig farming, poultry farming, and forestry are also activities that contribute to local development. Generally, residents tend to consume what they harvest and collect, adjusting their diet to the products available in the region.

Complications associated with T2DM, such as diabetic retinopathy, nephropathy, and neuropathy, affect the quality of life of those who suffer from them. Retinopathy can lead to progressive vision loss, and nephropathy compromises kidney function, increasing the risk of chronic kidney failure. Diabetic neuropathy causes damage to the peripheral nervous system, resulting in chronic pain, loss of sensation, and difficulty with mobility, which reduces the ability to perform daily activities (Vallejo, 2022).

Treatment for TDM II consists of pharmacological strategies and lifestyle modifications. First-line medications include metformin, which improves insulin sensitivity and reduces hepatic glucose production. Other treatments, such as sodium-glucose cotransporter 2 (SGLT2) inhibitors and GLP-1 receptor agonists, are effective in glycemic control and cardiovascular risk reduction. However, therapeutic success also depends on changes in diet and physical activity, which help control weight and improve insulin sensitivity. Treatments are sometimes inaccessible to the most vulnerable populations. Therefore, this study aimed to analyze the risk factors associated with TDM II in the community of the Miraflores Health Center, located in the 24 de Mayo canton, Ecuador.

METHODOLOGY

The study was designed as a descriptive and cross-sectional study, conducted in the community of Miraflores, located in the 24 de Mayo canton, Manabí province, Ecuador, between January and March 2024. The target population consisted of 185 people diagnosed with Type II Diabetes Mellitus in the community, from which a representative sample of 60 individuals was selected, equivalent to 32.4% of the total. The selection was carried out through simple random sampling to ensure representativeness. Individuals over 18 years of age with a confirmed diagnosis and permanent residents of the community who gave their consent to participate in the study were included. Individuals with chronic diseases other than diabetes and those with cognitive difficulties that prevented them from completing the survey were excluded. Individuals who did not agree to participate were also excluded. Incomplete surveys and those with inconsistent responses were eliminated from the analysis, as were cases in which participants dropped out of the study before completing the questionnaire.

Data collection involved a structured survey with 15 multiple-choice questions designed to assess risk factors associated with diabetes, including diet, physical activity, family history, tobacco and alcohol use, and access to health services. Before administration, a pilot test was conducted with ten participants to assess the clarity and relevance of the questions, which allowed for adjustments to the wording of some of them. The surveys were administered in person by previously trained researchers, ensuring privacy during the administration of the questionnaires. Each interview lasted approximately ten minutes.

Data analysis was performed manually, organizing responses into categories for ease of interpretation and comparison. Descriptive statistics such as frequencies and percentages were used to identify trends within the sample. No specialized software was used for data processing.

Participant anonymity and confidentiality of responses were guaranteed throughout the study. Each participant was informed about the nature of the study and was allowed to withdraw at any time without consequences.

RESULTS AND DISCUSSION

Figure 1 shows that 55% of respondents have a good understanding of T2DM, while 36.7% have limited knowledge of the condition. 8.3% reported being unaware of the disease, making an educational intervention plan a necessity, as access to information and educational level lead to better control over diabetes (Allen & McFarland, 2020).

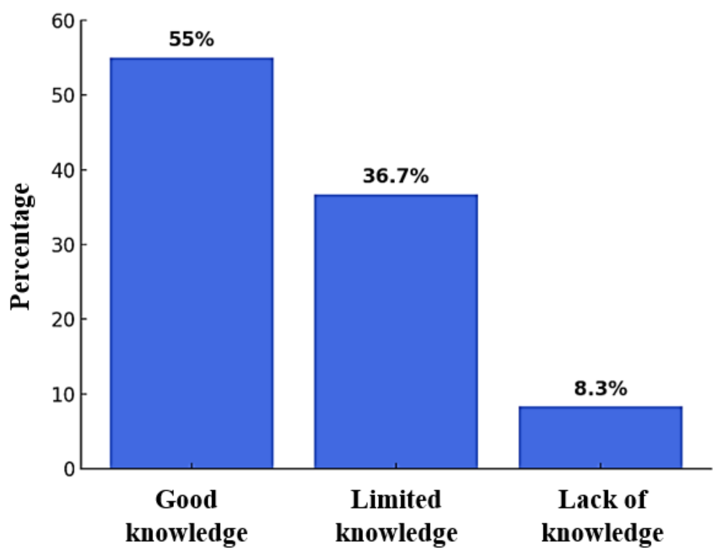

Figure 1. Knowledge about type 2 diabetes mellitus.

Previous research has shown that individuals with lower levels of education or from rural areas tend to exhibit greater ignorance and difficulty adhering to treatments (Farías-Vílchez et al., 2021). This finding aligns with the report by Vaesken et al. (2021), who observed that a better educational level is linked to better metabolic control. In a study conducted in Santa Elena, Ecuador, researchers identified that ignorance about DMT II was more pronounced in women and individuals with incomplete secondary education, reinforcing the need to adapt educational strategies to different population sectors (Suárez & Maggi, 2020).

Family members also affect how patients cope with their illness. Ávalos et al. (2017) highlighted that many of them perceive diabetes with fear, misinformation, or even critical attitudes toward the patient. This makes family support challenging and, consequently, makes it difficult to maintain healthy habits. The lack of information affects patients and influences those around them, perpetuating myths and inappropriate decisions about the disease.

India has the second highest number of people with diabetes in the world, with more than 77 million reported cases. Despite this, 57% of adults with the disease are unaware of their condition, putting them at risk of serious complications (Pradeepa & Mohan, 2021). Misinformation is a silent risk factor because it prevents early detection and access to appropriate treatment.

Thirty-five percent of respondents reported having multiple relatives with T2DM, while 43.3% indicated that at least one family member had been diagnosed with the disease (Figure 2). Only 21.7% reported having no family history, clearly indicating the influence of the genetic component on the prevalence of the disease.

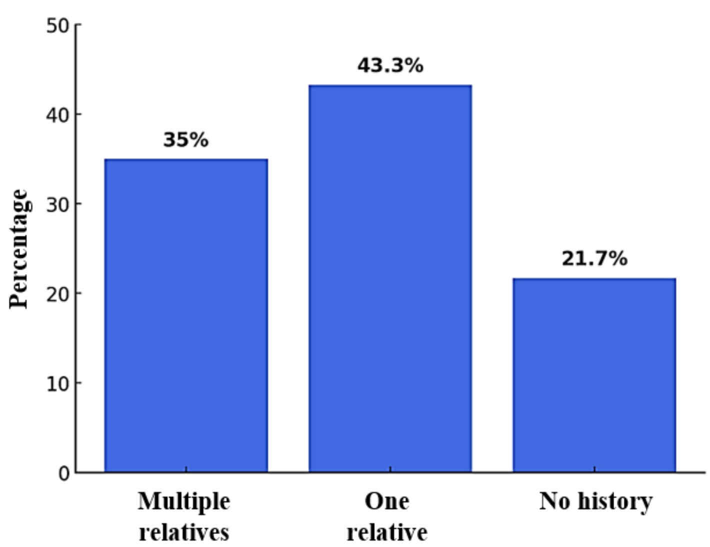

Figure 2. Family history of type 2 diabetes mellitus.

More than 400 genetic variants have been identified in association with this disease, indicating a hereditary predisposition that, although not acting in isolation, increases the likelihood of its development (Cole & Florez, 2020). Genome-wide association studies (GWAS) help identify DNA regions associated with altered glucose metabolism. Many of these variants directly affect the function of pancreatic beta cells, reducing their capacity to produce insulin and accelerating the progression of the disease in individuals with a family history (Krentz & Gloyn, 2020). The expression of specific genes is modulated by diet and other metabolic stimuli, demonstrating the interaction between hereditary and environmental factors (Lopes & Tenani, 2024).

The genetic component exhibits variations in its level of expression depending on the combination of multiple loci associated with the disease. In a study on the interaction between genetic polymorphisms and the predisposition to T2DM, it was found that people with a high genetic risk presented a relative risk 2.00 times higher compared to those without these variants, indicating the influence of the hereditary load on the expression of the disease (Schnurr et al., 2020).

Family history reveals shared habits within households that favor the onset of the disease. High-calorie processed foods, low physical activity, and irregular eating patterns are directly related to the development of T2DM in people with a genetic predisposition. It has been documented that those bad habits associated with insulin resistance are more easily acquired if the social environment regularly practices them, reinforcing the importance of nutrition in the prevention and control of the disease (Lopes & Tenani, 2024).

Figure 3 shows the frequency with which the surveyed population engages in physical activity. Exercise has been recognized as an effective strategy for preventing and controlling T2DM, improving insulin sensitivity, and modulating various metabolic pathways. In the survey, 48.3% of respondents did not engage in regular physical activity, while 31.7% engaged in physical activity less frequently than four times a week. Only 20% maintained a more consistent routine, indicating low adherence to exercise as a preventive measure.

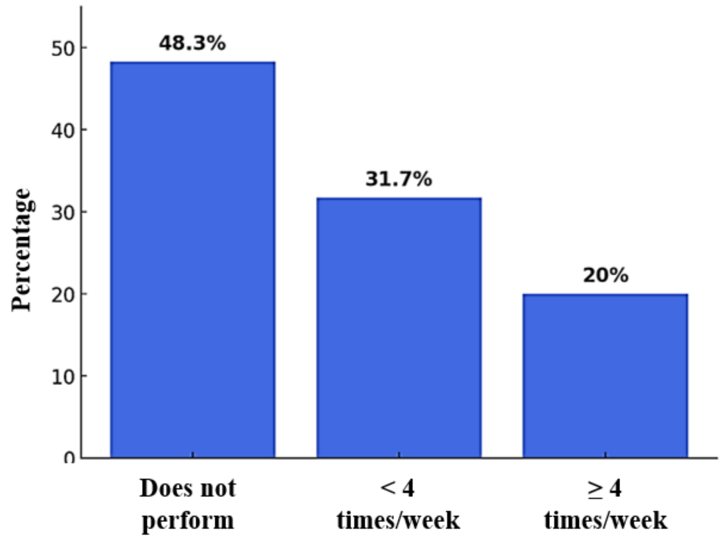

Figure 3. Frequency of physical exercise.

The impact of exercise on glucose regulation varies across individuals. There are interindividual differences in the metabolic response to training, which has led to the concept of exercise resistance. Studies have shown that between 7% and 69% of individuals with T2DM or prediabetes do not experience improvements in insulin sensitivity after a structured training program (Böhm et al., 2016). The composition of the gut microbiome has been identified as a determining factor in this variability. An analysis of men with prediabetes revealed that those who responded positively to exercise had a microbiota with a greater capacity for producing short-chain fatty acids and an optimized metabolism of branched-chain amino acids. In contrast, non-responders showed a microbiota associated with the production of metabolically unfavorable compounds (Liu et al., 2020).

At the cellular level, exercise regulates the expression of genes linked to energy metabolism and inflammation. Physical activity has been documented to improve mitochondrial function and reduce oxidative stress in metabolically active tissues such as the liver and kidneys. These metabolic improvements align with findings in dietary antioxidant research, where a greater antioxidant capacity has been linked to better glucose regulation and reduced oxidative markers (Forbes-Hernández et al., 2020; Forbes-Hernández et al., 2021). In an experimental model using diabetic rats, exercise training reduced the production of reactive oxygen species and restored glutathione metabolism. It regulated the activity of NADPH oxidase, an important enzyme involved in lipid peroxidation and cellular damage (John et al., 2022). These changes are also evident in the activation of pathways such as AMPK and SIRT-1, indicative of a protective effect mediated by mitochondrial biogenesis.

Exercise enhances insulin sensitivity and epigenetic regulation of genes involved in glucose metabolism. Modifications in DNA methylation and the expression of proteins such as Glut-4 and PPAR-γ, which are involved in glucose uptake and lipid storage, have been identified (Yang et al., 2019). These cellular adaptations partly explain the reduction in glycated hemoglobin (HbA1c) observed in individuals with T2DM who undergo regular exercise programs (Sampath Kumar et al., 2019).

A recent bibliometric review identified that the most relevant lines of research in this field have centered on the combination of aerobic and resistance training, reducing the need for hypoglycemic drugs, and the impact of a sedentary lifestyle on disease progression (Zhang et al., 2022). Optimizing exercise protocols based on each individual's metabolic and genetic profile presents a challenge in implementing personalized strategies.

A proper diet is crucial in managing this condition. In the survey, 73.3% of respondents reported consuming rice with almost all their meals, while 51.7% reported eating green plantains on a frequent basis. The regional diet, rich in high-glycemic traditional foods such as rice and plantains, tends to have high energy density, as reported in other studies of typical Manabí dishes (Alvarado et al., 2021; Alvarado & Zambrano, 2023). Diets based on rapidly absorbed carbohydrates, such as rice and processed starch products, increase the glycemic load and promote insulin resistance. Research has shown that excessive consumption of foods with a high glycemic index is associated with an increased incidence of type 2 diabetes mellitus (T2DM) in Asian populations, particularly those with diets based on rice and other refined grains (Wee & Henry, 2020). Likewise, the effect of green plantains on glucose metabolism has been analyzed in glycemic load studies in African and Latin American diets. It has been determined that the glycemic load it generates depends on the state of ripeness, with a lower glycemic response when consumed boiled compared to other preparations (Asante, 2019). Therefore, its frequent consumption increases the progression of insulin resistance.

Around half of respondents (51.7%) reported occasional consumption of sugary drinks, while 23.3% consumed them daily. Regular consumption of these products predisposes individuals to sustained hyperglycemia, which affects pancreatic beta-cell function. In China, rapid urbanization and increased consumption of ultra-processed foods have contributed to the acceleration of T2DM prevalence, rendering access to low-quality foods a significant public health concern (Luo et al., 2019). Additionally, the social perception of ultra-processed foods and their widespread availability can reinforce unhealthy habits that contribute to the risk of T2DM (Gallardo & García, 2024).

Regular blood glucose monitoring helps prevent complications associated with T2DM. In the survey, 43.3% of respondents had easy access to blood glucose monitoring, while 23.3% had difficulty accessing it, and 33.3% were unable to access these services. Lack of access to monitoring methods is a persistent problem in low- and middle-income countries, where the purchase of glucometers and test strips represents a significant cost for the population (Klatman et al., 2019).

Access to healthy foods depends on nutrition education and financial means. In the survey, 35% of respondents reported being able to purchase adequate food to maintain a balanced diet, while 40% do so occasionally, and 25% lack sufficient resources. Limited access to fresh, high-fiber foods has been linked to a greater reliance on ultra-processed products, which can impair glycemic control—in a clinical trial, providing meals tailored for individuals with diabetes reduced episodes of hypoglycemia and improved quality of life compared to those without access to a regulated diet (Berkowitz et al., 2019).

In low-income regions, the availability of healthy options is almost nonexistent. The reliance on refined carbohydrates and low consumption of quality protein have increased the incidence of T2DM in developing countries (Mohan et al., 2020).

In the survey, 35% of respondents indicated having smoked or actively smoked, while 28.3% do so occasionally. Nicotine and other components of tobacco affect insulin sensitivity and cause oxidative stress, leading to chronic inflammation and liver dysfunction in the body (Marti-Aguado et al., 2022). Alcohol consumption was also relevant, with 50% of respondents stating that they do not consume it, 31.7% drinking occasionally, and 18.3% doing so regularly. Alcohol has been documented to affect hepatic glucose metabolism, worsening insulin resistance in individuals predisposed to T2DM (Kim et al., 2019). In patients with metabolic liver disease, alcohol consumption enhances the progression of fibrosis, complicating diabetes management (Marti-Aguado et al., 2022).

CONCLUSIONS

T2DM in the Miraflores community is influenced by a complex interplay between genetic predisposition, lifestyle habits, and socioeconomic conditions that affect its development and management. Hereditary load determines susceptibility, but its expression depends on environmental factors, including diet and physical activity. Diets high in rapidly absorbed carbohydrates, combined with frequent consumption of sugary drinks, can affect glucose regulation and exacerbate insulin resistance. A lack of exercise also limits the metabolic response and favors disease progression. Added to this is restricted access to blood glucose monitoring, making early detection and prevention of complications difficult. The ability to adopt a healthy diet depends on economic stability, and it is evident that difficulties in acquiring adequate food restrict the ability to modify habits. Smoking and alcohol consumption also alter metabolic function, affecting insulin response and increasing the risk of liver complications. The evidence obtained indicates the need for interventions focused on education, monitoring, and access to resources that enable modification.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Jefferson J. Gutiérrez and Joseph J. Castro. **Data curation:** Vicente A. Franco. **Formal analysis:** Joseph J. Castro and Irene N. Panta. **Investigation:** Jefferson Jail Gutiérrez, Joseph J. Castro, Vicente A. Franco, Irene N. Panta, Lester W. Loor, and María A. Rivadeneira. **Methodology:** Lester W. Loor and María A. Rivadeneira. **Software:** Irene N. Panta. **Supervision:** Lester W. Loor and María A. Rivadeneira. **Validation:** Lester W. Loor and María A. Rivadeneira. **Visualization:** Irene N. Panta. **Writing – original draft:** Jefferson Jail Gutiérrez, Joseph J. Castro, Vicente A. Franco, and Irene N. Panta. **Writing – review & editing:** Jefferson Jail Gutiérrez, Joseph J. Castro, Vicente A. Franco, Irene N. Panta, Lester W. Loor, and María A.

Rivadeneira.

References

Allen, K., & McFarland, M. (2020). How Are Income and Education Related to the Prevention and Management of Diabetes? *Journal of Aging and Health*, *32*(9), 1063-1074. https://doi.org/10.1177/0898264319879608

Alvarado, J. M., & Zambrano, J. I. (2023). Tradition and nutrition: an analysis of Manabí cuisine and its impact on health and cultural identity. *Journal of Food Science and Gastronomy*, *1*(2), 25-29. https://doi.org/10.5281/zenodo.13994886

Alvarado, J. M., Zambrano, J. I., & García, M. A. (2021). Densidad energética nutricional de platos típicos manabitas. *QhaliKay*, *5*(3), 66-74. https://doi.org/10.33936/qkrcs.v5i3.3911

Angulo, A. A., Rodríguez, D., & García, M. A. (2024). Estado nutricional y calidad de vida del adulto mayor: revisión sistemática. *Revista Gregoriana de Ciencias de la Salud*, *1*(2), 165-177. https://doi.org/10.36097/rgcs.v1i2.3149

Asante, R. B. (2019). *Determining the glycemic load of boiled yam, cassava and plantain in Abura, Central Region of Ghana* [Thesis, University of Cape Coast]. http://ir.ucc.edu.gh/jspui/handle/123456789/4225

Avalos, M. I., López, C., Morales, M. H., Priego, H. R., Garrido, S. M. G., & Cargill, N. R. (2017). Calidad en el control de la diabetes mellitus en unidades de atención primaria de México. Un estudio desde la perspectiva de la familia de los pacientes. *Atención Primaria*, *49*(1), 21-27. https://doi.org/10.1016/j.aprim.2016.02.012

Berkowitz, S. A., Delahanty, L. M., Terranova, J., Steiner, B., Ruazol, M. P., Singh, R., Shahid, N. N., & Wexler, D. J. (2019). Medically Tailored Meal Delivery for Diabetes Patients with Food Insecurity: A Randomized Cross-over Trial. *Journal of General Internal Medicine*, *34*(3), 396-404. https://doi.org/10.1007/s11606-018-4716-z

Böhm, A., Hoffmann, C., Irmler, M., Schneeweiss, P., Schnauder, G., Sailer, C., Schmid, V., Hudemann, J., Machann, J., Schick, F., Beckers, J., Hrabě de Angelis, M., Staiger, H., Fritsche, A., Stefan, N., Nie, A. M., Häring, H.-U., & Weigert, C. (2016). TGF-β Contributes to Impaired Exercise Response by Suppression of Mitochondrial Key Regulators in Skeletal Muscle. *Diabetes*, *65*(10), 2849-2861. https://doi.org/10.2337/db15-1723

Cole, J. B., & Florez, J. C. (2020). Genetics of diabetes mellitus and diabetes complications. *Nature Reviews Nephrology*, *16*(7), 377-390. https://doi.org/10.1038/s41581-020-0278-5

Enríquez-Navascués, J. M., & Aguirre-Allende, I. (2022). Concepto de factor de riesgo como medida de asociación y efecto: Tipos y utilización. *Cirugía Española*, *100*(10), 652-655. https://doi.org/10.1016/j.ciresp.2021.10.003

Farías-Vílchez, B. A., Ruíz, D. B., Farías-Vílchez, B. A., & Ruíz, D. B. (2021). Conocimientos sobre diabetes mellitus tipo 2 y adherencia al tratamiento en pacientes del hospital Reátegui de Piura, Perú. *Acta Médica Peruana*, *38*(1), 34-41. https://doi.org/10.35663/amp.2021.381.1119

Fernández, C. I. J., Pereira, Y. A. M., Chang, A. S. O., Olmedo, S. I. G., & Gaete, M. C. A. (2022). Fisiopatología y alteraciones clínicas de la diabetes mellitus tipo 2: Revisión de literatura. *Revista Nova*, *20*(38), Article 38. https://doi.org/10.22490/24629448.6184

Forbes-Hernández, T. Y., Betancourt, G., Bilbao, T., Rodríguez, D., & García, M. A. (2021). Estimación de la calidad antioxidante de la dieta de estudiantes universitarios mexicanos. *QhaliKay*, *5*(2), 30-41. https://doi.org/10.33936/qkrcs.v5i2.3494

Forbes-Hernández, T. Y., Betancourt, G., Rodríguez, D., & García, M. A. (2020). Capacidad antioxidante total de la dieta vs. balance redox. *QhaliKay*, *4*(1), 35-48. https://doi.org/10.33936/qkrcs.v4i1.2711

Gallardo, W. D., & García, M. A. (2024). Junk food: analysis of risks, benefits, and social perception. *Journal of Food Science and Gastronomy*, *2*(1), 26-34. https://doi.org/10.5281/zenodo.13996283

John, A., Howarth, F. C., & Raza, H. (2022). Exercise alleviates diabetic complications by inhibiting oxidative stress-mediated signaling cascade and mitochondrial metabolic stress in GK diabetic rat tissues. *Frontiers in Physiology*, *13*. https://doi.org/10.3389/fphys.2022.1052608

Kim, S. Y., Min, C., Oh, D. J., & Choi, H. G. (2019). Tobacco Smoking and Alcohol Consumption Are Related to Benign Parotid Tumor: A Nested Case-Control Study Using a National Health Screening Cohort. *Clinical and Experimental Otorhinolaryngology*, *12*(4), 412-419. https://doi.org/10.21053/ceo.2018.01774

Klatman, E. L., Jenkins, A. J., Ahmedani, M. Y., & Ogle, G. D. (2019). Blood glucose meters and test strips: Global market and challenges to access in low-resource settings. *The Lancet*

Diabetes & Endocrinology, *7*(2), 150-160. https://doi.org/10.1016/S2213-8587(18)30074-3

Krentz, N. A. J., & Gloyn, A. L. (2020). Insights into pancreatic islet cell dysfunction from type 2 diabetes mellitus genetics. *Nature Reviews Endocrinology*, *16*(4), 202-212. https://doi.org/10.1038/s41574-020-0325-0

Liu, Y., Wang, Y., Ni, Y., Cheung, C. K. Y., Lam, K. S. L., Wang, Y., Xia, Z., Ye, D., Guo, J., Tse, M. A., Panagiotou, G., & Xu, A. (2020). Gut Microbiome Fermentation Determines the Efficacy of Exercise for Diabetes Prevention. *Cell Metabolism*, *31*(1), 77-91.e5. https://doi.org/10.1016/j.cmet.2019.11.001

Lopes, K. F. C., & Tenani, G. D. (2024). Diabetes mellitus tipo 2: o papel da genética e da nutrição na prevenção e controle da doença: uma revisão integrativa. *CERES - Health & Education Medical Journal*, *2*(2), Article 2. https://doi.org/10.62234/ceresv2n2-003

Luo, Z., Fabre, G., & Rodwin, V. G. (2019). Meeting the Challenge of Diabetes in China. *International Journal of Health Policy and Management*, *9*(2), 47-52. https://doi.org/10.15171/ijhpm.2019.80

Marti-Aguado, D., Clemente-Sanchez, A., & Bataller, R. (2022). Cigarette smoking and liver diseases. *Journal of Hepatology*, *77*(1), 191-205. https://doi.org/10.1016/j.jhep.2022.01.016

Miksi, S. L. (2022). *Estimación de los costos directos de la atención de diabetes mellitus 2 en Colombia*. http://hdl.handle.net/1992/57362

Mohan, V., Khunti, K., Chan, S. P., Filho, F. F., Tran, N. Q., Ramaiya, K., Joshi, S., Mithal, A., Mbaye, M. N., Nicodemus, N. A., Latt, T. S., Ji, L., Elebrashy, I. N., & Mbanya, J. C. (2020). Management of Type 2 Diabetes in Developing Countries: Balancing Optimal Glycaemic Control and Outcomes with Affordability and Accessibility to Treatment. *Diabetes Therapy*, *11*(1), 15-35. https://doi.org/10.1007/s13300-019-00733-9

Moreira-Saltos, J. R., & Zambrano-Cedeño, X. C. (2024). Caracterización agroproductiva integral: Un estudio de los cantones de Manabí – Ecuador. *Investigación Valdizana*, *18*(3), Article 3. https://doi.org/10.33554/riv.18.3.2206

Pradeepa, R., & Mohan, V. (2021). Epidemiology of type 2 diabetes in India. *Indian Journal of Ophthalmology*, *69*(11), 2932. https://doi.org/10.4103/ijo.IJO_1627_21

Sampath Kumar, A., Maiya, A. G., Shastry, B. A., Vaishali, K., Ravishankar, N., Hazari, A., Gundmi, S., & Jadhav, R. (2019). Exercise and insulin resistance in type 2 diabetes mellitus: A systematic review and meta-analysis. *Annals of Physical and Rehabilitation Medicine*, *62*(2), 98-103. https://doi.org/10.1016/j.rehab.2018.11.001

Schnurr, T. M., Jakupović, H., Carrasquilla, G. D., Ängquist, L., Grarup, N., Sørensen, T. I. A., Tjønneland, A., Overvad, K., Pedersen, O., Hansen, T., & Kilpeläinen, T. O. (2020). Obesity, unfavourable lifestyle and genetic risk of type 2 diabetes: A case-cohort study. *Diabetologia*, *63*(7), 1324-1332. https://doi.org/10.1007/s00125-020-05140-5

Suárez, B. G., & Maggi, B. L. (2020). *Escala de Likert en el nivel de conocimiento de Diabetes Tipo 2 en la provincia de Santa Elena*. https://repositorio.upse.edu.ec/handle/46000/8382

Vaesken, A. M. L., Tercero, A. B. R., & Comelli, P. C. V. (2021). Conocimientos de diabetes y alimentación y control glucémico en pacientes diabéticos de un hospital de Asunción. *Revista Científica Ciencias de la Salud*, *3*(1), Article 1. https://doi.org/10.53732/rccsalud/03.01.2021.45

Vallejo Carmona, L. (2022). *Efecto sinérgico del 3',4'-dihidroxifenilglicol e hidroxitirosol sobre el estrés oxidativo, nitrosativo y biomarcadores cardiovasculares en un modelo experimental de diabetes mellitus tipo 1*. https://riuma.uma.es/xmlui/handle/10630/25436

Villegas Baquero, A. D. (2020). *Incidencia de pacientes con diabetes mellitus tipo 2 descompensada en la unidad de medicina interna hospital Alfredo Noboa Montenegro. Mayo-Agosto 2019* [Bachelor's Thesis]. https://dspace.uniandes.edu.ec/handle/123456789/10975

Wee, M. S. M., & Henry, C. J. (2020). Reducing the glycemic impact of carbohydrates on foods and meals: Strategies for the food industry and consumers with special focus on Asia. *Comprehensive Reviews in Food Science and Food Safety*, *19*(2), 670-702. https://doi.org/10.1111/1541-4337.12525

Yang, D., Yang, Y., Li, Y., & Han, R. (2019). Physical Exercise as Therapy for Type 2 Diabetes Mellitus: From Mechanism to Orientation. *Annals of Nutrition and Metabolism*, *74*(4), 313-321. https://doi.org/10.1159/000500110

Zavala-Hoppe, A. N., Arteaga-Hernández, & Teresa Belén Cañarte-Suarez. (2024). Factores de riesgo y sus complicaciones en pacientes con diabetes mellitus en Latinoamérica. *MQRInvestigar*, *8*(1), 1446-1463. https://doi.org/10.56048/MQR20225.8.1.2024.1446-1463

Zhang, Z., Zhu, Y., Wang, Q., Chang, T., Liu, C., Zhu, Y., Wang, X., & Cao, X. (2022). Global Trends and Research Hotspots of Exercise for Intervening Diabetes: A Bibliometric Analysis. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.902825

Disclaimer / Editor's Note: All publications' statements, opinions, and data are solely those of the individual authors and contributors, not *Revista Gregoriana de Ciencias de la Salud* or the editors. *Revista Gregoriana de Ciencias de la Salud* and/or the editors disclaim all responsibility for any injury to persons or property resulting from any ideas, methods, instructions, or products referred to in the content.