ORIGINAL RESEARCH

The Impact of Psychological Insulin Resistance and Dyadic Coping on Insulin Medication Adherence in Elderly Diabetes Patients and Their Spouses: A Latent Profile Analysis

Yuanhong Wu[1], Huijing Xu[2], Yuxin Wang[1], Xiaohui Wang[3], Shanyu Wu[1]

[1]College of Nursing, Yanbian University, Yanji, People's Republic of China; [2]College of Nursing, Seoul National University, Seoul, South Korea; [3]Department of Nursing, Binzhou People's Hospital, Binzhou, People's Republic of China

Correspondence: Shanyu Wu, Email wusy@ybu.edu.cn

Aim: To investigate the characteristics of psychological insulin resistance and dyadic coping in elderly diabetic patients and their spouses, and their association with insulin medication adherence.

Design: Observational, cross-sectional study.

Methods: A convenience sampling method selected 300 elderly diabetic patient-spouse pairs from a community. Data were collected using general information questionnaires, the My Views on Insulin questionnaire, Dyadic Coping questionnaire, and ARMS refill and medication adherence questionnaire. Latent Profile Analysis (LPA) was used to categorize the "psychological-coping" patterns of psychological insulin resistance and dyadic coping among these pairs. Multiple linear regression analysis identified factors influencing insulin medication adherence.

Results: Four latent classes were identified: patients and spouses with low resistance-high coping (30.3%), patients with low resistance-moderate coping and spouses with high resistance-low coping (16.3%), patients with high resistance-moderate coping and spouses with moderate resistance-high coping (33.7%), patients and spouses with high resistance-low coping (19.7%). Multiple linear regression analysis showed that the number of chronic diseases a patient has, the use of oral hypoglycemic agents, family per capita monthly income, and latent classes of psychological insulin resistance and dyadic coping significantly affected insulin medication adherence ($P<0.05$).

Conclusion: It is crucial to consider the psychological insulin resistance and dyadic coping of both patients and their spouses, include both in health plans, and develop comprehensive intervention strategies that address the couple as a unit.

Implications for the Profession and/or Patient Care: This study informs healthcare professionals by raising awareness of the different "psychological-coping" characteristics between elderly diabetic patients and their spouses, with insulin medication adherence and reducing the likelihood of readmission.

Keywords: diabetes, psychological insulin resistance, dyadic coping, medication compliance, latent profile analysis

Introduction

The global diabetic population is increasing annually. China reports the highest number of diabetic individuals, with over 60 years of age accounting for 78.13 million.[1,2] Inadequate long-term glucose management can precipitate a spectrum of acute and chronic complications, escalating emergency visits, hospitalizations, and mortality rates.[3,4] This situation significantly deteriorates patient quality of life and augments the burden on families and society. Insulin is recognized as an effective treatment for diabetes, capable of stabilizing blood glucose and mitigating complications. The 2020 "ADA Diabetes Diagnosis and Treatment Guidelines" advocate for early insulin use.[5] However, adherence to insulin therapy among China's diabetic population remains suboptimal.[6] The psychological barrier to initiating or delaying insulin use is referred to as psychological insulin resistance (PIR).[7] Dyadic coping is an important strategy within families, defined as

the joint response and tactics employed by couples when confronted with stress either individually or together. Psychological insulin resistance (PIR) and dyadic coping are primary factors influencing insulin medication adherence.[8,9] According to dyadic coping theory,[10] patients and their spouses should be viewed as a unit, with health issues considered shared concerns. Nonetheless, existing research on medication adherence frequently focuses solely on patients from an individual perspective, overlooking the interactions between patients and their spouses. The inability to provide effective and comprehensive personalized intervention strategies may result in poor medication adherence among patients, adversely affecting treatment outcomes and ultimately having a severe negative impact on patients' physical and mental health. Using Latent Profile Analysis (LPA),[11] this study employs LPA to explore the heterogeneity among groups with similar characteristics by categorizing the "psychological-coping" patterns of psychological insulin resistance and dyadic coping into distinct subgroups. It examines how these patterns influence insulin medication adherence, aiming to assist clinical and community medical personnel in recognizing subgroup traits and developing precise intervention strategies for elderly diabetic patients.

Methods

Subjects

Elderly diabetic patients and their spouses were selected through convenience sampling from two community health service centers in Yanji City between January and June 2023. The inclusion criteria for patients included: ①Meeting the World Health Organization's diagnostic criteria for diabetes; ② Age ≥ 60 years; ③ Marriage status with cohabitation; ④ Current use of insulin injections; ⑤ Voluntary informed consent. For spouses, the criteria were acting as the primary caregiver and providing voluntary informed consent. The exclusion criteria for both groups were cognitive impairments, mental disorders, severe comorbidities, or life-threatening diseases. This study was approved by the Medical Ethics Review Committee of the School of Medicine, Yanbian University (20231047).

Research Tools

General Information Questionnaire

A self-developed questionnaire was used, gathering data on gender, age, ethnicity, education level, diabetes-related education, duration of diabetes, number of chronic diseases, diabetes complications, daily insulin injections, duration of insulin use, reactions to insulin, use of oral hypoglycemic drugs, family income per capita, method of medical expense payment, and living conditions for elderly diabetic patients. Information on the spouse's gender, age, ethnicity, education level, diabetes-related education, and number of chronic diseases was also collected.

My Views on Insulin Questionnaire

Developed by the Diabetes Branch of the Chinese Medical Association in 2011, this questionnaire is used to assess the level of psychological insulin resistance in diabetic patients.[12] It features a Cronbach's α coefficient of 0.85 and a content validity index of 0.75. The questionnaire encompasses 27 items across seven dimensions: advantages of insulin (A1-A4), cognition (B1-B3, G1-G2), life management (C1-C4, H1), attitude (D1-D3), injection-related issues (E1-E4, I1), adverse reactions (F1-F2, J1), and cost (K1-K2). A 5-point Likert scale is employed for scoring, ranging from strongly disagree (1 point) to strongly agree (5 points), with A1-A4 positively scored and the remainder scored in reverse. Scores range from 27 to 135, with higher scores indicating lower psychological insulin resistance. In this study, Cronbach's α coefficients were 0.941 for elderly diabetic patients and 0.943 for their spouses. Content validation involved six experts, yielding a good content validity index[12] (Item-level CVI ranging from 0.83 to 1.00, Scale-level CVI/UA of 0.93, and Scale-level CVI/Ave of 0.99). Confirmatory Factor Analysis demonstrated good structural validity[13] (Chi-square to degrees of freedom ratio = 1.856, Root Mean Square of Approximation = 0.053, Tucker-Lewis Index, Comparative Fit Index = 0.943, Incremental Fit Index = 0.944, and Normed Fit Index = 0.934).

Dyadic Coping Inventory (DCI)

The DCI, created by Bodenmann[10] in 1995 and adapted for China by Xu Feng[14] in 2016, measures perceived communication and coping strategies within a couple's relationship under stress. It consists of six dimensions: stress

communication (8 items), supportive coping (10 items), negative coping (8 items), delegated coping (4 items), common coping (5 items), and dyadic coping evaluation (2 items), totaling 37 items. Scoring is conducted using a 5-point Likert scale, from rarely (1 point) to very often (5 points), with some items scored in reverse. The total score ranges from 35 to 175 points. Cronbach's α coefficients for this inventory were 0.908 for patients and 0.917 for spouses in this study.

Adherence to Refills and Medications Scale (ARMS)

Developed by Kripalani et al[15] in 2009 and based on the Morisky and Hill-Bone scale, this scale assesses medication adherence in chronic disease patients. It was adapted for type 2 diabetes by Wu[16] in 2021. The Chinese version consists of 10 items scored on a 4-point Likert scale (never = 1, sometimes = 2, often = 3, always = 4), with item 10 scored in reverse. Scores range from 10 to 40, with higher scores indicating poorer adherence. The Cronbach's α coefficient for this scale in this study was 0.766.

Data Collection Method

With the approval of the survey sites' management and in collaboration with community hospital staff, eligible subjects were identified. Four trained investigators administered the survey during patient visits for physical examinations, outpatient appointments, and home visits. The importance of the survey and questionnaire instructions were explained to participants, who then provided informed consent. The medication adherence questionnaire was distributed only to patients, while other questionnaires were completed by both patients and spouses. Participants were instructed to respond independently and anonymously; questionnaires were numerically coded for pairing. Assistance was provided to those unable to complete the survey independently, following a standardized protocol. All questionnaires were collected immediately, checked for completeness, and any omissions were promptly addressed. If a participant withdrew during the process, both questionnaires in the pair were invalidated. Out of 640 distributed questionnaires (320 pairs), 600 valid responses (300 pairs) were collected, resulting in a valid recovery rate of 93.7%.

Statistical Methods

Mplus 8.3 software was employed for latent profile analysis (LPA) to examine psychological insulin resistance and dyadic coping in elderly diabetic patients and their spouses. Model fit indices for LPA included: Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-adjusted Bayesian Information Criterion (aBIC). The Lo-Mendell-Rubin likelihood ratio test (LMR) and the bootstrap likelihood ratio test (BLRT) were utilized to compare the fit of different latent class models. Entropy, with values ranging from 0 to 1, indicates classification accuracy; values closer to 1 suggest higher accuracy. SPSS 26.0 software conducted statistical descriptions and analyses, using t-tests and one-way ANOVA to compare differences in insulin medication adherence based on general data and varying "psychological-coping" patterns among elderly diabetic patients. Multiple linear regression analysis was used to identify factors influencing insulin medication adherence. The significance level was set at α=0.05.

Results

Latent Profile Analysis of Psychological Insulin Resistance and Dyadic Coping Patterns in Elderly Diabetic Patients and Their Spouses

Five latent profile models were tested in this study (Table 1). As the number of profiles increased, the AIC, BIC, and aBIC values decreased. The model with four profiles displayed an Entropy value close to 1, and both LMR and BLRT P-values were below 0.05, indicating this as the optimal model for higher accuracy and reliability.

Category 1: Patients exhibited high psychological insulin resistance (low resistance) and moderate dyadic coping scores. Spouses had low psychological insulin resistance (high resistance) and low dyadic coping scores, termed "Patients Low Resistance Moderate Coping - Spouses High Resistance Low Coping Group".

Category 2: Patients showed low psychological insulin resistance (high resistance) and moderate dyadic coping scores. Spouses presented moderate psychological insulin resistance (moderate resistance) and high dyadic coping scores, termed "Patients High Resistance Moderate Coping - Spouses Moderate Resistance High Coping Group".

Category 3: Both patients and spouses scored low in psychological insulin resistance (high resistance) and dyadic coping, named "Patients and Spouses High Resistance Low Coping Group".

Table I Fit Indices for Latent Profile Models of Psychological Insulin Resistance and Dyadic Coping in the Study Subjects

| Category	K	LL	AIC	BIC	aBIC	Entropy	LMR	BLRT	Category Probabilities (%)
1	8	−4956.736	9929.472	9959.102	9933.731				
2	13	−4856.485	9738.970	9787.119	9745.891	0.692	0.2891	<0.001	60.0/40.0
3	18	−4829.505	9695.011	9761.679	9704.593	0.698	0.2309	<0.001	25.6/47.3/27.1
4	23	−4785.072	9616.145	9701.332	9628.389	0.810	0.0123	<0.001	16.3/33.7/19.7/30.3
5	28	−4770.328	9596.656	9700.362	9611.563	0.813	0.2618	<0.001	9.7/19.0/26.0/16.7/28.6

Category 4: Both patients and spouses scored high in psychological insulin resistance (low resistance) and dyadic coping, named "Patients and Spouses Low Resistance High Coping Group" (Figure 1).

Univariate Analysis of Insulin Medication Adherence in Elderly Diabetic Patients

The study results indicate that differences in patients' insulin adherence scores based on age, education level, duration of illness, diabetic complications, diabetes-related education received, years of insulin use, daily frequency of insulin injections, adverse reactions to insulin injections, method of medical payment, and living conditions were not statistically significant ($P > 0.05$). However, statistically significant differences were observed among patients based on gender, ethnicity, number of chronic diseases, oral hypoglycemic medication use, family per capita monthly income, and psychological coping patterns ($P < 0.05$). Specifically, lower adherence scores were associated with male patients, minority groups, those with fewer than three chronic conditions, those not taking oral hypoglycemic agents, higher family incomes, and patients and their spouses who are part of the weak resistance-high response group (Table 2).

Multivariate Linear Regression Analysis of Different Categories of Psychological Insulin Resistance and Dyadic Coping Patterns on Insulin Medication Adherence

Significant variables from univariate analysis were selected as independent variables, with insulin medication adherence as the dependent variable, in a multivariate linear regression analysis. The independent variables were assigned as follows: Gender (male=0, female=1), Ethnicity (Han=0, other ethnicities including Korean=1), Number of Chronic Diseases (fewer than 3=0, 3 or more=1), Use of Oral Hypoglycemic Medication (yes=0, no=1), Family Per Capita Monthly Income (less than 2000=1, between 2000 and 4000=2, 4000 or more=3), and Latent Classes of Psychological Insulin Resistance and Dyadic Coping Patterns (Patients and Spouses with Low Resistance - High Coping Group: $Z1=0$, $Z2=0$, $Z3=0$, $Z4=0$; Patients with Low Resistance and Moderate Coping - Spouses with High Resistance and Low Coping Group: $Z1=0$, $Z2=1$, $Z3=0$, $Z4=0$; Patients with High Resistance and Moderate Coping - Spouses with Moderate Resistance and High Coping Group: $Z1=0$, $Z2=0$, $Z3=1$, $Z4=0$; Patients and Spouses with High Resistance - Low Coping Group: $Z1=0$, $Z2=0$, $Z3=0$, $Z4=1$). The results indicate that the number of chronic diseases, the use of oral hypoglycemic drugs, family per capita monthly income, and the latent classes of psychological insulin resistance and dyadic coping are key factors influencing insulin medication adherence in elderly diabetic patients (Table 3).
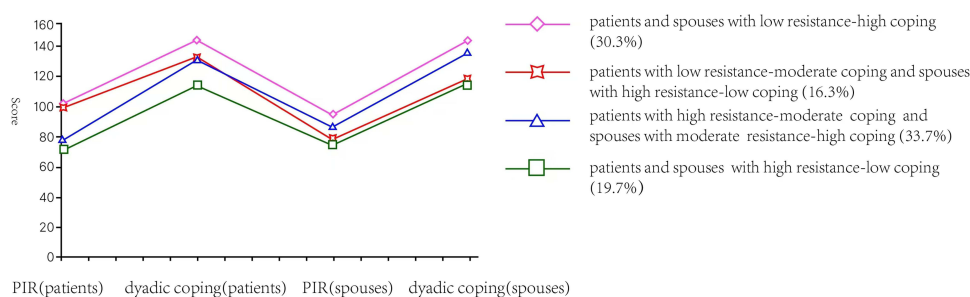
Figure I Latent Profile Analysis Chart of Psychological Insulin Resistance and Dyadic Coping in Elderly Diabetic Patients and Their Spouses.

Table 2 Differences in Insulin Adherence Based on General Information of Elderly Diabetic Patients (n=300)

Item	Classification	Mean ± SD	t/F	P-value	LSD Post-hoc
Gender	Male	19.58±2.57	−3.646	<0.001	Male < Female
	Female	20.67±2.58			
Ethnicity	Han	20.35±2.63	2.169	0.031	Han > Ethnic Minorities
	Ethnic minorities	19.57±2.52			
Number of Chronic Diseases	<3	19.30±2.37	−7.40	<0.001	
	≥3	21.40±2.49			-
Concurrent Oral Hypoglycemic Medication	Yes	21.19±2.25	5.718	<0.001	
	No	19.51±2.64			-
Family Per Capita Monthly Income (CNY)	<2000	20.79±2.52	14.534	<0.001	①②>③
	2000 to <4000	20.40±2.59			-
	≥4000	18.56±2.28			-
Psychological-Coping Pattern	Patients and Spouses Low Resistance - High Coping Group ①	17.76±1.88	87.217	<0.001	②>③>④>①
	Patients and Spouses High Resistance - Low Coping Group ②	22.76±1.76			
	Patients Low Resistance Moderate Coping - Spouse High Resistance Low Coping Group ③	21.00±1.74			
	Patients High Resistance Moderate Coping - Spouse Moderate Resistance High Coping Group ④	20.45±2.12			

Table 3 Multivariate Linear Regression Analysis of Factors Affecting Insulin Medication Adherence in Elderly Diabetic Patients (n=300)

Variable	Regression Coefficient	Standard Error	Standardized Regression Coefficient	t	P
(Constant)	19.267	0.426		45.268	<0.001
Number of Chronic Diseases (referencing fewer than 3)					
≥3	1.279	0.215	0.241	5.946	<0.001
Use of Oral Hypoglycemic Medication (referencing use of oral hypoglycemic medication)					
Not using in combination with oral hypoglycemic medication	−0.604	0.218	−0.113	−2.768	0.006
Family Per Capita Monthly Income	−0.591	0.152	−0.152	−3.885	<0.001
Psychological-Coping Pattern (referencing Patients and Spouses with Low Resistance - High Coping Group)					
Patients and Spouses with High Resistance - Low Coping Group	4.198	0.317	0.637	13.244	<0.001
Patients with Low Resistance and Moderate Coping - Spouses with High Resistance and Low Coping Group	2.651	0.322	0.374	8.231	<0.001
Patients with High Resistance and Moderate Coping - Spouses with Moderate Resistance and High Coping Group	2.266	0.260	0.408	8.719	<0.001

Note: F=87.217, P<0.001, R=0.756, R²=0.560.

Discussion

The Four Latent Categories of Psychological Insulin Resistance and Dyadic Coping Patterns in Elderly Diabetic Patients and Their Spouses

Latent Profile Analysis revealed four distinct "psychological-coping" patterns among elderly diabetic patients and their spouses. These patterns are Patients and Spouses with Low Resistance - High Coping, Patients and Spouses with High Resistance - Low Coping, Patients with Low Resistance and Moderate Coping - Spouses with High Resistance and Low Coping, and Patients with High Resistance and Moderate Coping - Spouses with Moderate Resistance and High Coping. This diversity indicates significant heterogeneity in coping patterns.

The "Patients and Spouses with Low Resistance - High Coping Group", representing 30.3% of the sample, features both patients and spouses exhibiting a positive attitude and high coping skills regarding insulin use. This group effectively manages the disease, suggesting that medical staff should promote active communication between patients and their spouses and the medical team, encourage family involvement in health management, and facilitate familiarity with insulin procedures and management benefits.[17]

The "Patients and Spouses with High Resistance - Low Coping Group" represents 19.7% of all "psycho-logical-coping" patterns observed. In this group, both patients and spouses display a negative attitude and reduced coping ability toward insulin usage. This highlights the need for medical staff to focus on evaluating the psychological insulin resistance and dyadic coping of both patients and their spouses. Efforts should be intensified in health education to thoroughly explain the significance of insulin therapy and its beneficial impact on disease management, thereby improving their reception and understanding of the treatment. Additionally, it is crucial to involve elderly diabetic patients and their spouses in developing and executing treatment plans, provide examples of successful family coping that have improved treatment outcomes, and promote proactive coping strategies for both partners.[18]

Among all patient and spouse "psychological-coping" patterns, 16.3% fall into the "weak resistance in patient-strong resistance in spouse, low coping" category. The primary issue in this pattern is the spouse's negative attitude towards the patient's use of insulin and a lower level of coping. This may be due to the spouse having never used insulin themselves and harboring misconceptions about insulin use, leading to negative psychological effects and a subsequently lower level of coping.[19,20] Therefore, healthcare providers should pay attention to the spouse's negative psychology and consider the spouse as a co-recipient of education when conducting health education for the patient, to improve the spouse's understanding of insulin use and promote unified positive perceptions through improved communication between the couple, thereby enhancing dyadic coping levels.[18]

The "Patients with High Resistance and Moderate Coping - Spouses with Moderate Resistance and High Coping Group" is responsible for 33.7% of all "psycho-logical-coping" patterns. The key concern with this pattern is the patient's negative attitude and moderate ability to cope with insulin use. It could be because using insulin makes the patient concerned about being perceived differ-rently by others, and the costs of injecting insulin and monitoring blood sugar can raise the economic strain on the patient's family, leading to resistance.[21,22] Furthermore, under the great psychological pressure brought on by the sickness, in order to prevent exacerbating the patient's anxieties and troubles, the patient may choose to face the condition alone and hide from others, demonstrating a lesser degree of coping.[23] It suggests that healthcare providers should focus on such patients, recommend suitable insulin treatment plans, guide them to make full use of policies and resources such as medical insurance to reduce the burden of treatment costs, and at the same time introduce relevant knowledge about diabetes management and treatment, and provide training on communication skills, allowing patients and their spouses to understand each other's pressures, promote emotional communication and mutual understanding, thereby reducing the patient's resistance to insulin use and improving the level of coping.

Factors Affecting Insulin Medication Adherence in Elderly Diabetic Patients
The Impact of the Number of Chronic Diseases, Oral Hypoglycemic Medication, and Family per Capita Monthly Income on Insulin Medication Adherence

This study demonstrates that the number of chronic conditions, the use of oral hypoglycemic medicines, and the family's per capita monthly income all have an impact on patients' insulin prescription adherence. Patients with fewer than three

chronic diseases have higher insulin medication adherence, possibly because patients with multiple coexisting diseases must manage multiple diseases at the same time, take a variety of medications, and make complex dietary and lifestyle changes, all of which affect insulin medication adherence. Furthermore, the study discovered that individuals taking oral hypoglycemic medicines had lower medication adherence than those who did not use them. This conclusion is consistent with the findings of Li et al,[24] presumably because patients who take both oral hypoglycemic medicines and insulin must manage numerous prescriptions at the same time, complicating insulin therapy for the elderly. Patients with higher family per capita monthly income have better insulin medication adherence, which is consistent with results of Mirahmadizadeh et al,[25] possibly because patients with lower family income face more economic pressure, and diabetic patients need lifelong medication maintenance. For some elderly diabetic patients, with lower labor capacity and economic income, this may bring more psychological pressure, thus affecting their insulin medication adherence. As a result, healthcare practitioners should pay close attention to the comorbidities, medication plans, and economic conditions of old diabetic patients, take into account the features of the elderly vulnerable group to the greatest extent feasible, and assist patients in developing reasonable medication strategies.

The Impact of Different "Psychological-Coping" Patterns Between Patients and Spouses on Insulin Medication Adherence

The results of this study reveal that the latent categories of psychological insulin resistance and dyadic coping of elderly diabetic patients and their spouses both entered the regression equation, indicating that this "psychological-coping" pattern is an important factor influencing patients' insulin medication adherence. In comparison to the group of patients and spouses with low resistance and strong coping, the influence of each group on patients' insulin medication adherence is shown below. First, the patients and spouses with high resistance and low coping have the lowest insulin medication adherence. This could be because strong psychological insulin resistance and low coping levels in the couple both have an impact on patients' insulin medication adherence, and when these two effects occur concurrently in the couple, they have a synergistic effect, severely reducing patients' insulin medication adherence.[26,27] Second, insulin medication adherence is lower among patients with low resistance and moderate coping compared to those with high resistance and low coping. The explanation for this could be that the spouse's attitude and conduct affect the patient, particularly for older diabetic patients, if the spouse does not support and understand insulin treatment, the patient's insulin prescription adherence suffers.[26] Finally, the group of patients with high resistance and moderate coping - spouses with moderate resistance and high coping has the second highest insulin medication adherence, trailing only the group of patients with low resistance and strong coping. Coping is an important process for regulating stress and emotions. Under the influence of the spouse's positive coping, a good family coping can help patients alleviate the psychological pressure brought by the disease, to some extent, mitigating the impact of the patient's strong insulin resistance, and for the elderly patients, the spouse can not only provide emotional support but also assistance in daily life. Therefore, effective family coping can help patients develop improved compliance habits.[28,29]

Conclusion

The "psychological-coping" patterns of psychological insulin resistance and dyadic coping in senior diabetic patients and their spouses are diverse and can be classified into four possible groups. Patients' insulin prescription adherence ranges from good to bad based on the following patterns: Patients and Spouses with Low Resistance - High Coping Group, Patients with High Resistance and Moderate Coping - Spouses with Moderate Resistance and High Coping Group, Patients with Low Resistance and Moderate Coping - Spouses with High Resistance and Low Coping Group, Patients and Spouses with High Resistance - Low Coping Group. It is clear that the "Patients and Spouses with High Resistance - Low Coping Group" is a high-risk population that must be screened and identified, implying that healthcare providers should recognize the vital supportive role of elderly couples. When developing health management plans for elderly diabetic patients, it is critical to include both spouses, identify different "psychological-coping" patterns, and propose targeted intervention methods to improve family coping ability, reduce the impact of psychological insulin resistance in couples, and promote the health management of elderly diabetic patients. This is a cross-sectional study, thus the causal relationship cannot be clearly determined. Future scholars should conduct long-term cohort studies to validate the causal link.

Acknowledgments

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; Yuanhong Wu and Shanyu Wu contributed to all stages of the research, including conception, study design, execution, acquisition of data, analysis and interpretation; Huijing Xu, Xiaohui Wang, and Yuxin Wang contributed to the survey research and data analysis. All authors gave final approval of the version to be published, agreed on the journal to which the article has been submitted, and accepted responsibility for all aspects of the work.

Ethics Statement

The Medical Ethics Review Committee of Yanbian University School of Medicine approved the study.(No 20231047), ensuring adherence to the principles of the Declaration of Helsinki. Before the survey, the research objectives were explained to the participants to ensure informed consent, and anonymity measures were taken to protect participants' information, with no unauthorized disclosure to others.

Funding

Disclosure

The authors declare no conflicts of interest.

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