Salud, Ciencia y Tecnología. 2026; 6:2540
doi: 10.56294/saludcyt20262540

ORIGINAL

Real-World Effectiveness of Oral Hypoglycemic Agents in Young Adults with Type 2 Diabetes in Northern Chile

Eficacia real de los hipoglucemiantes orales en adultos jóvenes con diabetes tipo 2 en el norte de Chile

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Cite as: Figueroa Sánchez M, Cornejo-Alaniz M, Marín Cortés Y, Figueroa Maldonado B, Mejia CR, Davies NM, et al. Real-World Effectiveness of Oral Hypoglycemic Agents in Young Adults with Type 2 Diabetes in Northern Chile. Salud, Ciencia y Tecnología. 2026; 6:2540. https://doi.org/10.56294/saludcyt20262540

Submitted: 14-08-2025 **Revised:** 17-10-2025 **Accepted:** 23-11-2025 **Published:** 01-01-2026

Editor: Prof. Dr. William Castillo-González

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ABSTRACT

Introduction: the rising prevalence of type 2 diabetes mellitus (T2DM) among adults aged 25–40 years in Latin America has emerged as a significant public health challenge, driven by lifestyle and metabolic risk factors. Evaluating the real-world effectiveness of oral hypoglycemic agents within primary health care (PHC) systems is essential to inform therapeutic strategies and improve glycemic control in this population. This study aimed to assess metabolic outcomes and treatment associations among young adults with T2DM managed in PHC settings in northern Chile.
Method: a retrospective longitudinal cohort study was conducted using 500 electronic medical records from patients aged 25–40 years diagnosed with T2DM and treated between 2021 and 2023 across eight family health centers (CESFAM) in Antofagasta, Chile. The primary outcome was glycosylated hemoglobin (HbA1c). Secondary analyses examined relationships between treatment type, body mass index (BMI), and comorbidities including dyslipidemia, hypertension, and depression.
Results: among all patients, 71,6 % were overweight and 28,4 % obese. Comorbidities were documented as 57,4 %, dyslipidemia (43,5 %), hypertension (27,9 %), and depression (18,8 %). The most common therapies were metformin monotherapy (84 %) and metformin plus glibenclamide (14,8 %). Mean HbA1c values remained unchanged between 2021 (8,91 ± 0,57) and 2022 (8,92 ± 0,55) but improved significantly in 2023 (7,41 ± 0,28), although international glycemic targets were not met.
Conclusions: oral hypoglycemic therapy in PHC settings was partially effective in improving glycemic control among young adults with T2DM. These findings underscore the need for broader pharmacological options, enhanced follow-up, and reinforcing patient education within Chile's primary care system.

Keywords: Pharmacoepidemiology; Type 2 Diabetes Mellitus; Primary Healthcare; Metabolic Control; Oral Hypoglycemic Agents.

RESUMEN

Introducción: la creciente prevalencia de diabetes mellitus tipo 2 (DM2) en adultos de 25 a 40 años en Latinoamérica se ha convertido en un importante desafío para la salud pública, impulsado por el estilo de vida y factores de riesgo metabólicos. Evaluar la efectividad real de los hipoglucemiantes orales en los sistemas de atención primaria de salud (APS) es esencial para fundamentar las estrategias terapéuticas y mejorar el control glucémico en esta población. Este estudio tuvo como objetivo evaluar los resultados metabólicos y las asociaciones con el tratamiento en adultos jóvenes con DM2 atendidos en centros de APS del norte de Chile.
Método: se realizó un estudio de cohorte longitudinal retrospectivo con 500 historias clínicas electrónicas de pacientes de 25 a 40 años diagnosticados con DM2 y tratados entre 2021 y 2023 en ocho centros de salud familiar (CESFAM) en Antofagasta, Chile. El resultado primario fue la hemoglobina glucosilada (HbA1c). Los análisis secundarios examinaron las relaciones entre el tipo de tratamiento, el índice de masa corporal (IMC) y las comorbilidades, como la dislipidemia, la hipertensión y la depresión.
Resultados: el 71,6 % de los pacientes presentó sobrepeso y el 28,4 % obesidad. Se documentaron comorbilidades en el 57,4 %, predominando la dislipidemia (43,5 %), la hipertensión (27,9 %) y la depresión (18,8 %). Las terapias más comunes fueron la monoterapia con metformina (84 %) y la combinación de metformina y glibenclamida (14,8 %). Los valores medios de HbA1c se mantuvieron sin cambios entre 2021 (8,91 ± 0,57) y 2022 (8,92 ± 0,55), pero mejoraron significativamente en 2023 (7,41 ± 0,28), aunque no se alcanzaron los objetivos glucémicos internacionales.
Conclusiones: el tratamiento hipoglucemiante oral en centros de atención primaria fue parcialmente eficaz para mejorar el control glucémico en adultos jóvenes con diabetes tipo 2. Estos hallazgos subrayan la necesidad de ampliar las opciones farmacológicas, mejorar el seguimiento y reforzar la educación del paciente en el sistema de atención primaria de Chile.

Palabras clave: Farmacoepidemiología; Diabetes Mellitus Tipo 2; Atención Primaria; Control Metabólico; Hipoglucemiantes Orales.

INTRODUCTION

Diabetes mellitus (DM) comprises a group of metabolic disorders characterized by impaired carbohydrate metabolism, resulting in chronic hyperglycemia due to reduced glucose utilization and increased production via gluconeogenesis and glycogenolysis.[1,2] Diagnosis relies on measurements of venous plasma glucose and elevated glycated hemoglobin (HbA1c) levels, the latter serving as a key indicator for disease monitoring within Chile's Family Health Centers (CESFAM).[3]

This study focuses on type 2 diabetes mellitus (T2DM), which has shown a marked rise among adults aged 25–40 years in Antofagasta, Chile, with a prevalence of 6,3 % nearly double the 3,8 % reported in 2010.[3] The increasing incidence of early-onset T2DM is concerning, as the disease in young adults tends to progress more aggressively and is associated with severe long-term complications.[4] Contributing factors include the high prevalence of obesity (34,4 %) and sedentary lifestyles (≈90 %) among Chilean adults, both of which are major determinants of chronic disease development.[3]

Early-onset T2DM has significant public health implications, being linked to an elevated risk of macrovascular complications (coronary artery disease, stroke, peripheral arterial disease) and microvascular complications (retinopathy, nephropathy, neuropathy).[5,6] It also accelerates the development of metabolic comorbidities such as hypertension and dyslipidemia and is frequently associated with non-metabolic conditions like depression, collectively reducing quality of life and life expectancy.[5,6] Despite its growing prevalence, evidence on the effectiveness of pharmacological treatments, particularly oral hypoglycemic agents in this age group remains limited, constraining evidence-based therapeutic decision-making in clinical practice.[7,8]

Chile's health system is structured across three levels of care to ensure comprehensive access. Primary Health Care (PHC) serves as the foundation, emphasizing disease prevention, health promotion, and chronic disease management.[9,10] Within PHC, Family Health Centers (CESFAM) play a pivotal role by providing continuous, community-based care and monitoring patients with chronic diseases such as T2DM.[9,10] However, the range of pharmacological options available at this level is often restricted, underscoring the need to evaluate the real-world effectiveness of current treatments. PHC also includes rural health posts and Public Emergency Care Services (SAPU), which extend care to underserved or urgent cases. The secondary and tertiary levels of care encompass medium- and high-complexity hospitals, respectively, providing more advanced diagnostics and

specialized treatments.[9,10,11]

Pharmacoepidemiology provides a vital framework for assessing medication use, effectiveness, adherence, and safety in real-world populations.[12] Within this context, the present study aims to evaluate the effectiveness of oral hypoglycemic therapy in achieving metabolic control among adults aged 25–40 years with T2DM treated in Antofagasta's PHC system, using changes in HbA1c levels as the primary indicator of metabolic improvement.

METHOD

A retrospective longitudinal cohort study conducted between 2021 and 2023 in eight Family Health Centers (CESFAMs) in Antofagasta, Chile, to evaluate the effectiveness of oral hypoglycemic agents in the metabolic control of young adults with type 2 diabetes mellitus (T2DM). The total population consisted of 15 170 electronic medical records registered on the national RAYEN platform, of which 2456 corresponded to individuals between 25 and 40 years of age who were users of the CESFAMs during the study period. From this population, a non-probability convenience sample of 500 medical records was selected from patients who attended their medical check-ups during the years analyzed, representing 20,4 % of the total in that age range. Inclusion criteria considered patients aged 25–40 years with a confirmed diagnosis of type 2 diabetes and a prescription for oral hypoglycemic agents, either as monotherapy or combination therapy. Patients with type 1 diabetes, gestational diabetes, pregnancy, insulin use as primary treatment, non-attendance at scheduled check-ups, terminal illnesses, or incomplete records were excluded. The variables analyzed included clinical parameters (HbA1c, lipid profile, blood pressure, body mass index), sociodemographic factors (age, sex, education, nationality, occupation), and pharmacological treatment variables (type of hypoglycemic agent, therapeutic regimen, and comorbidities). The operationalization included continuous, categorical, and dichotomous quantitative variables, recorded annually or upon entry into the system, as appropriate.

The instruments used in this research included an institutional authorization letter, electronic medical records, and a database developed by the authors from anonymized records. This database was validated by five experts from the University of Antofagasta, ensuring its rigor and reliability. These resources allowed for the systematic collection of standardized information, guaranteeing the quality of the data obtained.

The data collection process comprised defining the protocol, identifying cases using electronic filters, extracting relevant clinical information, and subsequently integrating, cleaning, and standardizing the data. Statistical analysis was performed using SPSS version 25, employing descriptive statistics, repeated measures ANOVA, and interpreting associations between variables through inferential and subgroup analyses.

The study strictly adhered to national and international ethical standards, applying anonymization and data protection techniques. Since the records were previously provided without any identifying information to the participants by the CMDS (Municipal Corporation for Social Development) health sector of the city of Antofagasta, it was not necessary to request informed consent. These measures guaranteed the confidentiality and protection of the participants, thus ensuring responsible and ethical scientific research.

Generative artificial intelligence (AI) tools were employed exclusively for language refinement and formatting of the manuscript. No AI-based systems were used in study design, data collection, statistical analysis, or interpretation.

RESULTS

Epidemiological Description of the Study Population

A total of 15,170 electronic medical records were initially retrieved from the national RAYEN health information platform, all corresponding to patients diagnosed with type 2 diabetes mellitus (T2DM). Of these, 2,456 records were identified from individuals aged 25–40 years who attended follow-up visits at eight Family Health Centers (CESFAM) in Antofagasta, Chile, between 2021 and 2023.

To ensure analytical consistency and data completeness, a final sample of 500 records was selected. These represented patients who attended all annual follow-up appointments during the three-year study period, ensuring reliable evaluation of treatment effectiveness under continuous primary care management.

Sociodemographic Characteristics

Among the 500 participants, 63,6 % were women (n = 318), and 36,4 % were men (n = 182). The highest representation was from CESFAM Corvallis (21 %), followed by CESFAM Juan Pablo II (16 %), CESFAM Rendic (13 %), and CESFAM Valdivieso (11 %).

Age distribution revealed that 75,2 % of patients were aged 35–40 years, 15,4 % were 30–34 years, and 9,4 % were 25–29 years. A family history of T2DM was reported by 78,6 % of participants.

The mean duration of disease was 4,06 ± 0,98 years (range: 3–8 years). Stratified by health center, the longest average duration since diagnosis was observed in CESFAM Valdivieso (5 years), while CESFAM Oriente and CESFAM Centro-Sur reported the shortest mean duration (3 years) (table 1).

Table 1. Sociodemographic and Clinical Characteristics of the Study Population (n = 500)

Variable	Category	N	Mean ± SD	%
Sex	Male	182	—	36,4
	Female	318	—	63,6
Age range (years)	25–29	47	27 ± 1,53	9,4
	30–34	77	32 ± 1,38	15,4
	35–40	376	38 ± 1,87	75,2
Nationality	Chilean	245	—	49,0
	Peruvian	18	—	3,6
	Bolivian	17	—	3,4
	Colombian	60	—	12,0
	Venezuelan	160	—	32,0
Educational level	Incomplete primary	30	—	6,0
	Completed primary	20	—	4,0
	Incomplete secondary	48	—	9,6
	Completed secondary	174	—	34,8
	Incomplete higher education	6	—	1,2
	Completed higher education	13	—	2,6
	Not reported	209	—	41,8
Occupational status	Salaried employment	464	—	92,8
	Self-employed	23	—	4,6
	Homemaker	13	—	2,6
CESFAM affiliation	Valdivieso	54	—	10,8
	María Cristina	47	—	9,4
	Juan Pablo II	80	—	16,0
	Norte	50	—	10,0
	Rendic	67	—	13,4
	Corvallis	103	—	20,6
	Oriente	49	—	9,8
	Centro-Sur	50	—	10,0
BMI classification	Normal weight	0	—	0,0
	Overweight	358	—	71,6
	Obesity I	90	—	18,0
	Obesity II	52	—	10,4
Comorbidities	Present	287	—	57,4
	Absent	213	—	42,6
Type of comorbidity	Hypertension	80	—	27,9
	Dyslipidemia	125	—	43,5
	Hypertension + Dyslipidemia	28	—	9,8
	Obesity	142	—	28,4
Other comorbidities	Depression	54	—	18,8
Disease characteristics	Duration of T2DM (years)	500	4,06 ± 0,98	—
Family history (mother and/or father)	Present	393	—	78,6
	Absent	107	—	21,4
Oral hypoglycemic treatment	Metformin	419	—	83,8
	Glibenclamide	6	—	1,2
	Vildagliptin	1	—	0,2
	Metformin + Glibenclamide	74	—	14,8
HbA1c (%)	2021	500	8,91 ± 0,57	—
	2022	500	8,92 ± 0,55	—
	2023	500	7,41 ± 0,28	—

Table 1 presents distributions of sex, age, nationality, educational level, occupational activity, and Family Health Center (CESFAM) of origin, as well as relevant clinical indicators: body mass index (BMI), presence and type of comorbidities, family history of type 2 diabetes mellitus (T2DM), time since diagnosis, oral hypoglycemic treatment, and glycated hemoglobin (HbA1c) levels during 2021–2023. Data are expressed as absolute frequencies (N), percentages (%), means, and standard deviations (SD), according to the analyses performed.

Nationality and Educational Level

The most frequent nationality was Chilean (49 %), followed by Venezuelan (32 %) and Colombian (12 %). Regarding educational attainment, secondary education completion was the most common level (34,8 %). However, 41,8 % of participants did not report their educational background, limiting stratified analyses by this variable.

Employment Status

Most participants reported dependent employment (92,8 %), while 4,6 % were self-employed, and 2,6 % identified as homemakers. This reflects a predominantly economically active population within the working-age range.

Baseline Metabolic Profile

At baseline (2021), the mean glycated hemoglobin (HbA1c) was 8,12 ± 1,25 %, indicating suboptimal metabolic control according to ADA criteria. The mean fasting plasma glucose level was 165,3 ± 27,8 mg/dL, consistent with hyperglycemia and insufficient therapeutic response at the beginning of observation.

Evolution of HbA1c Levels (2021–2023)

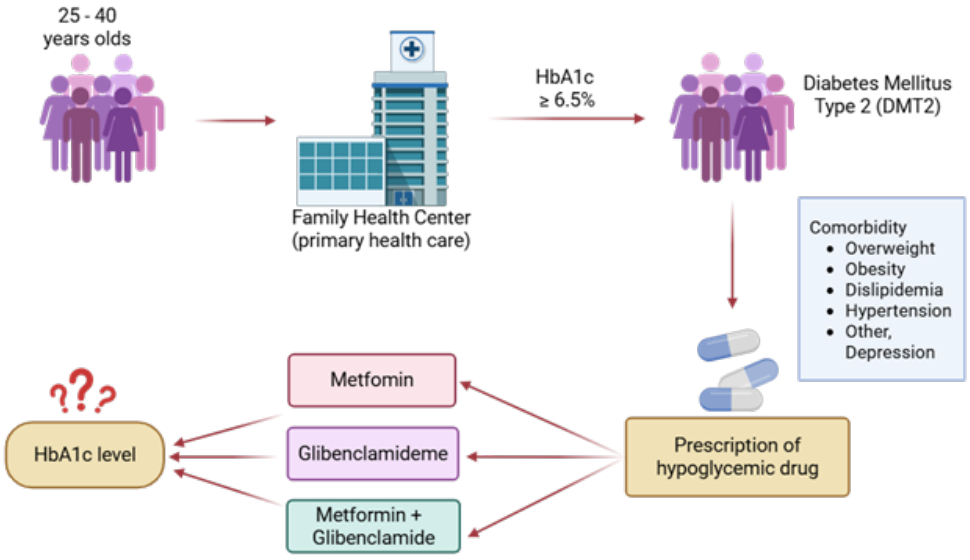

Figure 1. Longitudinal cohort study design based on 500 anonymized electronic records of patients aged 25–40 years treated at CESFAM in Antofagasta (2021–2023)

A progressive and statistically significant reduction in HbA1c was observed over the three-year period. Mean values decreased from 8,12 % (2021) to 7,68 % (2022) and 7,24 % (2023). Repeated measures ANOVA indicated a significant effect of time on HbA1c levels, $p < 0,001$). Tukey's post hoc analysis confirmed significant differences between all consecutive years ($p < 0,05$).

Figure 1 illustrates the decreasing trend in HbA1c across the study period, suggesting that regular follow-up and adherence to pharmacological treatment were associated with improved glycemic control. It includes HbA1c levels, oral hypoglycemic therapy, comorbidities, and associated treatments.

Distribution of Therapy Regimens

Monotherapy was prescribed to 46,2 % of participants, with metformin being the most common agent (42,8 %). The remaining 53,8 % received combination therapy, predominantly metformin + glibenclamide (32 %) and metformin + sitagliptin (14 %). A smaller subset (7,8 %) received triple therapy, typically metformin + glibenclamide + pioglitazone.

Relationship Between Therapy Type and HbA1c Change

Patients on combination therapy achieved a greater mean reduction in HbA1c compared to those on monotherapy (ΔHbA1c = -0,94 ± 0,35 vs. -0,52 ± 0,29; $p < 0,01$). Nevertheless, interindividual variability was notable, and treatment adherence emerged as a significant determinant of metabolic response.

Pearson's correlation analysis identified a moderate positive correlation between body mass index (BMI) and HbA1c levels ($r = 0,46$, $p < 0,001$), indicating that higher BMI values were associated with poorer glycemic

control. Conversely, a negative correlation was observed between duration of diabetes and HbA1c reduction ($r = -0,31$, $p < 0,01$), suggesting that patients with longer disease duration experienced smaller improvements in metabolic control.

No statistically significant correlations were found between HbA1c variation and sex, nationality, or employment status.

Relationship of HbA1c Levels with Hypoglycemic Drugs

Glycated hemoglobin (HbA1c) levels among patients remained stable between 2021 and 2022, with mean values of 8,91 % ± 0,57 and 8,92 % ± 0,55, respectively. In 2023, however, a reduction in HbA1c was observed, reaching a mean of 7,41 % ± 0,28, indicating improved metabolic control over the follow-up period. Regarding pharmacotherapy, most patients received metformin monotherapy (84 %), followed by the combination of metformin and glibenclamide (14,8 %). Monotherapy with glibenclamide was minimal (1 %), as was the use of vildagliptin (0,2 %). Concerning comorbidities potentially affecting metabolic control, 57,4 % of participants had at least one comorbidity. Dyslipidemia was the most prevalent (43,5 %), followed by hypertension (27,9 %). Depression, a condition not directly related to metabolic control, was reported in 18,8 % of participants. The most prescribed treatments for these conditions were atorvastatin (42 %), sertraline, and clonazepam (both 19 %), as well as enalapril (9 %) and hydrochlorothiazide (8 %). It can be observed in figure 2 that the HbA1c levels remained stable between 2021 and 2022, followed by a significant reduction in 2023, particularly among patients receiving metformin monotherapy or combination therapy. Data are presented as mean ± SEM, with n representing the number of participants. Statistical analysis: one-way ANOVA with Tukey post hoc test.

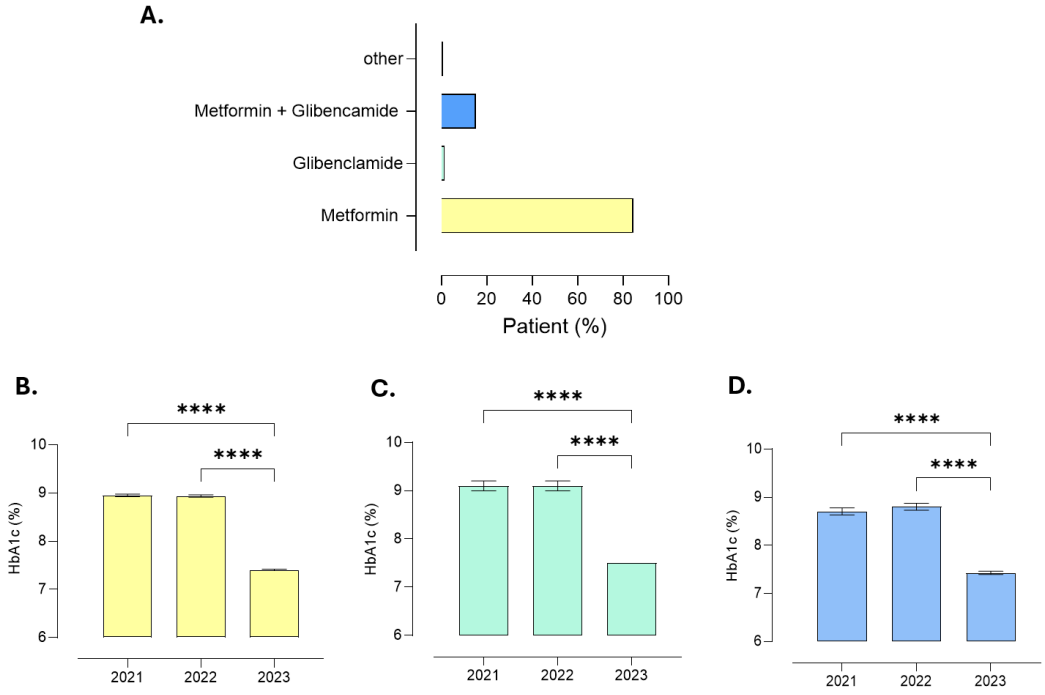

Figure 2. Evolution of glycated hemoglobin (HbA1c) levels in patients with type 2 diabetes mellitus aged 25–40 years treated at CESFAM in Antofagasta between 2021 and 2023. (A) Proportion of patients by oral hypoglycemic prescription; (B) HbA1c levels in patients treated with glibenclamide; (C) HbA1c levels in patients treated with metformin plus glibenclamide; (D) HbA1c levels in patients treated with metformin

Relationship of HbA1c Levels with Patient BMI

Nutritional status in the study sample showed that 71,6 % of patients were overweight, 18 % had obesity class I, and 10,4 % had obesity class II. When HbA1c levels were compared by sex, the mean values were similar between women (8,41 % ± 0,86) and men (8,43 % ± 0,85). Likewise, HbA1c values remained stable across BMI categories: obesity class I (8,42 % ± 0,85), obesity class II (8,39 % ± 0,83), and overweight (8,41 % ± 0,87).

According to oral hypoglycemic therapy, mean HbA1c levels were 8,43 % ± 0,87 for metformin, 8,57 % ± 0,80 for glibenclamide, 8,0 % ± 0,87 for vildagliptin, and 8,31 % ± 0,82 for the metformin–glibenclamide combination. It can be observed in figure 3 that HbA1c values remained stable across overweight, obesity class I, and obesity class II categories, with no significant differences between men and women or according to the type of oral hypoglycemic therapy. Values are presented as mean ± SEM, with n representing the number of participants.

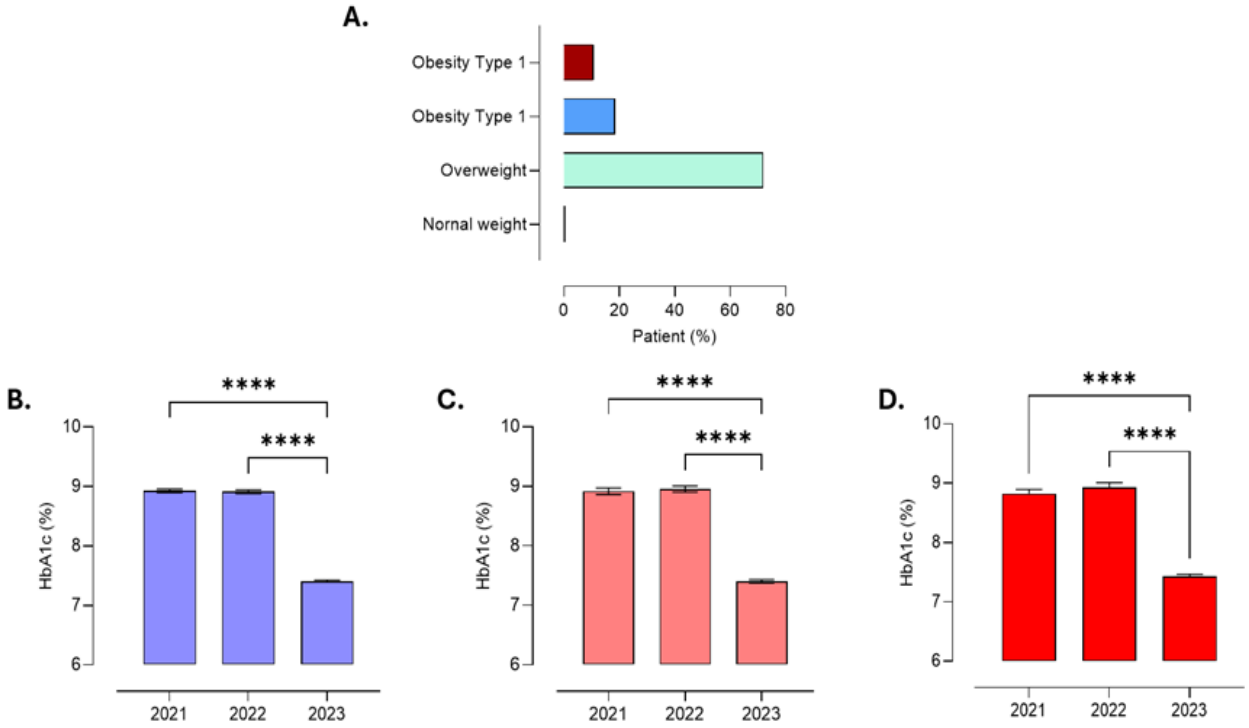

Figure 3. Relationship between glycated hemoglobin (HbA1c) levels and body mass index (BMI) in patients with type 2 diabetes mellitus aged 25–40 years. (A) Percentage distribution of participants by nutritional status; (B) HbA1c levels in overweight patients (n = 358); (C) HbA1c levels in patients with obesity class I (n = 90); (D) HbA1c levels in patients with obesity class II (n = 52)

Comorbidities Present in the Sample

In the sample analyzed, 57,4 % of patients had at least one comorbidity potentially affecting metabolic control. Dyslipidemia was the most prevalent (43,5 %), followed by obesity (28,4 %) and hypertension (27,9 %). Depression, a condition not directly related to metabolic control, was reported in 18,8 % of participants. These findings align with epidemiological evidence describing a close association between components of metabolic syndrome and the progression of type 2 diabetes mellitus. The most prescribed treatments for these conditions were atorvastatin (42 %), sertraline, and clonazepam (both 19 %), enalapril (9 %), and hydrochlorothiazide (8 %).

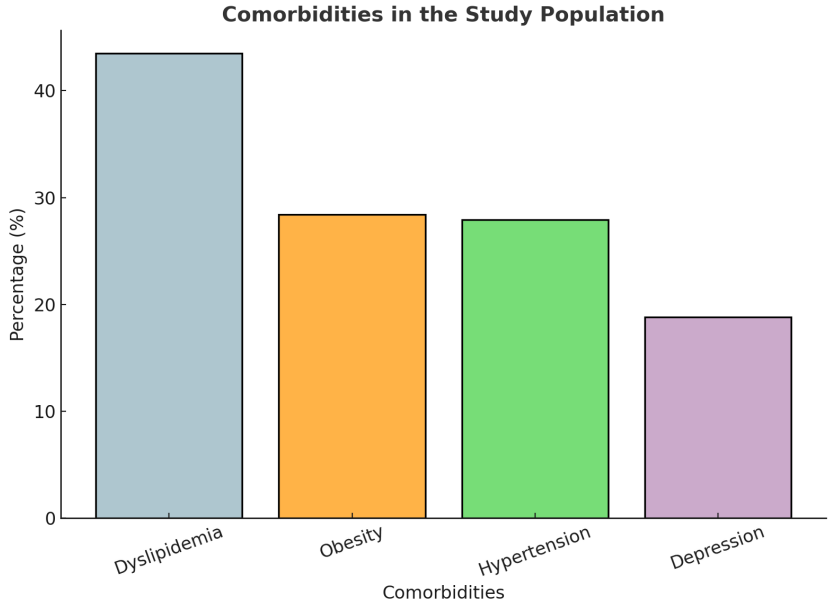

Figure 4. Distribution of comorbidities in the study sample. Analysis was performed using simple descriptive statistics

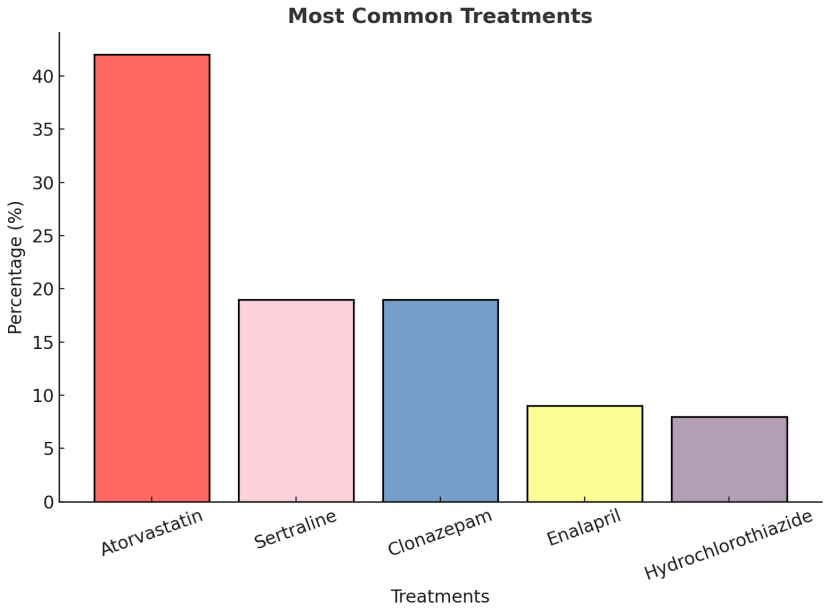

Figure 5. Most common treatments used in patients with type 2 diabetes mellitus presenting comorbidities at primary health care centers (APS) in the city of Antofagasta. Analysis performed using simple descriptive statistics

Summary of Key Findings

From 15,170 total T2DM records, 2,456 corresponded to adults aged 25–40 years; 500 with continuous annual follow-up were included in the final analysis. Women represented 63,6 % of the study population, and most participants were aged 35–40 years. Mean disease duration was approximately four years, with the majority having a family history of diabetes. A significant reduction in HbA1c was observed from 2021 to 2023, demonstrating improved metabolic control under oral hypoglycemic therapy.

Combination therapy (especially metformin-based) resulted in superior glycemic improvement compared to monotherapy. Higher BMI was associated with poorer glycemic control, underscoring the impact of obesity on diabetes management outcomes.

DISCUSSION

The present study provides valuable insights into the metabolic control and clinical characteristics of young adults (25–40 years) with type 2 diabetes mellitus (T2DM) attending Family Health Centers (CESFAM) in Antofagasta, Chile. Over the three-year follow-up period (2021–2023), mean glycated hemoglobin (HbA1c) levels significantly decreased from approximately 8,9 % to 7,4 %, reflecting improved glycemic control in this population. This outcome is clinically relevant, as sustained HbA1c reductions are associated with decreased risks of both microvascular and macrovascular complications. Findings from the UKPDS and other landmark studies have shown that each 1 % decrease in HbA1c corresponds to a 35–37 % reduction in microvascular events, supporting the clinical importance of the observed changes.[13]

A notable demographic feature of this cohort was the predominance of women (63,6 %), which mirrors reports from other Latin American and global studies showing a higher prevalence of T2DM among women in certain age ranges. This may be explained by differences in hormonal profiles, fat distribution, and health service utilization patterns. Most participants were between 35 and 40 years of age (75,2 %), consistent with an epidemiological shift toward earlier onset of T2DM in working-age adults, as observed in developing countries undergoing rapid nutritional and lifestyle transitions.[14,15]

A strong family history of diabetes was observed in 78,6 % of participants, underscoring the role of genetic predisposition in disease development. Previous studies have shown that individuals with first-degree relatives affected by T2DM have approximately double the risk of developing the disease, particularly when combined with environmental and lifestyle factors such as diet and physical inactivity.[16,17] This emphasizes the need for early screening and prevention strategies in younger adults with familial risk.

Metformin was the most frequently prescribed oral hypoglycemic agent (84 %), either as monotherapy or in combination with glibenclamide. This finding aligns with international and national guidelines recommending metformin as the first-line treatment for T2DM due to its efficacy, safety profile, and cardiovascular benefits.[18] The ANOVA analysis demonstrated that both metformin monotherapy and combination therapy significantly improved HbA1c levels over the study period. In contrast, patients treated with glibenclamide alone exhibited less favorable glycemic control, consistent with previous evidence highlighting sulfonylureas' higher risk of hypoglycemia and reduced long-term durability of effect.

Comorbid conditions were highly prevalent (57,4 %), with dyslipidemia (43,5 %) and hypertension (27,9 %) being the most common. The widespread use of atorvastatin (42 %) is consistent with international recommendations for cardiovascular risk reduction in diabetic patients over 40 years or those with multiple risk factors.[19] Furthermore, the presence of depression in nearly one-fifth of the cohort (18,8 %) highlights the critical need for integrated mental health care in diabetes management, as psychological comorbidities are known to impair treatment adherence and worsen glycemic outcomes.

Regarding nutritional status, 71,6 % of patients were overweight and 28,4 % obese, reflecting the well-established association between adiposity and T2DM risk. Interestingly, no significant association was observed between body mass index (BMI) and glycemic control in this cohort. This suggests that pharmacological therapy, rather than BMI alone, may be the dominant determinant of metabolic improvement. Emerging evidence indicates that central adiposity or visceral fat distribution may serve as more sensitive indicators of metabolic dysfunction than BMI in isolation.[20,21]

Overall, these findings demonstrate significant improvements in glycemic control among young adults with T2DM yet highlight persistent challenges in achieving optimal metabolic targets (HbA1c ≤ 7,0 %) as recommended by international guidelines. The results suggest that pharmacological interventions, while essential, must be complemented by non-pharmacological strategies such as nutritional counseling, structured physical activity, and patient education to achieve sustainable metabolic control.[22]

This study highlights critical gaps in the management of young adults (25–40 years) with type 2 diabetes mellitus (T2DM) receiving care at Family Health Centers in Antofagasta, Chile. Although improvements in glycemic control were observed, the overall care model remains limited in scope and frequency. Current follow-up practices, focused primarily on annual assessments of basic metabolic parameters, contrast with international recommendations advocating for more comprehensive and frequent monitoring from the early stages of the disease.[23]

One of the main challenges identified is the restricted availability of oral hypoglycemic agents in primary care settings, which constrains clinicians' ability to individualize treatment and may contribute to suboptimal metabolic control and increased risk of long-term complications.[24] Furthermore, the absence of detailed clinical records on microvascular and macrovascular complications, coupled with limited referral pathways to specialized services such as ophthalmology, vascular medicine, and nursing, underscores fragmented care inconsistent with global diabetes management standards.[25] Equally concerning is the lack of structured nutrition and physical activity programs, which reflect a predominantly reactive rather than preventive care model. The absence of sustained interventions targeting weight management, dietary habits, and exercise substantially limits opportunities to achieve lasting behavioral change and prevent comorbidities such as obesity and cardiovascular disease.[26] From a methodological standpoint, limitations related to data collection such as the nominal recording of body mass index (BMI) and the use of only the most recent 2023 lipid and blood pressure data may have affected the precision and generalizability of findings.

Study Limitations

This study has several limitations. The use of a non-probabilistic sample may limit generalizability to broader populations. Additionally, BMI was used as a categorical rather than continuous variable, and only the most recent lipid profile and blood pressure data from 2023 were analyzed, which may affect precision. Moreover, potential selection bias could arise from including only patients with consistent annual follow-up. Future studies should incorporate longitudinal anthropometric and biochemical data, consider psychosocial variables, and explore the impact of integrated lifestyle and pharmacological interventions on long-term outcomes.

CONCLUSIONS

The study concludes that, although there was a significant improvement in HbA1c levels, the effectiveness of oral hypoglycemic treatment is insufficient to achieve optimal control. This highlights the need to strengthen treatment adherence, health education, and continuous monitoring in northern Chile.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study protocol was approved by the Health Ethics Committee of the Universidad Internacional Iberoamericana de México (approval No. CR-234) and by the accredited local committee of the University of Antofagasta (file No. 469/2024). All data were anonymized to maintain confidentiality.

ACKNOWLEDGMENTS

Special thanks to CMDS, the health sector of the city of Antofagasta, for granting access to the electronic medical records. Special recognition to the Universidad Internacional Iberoamericana de México and the ethics committees that approved the study. This work is part of the Doctoral Thesis of Manuel Figueroa Sanchez to obtain his Ph.D. in Public Health Sciences from Universidad Internacional Iberoamericana, Mexico.

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FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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