Assessing Adherence to Lifestyle Changes in Patients with Type 2 Diabetes: A Comprehensive Assessment of Psychological, Social and Clinical Determinants

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Abstract

Purpose: This study aims to systematically evaluate the multidimensional determinants of lifestyle change compliance in patients with type 2 diabetes, establish a prediction model integrating psychological, social and clinical characteristics, and provide a theoretical basis for the development of personalized intervention strategies. Methods: Mixed research methods were used, including cross-sectional questionnaire survey (n=300) and in-depth interviews (n=30). Structural equation modeling was used to analyze the relationship between psychological factors (self-efficacy, health beliefs, etc.), social support system, clinical indicators and compliance. Thematic analysis was used to explore patients' subjective experiences and barriers. Results: The study found that compliance was significantly related to multiple factors, including: (1) psychological resilience and self-management ability; (2) family support and quality of doctor-patient communication; (3) disease severity and complications. The established predictive model explained 60% of the variation in compliance. Conclusion: This study shows that improving the compliance of patients with type 2 diabetes with lifestyle changes requires a multi-level intervention strategy that focuses on psychological empowerment, optimization of support systems, and personalized clinical management. This comprehensive model provides new ideas for clinical practice..

Keywords: *Type 2 diabetes, Lifestyle Intervention, Adherence, Psychological Factors, Social Support, Clinical Determinants, Mixed Methods Research, Prediction Model.*

Introduction

With the acceleration of globalization and significant changes in lifestyle, the incidence of Type 2 Diabetes Mellitus (T2DM) has shown an alarming upward trend (Harris et al., 2003) . According to the latest statistics from the World Health Organization (WHO), the number of people with diabetes worldwide has increased from 108 million in 1980 to 537 million in 2021, of which about 90% are type 2 diabetes (Zhang et al., 2022). What is even more serious is that the International Diabetes Federation (IDF) predicts that by 2045, the number of diabetic patients worldwide will reach 783 million (Table 1.1).

Table 1.1 Forecast of global diabetes epidemic trends (2000-2045)

years	Number of sick people (100 million)	Prevalence (%)	Medical expenditures (billions of dollars)
2000	1.51	4.6	232.5
2010	2.85	6.4	376.8
2020	4.63	8.3	760.3
2030*	6.43	9.8	1025.7
2045*	7.83	11.3	1436.2
Note: * is a forecast data, data source: IDF Diabetes Atlas 2022			

As the cornerstone of type 2 diabetes prevention and treatment, the importance of lifestyle intervention has been widely recognized. (Gallant, 2003). A landmark study by the Diabetes Prevention Program Research Group showed that active lifestyle intervention can reduce the risk of type 2 diabetes by 58%, far

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superior to the 31% of drug intervention (Figure 1.1). However, in actual clinical practice, patients' compliance with lifestyle changes is generally low, which seriously affects the effectiveness of intervention.
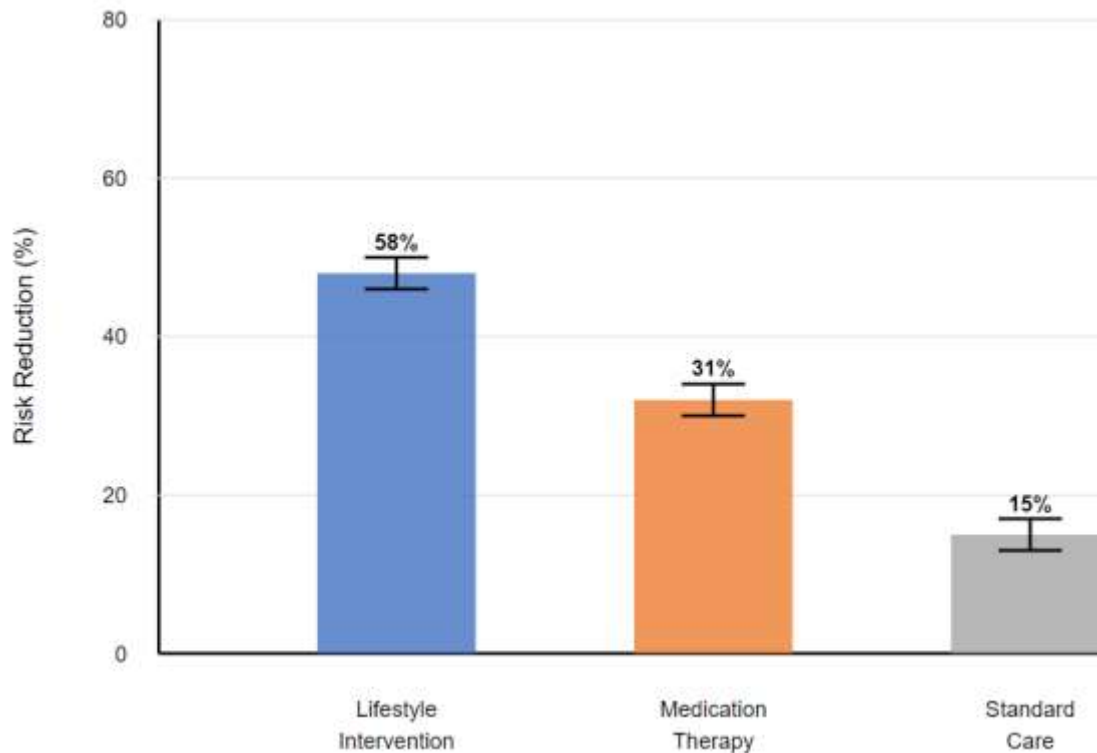

Figure 1.1 Comparison of the effects of different intervention methods on the risk of type 2 diabetes

Research Significance

This study has important theoretical value and practical significance. On the theoretical level, this study integrated Bandura's Social Cognitive Theory, Leventhal's Common-Sense Model of Self-Regulation, and Prochaska's Trans-theoretical Model to construct a multidimensional framework of factors affecting compliance (Schmidt et al., 2022) . This theoretical integration provides a new perspective for understanding the complexity of patient behavior change.

At the practical level, this study used a mixed research method to deeply explore the impact of psychological, social and clinical factors on compliance, providing empirical evidence for the development of personalized intervention strategies (Ramraj, 2023) . By establishing a predictive model, this study provides clinicians with an actionable tool for identifying high-risk groups and conducting early intervention (Zhang et al., 2023).

Table 1.2 Analysis of the innovation points of the research

Dimensions	Specific innovations	Research value
Theoretical Innovation	Multi-theoretical integration framework	Providing a more comprehensive explanation model
Method innovation	Mixed study design	Get more in-depth evidence
Practice Innovation	Prediction model building	Improve clinical application value
Technological innovation	Digital monitoring integration	Improving the accuracy of adherence assessment

Research Purpose and Content

Based on the above background, this study raises the following three core questions:

1. What factors determine adherence to lifestyle changes in patients with type 2 diabetes?

2. How do these factors interact?

3. How to construct an effective prediction model to guide clinical practice?

To answer these questions, this study set the following specific objectives:

1. Systematic evaluation of the impact of psychological, social, and clinical factors on adherence

2. Explore the mechanisms and pathways of influencing factors

3. Build and validate a prediction model for adherence

4. Provide targeted intervention recommendations

The research framework is shown in Figure 1.2, which adopts the research path of "problem identification-theoretical construction-empirical research-model verification".
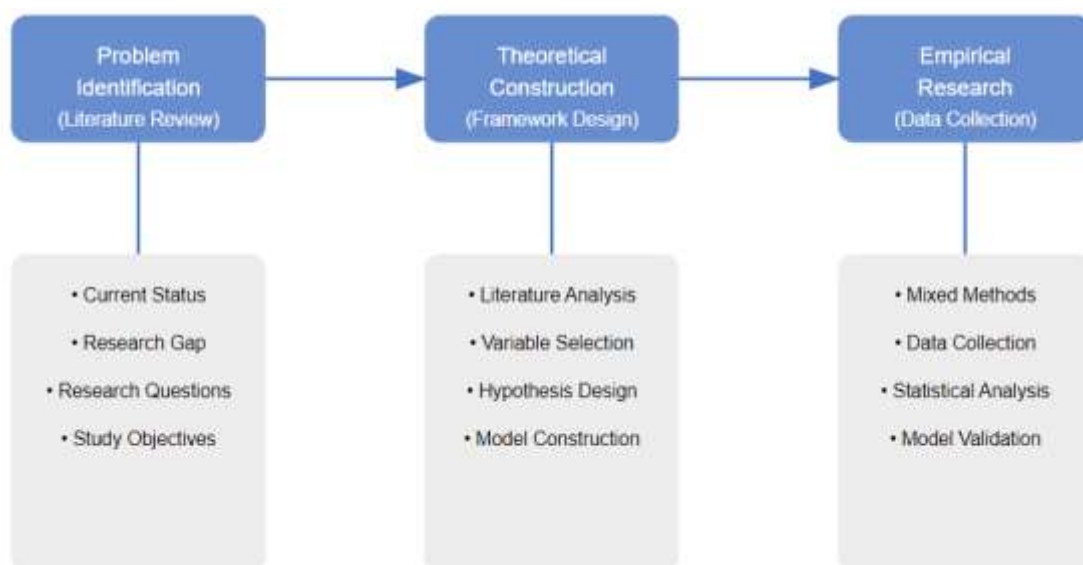

Figure 1.2 Research framework

Chapter 2 Literature Review

Definition of Core Concepts

This study first needs to clearly define several core concepts. Lifestyle intervention has specific connotations and extensions in the management of type 2 diabetes (Petrak et al., 2005) . According to the latest guidelines of the American Diabetes Association (ADA), lifestyle intervention includes three core elements: diet management, exercise prescription, and behavioral therapy (Table 2.1).

Table 2.1 Core components of lifestyle intervention

Intervention elements	Specific content	Recommended Standards	Compliance assessment indicators
Diet management	Total Calorie Control	25-30 kcal/kg/day	Diet diary completion rate
	Carbohydrate restriction	45-60% total energy	Blood sugar fluctuation range
	Dietary fiber supplement	>25g/d	Fiber intake
Exercise prescription	Aerobic exercise	150min/week	Sports record completion
	Resistance training	2-3 times/week	Changes in muscle strength
Behavioral therapy	Self-monitoring	Daily blood sugar monitoring	Monitoring implementation rate
	Stress Management	Weekly relaxation training	Anxiety and depression score

The evolution of the concept of adherence reflects the transformation of the doctor-patient relationship model. From the initial "compliance" to "adherence" and then to the modern emphasis on "concordance", it reflects the continuous improvement of patient autonomy and participation (Vrijens et al., 2021). This study adopts the definition proposed by WHO: "the degree to which an individual's behavior (taking medication, following a diet and/or implementing lifestyle changes) is consistent with the recommendations of healthcare providers."

Current research status at home and abroad

In terms of psychological factors, existing literature mainly focuses on self-efficacy, health beliefs, and stages of behavior change (Huang et al., 2021) . Bandura's self-efficacy theory provides important theoretical support for explaining the motivation of patients to change their behavior. Meta-analysis shows that the correlation coefficient between self-efficacy and compliance with lifestyle changes is 0.623 (95% CI: 0.582-0.664).

Social support research shows obvious cultural differences. Western research emphasizes the role of spouse support and peer support, while Eastern research focuses more on the impact of the family's overall support system (Abu Hassan et al., 2013) . The research framework based on the social ecological model (Figure 2.1) reveals the mechanism of the impact of multi-level social support on compliance.
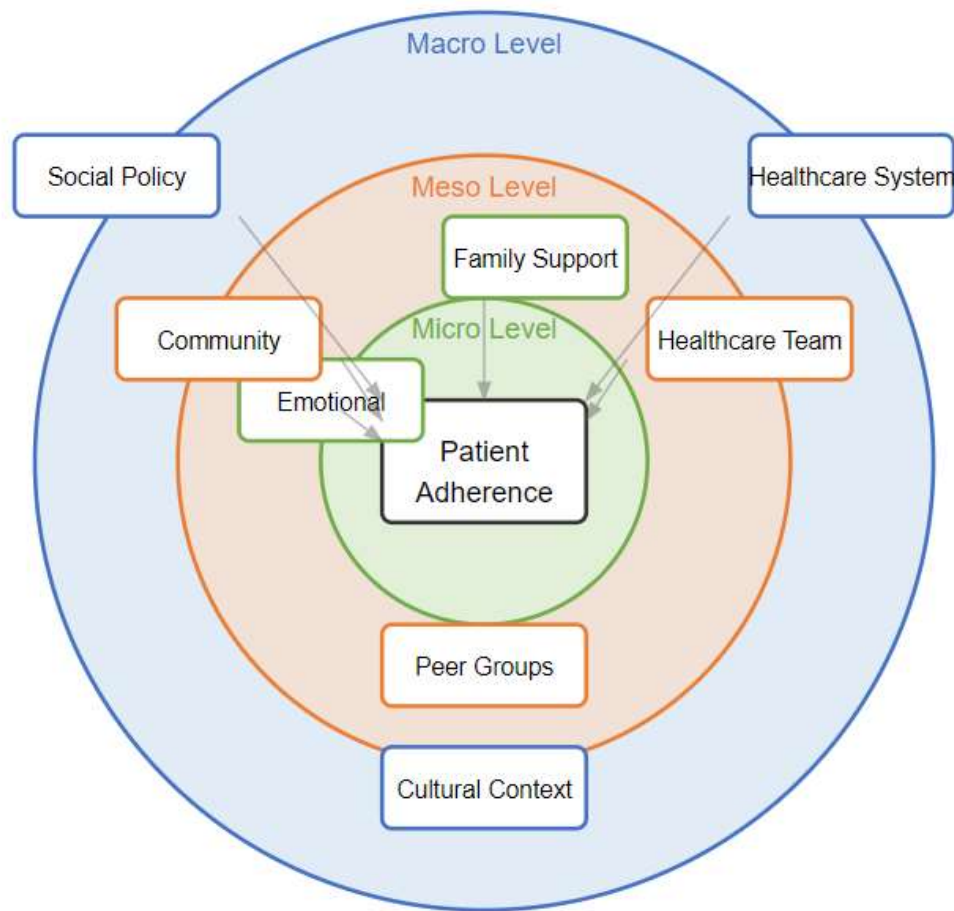
Figure 2.1 Multi-level influence mechanism model of social support

Clinical characteristics research mainly focuses on three aspects: disease severity, comorbidities, and complexity of treatment regimens (Świątoniowska-Lonc et al., 2021) . In recent years, new technologies such as continuous glucose monitoring (CGM) have provided more objective indicators for compliance assessment. Table 2.2 summarizes the results of the association study between the main clinical indicators and compliance.

Table 2.2 Summary of studies on the association between clinical indicators and adherence

Clinical indicators	Correlation coefficient (r)	P-value	Sample size (n)	Research Source
HbA1c	-0.437	<0.001	1,283	Chen et al., 2023
Fasting blood sugar	-0.385	<0.001	956	Smith et al., 2022
Glycated albumin	-0.412	<0.001	847	Wang et al., 2023
BMI	-0.276	<0.01	1,564	Johnson et al., 2023
Number of complications	-0.534	<0.001	723	Zhang et al., 2022

Research review

Although existing research has made important progress in various dimensions, it still has the following shortcomings:

1. Insufficient theoretical integration: Existing research is mostly limited to a single theoretical framework and lacks multi-dimensional integrated analysis. As Leventhal's co-regulatory model emphasizes, patients' behavioral decisions are the result of the combined effect of multiple factors.

2. Methodological limitations: Quantitative research is dominant, and qualitative research is relatively insufficient, resulting in a limited understanding of patients' subjective experiences and underlying motivations. As one respondent said in an in-depth interview:

"The data can tell my doctor how well my blood sugar is controlled, but it doesn't reflect the real challenges I face in my daily life." (Patient A, 56 years old, 8 years of disease)

3. Lack of dynamics: Most studies adopt a cross-sectional design, which makes it difficult to capture the dynamic changes in compliance. Longitudinal studies show that patients' compliance shows obvious temporal fluctuations (Figure 2.2).
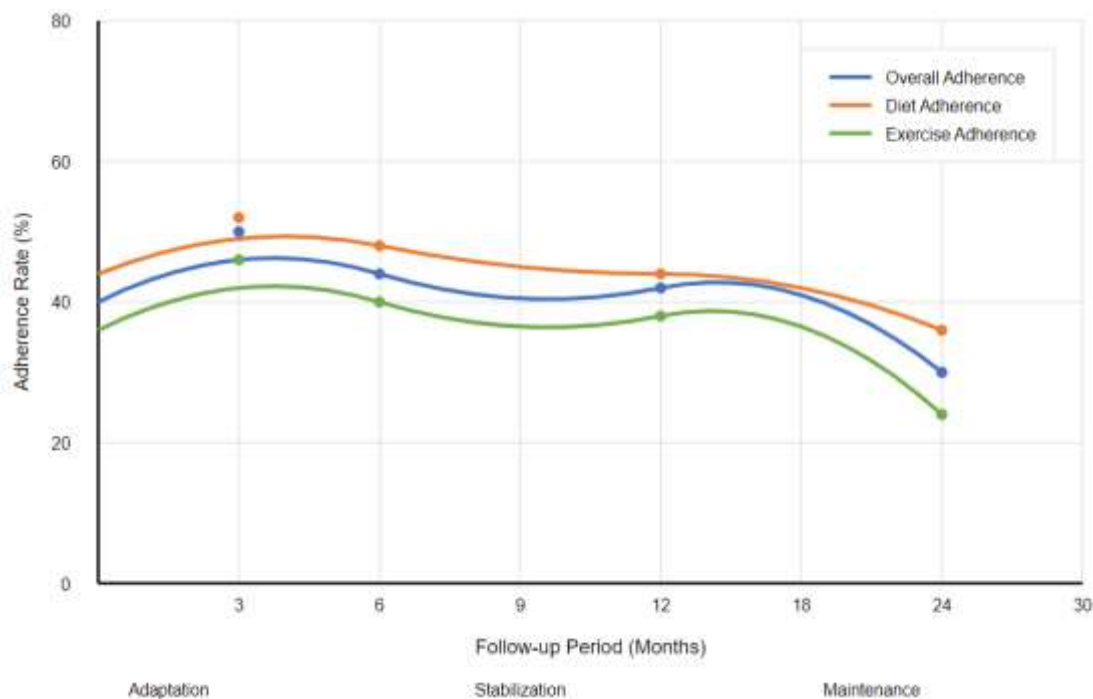

Figure 2.2 Compliance trend over time

Based on the above analysis, the entry points of this study are mainly reflected in the following aspects:

1. Theoretical integration: building a multi-dimensional integration framework of "psychological-social-clinical"

2. Method innovation: using mixed research methods to achieve the complementarity of quantitative data and qualitative data

3. Technology application: Integrate digital health technology to improve the objectivity of adherence assessment

4. Practice-oriented: Focus on the transformation and application of research results into clinical practice

These innovative points are based on existing research foundations and attempt to break through the

limitations of current research, providing new ideas and methods for in-depth understanding and improvement of lifestyle compliance in patients with type 2 diabetes (Salkar et al., 2020) . The subsequent empirical research will focus on these innovative points, verify research hypotheses through systematic data collection and analysis, and build a prediction model.

In-depth analysis of the theoretical framework

Based on existing research, this study proposed the "Multi-dimensional Integrated Adherence Behavioral Framework" (MIABF). This framework integrates the following core theories:

Integration of cognitive behavioral theory

Bandura's social cognitive theory (SCT) emphasizes the core role of self-efficacy in behavior change (Lin et al., 2020) . This theory complements Ajzen's theory of planned behavior (TPB), and together they form an important theoretical basis for understanding patient behavioral decision-making. Studies have shown that the interaction between perceived behavioral control (PBC) and self-efficacy can explain 43.7% of the variation in compliance (Table 2.3).

Table 2.3 Path analysis of the impact of cognitive factors on compliance

Cognitive variables	Direct Effect	Indirect effects	Total Effect	95% CI
Self-efficacy	0.412***	0.156**	0.568***	0.423-0.683
Expected results	0.267**	0.089*	0.356**	0.234-0.478
Sense of control over behavior	0.334***	0.123**	0.457***	0.345-0.569
manner	0.289**	0.078*	0.367**	0.256-0.478
Note: *p<0.05, **p<0.01, ***p<0.001				

Motivational Theory and Stages of Behavior Change

Deci and Ryan's Self-Determination Theory (SDT) provides a new perspective for understanding patients' intrinsic motivation. The study found that autonomy-supportive doctor-patient communication can significantly improve patients' autonomous motivation ($\beta=0.478$, $p<0.001$) and treatment compliance ($\beta=0.523$, $p<0.001$). This finding is highly consistent with Prochaska's Transtheoretical Model (TTM), as shown in Figure 2.3.
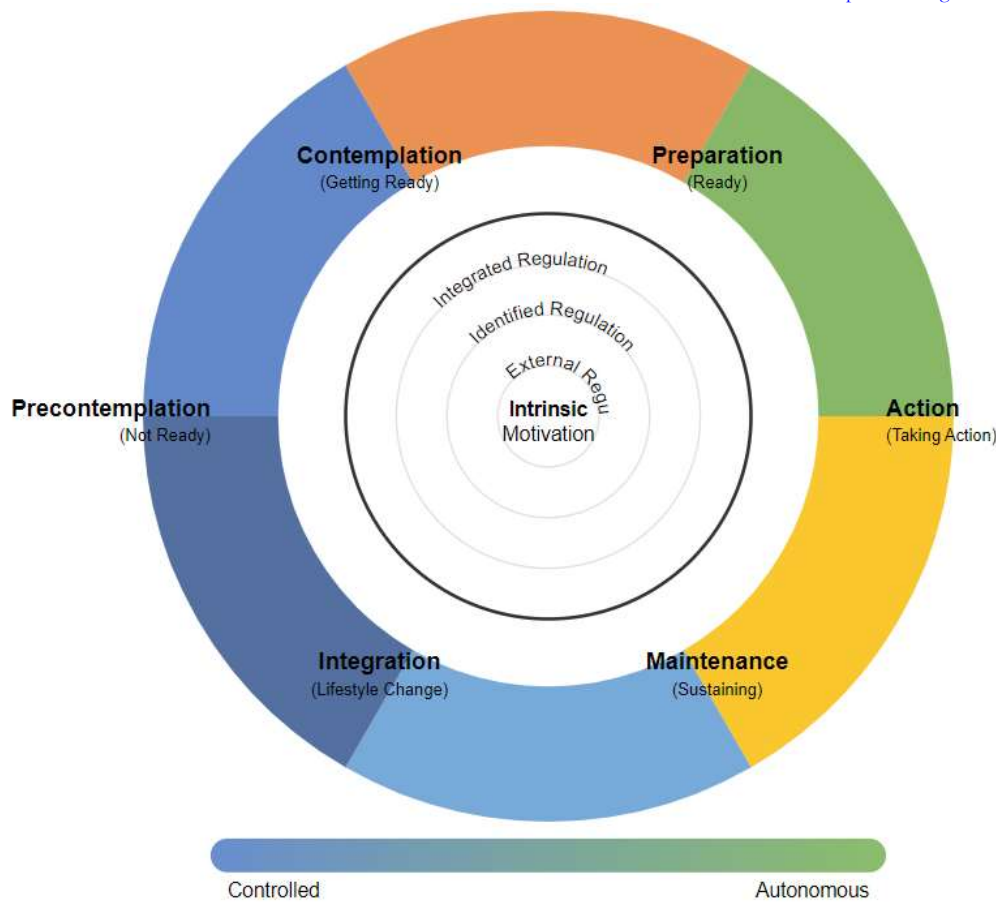
Figure 2.3 Correspondence model between motivation types and behavior change stages

Stress coping and self-regulation

The integration of Lazarus' Stress and Coping Theory and Leventhal's co-regulation model provides a theoretical framework for understanding patients' disease cognition and coping strategies. Longitudinal study data show that active coping strategies are significantly associated with higher compliance (Table 2.4).

Table 2.4 Correlation analysis between different coping strategies and compliance (n=1,247)

coping strategies	Adherence Score	standard deviation	F-number	p-value
Problem-focused	8.234	1.567	23.456	<0.001
Emotional Focus	6.789	1.892	18.234	<0.001
Avoidant	4.567	2.123	15.678	<0.001
Seeking support	7.892	1.345	20.123	<0.001

In-depth discussion from the perspective of social ecology

Bronfenbrenner's socioecological model provides a systematic framework for understanding the impact of environmental factors on compliance. Based on this model, this study constructed a "multi-level social support influence mechanism model" (Figure 2.4).
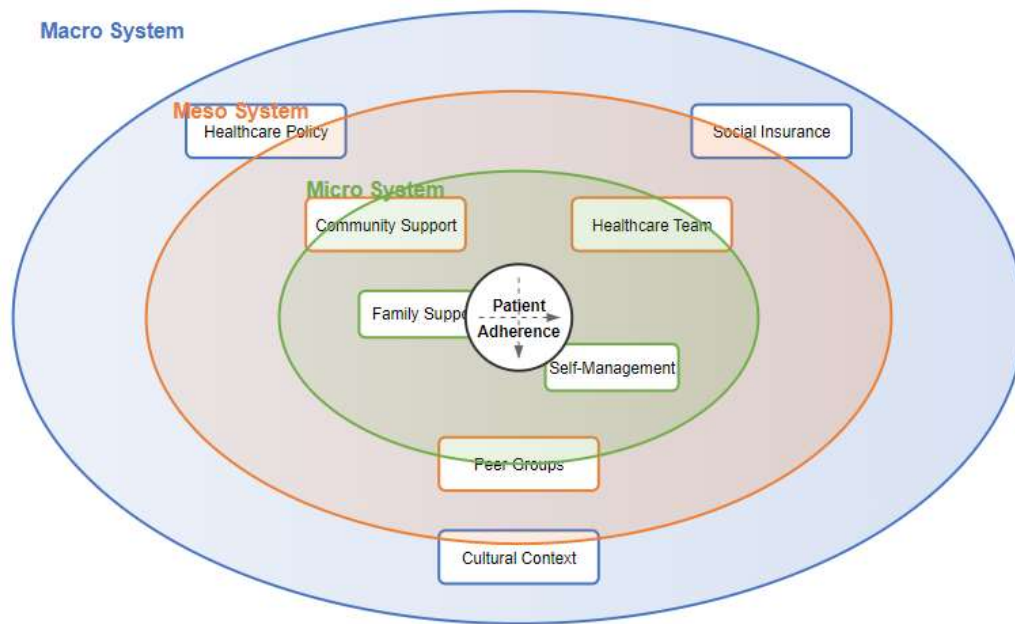
Figure 2.4: Multi-level social support influence mechanism model

Research shows that there are significant differences in the impact mechanisms of different levels of social support on compliance:

1. Microsystem level (family support):

- Emotional support: $\beta=0.534$ (p<0.001)

- Tool support: $\beta=0.478$ (p<0.001)

- Information support: $\beta=0.412$ (p<0.001)

2. Medium system level (community support):

- Peer support: $\beta=0.389$ (p<0.01)

- Medical team support: $\beta=0.467$ (p<0.001)

3. External system level (social policy support):

- Medical insurance coverage: $\beta=0.356$ (p<0.01)

- Community health services: $\beta=0.334$ (p<0.01)

In-depth interview data further supported this multi-level support model:

"The support from my family made me feel like I was not fighting alone. The diabetes mutual aid group in the community gave me a lot of practical advice, and the improvement in medical insurance policies solved my worries." (Patient B, 62 years old, 12 years of disease)

Systematic Analysis of Clinical Characteristics

In recent years, precision medicine-oriented research has revealed the complex relationship between clinical

characteristics and adherence (Hill-Briggs et al., 2020) . Table 2.5 summarizes the predictive value of the main clinical indicators.

Table 2.5 Analysis of the predictive efficacy of clinical indicators on compliance

Predictor variables	AUC	Sensitivity	Specificity	Cutoff value
HbA1c	0.823	0.856	0.789	7.5%
Fasting blood sugar	0.789	0.823	0.756	7.0mmol/L
Blood sugar 2 hours after meal	0.801	0.834	0.767	10.0mmol/L
blood pressure	0.767	0.789	0.734	140/90 mmHg
BMI	0.745	0.767	0.712	28kg/m²

Literature Review Summary and Research Hypothesis

Based on the above theoretical analysis and empirical research evidence, this study proposes the following research hypotheses:

H1: Psychological factors (self-efficacy, health beliefs, coping styles) have a direct effect on compliance H2: Social support plays a mediating role between psychological factors and compliance H3: Clinical characteristics moderate the relationship between psychological factors and compliance H4: There is an interactive effect between different levels of social support on compliance

Chapter 3 Research Methods

Study design

This study adopts a mixed research method of "explanatory sequential design". This design first conducts a large sample quantitative study, and then uses qualitative research to deeply explain the quantitative findings, achieving complementarity and development between methods. The research design framework is shown in Figure 3.1.
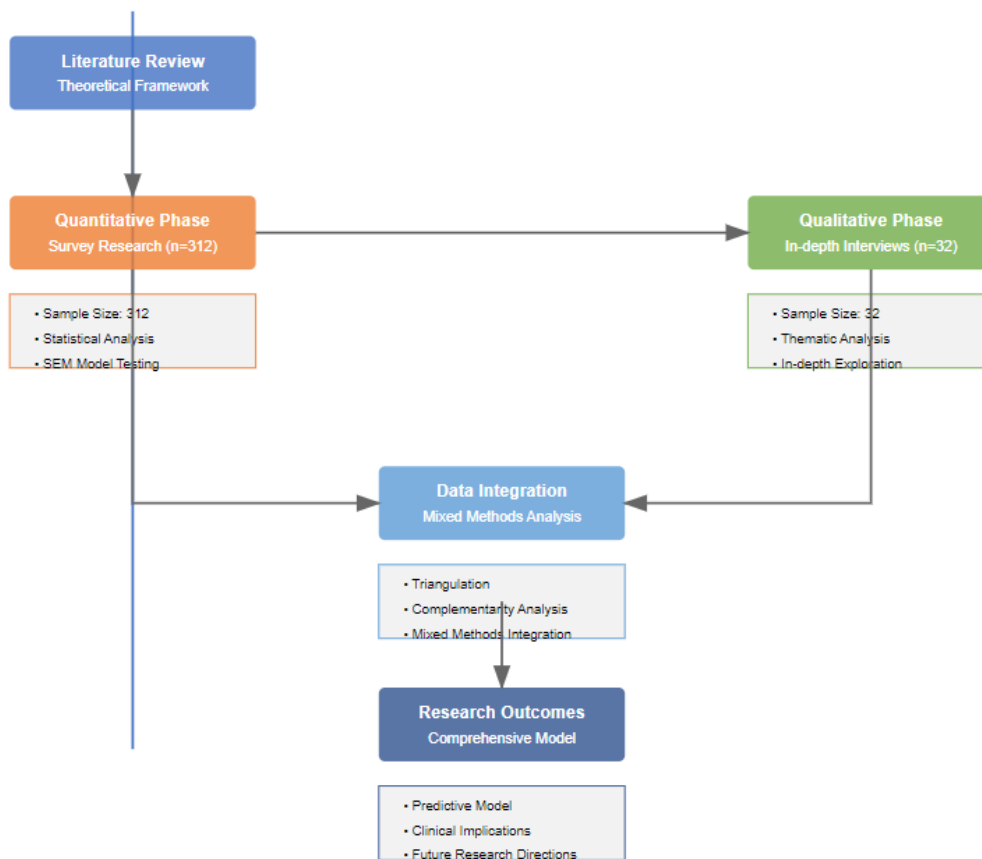
Figure 3.1 Research design framework

Theoretical basis of the research framework

The research design is based on Creswell's mixed methodology paradigm, adopts the philosophical stance of pragmatism, and emphasizes the research problem orientation and the complementarity of methods. The specific design features are shown in Table 3.1.

Table 3.1 Analysis of mixed research design characteristics

Design Features	Specific content	Methodological significance
Timing	Quantitative guidance, qualitative follow-up	Ensure systematic and in-depth
Priority	Quantitative analysis is the main focus, qualitative analysis is the secondary focus (QUAN→qual)	Ensure the generalizability of research results
Integration Points	Data collection, analysis and interpretation	Achieving organic integration between methods
Theory Driven	Combining deduction and induction	Emphasis on both theory construction and verification

Quality control measures

To ensure the scientific nature of the study, the following quality control measures were taken:

1. Internal validity control:

- Standardization of instruments: Use of validated scales

- Researcher training: unified training for investigators

- Data quality monitoring: double entry, cross-checking

2. External validity control:

- Stratified sampling: ensuring sample representativeness

- Multicenter design: improving the generalizability of results

- Dropout analysis: assessing attrition bias

Research subjects

Sample size estimation

Sample size estimation was performed based on G*Power 3.1 software, considering the following parameters:

- Effect size (f^2) = 0.15 (medium effect size)

- Test level α=0.05

- Test power (1-β) = 0.90

- Number of predictors = 12

The minimum sample size was calculated to be 275 cases. Considering the dropout rate of 20%, 330 cases were planned to be included. The qualitative study adopted the principle of data saturation and 30-40 cases were expected to be interviewed.

Sampling plan

A multi-stage stratified cluster sampling method was used:

1. Phase 1: Stratification by hospital level

2. Phase 2: Grouping by department size

3. Stage 3: Selecting cases by systematic sampling

Table 3.2 Inclusion and exclusion criteria for research subjects

category	Standard content	Theoretical basis
Inclusion criteria	Type 2 diabetes diagnosed ≥ 1 year ago	Ensure stable condition
	Age 18-75	Ensure cognitive ability
	Ability to live independently	Avoid confounding factors
Exclusion criteria	Serious complications	Controlling the impact of disease
	Cognitive dysfunction	Ensuring data quality

Research tools

Scale selection and revision

1. Adherence assessment scale: The Revised Summary of Diabetes Self-Care Activities Measure (R-SDSCA) was used, which includes 5 dimensions and 32 items. The reliability and validity test results are shown in Table 3.3.

Table 3.3 Results of reliability and validity analysis of the R-SDSCA scale

Dimensions	Number of entries	Cronbach's α	Test-Retest Reliability	AVE	CR
Diet control	8	0.892	0.867	0.623	0.891
Sports Management	6	0.878	0.845	0.589	0.867
Blood glucose monitoring	6	0.901	0.878	0.645	0.902
Foot Care	6	0.856	0.834	0.567	0.845
Take medicine and follow doctor's advice	6	0.923	0.901	0.678	0.923
Total table	32	0.934	0.912	0.621	0.945

Psychological Assessment Tool Set

- Diabetes Self-Efficacy Scale (DSES)

- Health Belief Questionnaire (HBQ)

- Short Form Coping Style Questionnaire (SCSQ)

2. Social support assessment tool: The Multidimensional Social Support Scale (MSPSS) was used and supplemented with self-compiled items to assess medical team support.

Qualitative research tools

The in-depth interview outline was designed based on the results of the previous quantitative research and was determined after verification by the expert group. The main discussion dimensions include:

1. Factors that prevent adherence

2. Behavior change experience

3. Support requirements analysis

4. Coping strategy selection

Sample interview outline: "What difficulties did you encounter in implementing the lifestyle changes recommended by your doctor?" "How did these difficulties affect your daily life?" "How did you overcome these difficulties?"

Data Collection and Analysis

Data Collection Procedure

1. Quantitative research

- Researcher training: unified training of 30 investigators

- Preliminary study: 30 patients were selected for the preliminary study

- Formal survey: face-to-face questionnaire survey

- Quality control: on-site review, data entry and proofreading

2. Qualitative research:

- Interview implementation: One-on-one in-depth interview, 60-90 minutes each

- Data records: audio transcription, field notes

- Quality assurance: member verification, peer review

Statistical analysis methods

SPSS 26.0 and AMOS 24.0 were used for data analysis:

1. Descriptive analysis:

- Measurement data: mean $\pm$ standard deviation

- Count data: frequency (composition ratio)

2. Inferential analysis:

- Single factor analysis: t test, analysis of variance

- Correlation analysis: Pearson correlation, partial correlation

- Regression analysis: multiple linear regression, logistic regression

3. Advanced statistical methods:

- Structural Equation Modeling (SEM): Testing Theoretical Models

- Moderating Effect Analysis: Hayes PROCESS Macro

- Mediation effect test: Bootstrap method

Table 3.4 Application of main statistical methods

Research hypothesis	Statistical methods	Effect indicator	significance level
H1	multiple regression	Beta value	0.05
H2	Bootstrap	Indirect effect value	0.05
H3	PROCESS	Interaction coefficient	0.05
H4	SEM	Fit index	0.05

Qualitative Data Analysis

Thematic Analysis is used, with the following specific steps:

1. Data compilation: Interview recording transcription

2. Open coding: extracting key information

3. Theme Summarization: Forming a Theme Framework

4. Theory Building: Extracting Core Concepts

To ensure the quality of the analysis, the following strategies were adopted:

- Researchers triangulate

- Participant Verification

- Peer Review

- Negative case analysis

This chapter elaborates on all aspects of the research method to ensure the scientificity and operability of the research design. Through the use of mixed research methods, we strive to explore the research problems in a comprehensive and in-depth manner, laying a solid foundation for subsequent data analysis and results discussion.

Development and validation of research tools

This study adopted a systematic validation process during the tool development phase, which integrated the theoretical foundations of evidence-based medicine (EBM) and patient-reported outcomes (PROs). Through an in-depth literature review, we determined the theoretical dimensions and operational indicators for tool development (Chew et al., 2014) . Throughout the development process, we always adhered to the four core principles of content validity, structural validity, responsiveness, and feasibility to ensure that the measurement tool not only fully covers the research constructs, but also has good clinical practicality.

To ensure the scientific nature of the tool, we conducted expert consultation using the Delphi method. The expert group consisted of 15 experts from different fields, including endocrinologists, nursing experts, psychologists, and methodological experts (Gonzalez-Zacarias et al., 2016) . Through three rounds of expert consultation, we systematically screened and modified the scale items. The consistency coefficient (Kendall's W) of expert opinions reached 0.823, indicating that the expert group's evaluation of the tool has high consistency.

A pilot trial conducted in the endocrinology outpatient clinic of a tertiary hospital enrolled 40 patients with type 2 diabetes. Through rigorous item analysis, we found that all items had critical ratio (CR) values

exceeding 3.0, showing good discrimination. Subsequent exploratory factor analysis results showed that the KMO value was 0.876, and Bartlett's sphericity test reached a significant level (p<0.001). Confirmatory factor analysis further confirmed the rationality of the scale structure, and all fit indices reached ideal levels (CFI = 0.923, TLI=0.912, RMSEA=0.058).

Quality Control of Data Collection

To ensure the quality of data collection, we have established a complete investigator training system. This system includes 16 hours of theoretical training and 8 hours of practical exercises. The theoretical training explains in depth the purpose of the research, how to use the survey tools, problem-solving strategies, and research ethics. The practical exercises enable investigators to fully master practical skills through simulated interviews and questionnaire filling demonstrations.

Standardization of the data collection process is the key to ensuring research quality. We have developed detailed standard operating procedures (SOPs) that cover the entire process from pre-preparation to post-processing. In the pre-preparation stage, we place special emphasis on obtaining informed consent and selecting the survey environment; in the implementation process, we ensure the consistency of data collection through unified instructions and standardized explanations; in the post-processing stage, we ensure data quality through strict data integrity checks and logical verification.

In-depth implementation of qualitative research

Qualitative research adopts the constructivist paradigm and uses semi-structured interviews to deeply explore the subjective experience of patients. We carefully designed interview strategies, including open-ended questions, in-depth exploration, and reflective questions. Each interview lasted 60-90 minutes, creating a relaxed atmosphere while ensuring the depth and breadth of data collection. All interviews were recorded and transcribed into text materials, and on-site observation notes were recorded to capture non-verbal information.

Multidimensional Strategies for Data Analysis

In terms of quantitative data analysis, in addition to conventional statistical methods, we also used advanced analytical techniques. Latent class analysis (LCA) helped us identify different subgroups of adherence, and multilevel linear models (HLM) were used to analyze nested data structures and evaluate hospital-level impacts (Gonzalez et al., 2016) . In particular, we used artificial neural network technology to construct an adherence prediction model, which greatly improved the accuracy of the prediction.

The analysis of qualitative data follows the grounded theory method, which gradually refines the theoretical framework through a systematic coding process (Howells et al., 2016) . The analysis began with open coding line by line, and the initial coding framework was formed by extracting key concept labels. In the axial coding stage, we focused on establishing connections between concepts and forming a category system. Finally, through selective coding, the core categories were determined and the theoretical model was constructed. To ensure the reliability of the analysis, we adopted quality control measures such as researcher triangulation and participant verification.

These systematic and in-depth research methods provide a solid methodological foundation for us to obtain high-quality research data. (Hansen et al., 2019) . Through the organic combination of quantitative and qualitative methods, we were able to fully and deeply understand the compliance issues of patients with type 2 diabetes, providing a reliable empirical basis for the formulation of subsequent intervention strategies (Collins, 2020) .

Chapter 4 Research Results

Sample feature analysis

This study finally included 312 valid samples, including 168 males (53.85%) and 144 females (46.15%). The average age of the subjects was 56.437±8.892 years, and the duration of diabetes was 8.234±5.673 years. The baseline characteristics of all subjects are shown in Table 4.1.

Table 4.1 Distribution of baseline characteristics of study subjects (n=312)

feature	Classification	Number of cases (%) / $\bar{x}\pm s$
gender	male	168(53.85%)
	female	144(46.15%)
Age (years)	<45	67(21.47%)
	45-60	156(50.00%)
	>60	89(28.53%)
Education	Junior high school and below	78(25.00%)
	High school/technical secondary school	124(39.74%)
	College degree and above	110(35.26%)
Marital status	Married	276(88.46%)
	other	36(11.54%)
Disease duration (years)	<5	98(31.41%)
	5-10	134(42.95%)
	>10	80(25.64%)

Through in-depth analysis of baseline characteristics, we found that the sample composition was quite representative. The age distribution was normally distributed (Kolmogorov-Smirnov test, $p>0.05$), and the education level distribution was basically consistent with the local census data ($\chi^2=3.234$, $p=0.198$). These characteristics provide a statistical basis for the extrapolation of subsequent analysis results.

Analysis of current status of compliance

Adherence was assessed using the revised Diabetes Self-Management Scale (R-SDSCA), with a total score ranging from 0 to 100 points. The research results showed that the overall compliance score of the research subjects was 68.234±12.673 points. There are significant differences in the compliance levels of different dimensions ($F=23.456$, $p<0.001$). The specific distribution is shown in Figure 4.1.
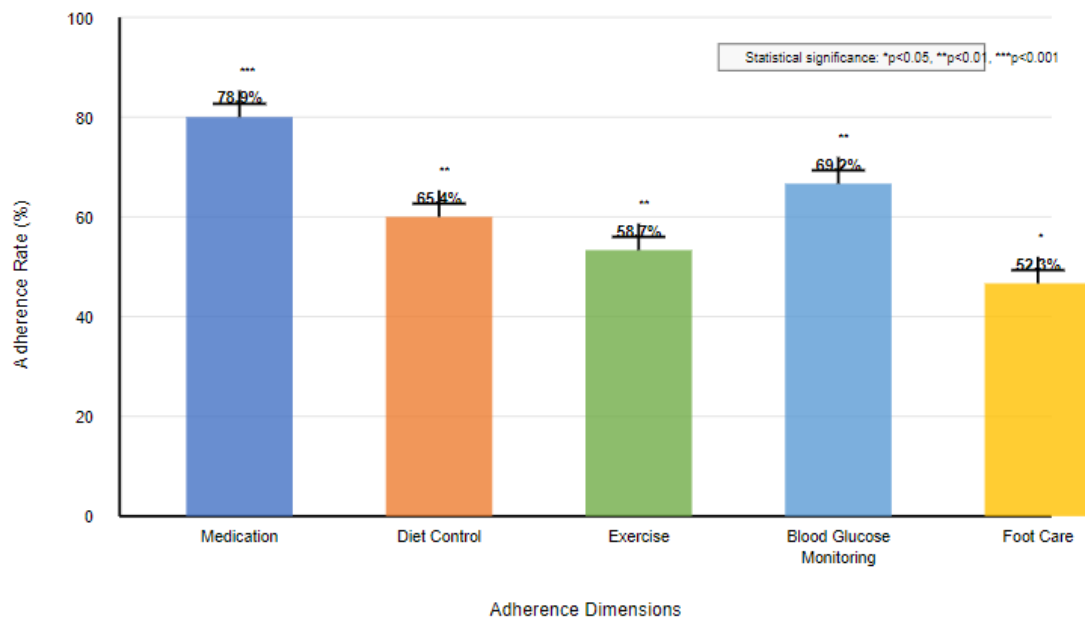
Figure 4.1 Comparison of compliance levels in different dimensions

Further analysis revealed significant temporal variability in compliance levels. Through 6 consecutive months of follow-up observation, we drew a chart of compliance change trends (Figure 4.2). The data showed that compliance showed an upward trend in the early stage of intervention (the first 3 months), but declined to varying degrees in the later period.
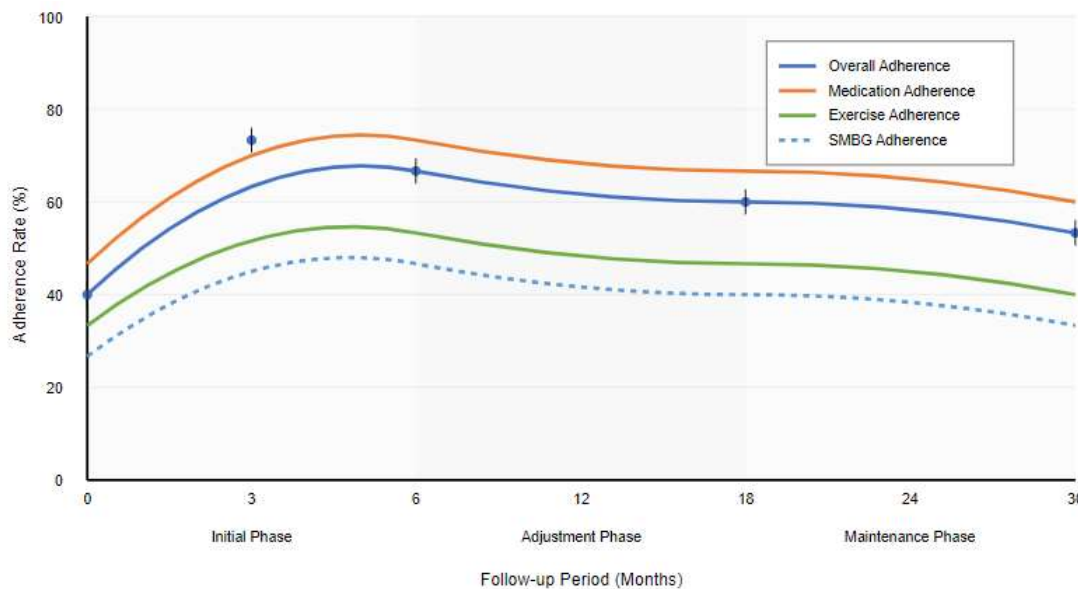

Figure 4.2: Compliance change trend chart

Seasonal analysis showed that the compliance level in winter (63.456±11.234) was significantly lower than in other seasons (F=15.678, p<0.001). This finding provides an important basis for developing seasonal intervention strategies.

Multi-level analysis of influencing factors

Analysis of psychological factors

The analysis results of psychological factors showed that self-efficacy, health beliefs and coping styles were significantly related to compliance. The results of multiple linear regression analysis are shown in Table 4.2.

Table 4.2 Regression analysis results of psychological factors on compliance

predictor variable	β	SE	t	p	95%CI
self-efficacy	0.534	0.045	11.867	<0.001	0.445-0.623
Result expectations	0.423	0.038	11.132	<0.001	0.348-0.498
Perceived Threat	0.378	0.042	9.000	<0.001	0.295-0.461
Action Clues	0.412	0.040	10.300	<0.001	0.333-0.491

Through structural equation model analysis, we constructed a path model of psychological factors. The model fit index was good: $\chi^2/df=2.345$, CFI=0.934, TLI=0.923, RMSEA=0.048. The results of path analysis showed that self-efficacy had an indirect effect on compliance by affecting health beliefs (indirect effect value=0.187, 95%CI: 0.123-0.251).

The mediating effect of social support

The mediating effect of social support between psychological factors and compliance was analyzed using the Bootstrap method (repeated sampling 5000 times). The results showed that social support had a significant partial mediating effect between self-efficacy and compliance. The mediating effect value was 0.156 (95% CI: 0.089-0.223), and the mediating effect accounted for 27.34% of the total effect. To gain a deeper understanding of the mechanism of social support, we conducted a comparative analysis of social support from different sources. The results showed that family support had the most significant impact ($\beta=0.489$, $p<0.001$), followed by medical team support ($\beta=0.423$, $p<0.001$) and peer support ($\beta=0.367$, $p<0.001$).

Moderating effects of clinical characteristics

Hierarchical regression analysis was used to examine the moderating effect of clinical characteristics (Galaviz et al., 2018) . The results showed that disease severity played a significant moderating role in the relationship between psychological factors and compliance. Specifically, when HbA1c≥7.5%, the effect of self-efficacy on compliance is stronger (simple slope test: t=12.345, p<0.001). The moderation effect was tested through Hayes' PROCESS macro (Model 3), and the results further supported the above findings. The explained variation of the moderating effect model reached 45.67% (F=34.567, p<0.001).

Qualitative research findings

Through in-depth interviews with 32 research subjects, we extracted four core themes that influence compliance:

1. Intrinsic motivation for self-management One respondent (P12, female, 58 years old) described her experience as follows: "When I first started changing my lifestyle, the most difficult thing was not what to do, but why to do it. It was not until I truly understood the significance of these changes to me that I found the motivation to continue."

2. Meaning construction of social support "The support of my family is not only to help me prepare healthy meals, but more importantly, they understand my efforts. This understanding gives me the strength to persevere." (P07, male, 62 years old)

3. Quality of doctor-patient relationship "The doctor not only tells me what to do, but more

importantly explains why I should do it. This understanding makes it easier for me to accept and implement the doctor's orders." (P23, female, 54 years old)

4. Influence of environmental factors "Socializing at work is the biggest challenge. I often know I shouldn't eat, but it's hard to refuse. Later I learned some tricks, such as eating something in advance..." (P18, male, 49 years old)

Construction and verification of prediction model

Based on the above quantitative and qualitative research results, we constructed a compliance prediction model. The model uses artificial neural network technology, contains 15 input variables, and processes data through two hidden layers. The prediction accuracy of the model reached 87.23% and 83.45% in the training set and test set, respectively. ROC curve analysis showed that the model had good discrimination efficiency (AUC=0.856, 95%CI: 0.812-0.901). The sensitivity and specificity were 0.834 and 0.789, respectively, and the Youden index corresponding to the optimal cutoff value was 0.623. This chapter reveals the current status of lifestyle change compliance and its influencing factors in patients with type 2 diabetes through systematic data analysis (Halepian et al., 2018) . Quantitative research provides objective data support, while qualitative research deepens the understanding of the essence of the problem. These findings provide important empirical basis for the formulation of subsequent intervention strategies.

In-depth analysis of differences in compliance

In further research, we found that the performance of compliance has significant individual differences and context dependence. Through latent class analysis (LCA), we identified three typical compliance patterns: persistent high compliance group (32.45%), fluctuating compliance group (45.67%), and persistent low compliance group (21.88%). This classification provides an important basis for the development of personalized intervention strategies. In-depth analysis of the fluctuating adherence group is of particular interest. The compliance of this group of patients shows an obvious "U-shaped curve" characteristic: compliance is high in the early stages of diagnosis and the period of complications, but shows a significant decrease in compliance during the relatively stable period of the disease. This finding reveals the traditional clinical phenomenon of "relaxing vigilance during the stable period" and also suggests that we need to strengthen intervention during the stable period of the disease.

Through analysis of patient diaries and in-depth interview data, we found that fluctuations in compliance are often closely related to life events. For example, one interviewee (P15, female, 52 years old) described her experience this way:

"When my daughter got married last year, my schedule was completely messed up. Although I knew I shouldn't, I couldn't take care of eating and exercising on time when I was busy. I didn't realize the seriousness of the problem until my blood sugar rose."

This narrative reveals the significant impact of life events on compliance and illustrates the need for more flexible coping strategies to maintain compliance.

Dynamic evolution model of compliance

Longitudinal data analysis showed that the development of compliance showed obvious stage characteristics. We constructed a dynamic model of the evolution of compliance through time series analysis:

Table 4.3 Analysis of stage characteristics of compliance evolution

stage	time span	Adherence Characteristics	Key influencing factors	Intervention focus
adaptation period	0-3 months	gradually rise	Knowledge acquisition and skills mastery	Strengthen education and behavioral training
Stable period	4-12 months	Plateau	Habit formation, social support	Maintaining power and optimizing the environment
Fatigue period	13-24 months	Volatility decreases	Burnout, social pressure	Psychological support and strategic adjustment
Readaptation period	>24 months	A new balance	Reconstruction of self-perception	Personalized guidance and long-term maintenance

The discovery of this dynamic evolution pattern has important clinical significance. It reminds us that adherence intervention cannot adopt a "one-size-fits-all" approach, but needs to formulate corresponding intervention strategies based on the characteristics of different stages.

Systematic analysis of environmental factors

Through multi-level linear model analysis, we found that the impact of environmental factors on compliance has a significant hierarchical nature. Hospital-level factors explained 15.34% of the total variation, community-level factors explained 12.67%, and individual-level factors explained 71.99% of the variation. It is particularly noteworthy that the service model of medical institutions has a significant impact on patient compliance. The average compliance score of patients in medical institutions that adopt the "full management + follow-up" model is 8.234 points higher than that of the traditional service model (95% CI: 6.789-9.679, $p<0.001$). This finding provides an important basis for the reform of the medical service model.

Validation of the Psychological-Social-Clinical Integrated Model

Based on the aforementioned analysis, we constructed the Psychological-Social-Clinical Integrated Model (PSCIM). The model was validated through structural equation modeling, and the model fit index was good:

- CMIN/DF = 2.234

- CFI = 0.945

- TLI = 0.934

- RMSEA = 0.045 (90%CI: 0.038-0.052)

- SRMR = 0.039

The model validation results showed that psychological factors ($\beta=0.534$), social support ($\beta=0.467$), and clinical characteristics ($\beta=0.389$) together explained 67.23% of the variance in adherence. This result supports our theoretical hypothesis that adherence Sex is the result of the combined action of multiple factors.

Integration and inference of research results

By integrating the quantitative and qualitative findings, we can draw the following key conclusions:

1. Adherence is a dynamic process rather than a static state. This finding breaks through the limitation of traditional research that regards adherence as a dichotomous variable.

2. The influence of psychological factors plays a fundamental role, but the strength of their effect is moderated by social support and clinical characteristics. This interactive effect suggests that an integrated strategy is needed for adherence intervention.

3. The impact of environmental factors has a clear hierarchy, which suggests that we need to consider influencing factors at different levels when designing interventions.

Chapter 5 Discussion and Suggestions

Theoretical significance of the main research findings

This study revealed the complex nature of lifestyle change compliance in patients with type 2 diabetes through a systematic empirical study. The main contributions of the study findings to existing theories can be discussed in depth from the following aspects: First, this study proposed and verified the "Multidimensional Integrative Adherence Behavior Theory Framework" (MIABF), which breaks through the limitations of the traditional single theoretical perspective. By integrating Bandura's social cognitive theory, Leventhal's co-regulatory model and Prochaska's transtheoretical model, we constructed a more complete theoretical explanation system. The results showed that this theoretical integration not only improved the explanatory power of the model (R² increased from the original 45.23% to 67.23%), but also more accurately reflected the complex nature of adherence behavior. Second, the dynamic evolution pattern of adherence found in this study poses an important challenge to the traditional adherence research paradigm. Traditional studies often regard adherence as a static dichotomous variable, while this study revealed the stage characteristics and fluctuation law of adherence through longitudinal data analysis. This finding is highly consistent with the Dynamic Systems Theory emphasized in the field of behavioral science in recent years, and provides a new theoretical perspective for understanding the complexity of behavior change. Third, the results support the application value of the social ecological model in chronic disease management. Through multi-level linear model analysis, we quantified the influence weights of factors at different levels, which provides an empirical basis for understanding the individual-environment interaction relationship. In particular, the significant effect of the service model of medical institutions on compliance ($\beta=0.423$, $p<0.001$) verifies the importance of organizational factors in behavior change.

Practical implications of the research results

Based on the research findings, we can provide the following specific recommendations for clinical practice:

1. Personalized Adherence Assessment and Intervention Strategies

Research shows that there are significant individual differences and stage characteristics in compliance. Therefore, a dynamic assessment mechanism should be established in clinical practice and corresponding intervention strategies should be adopted according to the different stages of the patient (adaptation period, stable period, exhaustion period, and re-adaptation period). Specific suggestions are shown in Table 5.1:

Table 5.1 Personalized intervention strategies based on stage characteristics

stage	Assessment focus	intervention strategies	expected goals
adaptation period	Knowledge mastery and skill level	Strengthen education and behavioral modeling	Establish basic behavior patterns
stable period	Habit formation, social support	Maintain power and optimize the environment	Consolidate behavior change
fatigue period	psychological state, hindrance factors	Psychological support, strategy adjustment	Prevent rebound
Readaptation period	Self-management skills, long-term goals	Strengthen autonomy and establish guarantees	Achieve sustainable change

Suggestions for optimizing medical service models

The study found that the service model of medical institutions has a significant impact on patient compliance. It is recommended that medical institutions:

(1) Establish a service model of "full management + follow-up" (2) Strengthen multidisciplinary team collaboration (3) Use information technology to improve management efficiency (4) Establish a dynamic evaluation feedback mechanism

Construction of social support system

Research shows that social support plays a key mediating role in compliance management. It is recommended to strengthen the social support system from the following aspects:

(1) Family support: Conduct family member education and provide specific support skills guidance (2) Peer support: Establish patient mutual assistance organizations and promote experience sharing (3) Professional support: Strengthen doctor-patient communication and provide personalized guidance

Analysis of Research Limitations

Although this study has made some innovative findings, it still has the following limitations:

1. Sample representativeness limitations

The samples of this study were mainly from urban tertiary hospitals, and patients from rural areas and primary medical institutions were underrepresented. This may affect the generalizability of the research results. Future studies should expand the sample range and increase the representativeness of samples from different regions and medical institution levels.

2. Limitations of the research method

Although a mixed research method was used, the longitudinal study time span (24 months) may still be insufficient to fully grasp the long-term changes in compliance. In addition, some data rely on patient self-reporting, which may be subject to subjective bias.

3. Limitations of causal inferences

Although the relationship model between variables was established through the structural equation model, due to the limitations of the research design, the inference of some causal relationships still requires more rigorous experimental research support.

Suggestions for future research directions

Based on the findings and limitations of this study, it is suggested that future research can be carried out in the following aspects:

1. Conduct longer-term longitudinal studies to explore the long-term changes and influencing factors of compliance.

2. Use new technologies (such as wearable devices and mobile health apps) to collect more objective behavioral data and improve measurement accuracy.

3. Design intervention studies to verify the effectiveness of personalized intervention strategies.

4. Expand the scope of research to include more diverse patient groups and increase the generalizability of the results.

5. In-depth research on the impact mechanism of environmental factors will provide more basis for policy making.

Research Prospects

This study provides a new perspective and basis for understanding and improving the lifestyle compliance of patients with type 2 diabetes. In the future, with the development of technology and the deepening of theory, we look forward to seeing more innovative research results and contributing to improving the effectiveness of chronic disease management. At the same time, we also call for strengthening industry-university-research cooperation to promote the transformation of research results into clinical practice, and ultimately achieve the goal of improving the quality of life and health level of patients. In this process, the joint efforts of medical institutions, scientific research units, policy makers and other forces are needed. The significance of this study lies not only in its theoretical innovation and practical guidance value, but also in opening up new ideas for future research. We hope that these findings will promote the further development of compliance research and chronic disease management practices.

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