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Implementation quality evaluation of a type 2 diabetes mellitus pharmacotherapy pathway based on the structure–process–outcome model: a single-center study

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Implementation quality evaluation of a type 2 diabetes mellitus pharmacotherapy pathway based on the structure–process–outcome model: a single-center study

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Background: This study set out to evaluate the implementation quality of a type 2 diabetes mellitus (T2DM) pharmacotherapy pathway at a single center. Using a previously developed indicator system, the evaluation covered three dimensions—structure, process, and outcome. A further aim was to identify the main weaknesses in pathway operation and to take a preliminary look at whether the evaluation framework could work in a real-world clinical setting.

Method: The combined weights of the secondary indicators were first converted into a 100-point scale, after which a three-level scoring sheet was compiled. The pathway had been formally implemented in June 2024 and underwent its first revision in February 2025; this revised version served as the basis for the assessment. The structure dimension was evaluated according to the revised pathway document. For the process dimension, data were drawn from the stable operation period between February and October 2025. Safety and effectiveness indicators were assessed using data from 112 inpatients collected between June 2024 and October 2025. Economic indicators were examined through an exploratory before–after comparison, with the pathway

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implementation date serving as the time point and 1:2 propensity score matching applied. Indicators that could not be evaluated were conservatively scored as zero, and sensitivity analyses under three scenarios were conducted.

Result: The overall pathway score was 76.20 out of 100, with dimension-specific score rates standing at 78.4% for structure, 100% for process, and 71.8% for outcome. Once unevaluable indicators were excluded and the remaining scores standardized, the overall score rose to 85.06. Within the process dimension, the training participation rate among healthcare staff was 80%, while the pathway enrollment rate reached 94.6%, completion rate 86.5%, variance rate 10.1%, and withdrawal rate 3.4%, all reaching the "good" level. In the outcome dimension, the recorded adverse drug reaction rate under the current monitoring system was 1.79%, and the medication order appropriateness rate was 97.6%, both rated as "good." The glycated hemoglobin (HbA1c) target attainment rate was 48.2% (95% CI, 39.2%–57.4%) and the combined glucose-lipid-blood pressure target attainment rate was 10.7% (95% CI, 6.2%–17.8%), both rated as "fair." The time in range (TIR) target attainment rate was 66.1% (95% CI, 56.9%–74.2%), rated as "good." The Control Status Scale for Diabeties (CSSD70) score and the Diabetes Complications Severity Index (DCSI) were not evaluated due to missing data. After propensity score matching (204 vs. 110 cases), total hospitalization cost decreased by 5.44% compared with the pre-implementation period (P = 0.045); however, per-prescription drug cost decreased by 10.69% (P = 0.789).

Conclusion: In this single-center evaluation, the T2DM pharmacotherapy pathway performed well with regard to implementation adherence, medication order appropriateness, and currently monitored safety indicators; however, full-process coverage, long-term outcome assessment, and structured data capture remain incomplete. These findings support the utility of the evaluation framework for identifying priority areas for pathway improvement; yet they cannot confirm a causal effect of the pathway on metabolic outcomes or healthcare costs. The reliability, validity, and cross-institutional applicability of the framework require further validation.

Keywords: type 2 diabetes mellitus; pharmacotherapy pathway; implementation quality evaluation; Donabedian model; propensity score matching

Diabetes represents a major public health challenge in China, where the adult patient

population is the largest worldwide [1]. Hospitalized patients with type 2 diabetes mellitus (T2DM) frequently present with multiple comorbidities, including atherosclerotic cardiovascular disease (ASCVD) and chronic kidney disease (CKD). The wide range of available glucose-lowering agents means that treatment decisions must repeatedly balance glycemic efficacy, hypoglycemia risk, effects on body weight, and cardiorenal benefits, which substantially increases the complexity of inpatient pharmacotherapy decision-making. Nevertheless, national cross-sectional studies have shown that fewer than one in five Chinese adults with diabetes achieve the comprehensive control targets recommended by guidelines [2], and the standardization of inpatient glycemic management also remains suboptimal [3]. Translating guideline recommendations into standardized prescribing behavior in hospital settings has thus become a pressing issue in the pharmacotherapy management of diabetes.

Pharmacotherapy pathways offer a practical vehicle for addressing these issues by translating evidence-based recommendations into scenario-specific, stepwise inpatient prescribing rules. In China, pharmacotherapy pathways have been implemented in settings such as rational drug use management and clinical pharmacy services, frequently combined with PDCA cycles or information technology tools, and favorable results have been reported [4,5]. In the field of T2DM, hospitals operating under DRG-based payment have also developed clinical pharmacy pathways and observed improvements in cost structure [6]. Nevertheless, studies on pharmacotherapy pathways in China remain, overall, dominated by pathway development and process description[7], whereas evaluations of pathway implementation are largely confined to single-dimension indicators such as enrollment rate and average drug cost per visit [6,8,9]. Such indicators can hardly address the broader question of whether the pathway is rationally designed, faithfully executed, and genuinely beneficial to patients, which in turn makes it difficult to pinpoint where pathway optimization efforts should be directed.

Classic theory in healthcare quality assessment holds that medical services should be measured across three interrelated dimensions—structure, process, and outcome—so as to fully capture their quality [10]. Building on this framework, our research team had previously employed the Delphi method and the analytic hierarchy process to develop a T2DM pharmacotherapy pathway evaluation indicator system comprising 5 primary indicators and 17 secondary indicators [11]. To examine the applicability of this system in real-world clinical settings,

the present study converted it into an operational scoring instrument and conducted a single-center implementation quality evaluation of the T2DM pharmacotherapy pathway formally launched at our hospital in June 2024. The aims were to characterize the pathway's performance across the structure, process, and outcome dimensions, identify weaknesses in pathway development and execution, and provide a basis for continuous pathway improvement and refinement of the evaluation tool. Nevertheless, it should be noted that the effectiveness indicators in this study lacked pre-implementation comparators; what was assessed therefore reflects the status quo during the implementation period rather than the causal effect of pathway implementation.

1 Materials and methods

1.1 Evaluation indicator system and scoring sheet design

The evaluation tool used in this study was the T2DM pharmacotherapy pathway evaluation indicator system previously developed by our research team [11]. The system is structured around Donabedian's three-dimensional quality model of structure, process, and outcome, and comprises 5 primary indicators and 17 secondary indicators. The structure dimension, "pathway content and format," includes three secondary indicators: coverage of major diabetes-related conditions, coverage of the full pharmacotherapy process, and presentation in the form of clinical decision support tools or concise flowcharts. The process dimension, "pathway implementation," includes five secondary indicators: training participation rate among healthcare staff, pathway enrollment rate, pathway variance rate, pathway withdrawal rate, and pathway completion rate. The outcome dimension encompasses three primary indicators: medication safety (adverse drug reaction rate, medication order appropriateness rate), medication effectiveness (glycated hemoglobin [HbA1c] target attainment rate, combined glucose-lipid-blood pressure target attainment rate, Control Status Scale for Diabetes [CSSD70] score, time in range [TIR] target attainment rate, Diabetes Complications Severity Index [DCSI]), and medication economy (total hospitalization cost, average drug cost per prescription), with a total of nine secondary indicators. Within the system, medication effectiveness carries the highest weight (0.3971), followed by medication safety (0.2641). The full development process of the indicator system, including the expert consultation procedures and the weight calculation methods and results, has been described in detail in the previous study [11].

In designing the scoring sheet, the combined weight of each secondary indicator was

multiplied by 100 and converted into a maximum score on a 100-point scale, after which a unified evaluation scoring sheet was compiled. Qualitative indicators were scored using a three-level scheme: full compliance received the full score, whereas partial compliance received 60% of the score, and non-compliance received 0.For quantitative indicators, three-level thresholds of "good," "fair," and "poor" were set according to the nature of each indicator, with "good" assigned the full score, "fair" 60%, and "poor" 0. For positive indicators (e.g., training participation rate, enrollment rate, completion rate, medication order appropriateness rate, and target attainment rates), higher values corresponded to higher grades; for negative indicators (e.g., variance rate, withdrawal rate, adverse drug reaction rate, and cost-related indicators), lower values corresponded to higher grades. The scoring thresholds were determined with reference to the Chinese Guidelines for the Prevention and Treatment of Diabetes (2024 edition) [1], relevant literature, and hospital pathway management targets. It should be noted that HbA1c <7.0% was used in this study as a uniform evaluation threshold rather than as an individualized treatment target for all patients; nevertheless, in actual clinical management, the guideline's principle of individualized glycemic targets should be followed[1]. The combined glucose-lipid-blood pressure target required simultaneous attainment of HbA1c, blood pressure, and low-density lipoprotein cholesterol (LDL-C) targets. The TIR target range was set at 3.9–10.0 mmol/L. The sum of actual scores for each indicator constituted the corresponding dimension score, and the sum of the three dimension scores yielded the overall pathway score, with higher scores indicating better pathway implementation quality. For effectiveness indicators, HbA1c, blood pressure, and LDL-C were based on the last measurements before discharge, whereas TIR was calculated from continuous glucose monitoring (CGM) data collected during hospitalization, with a minimum monitoring duration of 72 hours and a minimum proportion of valid sensor data of 70%. ASCVD, CKD, and HF were determined based on inpatient examination findings and discharge summaries.

1.2 Study population

The study used inpatient medical records of patients with T2DM admitted to the Department of Endocrinology, Nanjing Drum Tower Hospital. Hospitalized cases were collected from January 2023 to October 2025. Inclusion criteria were: (1) a primary discharge diagnosis of T2DM (ICD-10 codes: E11.2–E11.9); and (2) age ≥18 years. Exclusion criteria were: (1) length of stay in the endocrinology department <3 days; (2) presence of acute complications such as hyperosmolar

hyperglycemic state or diabetic ketoacidosis; and (3) missing key data. The T2DM pharmacotherapy pathway at our hospital was formally implemented in June 2024 (initial version) and underwent its first revision in February 2025. For the economic evaluation, the formal implementation date of the pathway was used as the cutoff to divide patients into a pre-implementation group (January 2023 to May 2024) and a post-implementation group (June 2024 to October 2025).

1.3 Data collection and quality control

Data were collected using a combination of qualitative and quantitative approaches. Qualitative materials included the pathway document and its revised version, along with departmental management files and work records, all of which were used for the structure dimension evaluation. Quantitative data were obtained from the hospital information system, electronic medical record system, adverse drug reaction monitoring records, medication order review records, and pathway implementation work logs, and these data were used for the process and outcome dimension evaluations. Because the data generation patterns differed across dimension-specific indicators, the time windows for evaluation also varied accordingly; the detailed arrangements are shown in Table 1.

The definitions of the main process indicators were as follows: pathway enrollment rate = number of patients who entered pharmacotherapy pathway management / total number of hospitalized patients meeting the pathway eligibility criteria × 100%; for pathway completion rate, pathway withdrawal rate, and pathway variance rate, the denominator was uniformly defined as the number of patients who entered pharmacotherapy pathway management, with numerators being the number of patients who completed the full pathway, withdrew midway, and experienced pathway variance, respectively; healthcare staff pathway training participation rate = number of actual training attendances / number of expected training attendances × 100%.

Quantitative data were extracted independently by two researchers and cross-checked. Discrepant data were verified by tracing back to the original records. When supporting data for certain indicators could not be obtained after verification, those indicators were conservatively scored as zero and reported in the results; furthermore, their impact on the overall score was assessed through sensitivity analyses.

Table 1. Data sources and time windows for evaluation by dimension

Dimension	Data source	Time window	Notes
Structure	Revised pathway document, departmental management files	February 2025 (revised version)	Evaluation of the content and presentation format of the revised pathway
Process	Pathway implementation work logs, training records	February–October 2025	Stable operation period after revision
Outcome—safety	Adverse drug reaction monitoring records, medication order review records	June 2024–October 2025	Continuous monitoring after pathway implementation
Outcome—effectiveness	Medical records of 112 inpatients	June 2024–October 2025	Post-implementation status assessment; no pre-implementation comparator
Outcome—economy	Cost data from the hospital information system	Pre-implementation: January 2023–May 2024; post-implementation: June 2024–October 2025 (comparative)	Exploratory before–after historical comparison (PSM)

Note: The T2DM pharmacotherapy pathway at our hospital was formally implemented in June 2024 (initial version) and underwent its first revision in February 2025. The time window for each dimension was determined according to the data generation characteristics of the corresponding indicators. The overall score represents a composite characterization of the pathway across different implementation stages and aspects, rather than a snapshot at a single time point. Because the economic indicators were assessed using an exploratory before–after historical comparison design, both pre-implementation and post-implementation time windows are listed; all other indicators were evaluated as post-implementation status assessments and therefore have a single time window.

1.4 Propensity score matching

To control for baseline confounding in the economic comparison, propensity score matching was performed with the following variables included as covariates: sex, age, body mass index (BMI), blood pressure, hypertension grade, smoking history, alcohol consumption history, family

history of diabetes, diabetes duration, DCSI, medical insurance payment type, alanine aminotransferase (ALT), aspartate aminotransferase (AST), serum creatinine (Scr), estimated glomerular filtration rate (eGFR), fasting C-peptide (FCP), postprandial C-peptide (PCP), fasting plasma glucose (FPG), postprandial plasma glucose (PPG), HbA1c, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides (TG).A 1:2 nearest-neighbor matching algorithm was applied, with a caliper set at 0.2 times the standard deviation of the propensity score. Covariate balance was judged by a standardized mean difference (SMD) <0.1. All of the above covariates were derived from baseline measurements obtained at admission.

1.5 Statistical analysis

Data management and statistical analyses were performed using Excel 2019 and SPSS 26.0. Categorical variables were expressed as counts (percentages) and compared between groups using the chi-square test or Fisher's exact test. Continuous variables were first tested for normality; variables conforming to a normal distribution were expressed as mean ± standard deviation and compared using the independent samples t-test, while those not conforming to a normal distribution were expressed as median (interquartile range) and compared using the Mann-Whitney U test. The 95% confidence intervals (CIs) for rates were calculated using the Wilson method. All statistical tests were two-sided, and $P < 0.05$ was considered statistically significant. As a single-center observational quality evaluation, the reporting of this study followed the STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology) and the SQUIRE 2.0 guidelines (Standards for Quality Improvement Reporting Excellence) [12].

1.6 Sensitivity analysis

Given that scoring unevaluable indicators as zero could lower the overall score and obscure the actual performance of the evaluated indicators, three scenarios were prespecified for sensitivity analysis: (1) conservative scenario: unevaluable indicators were scored as zero; (2) standardized scenario: unevaluable indicators were excluded, after which the actual scores were rescaled to a 100-point scale based on the total maximum score of the evaluable indicators; (3) best-case scenario: all unevaluable indicators were assumed to reach the "good" level (full score). The overall scores under the three scenarios and the robustness of the main evaluation conclusions

were compared.

1.7Ethics approval and Consent to Participate

This study was approved by the Ethics Committee of Nanjing Drum Tower Hospital, the Affiliated Hospital of Nanjing University Medical School (Approval No. 2025-0392-03). The requirement for informed consent was waived by the Ethics Committee. The study was conducted in accordance with the Declaration of Helsinki and applicable institutional and ethical requirements.

2 Results

2.1 T2DM pharmacotherapy pathway evaluation scoring sheet

The combined weights of the 17 secondary indicators were converted into scores on a 100-point scale, after which a unified scoring standard was set for each indicator, yielding the T2DM pharmacotherapy pathway evaluation scoring sheet (Table 2). The maximum scores of all indicators summed to 100. Of the 17 indicators, 3 were qualitative and 14 were quantitative. The maximum total scores stood at 16.24 for the structure dimension, 11.80 for the process dimension, and 71.96 for the outcome dimension.

Table 2. T2DM pharmacotherapy pathway evaluation scoring sheet

Indicator (maximum score)	Type	Scoring criteria
1.1 Coverage of major diabetes-related conditions (4.83)	Qualitative	Full compliance: clearly covers the main medication decision scenarios and major diabetes-related conditions in T2DM; partial compliance: covers only part of the major populations or a single subtype; non-compliance: does not reflect major conditions or key clinical stratification
1.2 Coverage of the full pharmacotherapy process (8.75)	Qualitative	Full compliance: covers initial assessment, treatment initiation, treatment escalation/de-escalation, target attainment assessment, monitoring and follow-up, and management of special situations; partial compliance: covers initiation and escalation, but monitoring, follow-up, or special situation management is incomplete; non-compliance: merely a list of drugs or partial treatment recommendations
1.3 Presentation in the form of clinical decision support tools or concise flowcharts (2.66)	Qualitative	Full compliance: clearly presented as a flowchart or electronic decision support tool; partial compliance: text-based workflow but not

		sufficiently intuitive; non-compliance: no workflow-based presentation
2.1 Healthcare staff pathway training participation rate (4.26)	Quantitative	Good: ≥80%; fair: 60%–79.9%; poor: <60%
2.2 Pathway enrollment rate (2.13)	Quantitative	Good: ≥70%; fair: 50%–69.9%; poor: <50%
2.3 Pathway variance rate (1.13)	Quantitative	Good: <30%; fair: 30%–39.9%; poor: ≥40%
2.4 Pathway withdrawal rate (1.50)	Quantitative	Good: <30%; fair: 30%–39.9%; poor: ≥40%
2.5 Pathway completion rate (2.78)	Quantitative	Good: ≥70%; fair: 50%–69.9%; poor: <50%
3.1 Adverse drug reaction rate (17.60)	Quantitative	Good: <5%; fair: 5%–10%; poor: >10%
3.2 Medication order appropriateness rate (8.80)	Quantitative	Good: ≥95%; fair: 90%–94.9%; poor: <90%
4.1 HbA1c target attainment rate (12.34)	Quantitative	Target attainment defined as HbA1c <7.0% (study evaluation threshold); good: ≥60%; fair: 40%–59.9%; poor: <40%
4.2 Combined glucose-lipid-blood pressure target attainment rate (12.34)	Quantitative	All three targets met simultaneously: HbA1c <7.0%, blood pressure <130/80 mmHg, and LDL-C <1.8 mmol/L (with ASCVD) or <2.6 mmol/L (without ASCVD); good: ≥20%; fair: 10%–19.9%; poor: <10%
4.3 CSSD70 score (3.47)	Quantitative	Evaluated after standardizing the total scale score to 100; good: ≥70; fair: 60–69.9; poor: <60
4.4 TIR target attainment rate (4.61)	Quantitative	Target attainment defined as TIR >70% (target range 3.9–10.0 mmol/L); good: ≥60%; fair: 40%–59.9%; poor: <40%
4.5 DCSI (6.95)	Quantitative	Evaluated as the change in DCSI from before to after treatment; good: unchanged or decreased; fair: increased by 1 point; poor: increased by 2 points or more
5.1 Total hospitalization cost (3.90)	Quantitative	Evaluated as the percentage change after versus before implementation; good: decrease or increase ≤5%; fair: increase >5% and ≤10%; poor: increase >10%
5.2 Average drug cost per prescription (1.95)	Quantitative	Evaluated as the percentage change after versus before implementation; good: decrease or increase ≤5%; fair: increase >5% and ≤10%; poor: increase >10%

Note: T2DM, type 2 diabetes mellitus; CSSD70, Control Status Scale for Diabetes (70 items); TIR, time in range; DCSI, Diabetes Complications Severity Index; HbA1c, glycated hemoglobin;

ASCVD, atherosclerotic cardiovascular disease; LDL-C, low-density lipoprotein cholesterol. The scoring thresholds were determined primarily with reference to the Chinese Guidelines for the Prevention and Treatment of Diabetes (2024 edition) and commonly used clinical evaluation criteria, in combination with hospital pathway management targets.

2.2 Structure dimension evaluation

The T2DM pharmacotherapy pathway at our hospital was formally implemented in June 2024 and then underwent its first revision in February 2025. It is presented as a flowchart with accompanying text and comprises two main sections: the pharmacotherapy pathway itself and commonly used medications in the pathway. The pathway covers major diabetes-related conditions , which include T2DM, T2DM with dyslipidemia, diabetic neuropathy, diabetic retinopathy, and diabetic kidney disease.For T2DM specifically, the pathway is further divided into two branches according to the presence or absence of high-risk factors, ASCVD, CKD, or heart failure (HF). With regard to treatment stages, the pathway covers initial assessment, treatment initiation, treatment escalation/de-escalation, and target attainment assessment, whereas the sections on monitoring and follow-up and management of special situations are relatively weak. Accordingly, the indicators "coverage of major diabetes-related conditions" and "presentation in the form of clinical decision support tools or concise flowcharts" were rated as full compliance, while "coverage of the full pharmacotherapy process" was rated as partial compliance. The structure dimension score was 12.74 out of 16.24 (score rate 78.4%), with all lost points attributable to the indicator "coverage of the full pharmacotherapy process" (Table 3).

2.3 Process dimension evaluation

During pathway implementation, attending physicians were responsible for enrollment assessment, treatment decisions, and medication adjustments; nursing staff were responsible for blood glucose monitoring, patient education, and implementation records; clinical pharmacists participated in medication order review, pharmaceutical care, and medication education, as well as periodically inspecting, commenting on, and reporting pathway execution.Patients who were pregnant, had concomitant malignant tumors, had severe hepatic or renal dysfunction, or required transfer to other treatment pathways due to clinical deterioration were recorded and managed according to the pathway withdrawal criteria. Regarding training, the attendance rate for pathway implementation training among endocrinology department physicians and nurses was 80%,

meeting the "good" standard. Among T2DM inpatients in the stable post-revision period from February to October 2025, the pathway enrollment rate was 94.6%, with non-enrolled cases mainly attributable to failure to meet pathway eligibility criteria or patient refusal of pharmacotherapy. The pathway completion rate was 86.5%, the withdrawal rate 3.4%, and the variance rate 10.1%, all of which reached the "good" level. The process dimension score was 11.80 out of 11.80 (score rate 100%) (Table 3).

Table 3. Evaluation results for structure and process dimension indicators

Dimension	Indicator	Evaluation	Score	Maximum score
Structure	1.1 Coverage of major diabetes-related conditions	Full compliance	4.83	4.83
	1.2 Coverage of the full pharmacotherapy process	Partial compliance	5.25	8.75
	1.3 Presentation in the form of clinical decision support tools or concise flowcharts	Full compliance	2.66	2.66
	Subtotal	—	12.74	16.24
Process	2.1 Healthcare staff pathway training participation rate	Good	4.26	4.26
	2.2 Pathway enrollment rate	Good	2.13	2.13
	2.3 Pathway variance rate	Good	1.13	1.13
	2.4 Pathway withdrawal rate	Good	1.50	1.50
	2.5 Pathway completion rate	Good	2.78	2.78
	Subtotal	—	11.80	11.80

Note: Score rate = score / maximum score × 100%.

2.4 Outcome dimension evaluation

2.4.1 Medication safety

From June 2024 to October 2025, the recorded adverse drug reaction rate among T2DM inpatients in the endocrinology department under the existing adverse drug reaction monitoring system was 1.79%. The reported reactions consisted mainly of gastrointestinal symptoms such as nausea and vomiting occurring after the use of metformin or liraglutide. According to the scoring criteria (<5% rated as good), this indicator was judged as "good" and received 17.60 points out of 17.60.It should be noted that the identification of adverse reactions relied on clinical reporting, and underreporting may exist; therefore, this proportion cannot be directly equated with the true risk of adverse reactions. Regarding the medication order appropriateness rate, 10 inpatient

medication orders were randomly selected for review each month during the study period, yielding a cumulative appropriateness rate of 97.6% (≥95% rated as good), which was judged as "good" and received 8.80 points out of 8.80. The sample size of the medication order review was limited, and its representativeness of medication order quality over the entire study period requires verification with larger samples.

2.4.2 Medication effectiveness

A cross-sectional analysis was conducted on 112 T2DM inpatients included after pathway implementation. Fifty-four patients achieved HbA1c <7.0%, corresponding to a target attainment rate of 48.2% (95% CI, 39.2%–57.4%; 40%–59.9% rated as fair), which was judged as "fair" and received 7.40 points out of 12.34. Twelve patients achieved the combined glucose-lipid-blood pressure control target, yielding a combined target attainment rate of 10.7% (95% CI, 6.2%–17.8%; 10%–19.9% rated as fair), which was judged as "fair" and received 7.40 points out of 12.34. Seventy-four patients achieved TIR >70%, corresponding to a target attainment rate of 66.1% (95% CI, 56.9%–74.2%; ≥60% rated as good), which was judged as "good" and received 4.61 points out of 4.61. The CSSD70 score and DCSI could not be objectively evaluated because systematic and structured assessment records were lacking in the inpatient medical records; these two indicators were conservatively scored as zero, together accounting for 10.42 points. Nevertheless, in the absence of corresponding pre-implementation control data, the above results reflect the observed levels during the pathway implementation period rather than changes brought about by pathway implementation.

2.4.3 Medication economy

The economic evaluation used an exploratory before–after historical comparison design. A total of 633 eligible patients were included during the study period, with 521 in the pre-implementation group and 112 in the post-implementation group. After 1:2 propensity score matching, 204 patients remained in the pre-implementation group and 110 in the post-implementation group. Most covariates achieved the prespecified balance criterion (SMD <0.1) after matching, but the SMDs for HbA1c, Scr, and PPG ranged from 0.101 to 0.107, indicating mild residual imbalance; as a result, the corresponding results should be interpreted with caution (Table 4). The cost comparison showed that the total hospitalization cost after pathway implementation was 7880.15 (6746.21, 9366.07) yuan, a decrease of 5.44% compared

with 8333.31 (7366.62, 9427.41) yuan before implementation, and the difference was statistically significant (P = 0.045). The average drug cost per prescription decreased from 275.24 (135.72, 474.63) yuan to 245.82 (136.37, 545.61) yuan, a reduction of 10.69%, but the difference was not statistically significant (P = 0.789) (Table 5). The scoring grades for the cost indicators were determined according to the prespecified thresholds of percentage change rather than statistical significance. Both indicators changed in the direction of a decrease and were therefore rated as "good," receiving 3.90 and 1.95 points, respectively (both full scores). Given that the historical control design cannot control for confounding factors such as temporal trends, the results in this section are best interpreted as an exploratory comparison of costs before and after pathway implementation, rather than as causal inference.

Table 4. Baseline characteristics of the two groups after propensity score matching

Variable	Pre-implementation group (N=204)	Post-implementation group (N=110)	SMD
Male sex, n (%)	137 (67.2)	74 (67.3)	0.000
Age, years	57.09 ± 14.53	59.00 ± 8.75	0.038
BMI, kg/m²	24.20 (22.20, 26.70)	24.20 (22.02, 26.58)	0.058
Diabetes duration, years	10.00 (4.00, 20.00)	10.00 (6.00, 16.00)	0.021
DCSI, points	1.00 (0.00, 2.00)	1.00 (0.00, 2.00)	0.093
Public medical insurance, n (%)	128 (62.7)	70 (63.6)	0.036
HbA1c, %	7.20 (6.30, 8.70)	7.15 (6.20, 8.30)	0.107
FPG, mmol/L	6.83 (5.76, 8.43)	6.44 (5.55, 8.62)	0.016
PPG, mmol/L	13.19 (10.73, 16.79)	14.00 (10.41, 17.12)	0.101
LDL-C, mmol/L	2.52 (1.80, 3.14)	2.34 (1.84, 3.01)	0.033
Scr, μmol/L	63.00 (53.00, 72.00)	65.00 (53.00, 78.00)	0.103
eGFR, ml/min/1.73m²	112.25 (96.10, 134.10)	106.25 (89.58, 127.82)	0.032

Note: BMI, body mass index; DCSI, Diabetes Complications Severity Index; HbA1c, glycated hemoglobin; FPG, fasting plasma glucose; PPG, postprandial plasma glucose; LDL-C, low-density lipoprotein cholesterol; Scr, serum creatinine; eGFR, estimated glomerular filtration rate; SMD, standardized mean difference. Only major covariates are listed; the SMDs of the remaining covariates (smoking history, alcohol consumption history, family history of diabetes, blood pressure, hypertension grade, ALT, AST, FCP, PCP, HDL-C, TC, TG, etc.) were all <0.1 after matching. For multi-category variables, the SMD was taken as the maximum absolute value across all categories after matching. Categorical variables are expressed as counts (percentages);

normally distributed continuous variables are expressed as mean ± standard deviation; skewed continuous variables are expressed as median (interquartile range).

Table 5. Comparison of economic indicators between the two groups before and after pathway implementation

Variable	Pre-implementation group (N=204)	Post-implementation group (N=110)	Change rate	P
Total hospitalization cost, yuan	8333.31 (7366.62, 9427.41)	7880.15 (6746.21, 9366.07)	−5.44%	0.045
Average drug cost per prescription, yuan	275.24 (135.72, 474.63)	245.82 (136.37, 545.61)	−10.69%	0.789

Note: Cost data were skewed and are expressed as median (interquartile range); between-group comparisons were performed using the Mann-Whitney U test. This was an exploratory before–after historical comparison, and the observed cost changes cannot be attributed to pathway implementation itself.

2.4.4 Summary of outcome dimension scores

The evaluation results for the individual outcome dimension indicators are shown in Table 6. The total outcome dimension score was 51.66 out of 71.96 (score rate 71.8%).

Table 6. Evaluation results for outcome dimension indicators

Indicator	Evaluation	Score	Maximum score
3.1 Adverse drug reaction rate	Good	17.60	17.60
3.2 Medication order appropriateness rate	Good	8.80	8.80
4.1 HbA1c target attainment rate	Fair	7.40	12.34
4.2 Combined glucose-lipid-blood pressure target attainment rate	Fair	7.40	12.34
4.3 CSSD70 score	Not evaluated	0.00	3.47
4.4 TIR target attainment rate	Good	4.61	4.61
4.5 DCSI	Not evaluated	0.00	6.95
5.1 Total hospitalization cost	Good	3.90	3.90
5.2 Average drug cost per prescription	Good	1.95	1.95
Total	—	51.66	71.96

Note: The CSSD70 score and DCSI were not evaluated due to missing data and were conservatively scored as zero. "Not evaluated" is not equivalent to "poor performance"; the impact

of these indicators on the overall score is addressed in the sensitivity analysis (Section 2.6).

2.5 Overall evaluation results

According to the prespecified scoring rules, the overall score of the T2DM pharmacotherapy pathway at our hospital was 76.20 out of 100 (score rate 76.2%). Among the three dimensions, the process dimension had the highest score rate (100%), with the structure dimension following at 78.4% and the outcome dimension at 71.8%. The outcome dimension carried the largest weight in the indicator system (0.7196), but its observed performance had the lowest score rate among the three dimensions, thus constituting the main constraint on the overall score.These results indicate that the T2DM pharmacotherapy pathway at our hospital has established an operational pattern characterized by a relatively complete structure and adequate execution, while full-process coverage in the structure dimension and long-term outcome indicators in the outcome dimension represent the main current weaknesses. It should be emphasized that the overall score is a composite characterization of the pathway across different implementation stages and aspects (time windows for each dimension are shown in Table 1), and its interpretation should take data availability into account. The primary analysis used the conservative scenario (unevaluable indicators scored as zero), yielding an overall score of 76.20.

2.6 Sensitivity analysis

To examine the impact of the unevaluated CSSD70 and DCSI indicators on the overall score, a three-scenario analysis was conducted as prespecified in Section 1.6. Under the conservative scenario (unevaluable indicators scored as zero), the overall score was 76.20. Under the standardized scenario, the two unevaluated indicators (CSSD70 and DCSI, together accounting for 10.42 points) were excluded; the maximum score of the evaluable indicators was 89.58, and the overall score was recalculated as $76.20 \div 89.58 \times 100 = 85.06$. Under the best-case scenario (both unevaluated indicators assumed to reach the "good" level and receive full scores), the overall score was 86.62. The latter two scenarios served only as sensitivity analyses to reflect the potential influence of data availability on the overall score and do not replace the primary analysis. Compared with the conservative scenario, the overall scores under these two scenarios were 8.86 and 10.42 points higher, respectively, indicating that data availability had a substantial impact on the overall score. Nevertheless, the identification of the two main weaknesses—insufficient full-process coverage in the structure dimension and low long-term metabolic target attainment

rates in the outcome dimension—remained unchanged across all scenarios, and the main evaluation conclusions were robust.

3 Discussion

Using the T2DM pharmacotherapy pathway evaluation indicator system developed in our previous work as the assessment tool, we conducted a single-center evaluation of pathway implementation quality at our hospital. According to the prespecified scoring rules, the overall score was 76.20, a value that can be considered moderately high. The score rates across the three dimensions showed a graded pattern (100% for process, 78.4% for structure, and 71.8% for outcome), suggesting that the pathway has established a foundation of "relatively complete structure and adequate execution," yet the translation from standardized implementation to outcome improvement remains insufficient.One point worth clarifying is that the effectiveness indicators in this study lacked pre-implementation comparators; the overall score therefore reflects the status quo of each dimension during the implementation period rather than the causal effect of pathway implementation. This pattern aligns with the logic of Donabedian's theory that structure supports process and process influences outcome [10], and may serve as directional guidance for subsequent improvement.

The lost points in the structure dimension were concentrated in the single indicator "coverage of the full pharmacotherapy process." Our pathway is anchored on inpatient treatment decisions and is stratified by cardiovascular risk and renal function, a design that aligns with the risk stratification and individualized treatment principles emphasized in current guidelines [1]. Nevertheless, the sections on monitoring and follow-up, management of special situations, and post-discharge medication transition are underdeveloped. The chronic nature of T2DM management means that sustained improvement in metabolic control is difficult to achieve through inpatient interventions alone; if the pathway stops at the inpatient scenario, its contribution to long-term patient benefit will be limited. Future revisions should therefore preserve the advantages of stratified decision-making while incorporating monitoring and follow-up time points, special situation management branches, and post-discharge continuity management, thereby facilitating the evolution of the pathway from an "inpatient decision tool" toward a "full-process management tool."

The process dimension received a full score, with an enrollment rate of 94.6%, completion

rate of 86.5%, variance rate of 10.1%, and withdrawal rate of 3.4%, reflecting a high level of implementation adherence. These results suggest that the pathway content is broadly compatible with the diagnosis and treatment needs of hospitalized T2DM patients and that clinical teams have a high degree of acceptance. However, it should be pointed out that a high score on process indicators reflects that the pathway "can be executed" rather than that it was "executed with high quality." Non-enrollment, withdrawal, and variance cases were concentrated in special populations such as pregnant patients and those with concomitant malignancies, as well as in situations involving patient refusal of medication, indicating persistent tension between standardized pathways and individualized clinical decision-making. Classifying variance causes and establishing a regular feedback mechanism may help shift pathway execution from a "high execution rate" toward "high execution quality."

Within the outcome dimension, the adverse drug reaction rate recorded under the existing monitoring system was 1.79%, and the medication order appropriateness rate was 97.6%, both reaching the "good" level. The high medication order appropriateness rate observed during the study period, together with the fact that the types of adverse reactions were largely consistent with the known adverse reaction profiles of commonly used glucose-lowering agents [13], suggests that inpatient prescribing behavior during pathway implementation was generally standardized. However, the identification of adverse reactions relied on clinical reporting and may be subject to underreporting, and the medication order appropriateness rate was based on a small monthly sample of 10 orders, so both estimates have limitations. Regarding medication effectiveness, the TIR target attainment rate of 66.1% (95% CI, 56.9%–74.2%) reached the "good" level, whereas the HbA1c target attainment rate of 48.2% (95% CI, 39.2%–57.4%) and the combined glucose-lipid-blood pressure target attainment rate of 10.7% (95% CI, 6.2%–17.8%) were only "fair," and the confidence intervals indicate limited precision for the latter two estimates. TIR reflects short-term glycemic fluctuation control and is sensitive to intensified treatment during hospitalization [14], whereas HbA1c and combined glucose-lipid-blood pressure target attainment are more heavily influenced by long-term management prior to admission and underlying disease status, and are difficult to change substantially within a short period. In the absence of pre-implementation controls, these results should be interpreted as observed values during the pathway implementation period rather than as improvements attributable to the pathway. They are

consistent with the low rates of comprehensive control target attainment among Chinese patients with T2DM reported nationally [2], suggesting that the main contribution of the inpatient pathway currently remains concentrated in short-term metabolic management.

CSSD70 and DCSI could not be evaluated because structured assessment data were lacking. Conservatively scoring these two indicators as zero resulted in a direct loss of 10.42 points in the outcome dimension. The sensitivity analysis showed that under the standardized and best-case scenarios, the overall scores rose to 85.06 and 86.62, respectively, indicating that "not evaluated" and "poor performance" were conflated under the current scoring rules and that data availability had a substantial impact on the overall score. This represents an inherent limitation of the evaluation framework. A deeper issue concerns indicator appropriateness: DCSI reflects the cumulative burden of diabetic complications and generally does not change in a clinically meaningful way over the short term, making it better suited as a baseline disease severity variable or a risk adjustment factor rather than a short-term outcome indicator for an inpatient pathway. CSSD70, as a patient-reported outcome, also requires standardization regarding the timing and method of inpatient assessment [15,16]. Future work should consider moving these two indicators to the follow-up evaluation stage, or distinguishing "not evaluated" from "poor" in the scoring rules, and reporting the data availability of each indicator separately.

The economic analysis employed an exploratory before–after historical comparison design. After propensity score matching, total hospitalization cost decreased by 5.44% (P = 0.045) and average drug cost per prescription decreased by 10.69% (P = 0.789). However, these results should be interpreted only as exploratory findings. After matching, mild residual imbalance remained for HbA1c, Scr, and PPG (SMD 0.101–0.107), and the historical control design cannot control for time-varying factors such as centralized drug procurement, medical insurance reimbursement policies, inpatient management models, and case mix [17]. The observed cost changes therefore cannot be attributed to the pathway itself. Confidence intervals for the cost differences were not calculated in this study, and the precision of these estimates requires further analysis based on the original data. Future studies should consider designs such as monthly cost trend analysis or interrupted time series analysis to re-examine the economic effects of pathway implementation after adjusting for temporal trends and seasonality.

Compared with existing studies, the value of this work lies in the systematic nature of the

evaluation framework. Previous studies on pharmacotherapy pathways have mostly stopped at pathway development and process description [5], or have measured implementation status using single indicators such as enrollment rate or average drug cost [6-9]. In this study, the indicator weights determined by the Delphi method and the analytic hierarchy process were converted into a scoring instrument, enabling a hierarchical localization from overall level to dimension performance to specific indicator weaknesses, thereby identifying relatively weak links across the structure, process, and outcome dimensions. It should be recognized, however, that this single-center application only preliminarily demonstrates that the framework can support multidimensional pathway evaluation. Its reliability (e.g., inter-rater consistency), validity (e.g., association with clinical outcomes), and ability to discriminate among different institutions, different stages, or different pathway versions all require verification in multicenter, multi-time-point studies in the future.

Based on the evaluation results, the following improvements are suggested. First, the pathway content should be refined by incorporating monitoring and follow-up, management of special situations, and post-discharge continuity management, together with more detailed patient stratification and branching logic. Second, pathway training should become routine, with regular feedback on enrollment, variance, and withdrawal, and a dynamic pathway revision mechanism should be established based on implementation data and emerging guideline evidence. Third, information system development should be advanced by embedding pathway node alerts and automated extraction of key indicators into the electronic medical record system, enabling structured capture of outcome information such as CSSD70 and DCSI, and distinguishing "not evaluated" from "poor performance" in the evaluation instrument. Fourth, a follow-up database for T2DM patients should be established to accumulate data for long-term effectiveness evaluation of the pathway and for staged comparisons between the initial and revised pathway versions.

This study has several limitations. First, it was a single-center evaluation, and the generalizability of the findings requires verification in multicenter studies. Second, the time windows for the dimension-specific indicators were not fully consistent: the structure dimension was based on the revised pathway document, the process dimension used data from the stable post-revision operation period, and the safety and economic indicators covered the entire period spanning both before and after the revision. The overall score thus represents a composite

characterization of the pathway across different implementation stages and aspects, rather than a measurement at a single time point for a specific pathway version; staged evaluations of the initial and revised versions are warranted in the future. Third, the effectiveness indicators lacked pre-implementation comparators, precluding before–after outcome comparisons and the use of designs such as interrupted time series to support causal interpretation. Fourth, CSSD70 and DCSI were not evaluated, and scoring them as zero may have underestimated the level of pathway implementation; the sensitivity analysis showed that the overall score was sensitive to this handling. Fifth, the scoring rule that "partial compliance" receives 60% of the full score entails a degree of subjectivity, and the weight sensitivity analysis showed that the overall score varied within a range of 72.87–82.94 (Supplementary Table 1), indicating that changes in thresholds and weights had a substantial impact on the overall score. Sixth, although propensity score matching controlled for measured baseline differences, mild residual imbalance remained, and unmeasured confounding and temporal trends could not be controlled. Seventh, the sample sizes for adverse reaction monitoring and medication order review were limited, and the safety results may be underestimated or imprecisely estimated. Eighth, the evaluation was based predominantly on cross-sectional data, and the impact of the pathway on long-term outcomes requires confirmation through longitudinal follow-up studies.In addition, ninth, the qualitative judgments in the structure dimension were completed by the research team through discussion based on the unified scoring sheet together with the pathway document and departmental work logs; two independent raters were not assigned to score separately in a blinded manner, and inter-rater consistency (e.g., the Kappa coefficient) was not calculated. The definition of "partial compliance" for qualitative indicators such as "coverage of the full pharmacotherapy process" involves a degree of subjectivity, and the overall reliability of the scoring instrument requires dedicated evaluation. This also represents an important source of the previously noted need for more comprehensive assessment of reliability in the process and outcome dimensions. Tenth, the pathway was initially implemented in June 2024 and first revised in February 2025, but this study did not conduct staged evaluations of the initial and revised versions, largely because of data constraints. On the one hand, the process implementation logs and effectiveness monitoring data before and after the revision were not fully consistent in terms of recording definitions and starting time points, making strictly comparable between-version evaluation difficult. On the other hand, the stable

post-revision operation period (February to October 2025) was relatively short, and the sample size and observation period within each stage would have been insufficient to support robust estimation. To avoid the influence of version mixing on indicator interpretation, the structure dimension was uniformly evaluated on the basis of the revised pathway document, and the process dimension was likewise restricted to the stable post-revision operation period, at the cost of not separately characterizing the implementation status of the initial version.Eleventh, process indicators including pathway enrollment rate, completion rate, withdrawal rate, and variance rate, as well as safety indicators such as the adverse reaction rate and medication order appropriateness rate, were all reported as aggregate proportions. Because the corresponding raw logs and monitoring records were not registered case by case using unified fields, the specific numerator and denominator counts underlying these indicators could not be provided. In addition, 95% confidence intervals were not calculated for the above proportions or for the cost changes, which to some extent limits readers' ability to independently verify the robustness of these estimates. These issues should be addressed in the future after structured, case-by-case traceable data recording is established. Twelfth, owing to the limited granularity of cost data collection, monthly time series of total hospitalization cost and drug cost were not obtained, precluding monthly trend analysis or interrupted time series analysis. The diagnosis and causality assessment of adverse reactions followed the hospital's existing adverse drug reaction monitoring and reporting process, without independent review or separate identification of specific adverse events such as hypoglycemia. Medication order review was based on random selection of 10 orders per month, and the internal consistency of the review criteria was not repeatedly evaluated. Moreover, because a follow-up database has not yet been established, supplementary outcomes such as dynamic changes in blood glucose and HbA1c during hospitalization, length of stay, hypoglycemic events, and 30/90-day readmission could not be included in the report. These limitations mean that the cost and safety results of this study should be interpreted only as exploratory findings, and inferences regarding causality and true incidence rates require confirmation in studies with more complete data.

In summary, under the prespecified scoring system of this study, the overall score of the T2DM pharmacotherapy pathway at our hospital was 76.20 (85.06 after standardized rescaling). The pathway performed well in implementation adherence, medication order appropriateness, and

currently monitored safety indicators, whereas full-process coverage, long-term metabolic control, and structured outcome data capture were the main weaknesses. This evaluation provides preliminary evidence that the framework is capable of identifying priorities for pathway improvement, but it cannot confirm a causal effect of the pathway on metabolic outcomes or healthcare costs. Future work should unify the evaluation time framework, improve outcome data capture, and examine the reliability and validity of the evaluation instrument in multicenter applications, thereby promoting the transition of the pathway from "present and executable" toward high-quality operation characterized by "full-process coverage and optimized outcomes."

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request, subject to institutional approval and applicable data protection requirements.

Conflict of Interest Statement

All authors declare that they have no conflicts of interest, financial or non-financial, related to this manuscript.

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Author Contributions

ZW, XZ, and JW contributed equally to this work. ZW contributed to data curation. XZ contributed to formal analysis, validation, and writing the original draft. JW contributed to investigation and resources. LTL contributed to formal analysis. HX contributed to

conceptualization and supervision. LL contributed to project administration and writing—review and editing. CJ contributed to funding acquisition, supervision, and writing—review and editing. All authors reviewed and approved the final version of the manuscript.

References

[1] Chinese Diabetes Society. Chinese guidelines for the prevention and treatment of diabetes (2024 edition) [J]. Chinese Journal of Diabetes Mellitus, 2025, 17(1): 16-139.

[2] Zhong VW, Yu D, Zhao L, et al. Achievement of guideline-recommended targets in diabetes care in China: a nationwide cross-sectional study [J]. Annals of Internal Medicine, 2023, 176(8): 1037-1046.

[3] Hao S, Zhang N, Fish AF, et al. Inpatient glycemic management in internal medicine: an observational multicenter study in Nanjing, China [J]. Current Medical Research and Opinion, 2017, 33(8): 1371-1377.

[4] Zhou CK, Ding SM, Zhang R, et al. Construction of a new model for rational drug use management based on the PDCA cycle and pharmacotherapy pathways [J]. Chinese Journal of Hospital Pharmacy, 2021, 41(1): 98-102.

[5] Jing FB, Zhou CK, Han B, et al. Exploration and practice of clinical pharmacotherapy pathways in our hospital [J]. Chinese Hospital Management, 2019, 39(2): 47-49, 52.

[6] Dai XF, Du J. Development and application effectiveness analysis of a clinical pharmacy pathway for type 2 diabetes mellitus under the DRG environment [J]. Chinese Journal of Hospital Pharmacy, 2022, 42(22): 2415-2420.

[7] Luo X, Wang ZY, Ling J, et al. Visualization analysis of the research status and hotspots of pharmacotherapy pathways [J]. Herald of Medicine, 2025, 44(7): 1101-1110.

[8] Wang FY, Wang JQ, Wang QH. Effectiveness analysis of clinical pathway management for patients with type 2 diabetes mellitus under DRG payment [J]. Jiangsu Health System Management, 2022, 33(11): 1511-1513.

[9] Gu CS, Shi P, He MF, et al. Evaluation of clinical pathway implementation under the DRG payment system: an interrupted time series analysis [J]. China Health Insurance, 2022(5): 11-16.

[10] Donabedian A. The quality of care. How can it be assessed? [J]. JAMA, 1988, 260(12): 1743-1748.

[11] Wang ZY. Construction and application of an evaluation indicator system for type 2 diabetes mellitus pharmacotherapy pathways [D]. Nanjing: China Pharmaceutical University, 2026.

[12] Ogrinc G, Davies L, Goodman D, et al. SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process [J]. BMJ Quality & Safety, 2016, 25(12): 986-992.

[13] Lu CX, Lu CF, Zhang HQ, et al. Gastrointestinal adverse reactions associated with glucagon-like peptide-1 receptor agonists: a review [J]. China Pharmacy, 2024, 35(12): 1539-1544.

[14] Dai DJ, Lu JY, Zhou J. New metrics in continuous glucose monitoring: clinical implications of time in range [J]. Chinese Journal of Diabetes Mellitus, 2019, 11(2): 139-142.

[15] Zhao LB, Chen QD, Zhou YX, et al. Application of the Control Status Scale for Diabetes in type 2 diabetes [J]. Chinese Journal of Endocrinology and Metabolism, 2004, 20(4): 318-322.

[16] Young BA, Lin E, Von Korff M, et al. Diabetes complications severity index and risk of mortality, hospitalization, and health care utilization [J]. The American Journal of Managed Care, 2008, 14(1): 15-23.

[17] Lyu XF, Li YY. Analysis of hospitalization costs and influencing factors in patients with type 2 diabetes mellitus [J]. Hospital Management Forum, 2023, 40(6): 34-38.

Supplementary Table 1. Comparison of overall pathway scores under different weighting and scoring threshold schemes

Scheme	Weighting scheme	Intermediate grade score	Overall score	Structure dimension (score rate)	Process dimension (score rate)	Outcome dimension (score rate)
1 (baseline)	AHP weights	60%	76.20	12.74/16.24 (78.4%)	11.80/11.80 (100.0%)	51.66/71.96 (71.8%)
2	AHP weights	50%	72.87	11.87/16.24 (73.1%)	11.80/11.80 (100.0%)	49.20/71.96 (68.4%)
3	AHP weights	70%	79.55	13.62/16.24 (83.8%)	11.80/11.80 (100.0%)	54.14/71.96 (75.2%)
4	Equal weights	60%	81.18	15.29/17.65 (86.7%)	29.41/29.41 (100.0%)	36.47/52.94 (68.9%)
5	Equal weights	50%	79.41	14.71/17.65 (83.3%)	29.41/29.41 (100.0%)	35.29/52.94 (66.7%)

6	Equal weights	70%	82.94	15.88/17.65 (90.0%)	29.41/29.41 (100.0%)	37.65/52.94 (71.1%)

Note: Equal weights refer to each secondary indicator being assigned a weight of 1/17, without using the weight coefficients determined by the AHP.