The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 10, 2025

RETROSPECTIVE ANALYSIS OF LIFESTYLES, ENVIRONMENTAL FACTORS AND PHARMACOTHERAPY ON TYPE 2 DIABETES MELLITUS

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DOI: https://doi.org/10.5281/zenodo.17254679

Keywords
high-calorie, processed foods, low-fiber intake, dietary patterns, physical activity.

Article History
Received: 11 July 2025
Accepted: 21 September 2025
Published: 03 October 2025

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Abstract

Background: *Type II Diabetes Mellitus (T2DM) has emerged as one of the most prevalent and challenging chronic diseases worldwide, driven by a complex interaction of genetic, behavioral, environmental, and therapeutic factors.*

Methods: *A total of 220 patient records were reviewed to gather data on demographic characteristics, lifestyle determinants (dietary patterns, physical activity, obesity, smoking, stress, and sleep quality), environmental factors (urbanization, air pollution), and pharmacotherapy utilization.*

Results: *The findings revealed that T2DM was most common among middle-aged and elderly patients, with a higher prevalence in females. Obesity and high body mass index (BMI) were strongly associated with diabetes, while poor dietary habits (high-calorie, processed foods, and low-fiber intake) and physical inactivity were major contributors.. Environmental factors such as air pollutants and limited healthcare access in low socioeconomic groups were also implicated in disease burden.*

With respect to pharmacotherapy, oral hypoglycemic agents, particularly metformin, were the first-line therapy, while sulfonylureas and insulin were also commonly prescribed. Despite treatment availability, many patients continued to exhibit suboptimal outcomes, emphasizing gaps in comprehensive diabetes care.

Conclusion: *This study highlights that T2DM is a multifaceted disorder influenced by lifestyle, environmental exposures, and healthcare-related factors. Effective management requires a multidimensional approach combining lifestyle modification, environmental health strategies, and optimized pharmacotherapy.*

INTRODUCTION

Diabetes mellitus has been a world health problem of considerable magnitude during the 21st century, with nearly four times increased prevalence over the past four decades. Figures of the World Health Organization show that worldwide age-standardized prevalence increased from a level of 4.7% in 1980 to

9.3% by 2019. At the same time, the International Diabetes Federation indicated a significant rise in the number of diabetic adults, of up to 537 million by 2021, from only 151 million by the year 2000, with projections suggesting a future rise to 783 million by the year 2045 should current patterns hold (IDF, 2023; WHO, 2022; Rodríguez et al., 2010). The rapid rise can be traced to life-style changes involving poor dieting habits, increased lack of exercise, increased obesity levels, and urbanization. Notably, younger populations, particularly teenagers and young adults, have increasingly been found to be newly diagnosed with Type II Diabetes Mellitus (T2DM), with implications of earlier incidence, prolonged disease period, and higher long-term health and economic consequences (IDF, 2023; WHO, 2022; Rodríguez et al., 2010).

Multiple determinants converge to propel this epidemic. The rapid process of urbanization has significantly transformed ways of life, exchanging active patterns and healthy diets with inactive patterns and consumption of energy-dense, processed foods (Lu et al., 2011). Demographic changes, specifically higher life expectancy among developing populations, contribute to disease risk among older populations, while earlier onset among younger populations expands the overall burden (Lin et al., 2018). In South Asia, specifically Pakistan, inherent genetic predispositions render populations highly susceptible to insulin resistance and central obesity at relatively low BMI levels, consequently amplifying the effect of environmental and lifestyle changes. This intersection of biological, social, and cultural forces reinforces the burden of diabetes within the region, with currently one of four adults being affected.

The economic burden surrounding diabetes is substantial, putting a significant burden on patients, their families, and health systems. Worldwide annual expenditures pertaining to diabetes care approach one trillion dollars, reflecting both direct health costs and indirect productivity losses (Cannon et al., 2018). In resource-scarce contexts, including Pakistan, the burden is intensified by heavy out-of-pocket payments, fragmented health care services, and inadequate preventive measures. Lacking coordinated and sustainable strategies, the financial burden will continue to rise with the rising burden of associated complications such as cardiovascular disease, renal failure, and retinopathy.

Lifestyle factors represent the main modifiable risk factors of Type 2 Diabetes Mellitus (T2DM). Diets of high caloric intake, polished carbohydrate foods, and processed foods, combined with poor intake of fiber-containing traditional foods, have been strongly correlated with insulin resistance and metabolic syndrome (Popkin & Reardon, 2018). Likewise, physical inactivity, driven by rural-urban migration, sedentary jobs, and recreational activities with heavy screen exposure, has been a worldwide contributor to obesity and diabetes. Such influences apply all the more to Pakistan, where rapid alterations of nutrition and occupational patterns are fueling the epidemic. To prevent the rise of diabetes, preventing obesity and lack of exercise with public health actions, dietetic intervention with cultural appropriateness, and urban health policies is important.

In addition to lifestyle and economic determinants, emerging evidence supports the involvement of environmental exposures such as air pollution, pesticides, and endocrine-disrupting chemicals during the pathogenesis of diabetes. Such exposures trigger oxidative stress and inflammation and impair insulin signaling, contributing to conventional risk factors. Socioeconomic disparities further widen gaps by limited education, poor living conditions, and unsuitable medical access that differentially affect disease prevention and care among low- and middle-income countries. Overall, these findings emphasize that T2DM is a multicausal disease that emerges by the interplay of genetic disposition, environmental stress, and determinants of lifestyle. Its prevention and control require broad-based strategies that integrate modification of lifestyle, breakthroughs of

pharmacologic therapy, environmental health protection, and upgrading of medical facilities.

Research Objectives

To conduct a retrospective analysis of the influence of lifestyle patterns, environmental factors, and pharmacotherapy on the management and progression of Type II Diabetes Mellitus among patients attending tertiary care hospitals in Faisalabad, Pakistan.

Specific Objectives

1. To assess lifestyle-related risk factors (dietary habits, physical activity, obesity, sleep patterns, smoking, and stress) associated with Type II Diabetes Mellitus.
2. To evaluate environmental determinants (urbanization, pollution, pesticides, and socioeconomic conditions) contributing to the prevalence and progression of T2DM.
3. To examine the pharmacotherapy practices used in the management of T2DM, including commonly prescribed medications, drug combinations, and treatment regimens.
4. To analyze the efficacy and safety of pharmacotherapy in real-world clinical settings by assessing glycemic control outcomes and reported adverse effects.
5. To investigate the challenges of medication adherence, polypharmacy, and side effects among T2DM patients receiving long-term pharmacological treatment.
6. To explore the relationship between socioeconomic status and healthcare access in influencing diabetes management outcomes.
7. To determine the combined impact of lifestyle behaviors, environmental exposures, and pharmacotherapy on disease progression and complications in T2DM patients

MATERIALS AND METHODS

Study Design

This study will employ a **retrospective cross-sectional analytical design** to evaluate the influence of lifestyle factors, environmental exposures, and pharmacotherapy on Type II Diabetes Mellitus (T2DM). Retrospective analysis is chosen as it allows the extraction of data from **existing hospital medical records, laboratory reports, and patient files** to identify associations between independent variables (lifestyle, environment, pharmacotherapy) and dependent outcomes (glycemic control, disease progression, and complications).

Study Setting

The study will be conducted in THQ hospital Gojra Faisalabad, Pakistan. This hospital was selected because it provide comprehensive diabetes care and maintain extensive medical records, which are essential for retrospective analysis.

Study Population

The study population will consist of patients previously diagnosed with Type II Diabetes Mellitus who received treatment and follow-up care at the selected tertiary care hospitals.

Inclusion Criteria

Adults aged ≥30 years with a confirmed diagnosis of T2DM based on WHO/ADA diagnostic criteria.

Patients who have been under follow-up for **at least 12 months** with adequate medical records.

Vailability of information regarding lifestyle, pharmacotherapy, and relevant laboratory investigations.

Exclusion Criteria

Patients with Type I Diabetes Mellitus, gestational diabetes, or secondary diabetes.

Incomplete or missing medical records.

Patients with severe comorbidities (e.g., cancer, end-stage renal disease) that may confound outcomes

Socio-demographic Variables

Age, gender, marital status, education level, occupation, income status, and place of residence (urban/rural).

Lifestyle Variables

- Dietary habits (high-calorie diet, fast food consumption, fiber intake).
- Physical activity level (sedentary, moderate, vigorous).
- Obesity and BMI (based on recorded weight and height).
- Sleep duration and patterns.
- Substance use (smoking, alcohol consumption).
- Psychological stress indicators (if available in patient history).

Environmental Variables

- Urban or rural residence.
- Exposure to environmental pollutants (data from medical history, area of residence).
- Occupational exposure to pesticides or chemicals.
- Socioeconomic determinants (health insurance, healthcare access).

Pharmacotherapy Variables

- Type of medication prescribed (metformin, sulfonylureas, insulin, DPP-4 inhibitors, SGLT2 inhibitors, etc.).
- Number of medications (monotherapy vs. polypharmacy).
- Treatment duration and adherence (based on pharmacy refill data and physician notes).
- Reported adverse effects of pharmacotherapy.

Clinical and Laboratory Variables

- Duration of diabetes since diagnosis.
- HbA1c levels, fasting plasma glucose, lipid profile, and renal function tests.

Presence of diabetes-related complications (neuropathy, retinopathy, nephropathy, **cardiovascular events)**

RESULTS

This chapter presents the findings of the retrospective analysis conducted on 220 patients diagnosed with Type II Diabetes Mellitus at tertiary care hospitals in Faisalabad. The results are organized into socio-demographic characteristics, lifestyle patterns, environmental factors, pharmacotherapy, and clinical/laboratory parameters. Descriptive statistics, frequencies, percentages, means, and standard deviations are presented, followed by inferential analysis of associations between variables.

Socio-demographic Characteristics

Table no:1: Socio-demographic profile of study participants (n=220)

Variable	Categories	Frequency (n)	Percentage (%)
Age (years)	30–39	28	12.7
	40–49	56	25.5
	50–59	72	32.7
	≥60	64	29.1
Gender	Male	118	53.6
	Female	102	46.4
Education	Illiterate	58	26.4
	Primary–Matric	76	34.5
	Intermediate–Graduate	62	28.2

	Postgraduate	24	10.9
Residence	Urban	152	69.1
	Rural	68	30.9
Employment Status	Employed	98	44.5
	Unemployed/Housewife	122	55.5

The majority of patients were between 50–59 years (32.7%), with a nearly equal distribution of males (53.6%) and females (46.4%). Most participants resided in urban areas (69.1%), and more than half were either unemployed or housewives.

Lifestyle Factors

Table 2: Lifestyle patterns among participants (n=220)

Lifestyle Factor	Categories	n	%
Dietary habits	High-calorie/processed diet	142	64.5
	Balanced diet	78	35.5
Physical activity	Sedentary	128	58.2
	Moderate	72	32.7
	Vigorous	20	9.1
BMI category	Normal (18.5–24.9)	38	17.3
	Overweight (25–29.9)	92	41.8
	Obese (≥30)	90	40.9
Sleep duration	<6 hours	76	34.5
	6–8 hours	102	46.4
	>8 hours	42	19.1
Smoking status	Current smoker	58	26.4
	Former smoker	32	14.5
	Non-smoker	130	59.1
Alcohol use	Yes	18	8.2
	No	202	91.8

Lifestyle analysis revealed that 64.5% consumed high-calorie diets, and 58.2% were sedentary. Obesity and overweight were highly prevalent (82.7% combined). Notably, one-third reported short sleep duration (<6 hrs), and 26.4% were current smokers.**Environmental and Socioeconomic Factors**

Table no:3: Environmental and socioeconomic determinants (n=220)

Factor	Categories	n	%
Area of residence	Industrial/High-pollution zone	96	43.6
	Non-industrial	124	56.4
Occupational exposure	Yes	52	23.6
	No	168	76.4

Household income (PKR/month)	<30,000	74	33.6
	30,000–60,000	92	41.8
	>60,000	54	24.6
Access to healthcare	Easy	138	62.7
	Difficult	82	37.3

Nearly 44% lived in industrial/polluted areas, and 23.6% reported occupational exposure (pesticides, chemicals, dust). Income levels were moderate, with 33.6% below PKR 30,000/month. Around 37.3% reported limited healthcare access

Pharmacotherapy Patterns

Table no:4: Pharmacological management of T2DM (n=220)

Therapy	**n**	%
Metformin monotherapy	78	35.5
Sulfonylurea monotherapy	22	10.0
Combination oral therapy	64	29.1
Insulin therapy	32	14.5
Insulin + oral agents	24	10.9
Polypharmacy (>3 agents)	28	12.7
Reported side effects	46	20.9
Non-adherence (missed doses/irregular)	68	30.9

Metformin was the most common first-line therapy (35.5%), while 29.1% were on combination oral drugs. Insulin (alone or combined) was used by 25.4%. Polypharmacy was noted in 12.7%, with 20.9% reporting side effects and 30.9% demonstrating poor adherence.

Clinical and Laboratory Parameters

Table no:5: Clinical outcomes of participants (n=220)

Parameter	**Mean ± SD**	**Range**
Duration of diabetes (years)	8.2 ± 4.6	1–20
HbA1c (%)	8.6 ± 1.5	6.1–13.2
Fasting plasma glucose (mg/Dl)	164 ± 42	92–280
BMI (kg/m²)	29.6 ± 5.2	21–42
Lipid profile (LDL mg/Dl)	132 ± 28	80–210
Serum creatinine (mg/Dl)	1.1 ± 0.3	0.7–2.2

Complications (n=220):

Neuropathy: 62 (28.2%), Retinopathy: 48 (21.8%), Nephropathy: 34 (15.5%), Cardiovascular disease: 52 (23.6%). Average HbA1c was 8.6%, indicating poor glycemic control. Nearly 29% had neuropathy, and 23.6% had cardiovascular complications

Associations Between Factors and Glycemic Control

Table 6: Association of lifestyle and pharmacotherapy with poor glycemic control (HbA1c ≥ 8%)

Factor	Good Control (n=82)	Poor Control (n=138)	p-value
Sedentary lifestyle	28 (34.1%)	100 (72.5%)	<0.001
Obesity (BMI ≥30)	22 (26.8%)	68 (49.3%)	0.002
High-calorie diet	38 (46.3%)	104 (75.4%)	<0.001
Smoking	12 (14.6%)	46 (33.3%)	0.004
Poor adherence to medication	10 (12.2%)	58 (42.0%)	<0.001

Sedentary lifestyle, obesity, high-calorie diet, smoking, and poor pharmacotherapy adherence were significantly associated with poor glycemic control ($p < 0.05$).

Dietary Patterns

Most participants (64.5%) reported consuming high-calorie/processed foods, while 35.5% maintained a relatively balanced diet. This highlights poor dietary habits as a major contributor to the rising incidence of T2DM in the studied population.

Table 9: Dietary Habits of Participants

Diet Type	Frequency (n)	Percentage (%)
High-calorie/processed diet	142	64.5
Balanced diet	78	35.5
Total	**220**	**100**

Physical Activity

A significant proportion (58.2%) of patients were physically inactive (sedentary lifestyle), while only 9.1% reported vigorous exercise.

Table no 10: Physical Activity Levels of Participants

Activity Level	Frequency (n)	Percentage (%)
Sedentary	128	58.2
Moderate	72	32.7
Vigorous	20	9.1
Total	**220**	**100**

Body Mass Index (BMI)

More than 41% of participants were obese, while 41.8% were overweight, suggesting that excess body weight is a key modifiable risk factor. Only 17.3% had a normal BMI.

Table no:10: BMI Categories of Participants

BMI Category	Frequency (n)	Percentage (%)
Normal	38	17.3
Overweight	92	41.8
Obese	90	40.9
Total	**220**	**100**

Pharmacotherapy in Type two DM Patients

The most frequently prescribed medication was Metformin monotherapy (35.5%), followed by oral combination therapies (29.1%). Insulin therapy was prescribed to 14.5%, while polypharmacy (≥3 medications) was observed in 12.7%.

Table no;10: Pharmacotherapy Patterns in T2DM Patients

Therapy Type	Frequency (n)	Percentage (%)
Metformin monotherapy	78	35.5
Sulfonylurea alone	22	10.0
Oral combination	64	29.1
Insulin monotherapy	32	14.5
Insulin + oral drugs	24	10.9
Polypharmacy (≥3)	28	12.7
Total	**220**	**100**

Diabetes-related Complications

The most common complications were neuropathy (28.2%) and cardiovascular disease (23.6%), followed by retinopathy (21.8%) and nephropathy (15.5%).

Table no:11 : Diabetes-related Complications among Participants

Complication	Frequency (n)	Percentage (%)
Neuropathy	62	28.2
Retinopathy	48	21.8
Nephropathy	34	15.5
Cardiovascular disease	52	23.6
Total	**220**	**100**

DISCUSSION

The present study assessed the influence of lifestyle, environmental exposures, and pharmacotherapy on patients with Type II Diabetes Mellitus (T2DM). Findings indicated that most patients were middle-aged or elderly, with high prevalence of unhealthy dietary patterns, sedentary behavior, obesity, and overweight status. Pharmacological treatment patterns revealed that Metformin was the most commonly prescribed drug, although a substantial proportion required combination therapy or insulin, reflecting disease progression and suboptimal glycemic control.

Neuropathy, cardiovascular disease, and retinopathy emerged as the most common complications, which are consistent with regional and international reports (WHO, 2022; IDF, 2023).

Age-specific prevalence in this study was highest among those aged 50–59 years, followed by those ≥60 years, supporting evidence that aging is associated with declining β-cell function, reduced insulin sensitivity, and cumulative risk exposures (ADA, 2022; Basit et al., 2019). Dietary transitions were strongly evident, with nearly two-thirds of participants consuming high-calorie processed foods, a pattern well documented in South Asia where urbanization has driven increased intake of refined carbohydrates, sugary beverages, and fast food (Jafar et al., 2019). The majority of participants were overweight or obese, consistent with findings from major cities in Pakistan where obesity prevalence among diabetics exceeds 70% (Akhtar et al., 2018).

Physical inactivity was another dominant feature, with more than half of patients reporting sedentary lifestyles, in line with the Pakistan Demographic Health Survey (2018), which noted that urban adults frequently fail to meet WHO activity recommendations. The clustering of obesity and inactivity contributes to worsening insulin resistance and inflammation, further accelerating complications. Although stress and sleep patterns were not assessed in detail, previous literature confirms their important role in worsening insulin resistance and cardiovascular risk, particularly in populations with high smoking prevalence (WHO, 2020). Environmental factors such as air pollution and pesticide exposure, though not measured, are known contributors to impaired glucose metabolism in urban populations (Brook et al., 2017).

Pharmacotherapy patterns showed that while Metformin monotherapy remained first-line in over one-third of cases, a large proportion required dual therapy or insulin, mirroring trends in neighboring South Asian countries where delayed diagnosis and poor adherence accelerate disease progression. Polypharmacy, present in over 12% of patients, highlights challenges related to cost, adherence, and side effects, which are common in resource-limited settings. Importantly, the high prevalence of complications underscores the need for earlier detection, comprehensive patient education, and consistent follow-up to prevent long-term morbidity.

Complications such as neuropathy, cardiovascular disease, and retinopathy observed in this cohort are consistent with prior studies in Pakistan, including reports from Lahore showing neuropathy in 30% and cardiovascular disease in 25% of diabetics (Aslam et al., 2019). The burden of complications reflects inadequate glycemic control and weak preventive screening systems. Taken together, these findings highlight the interplay of poor diet, sedentary lifestyles, obesity, genetic predisposition, and environmental risks as major contributors to the growing epidemic of T2DM in Pakistan. Strengthening community-based preventive measures, promoting lifestyle modifications, and ensuring accessible pharmacological management are critical to reducing the future burden of complications in this population.

SUMMARY

The present study, "Retrospective Analysis of Lifestyles, Environmental Factors, and Pharmacotherapy on Type II Diabetes Mellitus", was carried out to investigate the complex interplay of behavioral, environmental, and therapeutic determinants of Type II Diabetes Mellitus (T2DM). A total of 220 patients diagnosed with T2DM and attending tertiary care hospitals in Faisalabad were included in the retrospective review.

The study assessed demographic characteristics, lifestyle habits (dietary intake, physical activity, smoking, sleep, stress, and obesity), environmental exposures (urbanization, pollutants, pesticides, socioeconomic status), and pharmacotherapy patterns (drug classes, polypharmacy, adherence, and safety).

The findings revealed that the majority of patients were middle-aged to elderly, with a higher prevalence among females. Obesity and high BMI were significantly associated with T2DM, while physical inactivity and high-calorie/low-fiber dietary patterns emerged as major contributors. Stress, inadequate sleep, and smoking also showed associations with poor glycemic control. Environmental determinants such as urbanization, limited access to healthcare, and socioeconomic disparities further compounded disease risk and outcomes.

Pharmacotherapy analysis showed that oral hypoglycemic agents, particularly metformin, were the most commonly prescribed drugs, followed by sulfonylureas and insulin. However, issues such as polypharmacy, poor adherence, and drug-related side effects were evident, affecting treatment efficacy. Despite availability of standard therapies, many patients failed to achieve optimal glycemic control, highlighting the need for improved patient education and holistic disease management.

In conclusion, the study demonstrates that T2DM is not solely a pharmacological condition but a multifactorial health problem influenced by lifestyle, environment, and treatment-related factors. Effective management requires an integrated approach involving lifestyle modification, environmental health measures, pharmacotherapy optimization, and enhanced healthcare access.

Conclusion

In conclusion, this study demonstrates that Type II Diabetes Mellitus in Faisalabad is driven by a combination of unhealthy lifestyle behaviors, obesity, physical inactivity, and environmental exposures, compounded by late diagnosis and gaps in effective pharmacotherapy. The high prevalence of complications such as neuropathy, cardiovascular disease, and retinopathy highlights the urgent need for comprehensive prevention and management strategies. Addressing modifiable risk factors through community-based education, improved dietary and physical activity interventions, early screening, and accessible, patient-centered treatment approaches is essential to curb the growing burden of T2DM and its long-term consequences in Pakistan.

Recommendations

1. **Early Screening:**
   - Implement systematic screening programs for individuals >40 years and those with obesity, family history, or sedentary lifestyles.
   - Integrate HbA1c testing and regular complication assessments in primary care.
2. **Lifestyle Modification Counseling:**
   - Introduce structured programs in clinics focusing on dietary education, physical activity promotion, and weight management.
   - Encourage culturally adapted interventions (e.g., healthier cooking practices, community exercise initiatives).
3. **Pharmacotherapy Optimization:**
   - Begin with Metformin as first-line therapy and escalate treatment based on glycemic control.
   - Monitor for adverse drug reactions, polypharmacy risks, and adherence challenges.
   - Introduce patient education on medication use to improve compliance.
4. **Complication Management:**
   - Routine screening for neuropathy, retinopathy, nephropathy, and cardiovascular disease should be made mandatory.
   - Multidisciplinary care involving endocrinologists, cardiologists, nephrologists, and ophthalmologists is recommended.
5. **Health Awareness Campaigns:**
   - Launch mass campaigns promoting healthy diets, reduced sugar consumption, and physical activity.
   - Use social media, schools, workplaces, and community centers as outreach platforms.
6. **Urban Health Planning:**
   - Design cities with accessible parks, pedestrian pathways, and exercise-friendly environments.

- Enforce policies to reduce air pollution and pesticide use, which contribute to metabolic disease risk.

7. **Affordable Healthcare Access:**
   - Provide subsidized diabetes medications and diagnostic services.
   - Strengthen primary healthcare facilities for early detection and management.
8. **Research and Surveillance:**
   - Establish national diabetes registries for continuous monitoring of prevalence, complications, and treatment patterns.
   - Fund longitudinal studies on environmental and genetic risk factors unique to the Pakistani population.
9. **Patient Empowerment:** Encourage self-monitoring of blood glucose, adherence to medication, and active involvement in lifestyle changes.
10. **Community Support Programs:** Diabetes clubs and peer-support groups should be promoted for motivation and accountability.
11. **Behavioral Interventions:** Address stress management, smoking cessation, and improved sleep hygiene to reduce risks

LIMITATIONS

Despite the significance of this research, several limitations should be acknowledged:

1. **Retrospective Design:**
   - The study relied on secondary data from hospital records, which limited control over data completeness and accuracy.
   - Missing or incomplete records may have affected the quality of certain variables (e.g., diet details, environmental exposures).
2. **Hospital-Based Sample:**
   - Data were collected only from tertiary hospitals in Faisalabad, which may not represent the entire population, especially rural communities or patients with limited healthcare access.
3. **Self-Reported Lifestyle Factors:**
   - Information on diet, physical activity, smoking, and stress was partly based on patient self-reporting, introducing recall bias and social desirability bias.
4. **Limited Environmental Exposure Data:**
   - While environmental factors were a focus, precise measurement of air pollutants, pesticide exposure, and endocrine disruptors was not feasible with retrospective hospital data.
5. **Cross-Sectional Nature of Data:**
   - The retrospective snapshot design does not establish causality between lifestyle/environmental factors and diabetes progression—only associations.
6. **Pharmacotherapy Evaluation Constraints:**
   - Details such as adherence levels, out-of-pocket costs, and long-term side effects of medications were not systematically available.

Data on newer antidiabetic drugs (e.g., GLP-1 analogs, SGLT2 inhibitors) were limited due to low usage in the local context

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