Chinese General Practice Journal 2 (2025) 100074

Contents lists available at ScienceDirect

Chinese General Practice Journal

journal homepage: https://www.keaipublishing.com/en/journals/chinese-general-practice-journal/

Multidimensional patterns of health-seeking behaviour in patients with type 2 diabetes: A latent class analysis☆

Jie Yu*, Chunxiang Wu, Ning Cai, Xiaoxia Zhu, Li Shen

Department of chronic disease prevention and control, Putuo District Center of Disease Control and Prevention (Putuo District Health Inspection and Supervision Office), Shanghai, 200032, China

ARTICLE INFO

Keywords:
Type 2 diabetes mellitus
Healthcare-seeking behavior
Latent class analysis
Healthcare resource utilization
Putuo district, Shanghai municipality

ABSTRACT

Background: China has 148 million people with diabetes, a heavy disease burden for the country. Health-seeking behaviour, as a core component of disease management, plays a critical role in diabetes control.
Objective: To identify multidimensional patterns of health-seeking behaviour among patients with type 2 diabetes, examine their associations with glycemic control and health resource utilization, informing targeted diabetes management.
Methods: Using follow-up and clinical data from 30,509 patients with type 2 diabetes in Putuo District, Shanghai (2023), latent class analysis (LCA) was applied to identify latent classes of health-seeking behaviour. Multinomial logistic regression was used to assess demographic, behavioral, and clinical determinants of health-seeking behaviour patterns. Multivariable logistic regression was then applied to evaluate the effects of health-seeking behaviour patterns and other factors on annual glycemic control.
Results: LCA identified four distinct patterns: specialist-dominated (14.68%), community-based (23.47%), enhanced community-based (38.72%), and comprehensive-complex (23.13%). Multinomial logistic regression showed that patients aged ≥60 were more likely to adopt community-based or enhanced community-based patterns (OR=2.117–2.667, P<0.001); longer disease duration reduced the likelihood of community-based pattern (OR=0.983, P<0.01) but increased the likelihood of comprehensive-complex pattern (OR=1.041, P<0.001); patients with complications or comorbidities were significantly more likely to fall into the enhanced community-based (OR=1.498–2.506) or comprehensive-complex patterns (OR=3.003–3.865, P<0.001). Multivariable logistic regression indicated that compared with the specialist-dominated pattern, both enhanced community-based (OR=0.923, P=0.041) and comprehensive-complex patterns (OR=0.791, P<0.001) were associated with poorer glycemic control; regular physical activity (OR=1.107, P=0.002) and HbA1c testing ≥2 times/year were protective factors for achieving annual glycemic control (OR=2.891–4.126, P<0.001).
Conclusions: Health seeking behaviour among patients with type 2 diabetes shows significant heterogeneity. Age, disease duration, and complications are key drivers of behavioral differentiation. Glycemic outcomes vary significantly across health-seeking behaviour patterns, emphasizing multidisciplinary collaboration in specialist-dominated pattern, enhancing integrated management in community-based pattern, and optimizing resource allocation for patients with complex needs to achieve stratified and targeted interventions.

Diabetes mellitus has emerged as one of the most pressing public health challenges of the 21st century. Globally, the number of adults with diabetes increased from 200 million in 1990 to 828 million by 2022. In China, an estimated 148 million adults with diabetes accounts for 18% of total and ranks second only to India[1]. Poor long-term glycemic control contributes to serious complications, including cardiovascular disease and chronic kidney disease, which substantially compromise quality of life and cause economic burden. In 2021, direct medical expenditures for diabetes in China reached USD 165.3 billion—second only to the United States—with escalating costs largely driven by the long-term treatment of chronic complications[2]. These figures underscore the urgent need to optimize diabetes management strategies. Health-seeking is the core of chronic disease management, its behaviour patterns, such as visit frequency, choice of health care institution, and adherence to specialty care, influence not only treatment compliance but also the efficiency of health resource allocation. Previous studies focused on single dimensions of such behaviors. For example, Miguel et al.[3] demonstrated that higher visit frequency sig-

☆ Peer review under the responsibility of Editorial Office of Chinese General Practice Journal.
* Corresponding author.
E-mail address: ptyujie@126.com (J. Yu).

https://doi.org/10.1016/j.cgpj.2025.100074

nificantly improved the likelihood of achieving multifactorial diabetes control (HbA1c, blood pressure, and cholesterol), while Peiju L. et al.[4] reported that greater consistency in provider and facility choice was associated with a lower risk of complications. Despite these insights, most research failed to integrate multiple dimensions of health-seeking behaviour, such as frequency, institutional level, and department choice, thereby limiting understanding of patients' overall behavioral patterns. Such an approach implicitly assumes homogeneity across patient populations, overlooking the heterogeneity of behaviors. In recent years, latent class analysis (LCA) were introduced in chronic disease research as a powerful tool to identify patient subgroups based on latent variables. For instance, Quan Z. et al.[5] classified multimorbidity patterns into five latent classes using 14 self-reported chronic conditions. Building on this methodological framework, we integrate indicators such as visit frequency, institutional level, and department to characterize multidimensional health-seeking behaviors among patients with type 2 diabetes, then investigate glycemic control among different behaviour patterns, with the aim to inform precise resource allocation and tailored interventions, contributing to the transition in health care delivery from disease-centered to patient-centered.

Methods

Data sources and study population

Data were obtained from three sources in Putuo District, Shanghai: (1) the Chronic Disease Management System, which provided follow-up records of patients with type 2 diabetes (T2DM); (2) the Hospital Information System (HIS); and (3) the Laboratory Information System (LIS). Eligible participants were patients with T2DM enrolled in the chronic disease health management program between January 1 and December 31, 2023 (n = 51,547). Patients with fewer than four follow-up visits during the study year or a management period shorter than one year (n = 10,365), no diagnostic or treatment records available in the HIS during the study period (n = 10,673) were excluded. After applying these criteria, 30,509 patients were included in the final analysis.

Data collection and variables

From the Chronic Disease Management System, we extracted 782,867 records containing patient registration details, quarterly follow-up data, and laboratory results for 2023. From the HIS, we extracted 242,087 outpatient records across all healthcare facilities within the district. The dataset included demographics (gender, age, residential address,etc), clinical characteristics

(disease duration, diabetes complications, comorbidities, blood glucose values with test dates, HbA1c levels and test frequency), medical visit information (visit dates, hospital visited, department visited, medical expenditures, and diagnostic information).

Diagnostic criteria

All diabetes-related complications(e.g., cardiovascular disease, diabetic nephropathy) and comorbidities (e.g., hypertension, hyperlipidemia) were confirmed by medical institutions within Putuo District and coded using the International Classification of Diseases (ICD).

Variable definitions

(1) Age: 18–44 years (young adults), 45–59 years (middle-aged), 60–74 years (younger elderly), and ≥75 years (older elderly).

(2) Annual glycemic control: based on the Chinese Diabetes Society 2024 guidelines[6], defined as HbA1c <7.0%, fasting glucose 4.4–7.0 mmol/L, or postprandial glucose≤10.0 mmol/L. Patients were considered to achieve annual glycemic control if they met these criteria in at least three of the four follow-up quarters. HbA1c was prioritized, followed by fasting glucose, then postprandial glucose. The most recent value per quarter was used.

(3)HbA1c testing frequency: categorized as <2, 2–4, or ≥5 times per year.

(4)Smoking: current or former smoking.

(5)Alcohol consumption: current or former drinking.

(6)Regular physical activity: ≥5 sessions per week, ≥30 minutes per session.

(7)Health-seeking behavior

① Visit frequency: low (1–3 visits), medium (4–6), high (7–12), or very high (>12) per year, based on national guidelines[7].

② Hospital preference: most frequently visited level of care (community, secondary, or tertiary); if tied, the higher level was selected.

③ Department preference: most frequently visited department, including endocrinology, general practice, traditional Chinese medicine, complication-related specialties (e.g., cardiology, neurology, nephrology, ophthalmology), or others; if tied, the higher level was selected.

④ Annual expenditure: categorized as low [≤25th percentile, 1,163.48 Chinese Yuan (CNY)], medium (25th–75th percentile, 1,163.49–5,707.72 CNY), or high (≥75th percentile, ≥5,707.73 CNY).

⑤ Cross-department visits: defined as visits to ≥2 departments within one year.

Quality control

A multi-level quality control approach was used to ensure data integrity and reliability. The management system performed real-time checks, flagging abnormal values (e.g., glucose <2.8 mmol/L) and missing mandatory fields, which required correction before submission. Community health centres conducted monthly self-checks of follow-up cards, while the district CDC carried out quarterly authenticity checks and annual telephone verification (>10,000 cases). Clinical and laboratory data were directly extracted from HIS and LIS databases across all healthcare facilities in the district. During data cleaning, gender, age, disease duration, blood glucose levels at four follow-up visits, BMI, smoking history, drinking history, family history of diabetes, and regular physical activities are mandatory items to be filled in on the diabetes patient management and follow-up card. If any of the required items are not filled in, the registration card or follow-up card cannot be saved, and it will be recorded in the system as a missed visit. Patients with incomplete mandatory variables (n = 177) were excluded. The final dataset contained no missing values, and no imputation was required.

Statistical analysis

All analyses were conducted using SPSS version 25.0. Measurement data with normal distribution were expressed as mean±standard deviation (SD) and compared using one-way analysis of variance (ANOVA). Non-normally distributed measurement data were expressed as median (interquartile range, IQR) and compared using the Kruskal–Wallis H test. Enumeration data were presented as counts and percentages, with group differences assessed using the Chi-square test.

Latent class analysis (LCA) was performed using Mplus version 8.3 to identify patterns of health-seeking behavior, including visit frequency, hospital preference, department preference, annual expenditure, and cross-department visit. Model estimation started with a one-class baseline model(c=1) and progressively increased the number of classes (c = 2, 3, …, n). Model fit was evaluated using the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-size adjusted BIC (aBIC), with smaller values indicating better parsimony. The Lo–Mendell–Rubin likelihood ratio test (LMRT) and Vuong–Lo–Mendell–Rubin test (VLMR) were applied to compare nested models, with $P < 0.05$ suggesting improved fit for the model with more classes. Classification quality was assessed using entropy, with values >0.80 indicating good separation (classification accuracy >90%).

Table 1
Variable assignment in Logistic regression analysis.

Variable	Assignment
Gender	Female = 0, Male = 1
Age	18-44 years=1, 45-59 years=2, 60~74 years=3, ≥75years=4
Disease duration	Measured value
Diabetes complications	No = 0, Yes = 1
Number of complications	Measured value
Macrovascular complications	No = 0, Yes = 1
Microvascular complications	No = 0, Yes = 1
Diabetes comorbidities	No = 0, Yes = 1
Number of comorbidities	Measured value
Hypertension	No = 0, Yes = 1
Dyslipidemia	No = 0, Yes = 1
Thyroid disease	No = 0, Yes = 1
Autoimmune disease	No = 0, Yes = 1
Osteoporosis	No = 0, Yes = 1
Mental disorders[a]	No = 0, Yes = 1
Annual glycemic control achieved	Not achieved = 0, Achieved = 1
HbA1c testing frequency	<2 times/year = 1; 2–4 times/year = 2; ≥5 times/year = 3
BMI	Measured value
Smoking status	Never smoker = 0; Former or current smoker = 1
Alcohol consumption	Never drinker = 0; Former or current drinker = 1
Regular physical activity	No = 0, Yes = 1
Family history	No = 0, Yes = 1

Note: [a] includes depression, anxiety, neurasthenia, neurotic disorders, and sleep disorders.

Subgroups identified through LCA were further analyzed using multinomial logistic regression to assess the effects of demographic, behavioral, and clinical variables on class membership. To evaluate the impact of health-seeking behavior on glycemic control, annual glycemic control status (yes/no) was modeled as the dependent variable using multivariable logistic regression. Health-seeking pattern categories were dummy coded along with demographic, behavioral, and clinical covariates. Variable coding is shown in Table 1.

Results

A total of 30,509 patients with type 2 diabetes were included in the analysis, comprising 15,626 females (51.22%) and 14,883 males (48.78%), with a mean age of 72.09±8.60 years. The majority (58.41%) were aged 60–74 years, and the median disease duration was 9.0 years (IQR: 4.0–15.0). The prevalence of diabetes-related complications was 73.13%, with macrovascular and microvascular complications reported in 62.16% and 41.55%, respectively. Comorbidities were present in 90.28% of patients, most commonly hypertension (74.84%) and dyslipidemia (39.88%), psychiatric disorders were noted in 29.66%, while thyroid disease, autoimmune disorders, and osteoporosis were present in 4.70%, 7.98%, and 8.90%, respectively. The annual rate of glycemic control was 32.47%, most patients (72.14%) had fewer than two HbA1c tests per year, whereas only 2.34% underwent testing five or more times annually. Regular physical activity was reported by 17.77%, while 5.08% and 7.58% had a history of smoking and drinking, respectively. A family history of diabetes was reported in 38.10%. In health-seeking preferences, 79.03% primarily visited community health centres, most frequently in general practice (62.72%) or endocrinology (27.60%), and 42.69% exhibited cross-department visits(Table 2).

Latent class analysis of health-seeking behaviors and model fit

LCA was conducted using visit frequency, hospital-level preference, department preference, cross-department utilization, and total annual medical expenditure. Models were sequentially estimated from one-class up to eleven-class solutions (Table 3). The Bayesian Information Criterion (BIC) values decreased consistently from the one- to ten-class models, but increased at the eleven-class model, meeting the stopping rule and indicating that further model expansion was unnecessary. The Lo-Mendell-Rubin test (LMRT) and the Vuong-Lo-Mendell-Rubin test (VLMR) were statistically significant ($P < 0.05$) for comparisons between two- through five-class models, suggesting improved model fit with additional classes. However, from five to six classes, the p-values were no longer significant (LMRT $P = 0.793$; VLMR $P = 0.791$), indicating that further increases in class number did not improve fit. Although the four-class model yielded slightly higher AIC, BIC, and aBIC values than the five-class model, these indices remained within an acceptable range. Importantly, the four-class model demonstrated highly significant LMRT and VLMR results (both $P < 0.001$), confirming a substantial improvement in fit compared with the three-class model. The distribution of class membership in the four-class solution was 14.68%, 23.13%, 23.47%, and 38.72%, with no class representing fewer than 15% of the sample. This ensured adequate representation across subgroups and avoided unstable estimates in subsequent analyses. In contrast, the five-class model included a subgroup accounting for only 7.88% of patients, raising concerns about statistical stability. Entropy values were comparable between the four-class (0.826) and five-class (0.829) models, both exceeding 0.8, indicating good classification precision. Considering model fit indices, statistical significance, subgroup balance, and robustness for subsequent analyses, the four-class solution was selected as the optimal model.

Naming and characterization of latent classes

Based on the optimal four-class model, conditional probabilities for the five observed indicators were obtained (Table 4). Each class was then named according to its defining characteristics.

Specialist-Dominated (Class 1): Most patients sought care at secondary or tertiary hospitals (95.7%) and primarily visited endocrinology departments (79.7%). Visit frequency was distributed across low, medium, and high levels (30.7%–35.6%). The majority fell into the medium expenditure group (64.9%), and nearly half engaged in multi-department visits (48.1%).

Community-Based (Class 2): Patients almost exclusively visited community health centres (99.1%), with the majority attending general practice department in hospital(81.7%). Low visit frequency was predominant (81.2%), most patients were in the low expenditure group (81.2%), and the rate of cross-department visit was the lowest among all classes (14.0%).

Enhanced Community-Based (Class 3): Nearly all patients received care in community health centres (99.9%), primarily within general

Table 2
Basic characteristics of survey subjects.

Characteristic	n(%)/ $M(P_{25}, P_{75})$
Gender	
Male	14 883(48.78)
Female	15 626 (51.22)
Age (years)	
18–44	216 (0.71)
45–59	1363 (4.47)
60–74	17 819(58.41)
≥75	11 111(36.42)
Disease duration (years)	9.00 (4.00,15.00)
Diabetes complications	
Yes	22 311(73.13)
No	8 198(26.87)
Number of complications	1.00 (0.00,2.00)
Macrovascular complications	
Yes	18 965 (62.16)
No	11 544 (37.84)
Microvascular complications	
Yes	12 678(41.55)
No	17 831 (58.45)
Comorbidities	
Yes	27 545 (90.28%)
No	2 964 (9.72%)
Number of comorbidities	2.00 (1.00,4.00)
Hypertension	
Yes	22 833 (74.84)
No	7 676 (25.16)
Dyslipidemia	
Yes	12 166(39.88)
No	18 343(60.12)
Thyroid disease	
Yes	1 433 (4.70)
No	29 076 (95.30)
Autoimmune disease	
Yes	2 435 (7.98%)
No	28 074 (92.02%)
Osteoporosis	
Yes	2 715 (8.90)
No	27 794 (91.10)
Mental disorders	
Yes	9 050 (29.66)
No	21 459 (70.34)
Annual glycemic control achieved	
Yes	9 895 (32.43%)
No	20 614 (67.57%)
HbA1c testing frequency	
<2 times/year	22 009(72.14)
2–4 times/year	7 787(25.52)
≥5 times/year	713(2.34)
BMI(kg/m²)	23.66 (22.49,25.21)
Smoking status	
Former or current smoker	1 550 (5.08)
Never smoker	28 959 (94.92)
Alcohol consumption	
Former/current drinker	2 312 (7.58)
Never drinker	28 197 (92.42)
Regular physical activity	
Yes	5 422 (17.77)
No	25 087 (82.23)
Family history	
Yes	11 623 (38.10)
No	18 886 (61.90)
Preferred hospital level	
Community health centre	24 110 (79.03)
Secondary hospital	3 633 (11.91)
Tertiary hospital	2 766 (9.07)
Preferred department	
Endocrinology	8 422 (27.60)
General practice	19 135 (62.72)
Traditional Chinese medicine	2 021 (6.62)
Complication-related specialties[a]	550 (1.80)
Others	381 (1.25)
Cross-department visits	
Yes	13 024 (42.69)
No	17 485 (57.31)
Annual medical expenditure (Yuan)	3 284.30 (1 423.25,6 179.75)
Annual number of visits	9.00 (5.00,14.00)

Note: [a] includes cardiology, neurology, vascular surgery, nephrology, and ophthalmology.

practice department in hospital (81.5%). Visit frequency was predominantly medium (39.0%) and high (58.4%). Most patients belonged to the medium expenditure group (84.9%), and 35.0% had multi-department visits.

Comprehensive-Complex (Class 4): Patients exhibited very high visit frequency (51.6%) and were mostly in the high expenditure group (85.9%). Cross-department visit was most common (81.2%). Hospital preference was split between community hospitals (71.1%) and secondary hospitals (18.8%). Departmental preference was divided between general practice (50.4%) and endocrinology department (39.3%).

Baseline characteristics across latent classes

Among the 30,509 patients included in this study, 4,480 (14.68%) were classified as specialist-dominated, 7,161 (23.47%) as community-based, 11,812 (38.72%) as enhanced community-based, and 7,056 (23.13%) as comprehensive-complex.

Comparisons across the four latent classes revealed significant differences in gender, age, disease duration, presence and number of diabetes-related complications, prevalence of macrovascular and microvascular complications, presence and number of comorbidities (hypertension, dyslipidemia, thyroid disorders, autoimmune conditions, osteoporosis, and psychiatric disorders), annual glycemic control, HbA1c testing frequency, BMI, smoking status, regular physical activity, and family history of diabetes (all $P < 0.05$). Detailed results are presented in Table 5.

Determinants of health-seeking behaviour patterns

Multinomial logistic regression was conducted with the four latent health-seeking behaviour patterns as dependent variables (reference group: specialist-dominated). Independent variables were selected from those baseline characteristics showing significant differences in Table 5. To address multicollinearity, highly correlated variables (number of complications, macrovascular disease, microvascular disease; $r = 0.677–0.777$) detected by Pearson correlation coefficient screening were excluded. Variance inflation factor (VIF) analysis confirmed no severe multicollinearity among the remaining variables (all VIF < 10, tolerance > 0.1). The variable "number of comorbidities" was also excluded due to redundancy with binary comorbidity indicators. The final model demonstrated good overall fit (likelihood ratio χ^2 = 7,250.316, df = 63, $P <$ 0.001), with AIC = 73,907.384 and BIC = 74,456.886, both substantially lower than the intercept-only model (–2 log-likelihood = 81,025.700). McFadden's pseudo-R^2 was 0.089, indicating moderate explanatory power.

Male patients were more likely to adopt a enhanced community-based pattern (OR = 1.133, P < 0.001). Older patients (≥60 years) were more likely to adopt community-based or enhanced community-based pattern, with the strongest effect among those≥75 years (OR = 2.477–2.667, both P < 0.001). Longer disease duration decreased the odds of community-based pattern utilization (OR = 0.983, P< 0.001) but increased the odds of comprehensive-complex pattern utilization (OR = 1.041, P < 0.001). In term of complications/comorbidities, patients with complications were more likely to adopt enhanced community-based pattern (OR = 1.498) or comprehensive-complex pattern (OR = 3.865, both P < 0.001), and less likely to adopt community-based pattern (OR = 0.759, P < 0.001). Comorbidities increased the odds of enhanced community-based pattern (OR = 2.506) and comprehensive-complex pattern (OR = 3.003, both P < 0.001). Hypertension was associated with lower odds of community-based and enhanced community-based pattern adoption (OR = 0.849–0.851, P < 0.01), while dyslipidemia decreased community-based care (OR = 0.726, P < 0.001) but increased community-intensified care (OR = 1.181, P< 0.001). For lifestyle factors, regular physical activity was associated with lower odds of community-based, enhanced community-based, and comprehensive-complex patterns adoption (OR = 0.672–0.835, all P < 0.001). For glycemic control, frequent

Table 3
Model fit evaluation for latent class analysis.

Model	LL	AIC	BIC	aBIC	Entropy	LMRT(p)	VLMR(p)	Class probabilities(%)
1-Class	-143 240.218	286 504.437	286 604.346	286 566.210				
2-Class	-132 807.159	265 664.318	265 872.463	265 793.013	0.746	<0.001	<0.001	42.27/57.63
3-Class	-127 493.661	255 063.323	255 379.702	255 258.939	0.840	<0.001	<0.001	19.78/35.40/44.82
4-Class	-124 530.304	249 162.608	249 587.223	249 425.146	0.826	<0.001	<0.001	14.68/23.13/23.47/38.72
5-Class	-122 375.299	244 878.598	245 411.448	245 208.057	0.829	0.044	0.046	7.88/13.51/20.75/22.10/35.75
6-Class	-121 492.293	243 138.587	243 779.671	243 534.966	0.825	0.793	0.791	6.47/6.55/10.30/20.79/21.67/34.22
7-Class	-121 153.016	242 486.032	243 235.352	242 949.333	0.857	0.759	0.757	6.27/6.45/8.39/15.78/20.71/20.76/21.63
8-Class	-120 970.939	242 147.879	243 005.434	242 678.101	0.844	0.816	0.814	3.97/5.78/6.48/8.21/13.05/18.74/19.10/24.68
9-Class	-120 861.742	241 955.483	242 921.273	242 552.627	0.849	0.960	0.959	1.02/3.97/5.05/6.45/8.26/13.05/18.43/19.10/24.68
10-Class	-120 781.330	241 820.659	242 894.684	242 484.724	0.822	0.942	0.942	1.01/2.54/5.45/6.01/6.10/6.76/13.50/17.97/18.73/21.94
11-Class	-120 723.100	241 730.201	242 912.461	242 461.187	0.887	0.778	0.778	0.37/1.82/3,93/5.31/5.48/7.61/13.56/13.93/14.30/16.84/16.85

Table 4
Conditional probability distributions of healthcare-seeking behaviors across latent classes in diabetic patients.

Indicator	Specialist-Dominated (Class 1, 14.68%)	Community-Based (Class 2, 23.47%)	Enhanced Community-based (Class 3, 38.72%)	Comprehensive-Complex (Class 4, 23.13%)
Visit frequency				
Low (1–3 visits/year)	0.356	0.812	0.000	0.022
Medium (4–6 visits/year)	0.307	0.188	0.390	0.118
High (7–12 visits/year)	0.334	0.000	0.584	0.344
Very high (>12 visits/year)	0.004	0.000	0.026	0.516
Hospital preference				
Community health centre	0.043	0.991	0.999	0.711
Secondary hospital	0.514	0.000	0.000	0.188
Tertiary hospital	0.443	0.008	0.001	0.101
Department preference				
Endocrinology	0.797	0.090	0.121	0.393
General practice	0.024	0.817	0.815	0.504
Traditional Chinese medicine	0.031	0.088	0.064	0.070
Complication-related specialties[a]	0.078	0.004	0.000	0.025
Others	0.069	0.001	0.000	0.009
Annual health care expenditure				
Low(≤928.58 Yuan)	0.301	0.812	0.039	0.000
Medium(928.58–4728.39 Yuan)	0.649	0.185	0.849	0.141
High(≥4728.39Yuan)	0.050	0.002	0.112	0.859
Cross-department visits				
No	0.519	0.860	0.650	0.188
Yes	0.481	0.140	0.350	0.812

Note: [a] includes cardiology, neurology, vascular surgery, nephrology, and ophthalmology.

HbA1c testing (≥5 times/year) reduced the likelihood of community-based and enhanced community-based pattern adoption (*OR* = 0.244–0.356, $P < 0.01$), but increased the likelihood of comprehensive-complex pattern (*OR* = 1.464, $P < 0.01$). Patients achieving annual glycemic targets were less likely to adopt comprehensive-complex pattern (*OR* = 0.776, $P < 0.001$) (Table 6).

Impact of health-seeking behaviour patterns on annual glycemic control

Univariate logistic regression was first conducted with annual glycemic control as the dependent variable, health-seeking behaviour pattern, demographic, behavioral, and clinical variables as independent variables (Table 1). Factors with $P < 0.05$ were then included in a multivariable logistic regression using a stepwise selection approach. The final model retained health-seeking behaviour pattern, smoking status, regular physical activity, and other significant predictors (Table 7). Variables such as alcohol consumption and family history were excluded due to lack of statistical significance. The likelihood ratio test indicated that the model provided a significantly better fit than the intercept-only model (χ^2= 2,070.308, *df*=12, P<0.001). The Hosmer–Lemeshow goodness-of-fit test suggested some miscalibration (χ^2= 16.11, *df* = 8, P= 0.041), but given the large sample size (n = 30,509) and high predictive accuracy for negative cases (92.31%), the model was considered acceptable. Variance inflation factors (VIF=1.02–1.55) confirmed the absence of multicollinearity.

Compared with specialist-dominated pattern, both community-intensified (*OR* = 0.923, 95% *CI*: 0.856–0.997, P = 0.041) and comprehensive-complex(*OR*= 0.791, 95% *CI*: 0.726–0.862, $P < 0.001$) patterns were associated with lower odds of achieving glycemic control. Smoking (*OR* = 0.851, P = 0.008), male(*OR* = 0.906, $P < 0.001$), the presence of complications (*OR* = 0.790, $P < 0.001$) or comorbidities (*OR* = 0.620, $P < 0.001$), thyroid disease (*OR* = 0.760, $P < 0.001$), and longer disease duration (*OR* = 0.977, $P < 0.001$) all reduced the likelihood of glycemic control. Regular physical activity (*OR* = 1.107, P= 0.002), HbA1c testing two to four times annually (*OR* = 2.891, P< 0.001), or five or more times annually (*OR* = 4.126, P< 0.001) significantly increased the likelihood of glycemic control. Interestingly, hypertension was also positively associated with glycemic control (*OR* = 1.092, P = 0.015), which may reflect the greater tendency of hypertensive patients to adopt specialist-dominated pattern, highlighting the interaction between comorbidity burden and care-seeking behavior.

Table 5
Univariate analysis across healthcare-seeking behavior groups.

Characteristic	Total (N = 30,509)	Specialist-Dominated (*n*= 4480)	Community-based(*n*=7161)	Enhanced community-based(*n*=11812)	Comprehensive-complex (*n*=7056)	χ^2/*H value*	*P* value
Gender, n (%)						97.413	<0.001
Male	14 883	2 249 (50.20)	3 617 (50.51)	5 938 (50.27)	3 079 (43.64)[abc]		
Female	15 626	2 231 (49.80)	3 544 (49.49)	5 874 (49.73)	3 977 (56.36)[abc]		
Age group, n (%)						321.913	<0.001
18-44 years	216	68(1.52%)	62(0.87%)[a]	51(0.43%)[ab]	35(0.50%)[abc]		
45-59 years	1363	316(7.05%)	384(5.36%)[a]	452(3.83%)[ab]	211(2.99%)[abc]		
60-74 years	17 819	2 724(60.80%)	4 330(60.47%)[a]	6 877(58.22%)[ab]	3 888(55.10%)[abc]		
≥75 years	11 111	1 372(30.63%)	2 385(33.31%)[a]	4 432(37.52%)[ab]	2 922(41.41%)[abc]		
Disease duration, median (IQR), y	30 509	8.00 (4.00,14.00)	8.00 (4.00,13.00)[a]	9.00 (4.00,15.00)[ab]	12.00 (6.00,19.00)[abc]	798.69[d]	<0.001
Diabetes complications, n (%)						2 806.894	<0.001
Yes	22 311	2 810 (62.72)	3 939 (55.01)[a]	9 068 (76.77)[ab]	6 494 (92.04)[abc]		
No	8 198	1 670 (37.28)	3 222 (44.99)[a]	2 744 (23.23)[ab]	562 (7.97)[abc]		
Number of complications, median (IQR)	30 509	1.00 (0.00,2.00)	1.00 (0.00,1.00)[a]	1.00 (1.00,2.00)[ab]	2.00 (1.00,3.00)[abc]	5 325.072[d]	<0.001
Macrovascular disease, n (%)						2 475.714	<0.001
Yes	18 965	2 230 (49.78)	3 221 (44.98)[a]	7 693 (65.13)[ab]	5 821 (82.50)[abc]		
No	11 544	2 250 (50.22)	3 940 (55.02)[a]	4 119 (34.87)[ab]	1 235 (17.50)[abc]		
Microvascular disease, n (%)						2 984.265	<0.001
Yes	12 678	1 441 (32.17)	1706 (23.82)[a]	4799 (40.63)[ab]	4732 (67.06)[abc]		
No	17 831	3 039 (67.84)	5455 (76.18)[a]	7013 (59.37)[ab]	2324 (32.94)[abc]		
Comorbidities, n (%)						1 637.497	<0.001
Yes	27 545	3 726 (83.170)	5 795 (80.924)[a]	11 116 (94.108)[ab]	6 908 (97.902)[abc]		
No	2 964	754 (16.83)	1366 (19.08)[a]	696 (5.89)[ab]	148 (2.09)[abc]		
Number of comorbidities, median (IQR)	30 509	2.00 (1.00,3.00)	2.00 (1.00,3.00)[a]	3.00 (1.00,4.00)[ab]	3.50 (2.00,5.00)[abc]	4742.256[d]	<0.001
Hypertension, n (%)						770.229	<0.001
Yes	22 833	3 098 (69.15)	4 675 (65.28)[a]	9 143 (77.40)[ab]	5917 (83.858)[abc]		
No	7 676	1 382 (30.85)	2 486 (34.72)[a]	2 669 (22.60)[ab]	1139 (16.142)[abc]		
Dyslipidemia, n (%)						2 034.417	<0.001
Yes	12 166	1 445 (32.25)	1 685 (23.53)[a]	4 845 (41.02)[ab]	4 191 (59.40)[abc]		
No	18 343	3 035 (67.75)	5 476 (76.47)[a]	6 967 (58.98)[ab]	2 865 (40.60)[abc]		
Thyroid disease, n (%)						302.494	<0.001
Yes	1 433	250 (5.58)	169 (2.36)[a]	442 (3.74)[ab]	572 (8.11)[abc]		
No	29 076	4 230 (94.420	6 992 (97.64)[a]	11 370 (96.26)[ab]	6 484 (91.89)[abc]		
Autoimmune disease, n (%)						488.978	<0.001
Yes	2 435	193 (4.31)	309 (4.32)[a]	994 (8.42)[ab]	939 (13.31)[abc]		
No	28 074	4 287 (95.69)	6 852 (95.68)[a]	10 818 (91.58)[ab]	6 117 (86.69)[abc]		
Osteoporosis, n (%)						669.329	<0.001
Yes	2 715	211 (4.71)	327 (4.57)[a]	1 067 (9.03)[ab]	1 110 (15.73)[abc]		
No	27 794	4 269 (95.29)	6 834 (95.43)[a]	10 745 (90.97)[ab]	5 946 (84.27)[abc]		
Psychological disorders, n (%)						756.036	<0.001
Yes	9 050	927 (20.69)	1 580 (22.06)	3 715 (31.45)[ab]	2 828 (40.08)[ab]		
No	21 459	3 553 (79.31)	5 581 (77.94)	8 097 (68.55)[ab]	4 228 (59.92)[ab]		
Annual glycemic control achieved, n (%)						85.603	<0.001
Yes	9 895	1 617(36.09%)	2 516(35.14%)	3 665(31.03%)[ab]	2 097(29.72%)[ab]		
No	20 614	2 863(63.91%)	4 645(64.87%)	8 147(68.97%)[ab]	4 959(70.28%)[ab]		
HbA1c tests, n (%)						1 246.801	<0.001
<2 times/year	22 009	3 112 (69.46)	5 964 (83.28)[a]	8 796 (74.47)[ab]	4137 (58.63)[abc]		
2-4 times/year	7 787	1 220 (27.23)	1 132 (15.81)[a]	2 857 (24.19)[ab]	2578 (36.54)[abc]		
≥5 times/year	713	148 (3.30)	65 (0.91)[a]	159 (1.35)[ab]	341 (4.83)[abc]		
Smoking status, n (%)	30 509	23.822(22.49,25.39)	23.671(22.49,25.26)[a]	23.661(22.49,25.06)[ab]	23.671(22.55,25.21)[ac]	10.999[d]	0.012
Smoking status, n (%)						33.824	<0.001
Former/current smoker	1 550	269 (6.00)	405 (5.66)	602 (5.10)[a]	274 (3.88)[abc]		
Never smoker	28 959	4 211 (94.00)	6 756 (94.34)	11 210 (94.90)[a]	6 782 (96.12)[abc]		
Alcohol consumption, n (%)						5.417	0.144
Former/current drinker	2 312	311 (6.94)	540 (7.54)	940 (7.96)	521 (7.38)		
Never drinker	28 197	4 169 (93.06)	6 621 (92.46)	10 872 (92.04)	6 535 (92.62)		
Regular physical activity, n (%)						200.569	<0.001
Yes	5 422	1 044 (23.30)	1 461 (20.40)[a]	1 876 (15.88)[ab]	1 041 (14.75)[abc]		
No	25 087	3 436 (76.70)	5 700 (79.60)[a]	9 936 (84.12)[ab]	6 015 (85.25)[abc]		
Family history, n (%)						25.529	<0.001
Yes	11 623	1 602 (35.76)	2 667 (37.24)	4 520 (38.27)[a]	2 834 (40.16)[abc]		
No	18 886	2 878 (64.24)	4 494 (62.76)	7 292 (61.73)[a]	4 222 (59.84)[abc]		

Notes: [a] indicates $P < 0.05$ compared with the Specialist-Dominated pattern group; [b] indicates $P < 0.05$ compared with the Community-based pattern group; [c] indicates $P < 0.05$ compared with the Enhanced Community-based pattern group; [d] indicates the Kruskal–Wallis H statistic.

Discussion

Diabetes is a major global public health challenge, and the heterogeneity of patients' health–seeking behaviors has important implications for both disease management and the allocation of medical resources. Using follow-up data from 30,509 patients with type 2 diabetes in Putuo District of Shanghai City, this study applied LCA and identified four distinct patterns of health-seeking behaviors: specialist-dominated (14.68%), community-based (23.47%), enhanced community-based (38.72%), and comprehensive-complex(23.13%). Together, the community-based and enhanced community-based patterns accounted for more than 60% of patients, suggesting that patients with

Table 6
Multinomial Logistic regression analysis of latent categorical influencing factors for healthcare-seeking behavior in diabetic patients

Variable	Community-based vs Specialist-Dominated		Enhanced Community-based vs Specialist-Dominated		Comprehensive-complex vs Specialist-Dominated	
	OR(95%*CI*)	*P*值	*OR*(95%*CI*)	*P*值	*OR*(95%*CI*)	*P*值
Gender(ref = female)						
Male	0.957(0.884 ~ 1.036)	0.275	1.133(1.053 ~ 1.220)	<0.001	1.057(0.972 ~ 1.149)	0.193
Age (ref = 18–44 years)						
45-59 years	1.412(0.965 ~ 2.065)	0.076	1.754(1.174 ~ 2.619)	0.006	1.140(0.698~ 1.861)	0.601
60-74 years	2.117(1.484 ~ 3.019)	<0.001	2.487(1.705 ~ 3.628)	<0.001	1.333(0.844 ~ 2.108)	0.218
≥75 years	2.477(1.727~ 3.553)	<0.001	2.667(1.820 ~ 3.906)	<0.001	1.338(0.844 ~ 2.124)	0.216
Disease duration (years)	0.983(0.977 ~ 0.988)	<0.001	1.005(1.000~ 1.010)	0.076	1.041(1.035 ~ 1.047)	<0.001
Diabetes complications (ref = no)						
Yes	0.759(0.698 ~ 0.826)	<0.001	1.498(1.381 ~ 1.625)	<0.001	3.865(3.453~ 4.327)	<0.001
Comorbidities (ref = no)						
Yes	1.149(0.998 ~ 1.323)	0.053	2.506(2.169 ~ 2.896)	<0.001	3.003(2.424 ~ 3.720)	<0.001
Hypertension (ref = no)						
Yes	0.849(0.760 ~ 0.949)	0.004	0.851(0.769 ~ 0.943)	0.002	0.933(0.831 ~ 1.047)	0.240
Dyslipidemia (ref = no)						
Yes	0.726(0.664 ~ 0.793)	<0.001	1.181(1.092 ~ 1.277)	<0.001	1.982(1.819~ 2.159)	<0.001
Thyroid disease (ref = no)						
Yes	0.451(0.368 ~ 0.553)	<0.001	0.570(0.485 ~ 0.671)	<0.001	1.045(0.886 ~ 1.231)	0.601
Autoimmune disease (ref = no)						
Yes	1.091(0.905 ~ 1.315)	0.360	1.612(1.372 ~ 1.893)	<0.001	2.167(1.837 ~ 2.556)	<0.001
Osteoporosis (ref = no)						
Yes	1.099(0.917 ~ 1.318)	0.307	1.633(1.398 ~ 1.908)	<0.001	2.339(1.997 ~ 2.740)	<0.001
Psychological disorders (ref = no)						
Yes	1.164(1.057 ~ 1.278)	0.002	1.378(1.264 ~ 1.501)	<0.001	1.647(1.502 ~ 1.807)	<0.001
Annual glycemic control (ref = not achieved)						
Achieved	1.076(0.992 ~ 1.167)	0.077	0.926(0.858 ~ 0.999)	0.048	0.776(0.711 ~ 0.847)	<0.001
HbA1c testing frequency (ref = <2 times/year)						
2–4 times/year	0.495(0.450 ~ 0.544)	<0.001	0.786(0.724 ~ 0.854)	<0.001	1.437(1.313 ~ 1.573)	<0.001
≥5 times/year	0.244(0.181 ~ 0.329)	<0.001	0.356(0.282 ~ 0.450)	<0.001	1.464(1.180 ~ 1.817)	0.001
BMI(kg/m^2)	0.992(0.978 ~ 1.007)	0.311	0.974(0.961 ~ 0.988)	<0.001	0.990(0.975 ~ 1.006)	0.232
Regular physical activity (ref = no)						
Yes	0.835(0.761 ~ 0.916)	<0.001	0.674(0.617 ~ 0.736)	<0.001	0.672(0.606 ~ 0.744)	<0.001
Family history (ref = no)						
Yes	1.143(1.055 ~ 1.238)	0.001	1.115(1.035 ~ 1.200)	0.004	1.099(1.012 ~ 1.194)	0.025

chronic diseases tend to prefer community health centers as their primary sites of care[8]. This finding is consistent with national policies on tiered diagnosis and treatment that encourage “primary care first” and reflects the contribution of family doctor contracts and chronic disease management programs in supporting routine diabetes care. Nonetheless, patients’ reliance on community health services may also be shaped by health care accessibility, insurance policies, and other structural determinants.

Our regression analyses identified several key determinants of health-seeking behaviors. Patients aged 60 years or older—particularly those ≥75 years—were more likely to adopt community-basic or community-intensified patterns, reflecting the pivotal role of primary care in managing chronic diseases among older adults. This trend may be facilitated by family doctor contract services, which improve access and continuity of care for elderly patients[9]. In contrast, longer disease duration was associated with a lower likelihood of community-based pattern (*OR*=0.983) but a higher likelihood of comprehensive-complex pattern (*OR*=1.041), complications/comorbidities was associated with higher likelihood of enhanced community-based(*OR*=1.498-2.506) and comprehensive-complex pattern(*OR*=3.003-3.865), indicating that disease progression, complications, and declining glycemic control shift patients toward higher-resource utilization models[10-11]. Furthermore, diabetes patients with coexisting hypertension showed a greater tendency to seek specialist-dominated care, consistent with previous find-

Table 7
Binary multivariate logistic regression analysis of potential classifications of medical-seeking behaviors and other influencing factors on annual glycemic control achievement.

Variable	Univariate Logistic Regression Analysis					Multivariable Logistic Regression Analysis				
	β	*S.E*	*Z*	*P*	*OR (95%CI)*	*β*	*S.E*	*Z*	*P*	*OR (95%CI)*
Health-seeking pattern (ref = Specialist-Dominated)										
Community-based	-0.042	0.040	-1.052	0.293	0.959 (0.887 ~ 1.037)	0.081	0.042	1.949	0.051	1.084 (1.000 ~ 1.176)
Enhanced Community-based	-0.228	0.037	-6.162	<0.001	0.797 (0.741 ~ 0.856)	-0.080	0.039	-2.048	0.041	0.923 (0.856 ~ 0.997)
Comprehensive-complex	-0.289	0.041	-7.133	<0.001	0.749 (0.691 ~ 0.811)	-0.234	0.044	-5.352	<0.001	0.791 (0.726 ~ 0.862)
Smoking (ref = never)										
Former or current	-0.116	0.057	-2.044	0.041	0.890 (0.797 ~ 0.995)	-0.161	0.061	-2.660	0.008	0.851 (0.756 ~ 0.958)
Alcohol consumption (ref = never)										
Former or current	-0.093	0.047	-1.980	0.048	0.911 (0.831 ~ 0.999)					
Regular physical activity (ref = no)										
Yes	0.148	0.032	4.684	<0.001	1.159 (1.090 ~ 1.233)	0.102	0.033	3.087	0.002	1.107 (1.038 ~ 1.181)
Family history (ref = no)										
Yes	-0.072	0.025	-2.838	0.005	0.931 (0.886 ~ 0.978)					
Gender (ref = female)										
Male	-0.080	0.024	-3.279	0.001	0.923 (0.880 ~ 0.968)	-0.099	0.026	-3.745	<0.001	0.906 (0.861 ~ 0.954)
Complications (ref = no)										
Yes	-0.295	0.027	-10.911	<0.001	0.744 (0.706 ~ 0.785)	-0.235	0.031	-7.646	<0.001	0.790 (0.744 ~ 0.839)
Comorbidities (ref = no)										
Yes	-0.476	0.039	-12.084	<0.001	0.621 (0.575 ~ 0.671)	-0.479	0.052	-9.265	<0.001	0.620 (0.560 ~ 0.686)
Hypertension (ref = no)										
Yes	-0.170	0.028	-6.097	<0.001	0.844 (0.799 ~ 0.891)	0.088	0.036	2.428	0.015	1.092 (1.017 ~ 1.172)
Thyroid disease (ref = no)										
Yes	-0.175	0.060	-2.931	0.003	0.840 (0.747 ~ 0.944)	-0.275	0.063	-4.395	<0.001	0.760 (0.672 ~ 0.859)
Autoimmune disease (ref = no)										
Yes	-0.169	0.046	-3.640	<0.001	0.845 (0.771 ~ 0.925)					
Mental disorders (ref = no)										
Yes	-0.126	0.027	-4.662	<0.001	0.882 (0.836 ~ 0.930)					
HbA1c testing frequency (ref = <2/year)										
2-4 times/year	0.961	0.027	35.105	<0.001	2.615 (2.478 ~ 2.759)	1.062	0.029	37.175	<0.001	2.891 (2.734 ~ 3.057)
≥5 times/year	1.255	0.077	16.321	<0.001	3.507 (3.017 ~ 4.078)	1.417	0.079	18.002	<0.001	4.126 (3.536 ~ 4.815)
Diabetes duration (years)	-0.026	0.002	-15.944	<0.001	0.974 (0.971 ~ 0.977)	-0.024	0.002	-13.641	<0.001	0.977 (0.973 ~ 0.980)

ings that comorbid type 2 diabetes and hypertension are linked to increased specialist visits[12], underscoring how complex multimorbidity drives reliance on higher-level medical services.

Patients with comorbid thyroid disease were more likely to adopt specialist-dominated patterns, likely because such conditions are perceived as requiring advanced diagnostic and therapeutic expertise, prompting patients to seek care at higher-level hospitals[13]. In contrast, patients with dyslipidemia showed a reduced likelihood of community-based pattern (*OR* = 0.726) but an increased likelihood of enhanced community-based (*OR* = 1.181), suggesting that primary care facilities are strengthening their capacity for integrated management of cardiometabolic risk. Patients with autoimmune diseases and osteoporosis were disproportionately concentrated in the comprehensive-complex pattern group (13.31% and 15.73%, respectively), consistent with the association between multisystem involved and high resource demand. Given the need for multidisciplinary coordination, these patients tend to rely on resource-intensive services; however, the expansion of community-integrated Traditional Chinese Medicine (TCM) services (e.g., herbal therapy, acupuncture, exercise rehabilitation) may explain why a notable proportion also fell into the enhanced community-based pattern. Notably, patients with mental health conditions—mainly depression, anxiety, neurosis, neurasthenia, and sleep disorders, rather than severe illnesses such as schizophrenia—were more likely to adopt community-based, enhanced community-based, or comprehensive-complex patterns. This differs from conventional assumptions, but aligns with accumulating evidence that community-level interventions can effectively improve depressive symptoms[14–15]. The survey showed that among 30,509 patients under management, the annual glycemic control rate was 32.43%, which was lower than rates reported in other Chinese cohorts—for example, 45.28% among patients in community health centres in Guangzhou Province[16] and 39.53% among residents aged ≥35 years with type 2 diabetes in Shanghai[17].

This discrepancy may be largely explained by differences in outcome definitions, our study required annual glycemic control, a stricter criterion than the point-in-time assessments used in the comparison studies. However, despite the lower control rate observed, an overestimate may still remain, as patients with incomplete follow-up were excluded and these individuals are generally less adherent and more likely to have poor glycemic control.

Multivariable logistic regression revealed that, compared with the specialist-dominated pattern group, both the enhanced community-based (OR = 0.923, P = 0.041) and comprehensive-complex (OR = 0.791, $P < 0.001$) pattern groups were significantly less likely to achieve annual glycemic control. This indicates that specialist-dominated pattern—characterized by endocrinology consultations and multispecialty treatment in secondary and tertiary hospitals—provides superior glycemic management. Prior studies have shown that endocrinology visits are independently associated with HbA1c control, and that endocrinologists are more proactive than general practitioners in intensifying pharmacotherapy, particularly initiating insulin[18-21]. Multidisciplinary, cross-department models implemented in tertiary hospitals have also been demonstrated to improve glycemic outcomes and patient self-management capacity[22].

In addition, several independent risk factors for poor glycemic control were identified, including smoking, male, complications, comorbidities, thyroid disease, and longer disease duration, consistent with previous research[23–26]. Conversely, regular physical activity and HbA1c monitoring more than twice per year were protective factors. Notably, patients with these protective behaviors, as well as those achieving annual glycemic control, were more often found in the specialist-dominated and comprehensive-complex patterns associated with high resource utilization. This suggests that the benefits of regular activity and adequate monitoring do not act in isolation, but rather operate synergistically within a "behavior–resource–metabolic" loop that reinforces favorable outcomes.

An unexpected finding was that hypertension appeared to be associated with better glycemic control (OR = 0.933), in contrast to prior studies identifying hypertension as a risk factor for poor control[27]. This paradox may be explained by health-seeking pattern mediation sample structure. In detail, patients with both diabetes and hypertension were more likely to adopt specialist-dominated pattern, which in this study achieved the high glycemic control rate (36.09%); In addition, the Putuo District policy of joint management for "diabetes–hypertension" comorbidity, covering 74.84% of the sample, may have resulted in more standardized treatment and closer follow-up compared with patients with diabetes alone, conferring a management advantage; Finally, excluded patients with unmanaged hypertension are typically less adherent, creating the illusion of overall good control

Study limitations

This study has several limitations. First, the sample included only patients who were continuously managed for diabetes throughout 2023. Patients with less than one year of follow-up were excluded, including those newly enrolled, deceased, relocated, or lost to follow-up. Consequently, the study population was skewed toward long-term and well-managed patients, which may have underestimated short-term variability, acute deterioration, and mortality risk factors, thereby limiting representativeness for the broader diabetic population. Second, all data were derived from the district's hospital and laboratory information systems, without capturing care received outside the district. As a result, health care utilization and expenditure data may be incomplete, potentially biasing the observed associations between care-seeking patterns and outcomes. Third, patients not enrolled in the chronic disease management program were not included for less adherence and higher complication rates. This omission may have led to an overestimation of glycemic control rates and an underestimation of complication prevalence, restricting the generalizability of our findings. Future studies should adopt multicenter, prospective cohort designs, integrate both district-level and external insurance data, track patients lost to follow-up, and incorporate patient-reported factors such as care preferences and treatment adherence to validate the stability and applicability of the identified subgroups and intervention strategies.

Conclusion

This study highlights the heterogeneity of health-seeking behaviors among patients with type 2 diabetes and their implications for glycemic control. Our findings suggest that chronic disease management in China can be further optimized through the following strategies:

(1) Prioritize care for older adults and frequent community health centre visitors. Build on family doctor contracting and integrated chronic disease management programs to provide quarterly home visits (including glucose and blood pressure testing) for patients aged ≥60 years, incorporate exercise programs (e.g., group exercise, Tai Chi) into annual care plans, with the aim to improve accessibility and adherence.

(2) Enhance comprehensive management in primary care.
For patients with dyslipidemia, establish integrated diabetes–lipid clinics within community health centres, implementing standardized treatment pathways (e.g., statin therapy combined with lifestyle interventions). Expand the use of evidence-based traditional Chinese medicine practices (e.g., acupuncture, herbal interventions) to provide essential care for autoimmune disease and osteoporosis, thereby reducing the burden on high-resource hospital services.

(3) Define clear tiered referral pathways. Guide newly diagnosed patients, those with shorter disease duration, and those without complications toward community-based or enhanced community-based patterns. For patients with comorbidities such as hypertension or thyroid disease, establish structured referral pathways ("first visit in community health centres→ specialist evaluation → bidirectional referral"), with tertiary endocrinology departments designing individualized treatment plans and community health centres providing long-term follow-up.

(4) Strengthen multidisciplinary care for complex patients. For patients with multisystem comorbidities, promote endocrinology-led multidisciplinary team (MDT) models in secondary and tertiary hospitals, involving cardiology, nephrology, and other specialties. This approach can reduce fragmented consultations and resource inefficiencies while ensuring integrated and coordinated care.

(5) Increase the frequency of HbA1c testing. Implement reminder systems in community health centres to ensure that all patients undergo at least two HbA1c tests annually, with priority given to community-based patients. For high-risk individuals undergoing ≥5 tests per year, introduce continuous glucose monitoring to detect glycemic variability early and adjust treatment accordingly.

(6) Develop a stratified patient database. Establish longitudinal databases to capture complication trajectories, health expenditures, and long-term outcomes across different health-seeking pattern subgroups (e.g., enhanced community-based, comprehensive-complex), to provide evidence to refine targeted interventions and inform population-level policy decisions.

Declarations

Not applicable.

Ethical approval and consent to participate

The study received approval from Shanghai Municipal Center for Disease Control and Prevention Ethical Review Committee(Approval No. 2025-53).

Consent for publication

Not applicable.

Funding

Not applicable.

Declaration of competing interest

The authors declare that they have no competing interest.

Acknowledgements

Not applicable.

References

1. Zhou B, Rayner A, Gregg E, et al. Worldwide trends in diabetes prevalence and treatment from 1990 to 2022: a pooled analysis of 1108 population-representative studies with 141 million participants. *Lancet*. 2024;404:2077–2093. doi:10.1016/S0140-6736(24)02317-1.
2. International Diabetes Federation. IDF diabetes atlas. 10th ed. Brussels: International Diabetes Federation; 2021. Available from: https://diabetesatlas.org/atlas/tenth-edition/. Accessed 2024 Sep 12.
3. García-Villarino M, Martínez-Camblor P, García AV, et al. Impact of general practitioner appointment frequency on disease management in type 2 diabetes mellitus patients. *Prim Care Diabetes*. 2025;19(2):165–172. doi:10.1016/j.pcd.2025.01.007.
4. Li P, Li Z, et al. The relationship between type 2 diabetic patients' early medical care–seeking consistency to the same clinician and health care system and their clinical outcomes. *Medicine (Baltimore)*. 2015;94(7):e554. doi:10.1097/MD.0000000000000554.
5. Quan Z, Xiao H, Xinyi Z, et al. Multimorbidity patterns and associated factors in older Chinese: results from the China health and retirement longitudinal study. *BMC Geriatr*. 2022;22(1):470. doi:10.1186/s12877-022-03154-9.
6. Chinese Diabetes SocietyGuidelines for the prevention and treatment of type 2 diabetes in China (2024 edition). (Chinese). *Chin J Diabetes Mellitus*. 2025;17(1):16–139. doi:10.3760/cma.j.cn115791-20241203-00705.
7. Chinese Diabetes Society; National Office for Primary Diabetes Prevention and Management. National primary care guidelines for diabetes prevention and management (2022). (Chinese). *Chin J Intern Med*. 2022;61(3):249–262. doi:10.3760/cma.j.cn112138-20220120-000063.
8. Sun XY, Yin J, Ye YX, et al. Selection of first-visit medical institutions among community residents in Beijing and influencing factors. (Chinese). *Chin J Gen Pract*. 2012;11(12):928–929. doi:10.3760/cma.j.issn.1671-7368.2012.12.016.
9. Wen D, Zhu YP, Ye T, et al. Evaluation of family physician contract service based on community information system in Shanghai. (Chinese). *Shanghai J Prev Med*. 2018;30(4):281–285. doi:10.19428/j.cnki.sjpm.2018.18591.
10. Ringborg A, Cropet C, Jönsson B, et al. Resource use associated with type 2 diabetes in Asia, Latin America, the Middle East and Africa: results from the International Diabetes Management Practices Study (IDMPS). *Int J Clin Pract*. 2009;63(7):997–1007. doi:10.1111/j.1742-1241.2009.02098.x.
11. Moiza JM, Pérez M, Cols M, et al. An analysis of the diabetic population in a Spanish rural area: morbidity profile, use of resources, complications and metabolic control. *Aten Primaria*. 2013;45(9):461–475. doi:10.1016/j.aprim.2013.04.007.
12. Sophia A, Clare L, Sharmin S, et al. Consultation rates in people with type 2 diabetes with and without vascular complications: a retrospective analysis of 141,328 adults in England. *Cardiovasc Diabetol*. 2022;21(8):1–12. doi:10.1186/s12933-021-01435-y.
13. Fang JG. Standardized diagnosis and treatment of thyroid nodules and strengthening of surgical training. (Chinese). *Int J Surg*. 2015;42(4):76–78. doi:10.3760/cma.j.issn.1673-4203.2015.02.002.
14. Zeng QZ, He YL, Shi ZY, et al. Effect evaluation of comprehensive psychological intervention for patients with chronic diseases in the community: a cluster-randomized controlled trial. (Chinese). *Shanghai Arch Psychiatry*. 2016;28(2):72–85. doi:10.11919/j.issn.1002-0829.216016.
15. Yang JJ, Xu JG. Effect of group rehabilitation training on patients with mild-to-moderate depression. (Chinese). *Chin J Phys Med Rehabil*. 2014;36(1):57–58. doi:10.3760/cma.j.issn.0254-1424.2014.01.015.
16. Zhiyu Z, Yunou Y, Guozhen L, et al. The hypertension and hyperlipidemia status among type 2 diabetic patients in the community and influencing factors analysis of glycemic control. *Diabetol Metab Syndr*. 2023;15:73. doi:10.1186/s13098-023-01013-0.
17. Li YY, Yang QP, Wu F, et al. Prevalence and influencing factors of type 2 diabetes among residents aged 35 years and older in Shanghai. (Chinese). *Chin J Prev Control Chronic Dis*. 2021;29(10):729–734. doi:10.16386/j.cjpccd.issn.1004-6194.2021.10.003.
18. Baiju R, Janet E, Andreas L, et al. Diabetic patients with prior specialist care have better glycaemic control than those with prior primary care. *J Eval Clin Pract*. 2005;11(8):568–575. doi:10.1111/j.1365-2753.2005.00582.x.
19. Zgibor J, Songer T, Kelsey S, et al. The association of diabetes specialist care with health care practices and glycemic control in patients with type 1 diabetes: a cross-sectional analysis from the Pittsburgh Epidemiology of Diabetes Complications Study. *Diabetes Care*. 2000;23(4):472–477. doi:10.2337/diacare.23.4.472.
20. Julie C, Jennifer L, Saira J, et al. Association of potentially modifiable diabetes care factors with glycemic control in patients with insulin-treated type 2 diabetes. *JAMA Netw Open*. 2020;3(1):e1919645. doi:10.1001/jamanetworkopen.2019.19645.
21. Baiju R, Janet E, Andreas L, et al. Clinical inertia in response to inadequate glycemic control: do specialists differ from primary care physicians? *Diabetes Care*. 2005;28(3):600–606. doi:10.2337/diacare.28.3.600.
22. Wang XJ, Zhao WY, Dong H, et al. Effect of MMC management led by specialist nurses on self-management in patients with type 2 diabetes. (Chinese). *China Med Her*. 2022;19(18):136–140.
23. Helaine A, Sotero S, Maria D, et al. Factors associated with glycemic control in a sample of individuals with diabetes mellitus taken from the Longitudinal Study of Adult Health, Brazil, 2008–2010. *Epidemiol Serv Saude*. 2020;29(3):e2019054. doi:10.5123/S1679-49742020000300017.
24. Wang S, Shao W, Jiang Q, et al. Risk factors for glycemic control in hospitalized patients with type 2 diabetes receiving continuous subcutaneous insulin infusion therapy. *Diabetes Ther*. 2022;14:167–178. doi:10.1007/s13300-022-01342-9.
25. Muhammad Q, Kavita S, Dimple K, et al. Factors affecting achievement of glycemic targets among type 2 diabetes patients in South Asia: analysis of the CARRS trial. *Diabetes Res Clin Pract*. 2020;171:108555. doi:10.1016/j.diabres.2020.108555.
26. Melkamu T. Magnitude, pattern, and associated factors of thyroid dysfunction in diabetic patients at Debre Markos Referral Hospital in North-West Ethiopia: a cross-sectional hospital-based study. *Ethiop J Health Sci*. 2025;35(2):125–134. doi:10.4314/ejhs.v35i2.9.
27. Hong Y, Junhua H, Ting D, et al. Impact of health management on medication adherence and blood pressure and blood glucose indices in elderly patients with hypertension and diabetes mellitus. *Endocrine*. 2025;89(2):448–455. doi:10.1007/s12020-025-04249-0.