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PHARMACOECONOMIC ANALYSIS OF THE CONSUMPTION OF GLUCOSE-LOWERING MEDICINAL PRODUCTS IN 2020–2025 USING THE ATC/DDD METHODOLOGY

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Introduction. Diabetes mellitus remains a global challenge for healthcare systems, requiring continuous optimization of expenditures alongside the implementation of innovative treatment approaches. Monitoring real-world drug consumption and the rational use of financial resources is critical to ensuring sustainable pharmaceutical care.

Aim is to conduct a comprehensive pharmacoeconomic analysis of the consumption of glucose-lowering medicinal products in the retail pharmaceutical market during 2020–2025 using the ATC/DDD methodology and integrated ABC/VEN analysis to assess the rationality and dynamics of pharmaceutical care for patients with diabetes mellitus.

Materials and Methods. The study object was a dataset on the retail sales of medicinal products belonging to ATC group A10. The ATC/DDD methodology (calculation of NDDD) was applied to assess natural consumption volumes, while the integrated ABC/VEN analysis was used to evaluate the cost structure and assortment rationality for 2025. Statistical analysis was performed using MS Excel 365.

Results. Modernization of therapeutic regimens was identified: the share of SGLT2 inhibitors increased from 3.6 % to 9.5 % (NDDD), while long-acting insulin analogues reached 14.1 %. Sulfonylurea derivatives maintained leadership in natural consumption (61.7 %), remaining the most affordable drug group (category C according to ABC analysis). The ABC analysis revealed that 84.6 % of total expenditures (group A) were allocated to vital insulin products. The integrated ABC/VEN matrix confirmed a high level of assortment rationality: 100 % of expenditures were concentrated on medicines classified as V (Vital) and E (Essential), with a complete absence of category N products.

Keywords: glucose-lowering agents, ATC/DDD analysis, ABC analysis, VEN analysis, pharmacoeconomics.

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ФАРМАКОЕКОНОМІЧНИЙ АНАЛІЗ СПОЖИВАННЯ ЦУКРОЗНИЖУВАЛЬНИХ ЛІКАРСЬКИХ ЗАСОБІВ У 2020–2025 РР. ІЗ ЗАСТОСУВАННЯМ ATC/DDD-МЕТОДОЛОГІЇ

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Стаття присвячена аналізу роздрібного споживання цукрознижувальних засобів (група А10) за 2020–2025 рр. Методом ATC/DDD встановлено модернізацію терапії: зростання частки інгібіторів SGLT2 з 3,6 % до 9,5 % (NDDD) та аналогів інсуліну (14,1 %), за збереження лідерства сульфонілсечовини (61,7 %). За результатами ABC-аналізу виявлено, що 84,6 % витрат припадає на життєво важливі інсуліни (група А). Матриця ABC/VEN підтвердила раціональність асортименту: 100 % коштів витрачено на препарати категорій V та E за повної відсутності другорядних засобів (категорія N). Отримані дані обґрунтовують необхідність подальшої оптимізації витрат у разі впровадження інноваційних підходів до лікування діабету.

Ключові слова: цукрознижувальні засоби, ATC/DDD-аналіз, ABC-аналіз, VEN-аналіз, фармакоекономіка.

Introduction

Diabetes mellitus (DM) remains one of the major medical and social problems of modern healthcare [1; 2]. According to projections of the International Diabetes Federation (IDF), the prevalence of this disease continues to increase steadily, leading to a persistent growth in the need for effective and affordable pharmacotherapy. Under conditions of limited financial resources and economic instability, the issues of rational selection of medicinal products (MPs) and optimization of expenditures for the treatment of DM acquire strategic importance for pharmacy chains and the healthcare system as a whole [3].

The modern pharmaceutical market offers a wide range of hypoglycemic agents, from traditional sulfonylurea preparations to innovative drug classes such as SGLT2 inhibitors and next-generation insulin analogues [4; 5]. However, the implementation of new therapeutic strategies requires continuous monitoring of real-world drug consumption and assessment of the extent to which treatment patterns comply with international clinical guidelines [6]. The most objective and internationally recognized tool for such population-based monitoring is the ATC/DDD methodology recommended by the World Health Organization (WHO), which enables the standardized

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analysis of consumption volumes and national utilization trends in natural units, regardless of price fluctuations and inflationary processes [6; 7].

Alongside clinical effectiveness, the economic component of pharmaceutical care is critically important. The use of integrated ABC/VEN analysis makes it possible not only to identify the highest-expenditure items within the assortment but also to correlate financial expenditures with the clinical priority of medicinal products. This approach allows for the identification of disproportions in budget allocation and ensures that patients are primarily provided with vital medicines [8; 9].

Despite the availability of numerous studies on the market of antidiabetic agents, the analysis of long-term consumption dynamics (2020–2025) under conditions of transformation of the reimbursement system and updates of treatment protocols remains insufficiently explored [10; 11]. This substantiates the need for a comprehensive pharmacoeconomic study that combines epidemiological consumption indicators with an assessment of expenditure rationality.

Aim is to conduct a comprehensive pharmacoeconomic analysis of the consumption of glucose-lowering medicinal products in the retail pharmaceutical sector during 2020–2025 using the ATC/DDD methodology and integrated ABC/VEN analysis to assess the rationality and dynamics of pharmaceutical care for patients with diabetes mellitus.

To achieve this aim, a series of consecutive research stages was defined. At the initial stage, a thorough analysis of the consumption dynamics of the main groups of glucose-lowering agents during 2020–2025 was planned using the international ATC/DDD methodology, which enables an objective assessment of pharmaceutical care volumes in natural units, expressed as the number of defined daily doses (NDDD).

The next stage involved examining structural changes in the use of different classes of hypoglycemic agents, including a comparison of the proportions of traditional therapies and innovative medicines such as SGLT2 and DPP-4 inhibitors, in order to identify current trends in diabetes mellitus treatment.

The economic component of the study included conducting an ABC analysis of the actual expenditures of the pharmacy network for 2025 to identify the highest-expenditure subgroups of medicinal products, as well as performing a VEN classification of the assortment in accordance with the requirements of the State Formulary of Medicines. The final stage of the research consisted of constructing an integrated ABC/VEN matrix, which allowed for a comprehensive assessment of the rationality of financial resource allocation and the compliance of the marketed assortment with the principles of evidence-based medicine and the clinical importance of medicinal products.

Materials and Methods

The study object was a dataset of anonymized data on the retail sales of medicinal products used for the treatment of diabetes mellitus (ATC group A10) through a pharmacy network during the period from 2020 to 2025. The primary data included comprehensive information on brand names, dosage forms, the strength of the active ingredients, the number of units per package, as well as sales volumes expressed in both natural units (packages) and monetary terms.

To ensure scientific accuracy and enable international comparability of the results, the medicinal products were systematized according to the international Anatomical Therapeutic Chemical (ATC) classification system. Standardization of consumption volumes was performed using the ATC/DDD methodology recommended by the World Health Organization (WHO) for pharmacoepidemiological studies [12]. The primary consumption indicator was the Defined Daily Dose (DDD), defined as the assumed average maintenance daily dose of a drug used for its main indication in adults. DDD values for each active substance were adopted in accordance with the official WHO ATC/DDD Index 2025 [13]. In particular, the DDD for metformin (A10BA02) was set at 2000 mg, for vildagliptin (A10BH02) at 100 mg, and for all types of insulin at 40 international units (IU). In cases of dosage discrepancies, the doses were converted to milligrams where applicable to ensure the accuracy of calculations.

Quantitative consumption assessment was expressed using the NDDD indicator (number of defined daily doses), calculated as the ratio of the total amount of the active substance sold to the established DDD value for a specific ATC code. The pharmacoeconomic analysis included the calculation of the cost per defined daily dose (Cost/DDD), which made it possible to assess the economic affordability of therapy and the dynamics of price fluctuations over the study period.

To analyze the expenditure structure and identify priority drug groups within the total consumption budget for 2025, the ABC analysis methodology was applied, allowing medicinal products to be categorized into three groups: A (80 % of expenditures), B (15 %), and C (5 %). To assess the rationality of resource utilization, economic data were integrated with the results of the VEN analysis. Classification according to clinical importance (V – vital, E – essential, N – non-essential) was performed based on the State Formulary of Medicines (17th edition, 2025) and current treatment protocols [14]. Statistical data processing and visualization of results, including the construction of the integrated ABC/VEN matrix, were carried out using Microsoft Excel 365 software [15].

The study is a part of the departmental research project of the Department of Social Medicine, Public Health and Healthcare Management at Dnipro State Medical University, entitled “Scientific substantiation of strategies for maintaining and restoring public health through the impact on the determinants of healthcare system effectiveness” (State Registration No. 0123U104849, running from 2024 to 2027).

A notable limitation of the present study is the exclusion of the biguanides group (ATC group A10BA, primarily metformin) from the primary retail dataset due to technical and data extraction constraints. As metformin represents the first-line therapy for type 2 diabetes and commands a substantial share of natural consumption, its absence may artificially inflate the relative percentage shares of other pharmacological groups (such as sulfonylurea derivatives)

in the NDDD structure. Consequently, the findings reflect the structural dynamics of the analyzed retail network segments excluding biguanides, and future studies should incorporate comprehensive biguanide data to refine these proportions.

Research results and their discussion

The analysis of the study results began with an assessment of general trends in the consumption of glucose-lowering medicinal products expressed in natural units, which made it possible to neutralize the impact of price fluctuations and inflationary processes during 2020–2025. The application of the international ATC/DDD methodology enabled an objective evaluation of the intensity of consumption of different pharmacological groups through the calculation of the number of defined daily doses (NDDD).

At the initial stage, a time-based retrospective analysis of consumption was constructed, clearly demonstrating the dynamics of pharmaceutical care within the pharmacy network. The market of antidiabetic agents was characterized by a high degree of stability of the main segments despite overall market fluctuations (Figure 1). Oral hypoglycemic agents accounted for the largest share of consumption throughout the entire study period, among which sulfonylurea derivatives consistently maintained absolute dominance, as reflected by the stable prevalence of the corresponding segment in the graphical representation.

At the same time, the visualization of consumption dynamics makes it possible to trace a gradual transformation in the structure of treatment. A clear trend toward an increasing share of SGLT2 inhibitors and modern long-acting insulin analogues can be observed, indicating a progressive update of therapeutic approaches in line with current clinical guidelines. Such year-by-year distribution of consumption provides the necessary context for further analysis of structural shifts and for the assessment of the economic feasibility of resource utilization, which is examined in more detail in the subsequent stages of the study.

The analysis of the consumption of glucose-lowering medicinal products (ATC group A10) over the period 2020–2025 made it possible to identify key trends in the pharmacotherapy of diabetes mellitus and to evaluate the economic efficiency of expenditures within the pharmacy network.

Subsequently, changes in consumption volumes calculated in defined daily doses (NDDD) were analyzed. This approach allowed for the assessment of the actual share of each pharmacological group in the treatment process while neutralizing the effects of inflation and price fluctuations (Table 1).

As shown in Table 1, sulfonylurea derivatives (A10BB) remained the leading pharmacological group in terms of consumption throughout the study period. Their share in 2025 accounted for 61.7 % of the total NDDD, which is only 0.4 % lower compared to 2020. This stability can be explained by the high affordability of this drug group and its widespread use as a second-line therapy.

At the same time, a clear trend toward the modernization of treatment regimens was observed. The most significant

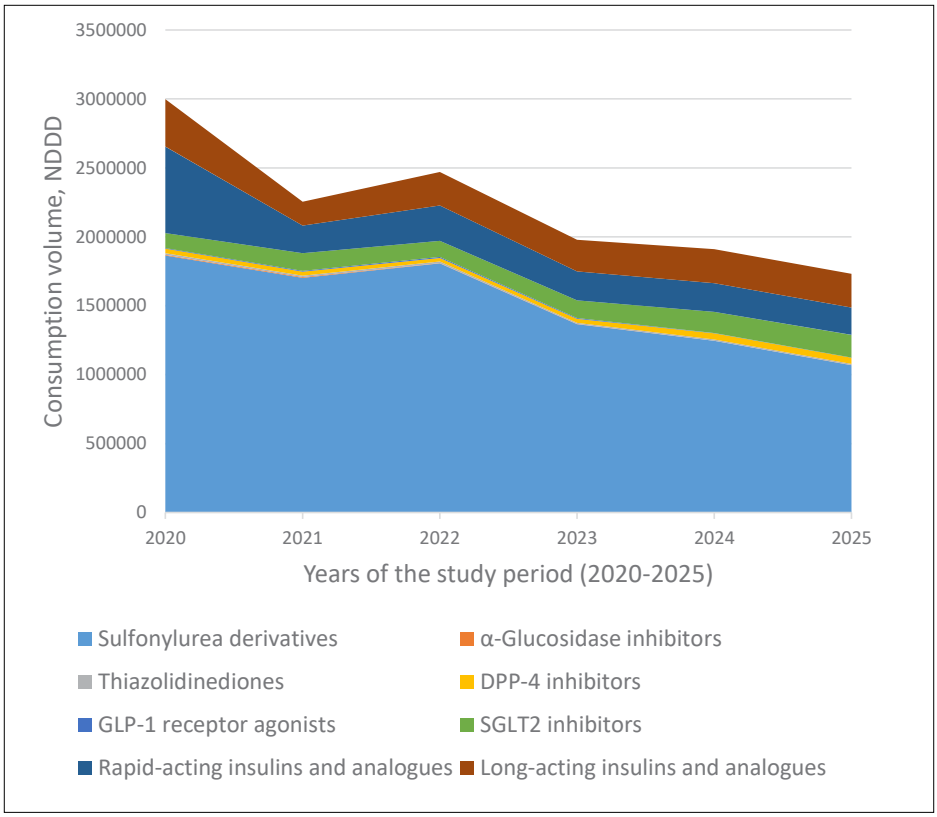


Fig. 1. Dynamics of consumption volumes of glucose-lowering medicinal products during 2020–2025 expressed as NDDD

Note: ATC group A10BA (biguanides) was not included in the analysis due to the absence of data in the primary dataset.

Table 1

Dynamics of consumption of glucose-lowering medicinal products in 2020 and 2025 expressed as NDDD

ATC code	Pharmacological group	NDDD, % (2020)	NDDD, % (2025)	Deviation (+/–)
A10BA	Biguanides	n/a	n/a	n/a
A10BB	Sulfonylurea derivatives	62.1 %	61.7 %	-0.4 %
A10BF	α-Glucosidase inhibitors	0.15 %	0.05 %	-0.1 %
A10BG	Thiazolidinediones	0.4 %	0.5 %	+0.1 %
A10BH	DPP-4 inhibitors	1.1 %	2.6 %	+1.5 %
A10BJ	GLP-1 receptor agonists	0.14 %	0.04 %	-0.1 %
A10BK	SGLT2 inhibitors	3.6 %	9.5 %	+5.9 %
A10A B	Rapid-acting insulins and analogues	20.9 %	11.4 %	-9.5 %
A10A E	Long-acting insulins and analogues	11.5 %	14.1 %	+2.7 %

Note: NDDD – number of defined daily doses. Calculations were based on retail pharmacy sales data. Due to technical limitations in the data extraction, the biguanides group (A10BA) was not included in the analysis.

increase was demonstrated by the group of sodium-glucose co-transporter 2 inhibitors (SGLT2 inhibitors, A10BK, gliflozins), whose share nearly tripled – from 3.6 % to 9.5 %. This aligns with current clinical guidelines, which recommend this group for patients with cardiovascular risks. DPP-4 inhibitors (A10BH) also showed a positive trend, with their share rising to 2.6 % (Figure 2).

Within the insulin segment, a redistribution toward long-acting insulin analogues (A10AE) was noted, with consumption increasing by 2.7 %, whereas the share of rapid-acting insulins (A10AB) decreased by 9.5 %.

For a clearer visualization of these structural changes, the data are presented in the diagram:

The next stage involved performing an ABC analysis based on 2025 expenditures, which allowed for the identification of drug groups that account for the main financial burden on the pharmacy turnover (Figure 3).

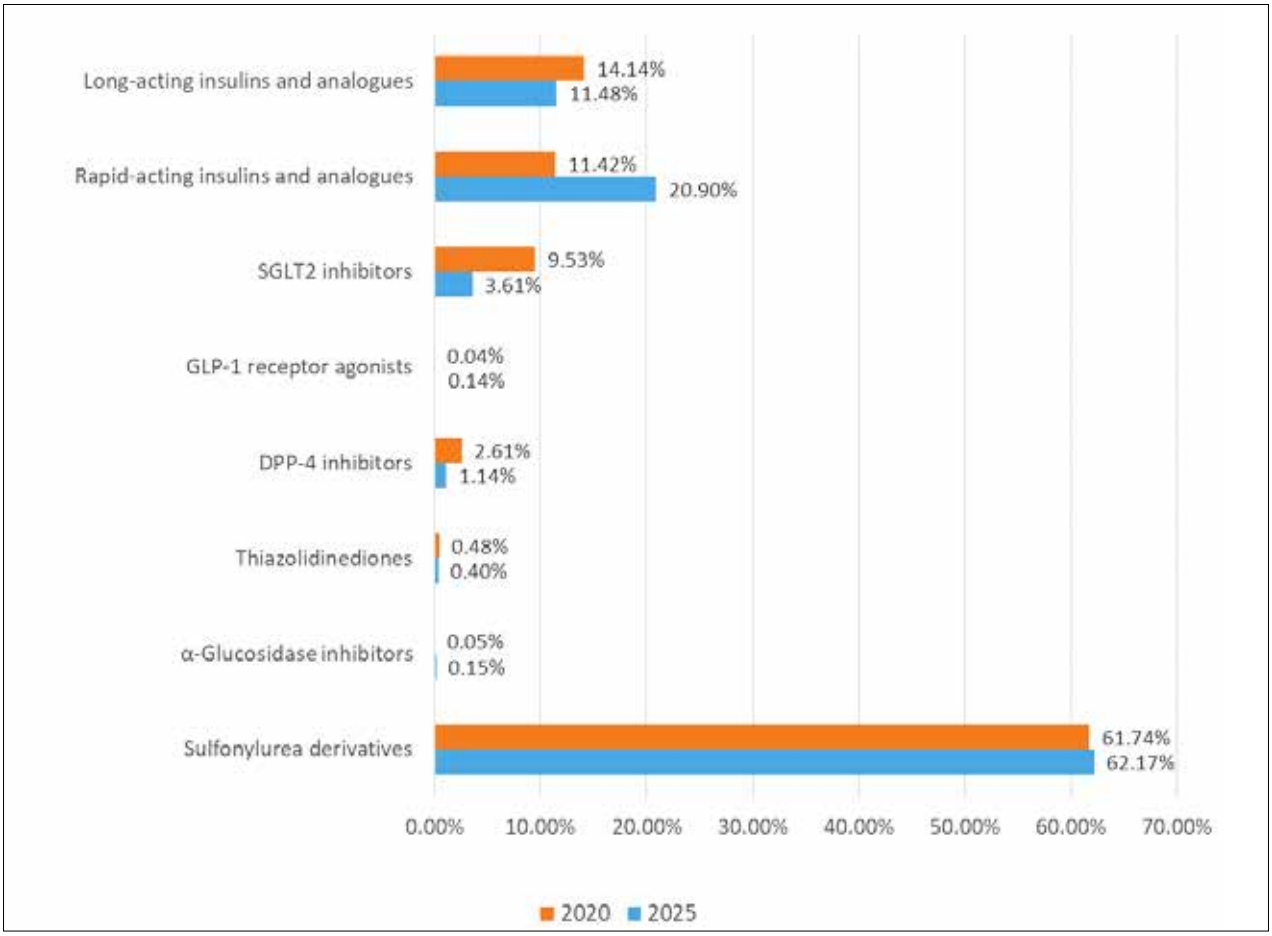


Fig. 2. Comparative structure of glucose-lowering medicinal product consumption in 2020 and 2025 (% of total NDDD)

Note: ATC group A10BA (biguanides) was not included in the analysis due to the absence of data in the primary dataset.

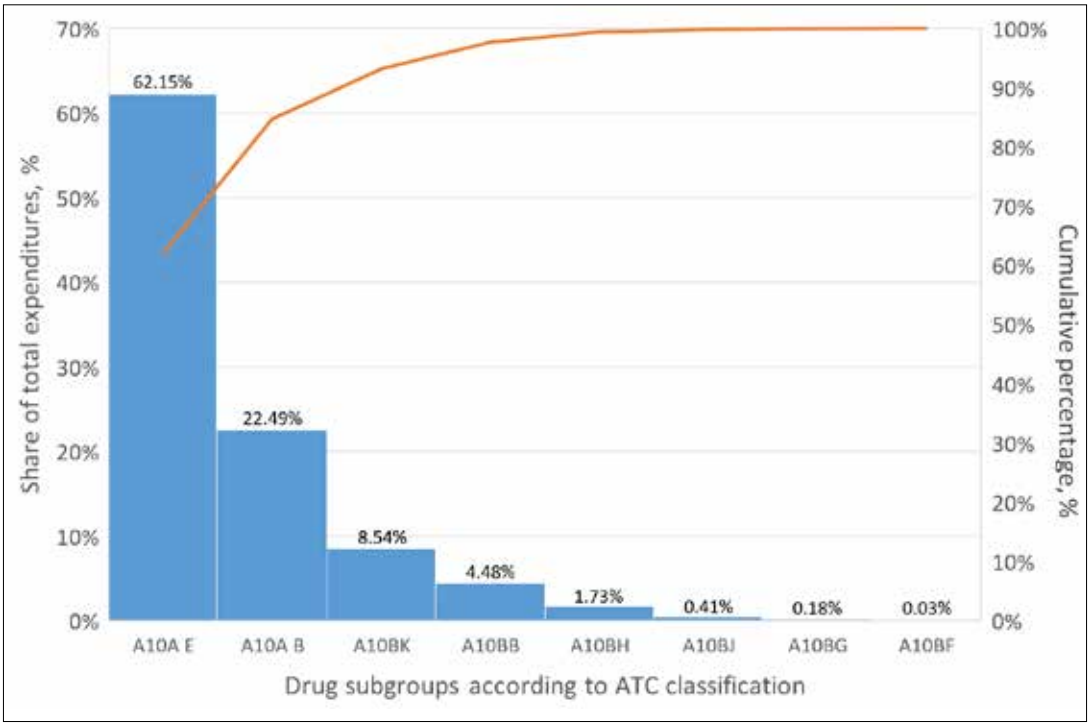


Fig. 3. Distribution of expenditures on glucose-lowering medicinal products according to ABC analysis (2025)

Note: ATC group A10BA (biguanides) was not included in the analysis due to the absence of data in the primary dataset

A detailed analysis of the expenditure structure revealed a pronounced disproportion between the natural volumes of medicinal product consumption and their financial equivalent.

The most illustrative finding concerns Group A. This category, which accounts for the lion's share of financial turnover (84.6 %), consists exclusively of biological insulin products (subgroups A10AE and A10AB). At the same time, it should be noted that in natural units (NDDD), their contribution to total consumption is considerably smaller, amounting to only about 25 %. This discrepancy highlights the high cost of biological therapy for the healthcare system compared to traditional oral agents.

Group B, representing a medium expenditure level, is comprised of SGLT2 inhibitors (A10BK). Occupying 8.5 % of the total cost structure, this drug group demonstrates a transition from "niche" innovations to financially significant agents, which correlates with their growing role in contemporary treatment protocols.

Group C, which collectively accounts for less than 7 % of the budget, includes five pharmacological subgroups. Of particular note are the sulfonylurea derivatives (A10BB). An inverse relationship is observed: while this group holds an absolutely dominant position in terms of the number of treatment days provided (61.7 % of all NDDD), it belongs to the category with the lowest financial expenditures (only 4.48 %). This fact vividly illustrates the status of sulfonylurea derivatives as the most economically accessible option for pharmacotherapy in the current market.

For a comprehensive assessment of the rationality of resource utilization, an integrated matrix combining financial indicators with the clinical importance of medicinal products according to the State Formulary was constructed (Table 2).

Table 2

Results of the integrated ABC/VEN analysis of glucose-lowering medicinal product consumption in 2025

ATC subgroup	Group name	Total (UAH)	Share (%)	Cumulative (%)	ABC category	VEN category
A10A E	Long-acting insulins and analogues	51871218.15	62.15	62.15	A	V
A10A B	Rapid-acting insulins and analogues	18770646.49	22.49	84.64	A	V
A10BK	SGLT2 inhibitors	7126911.76	8.54	93.18	B	E
A10BB	Sulfonylurea derivatives	3735065.53	4.48	97.66	C	E
A10BH	DPP-4 inhibitors	1440627.49	1.73	99.39	C	E
A10BJ	GLP-1 receptor agonists	339482.59	0.41	99.79	C	E
A10BG	Thiazolidinediones	150564.17	0.18	99.97	C	E
A10BF	α-Glucosidase inhibitors	22832.11	0.03	100.00	C	E

A detailed interpretation of the resulting matrix revealed a clear correlation between the clinical importance of medicinal products and the financial expenditures allocated for their procurement.

The dominant position in the expenditure structure is occupied by the Vital (V) category. This group includes insulins and their analogues (A10AE, A10AB), which simultaneously constitute Group A according to the ABC analysis. Such a concentration of the lion's share of the budget (over 80 %) on replacement therapy products is direct evidence of rational resource allocation, as funds are directed toward providing patients with medications whose absence poses an immediate threat to life.

The Essential (E) category demonstrated a balanced combination of innovative and traditional therapeutic approaches. It includes both high-cost SGLT2 inhibitors (A10BK, Group B) and economically accessible sulfonylurea derivatives (A10BB, Group C). This indicates that the pharmacy assortment ensures treatment accessibility for different patient categories, harmoniously combining modern cardioprotective strategies with baseline glucose-lowering therapy.

A marker of high pharmacoeconomic efficiency was the complete absence of Non-essential (N) products – secondary agents with unproven efficacy or questionable clinical appropriateness (0 % of expenditures).

Summarizing the results of the integrated analysis, it can be concluded that the financial policy of the studied pharmacy network is highly rational: 100 % of expenditures are concentrated in segments of medicinal products classified as Vital and Essential (V and E categories). This alignment underscores a resilient supply strategy tailored to the clinical needs of patients with diabetes mellitus.

Conclusions

A comprehensive pharmacoeconomic analysis of the consumption of glucose-lowering medicinal products over the period 2020–2025 allowed for the formulation of several key conclusions regarding the state and dynamics of pharmaceutical care for patients with diabetes mellitus.

During the study period, a clear trend toward the modernization of therapeutic approaches was observed. The main direction of change was an approximately 2.6-fold increase in the share of SGLT2 inhibitor consumption (from 3.6 % to 9.5 % NDDD) and a gradual shift in insulin therapy from rapid-acting insulins to modern long-acting analogues. This indicates the successful implementation of international treatment standards aimed at improving patients' quality of life and ensuring long-term cardiovascular protection.

Despite these innovative shifts, sulfonylurea derivatives remain the foundation of widespread pharmacotherapy, consistently accounting for over 60 % of total treatment days. The analysis of the "expenditure–consumption" disproportion confirmed the status of this group as the most economically accessible segment of the market, since expenditures on these drugs do not exceed 5 % of the total pharmacy network budget, despite their dominant consumption volumes.

The results of the integrated ABC/VEN analysis for 2025 confirmed the high rationality of financial resource utilization. It was established that 100 % of the pharmacy network's expenditures were directed toward the procurement of medicinal products classified as Vital and Essential. The concentration of the main funds (84.6 %) on vital insulins in the A/V segment of the ABC/VEN matrix emphasizes the priority of meeting the critical needs of patients.

Thus, the structure of glucose-lowering medicinal product consumption in 2020–2025 is characterized by balance, a high level of evidence-based practice, and a rational combination of modern high-cost treatment approaches with economically accessible traditional therapy, ensuring sustainability and efficiency of pharmaceutical provision.

Future scientific investigations will focus on deepening the pharmacoeconomic evaluation by incorporating biguanide consumption data, analyzing the direct impact of the governmental reimbursement program on patient adherence and market shifts, and assessing the cost-effectiveness of combination therapies in real-world clinical practice.

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