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ORIGINAL RESEARCH

Exercise Adherence and Compliance and Its Related Factors Among Elderly Patients with Type 2 Diabetes in China: A Cross-Sectional Study

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Purpose: To explore exercise adherence and compliance as well as its related factors among elderly patients with type 2 diabetes mellitus (T2DM) to provide a basis for clinical intervention strategies.

Patients and Methods: The present study was a cross-sectional study of 205 elderly patients with T2DM who regularly visited a Shanghai community health center from August 2020 to July 2021. Exercise adherence and compliance was measured using an exercise adherence and compliance questionnaire, and potential correlates were explored using multiple linear regression analysis.

Results: The mean total score of the exercise adherence and compliance questionnaire was 16.72±5.08. The stepwise regression results revealed that exercise adherence and compliance was positively correlated with self-monitoring (F=3.510, P=0.005), exercise knowledge (r=0.784, P<0.001), exercise willingness (r=0.556, P<0.001), professional support (r=0.426, P<0.001), and self-efficiency (r=0.5, P<0.001). There was a negative correlation between hypoglycemia and exercise adherence and compliance (F=−3.672, P<0.001).

Conclusion: Low exercise adherence and compliance was related to low glucose self-monitoring frequency, increased hypoglycemia, less exercise knowledge, less exercise willingness, less professional support, and less self-efficiency. When developing exercise instructions adapted to the cognitive and volitional needs of diabetic patients, it is essential to focus on their daily self-management habits and extrinsic motivation to improve exercise adherence and compliance.

Keywords: aged, type 2 diabetes mellitus, T2DM, exercise, adherence and compliance

Introduction

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes in China, accounting for more than 90% of diabetes cases.[1] There will be 260.42 million older adults in 2020,[2] including a 30.0% prevalence of diabetes in older adults suggested by the 2017 diabetes prevalence survey.[3] Compared to young adult patients, older patients with T2DM have significantly higher complication, fatality, and disability rates.[2]

Exercise as a therapeutic strategy for managing T2DM. Strengthening community-based exercise is one of the most cost-effective measures recommended by the World Health Organization to combat the effects of T2DM.[4] However, the outbreak of coronavirus disease 2019 (COVID-19) caused healthcare service upheaval that limited out-of-home activities.[5] As the pandemic abates, it is critical to advocate exercise to help improve immunity in the elderly, who are the most susceptible population to disease.[6] Exercise therapy adherence and compliance is the primary predictor to ensure the effectiveness of exercise therapy and good long-term prognosis, which directly impact the clinical therapeutic effect and quality of life of elderly patients with T2DM.[7]

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Several different types of factors influence the exercise adherence and compliance of patients with T2DM, including demographic variables such as age, gender, and education level.[8,9] Related disease factors include duration of illness and hypoglycemia, while individual factors involve cognition, self-efficacy, and mood.[10–14] Relevant social factors include the availability of professional support and exercise environment.[15] Because elderly patients have spent a lifetime developing patterns and habits, it is important to determine how to move these individuals out of their comfort zone to participate in exercise regimens. In addition, the drivers of exercise affecting patients changed during the epidemic, and this issue requires exploration. Therefore, the present study was based on exercise adherence and compliance status and influencing factors in elderly patients with T2DM.

Materials and Methods

Participants

A total of 209 participants were recruited from a community health center in Shanghai, a city in China. We used a cluster sampling method and collected data from August 2020 to July 2021. The inclusion criteria were as follows: 1) age ≥60, 2) diagnosed with T2DM, and 3) willing to participate in the study. Participants were excluded if they had impaired hearing, vision, or cognition that could prevent them from providing informed consent and answering the questionnaires. All 209 subjects met the inclusion criteria and exclusion criteria. But 2 refused to participate in, and 2 dropped out in the questionnaire survey. Finally, 205 participants were included in the study, as shown in Figure 1.

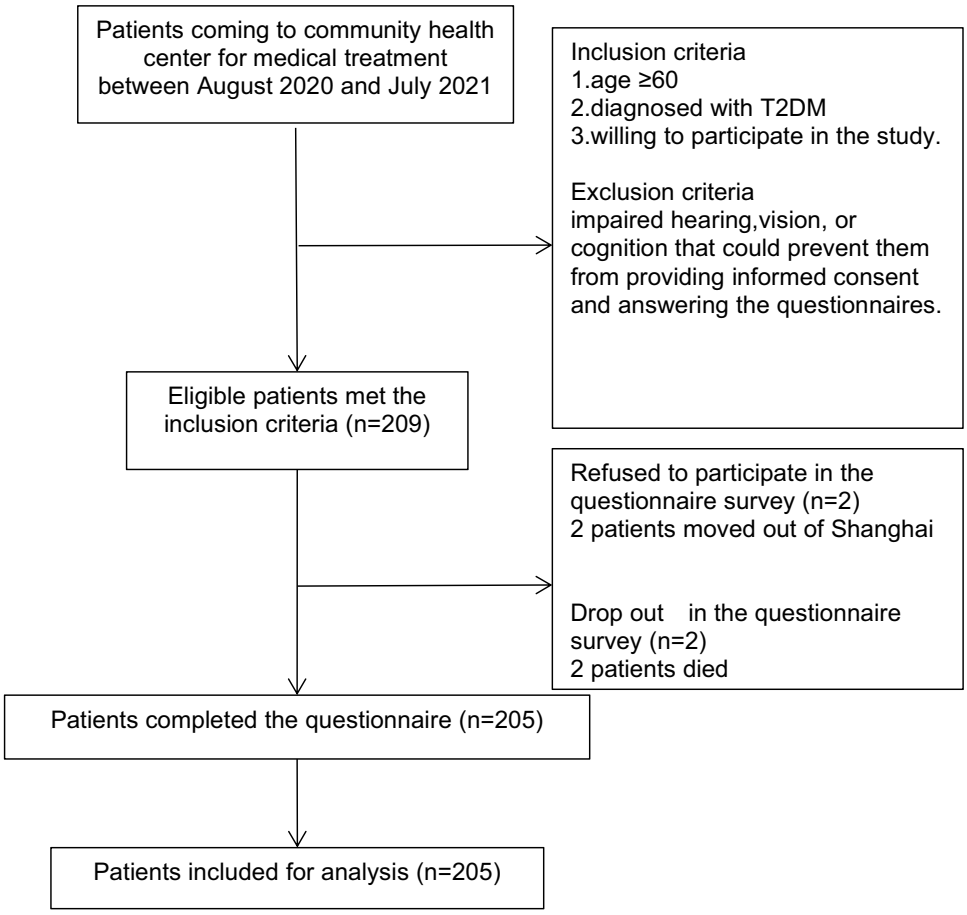

Figure 1 Flowchart of inclusion of elderly patients with type 2 diabetes patients.

Sample Size Calculation

A priori analysis[16] indicated that the exercise behavior dimension score was 16.14 ± 1.68, considering α = 0.05, σ = 1.68, and δ = 0.25.[16] Based on the following formula, a minimum of 173 participants were required. Considering a 15% sample attrition rate,[17] a total of 199 study subjects was required.

$$n = \left(\frac{\mu_{\alpha/2}\sigma}{\delta}\right)^2$$

According to the empirical method, the sample size should be more than 5 times the number of independent variables. In the present study, the number of independent variables was 21. Therefore, according to the empirical method, the sample size was considered as 105. To make the sample size calculation results more convincing, the formula method was adopted in this study.

Measures

The present study used three questionnaires and scales. The first questionnaire covered the following general information: 1) social demographic data, gender, age, marital status, educational level, etc.; 2) disease-related data such as diabetes course, concomitant diseases, falling, hypoglycemia, etc.; and 3) daily living habit-related information about diet, alcohol consumption, etc.

Exercise adherence and compliance was measured using the Specific Exercise Questionnaire for Senile Diabetes Mellitus developed by Yang in China, including exercise knowledge, exercisewillingness, exercise behavior, professional support, and social support.[18] The coefficient of variation index and Cronbach's α coefficient of the questionnaire are 0.915 and 0.851, respectively.[18] The Cronbach's α of all five dimensions was > 0.817. Each of the 35 items was rated on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=slightly agree, 4=moderately agree, and 5=strongly agree). We selected the exercise behavior dimension of the scale to assess patients' exercise adherence and compliance in terms of duration, frequency, timing, pre-exercise monitoring, prevention of exercise-related hypoglycemia, and exercise program implementation. The dimension score ranges from 6 to 30 with higher scores indicating better exercise adherence behavior.

Self-efficacy was measured using the Diabetes Management Self-efficacy Scale.[19] The Cronbach's α coefficient, test-retest reliability, and construct validity were 0.91, 0.85, 0.82, respectively.[19] This study selected four items in the exercise therapy dimension, which measured patients' subjective level of confidence in their ability to complete motor activities in a variety of difficult situations. The Cronbach's α of the dimension was 0.94.[19] Each item was rated on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=unsure, 4=moderately agree, and 5=strongly agree). The dimension score ranges from 4 to 20, with higher scores indicating better self-efficacy.

Data Collection

Three postgraduate students were trained prior to data collection to ensure they understood the following factors: questionnaire structures and contents; the purpose and significance of the survey, critical points of communicating with the elderly;, and how to complete the questionnaires in a standardized fashion. Data were collected face to face. The investigators read the answers one by one for the elderly with poor eyesight or those who are not comfortable filling in the questionnaires by themselves. In such cases, the subjects answered the questions orally, and the investigators recorded the answers. All the questionnaires were checked on the spot to ensure result accuracy and authenticity.

Statistical Analyses

Statistical analyses were performed using the IBM SPSS version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used for participant characteristics. Dimension scores, average scores for each dimension, and item scores were calculated. We then analyzed which characteristics considerably influencing exercise adherence and compliance were related to the total exercise adherence and compliance score. Factors with P<0.05 in univariate analysis were input into the multiple linear regression model. When P>0.05, the independent variable is not statistically significant in this model, and the corresponding variable should be deleted from the regression model. And we use VIF which were all less than 10 to ensure there was no multicollinearity between variables. To analyze these relationships, we entered variables

into multiple linear regression models using a stepwise selection mode and retained the significant ones in the final regression model. The significance level was set at 0.05, and all comparisons were two-tailed.

Results

Participant Characteristics

A total of 205 (95 male, 107 female) elderly patients with T2DM were included in this study. The age of the participants ranged from 60 to 85 years, with a mean age of 69.76±5.98 years old, and the mean T2DM duration was 10.31±7.32 years. The exercise adherence and compliance data are shown in Table 1. The mean score was 16.72±5.08.

Table 1 Exercise Adherence and Compliance Scores of Elderly Patients with T2DM (n=205)

Variable	Number	Total Diabetes Exercise Compliance Questionnaire Score	t	*P*
Age				
60–69	104	17.63±4.97	3.652	0.028
70–79	86	15.65±4.76		
80–89	15	16.60±6.64		
Sex				
Female	103	17.10±4.84	1.133	0.290
Male	102	16.34±5.31		
Educational level				
Elementary school and below	81	15.65±4.87	5.212	0.002
Junior high school	91	16.62±4.99		
Senior high school	25	19.88±4.71		
College and above	8	18.88±5.54		
Course of disease				
<5 years	53	17.25±4.97	0.731	0.535
5 to 10 years	73	16.18±5.28		
10 to 15 years	28	16.21±5.78		
>15 years	51	17.24±4.50		
Family history				
Yes	63	18.00±4.47	3.683	0.002
No	101	15.83±4.94		
Unknown	41	16.95±5.91		
Self-monitoring				
None	116	15.47±5.17	3.510	0.005
Less than once a month	32	18.03±4.55		
2–4 times a month	17	18.59±4.50		
5–8 times a month	29	18.66±4.39		
9–16 times once a month	4	1875±3.69		
More than 16 times a month	7	17.71±6.02		
Follow the diabetic diet				
Yes	117	17.41±4.88	3.804	0.024
No	48	15.04±5.31		
Not always	40	16.73±5.02		
Diabetes education				
None	123	16.28±4.98	2.813	0.04
Less than once a year	59	18.07±5.22		
Twice a year	6	18.17±6.49		
More than once a month	17	14.71±3.85		

(*Continued*)

Table 1 (Continued).

Variable	Number	Total Diabetes Exercise Compliance Questionnaire Score	t	P
Awareness of physical impairment due to improper exercise				
Yes	121	17.87±4.99	−4.026	<0.001
No	84	15.07±4.77		
Physical activity level				
Low	60	14.12±4.49	−2.907	0.027
Medium	108	17.26±4.81		
High	37	19.38±4.99		
Loss of skeletal muscle mass				
Yes	24	16.58±6.36	3.270	0.89
No	181	16.74±4.91		
Body pain				
Yes	84	16.32±452	−1.019	0.308
No	121	17.00±5.43		
Falling				
Yes	32	16.69±4.69	−0.330	0.741
No	173	16.73±5.16		
Hypoglycemia				
Yes	45	19.29±4.86	−3.672	<0.001
No	160	16.00±4.92		
Complications				
Yes	48	17.08±4.74	0.162	0.851
No	127	16.63±5.03		
Unknown	30	16.53±5.89		

Bivariate Correlations

The bivariate correlation results showed that exercise adherence and compliance were associated with grip, exercise knowledge, exercise willingness, professional support, social support, and self-efficacy. As shown in Figure 2, participants who have good exercise adherence and compliance got higher scores in grip (r=0.146, P=0.036), exercise knowledge (r=0.784, P<0.001), exercise willingness (r=0.556, P<0.001), professional support (r=0.426, P<0.001), social support (r=0.313, P<0.001), self-efficacy (r=0.548, P<0.001).

Hierarchical Multiple Regression Analysis

The final regression model derived from the stepwise multiple linear regression analysis revealed that six variables affected exercise adherence and compliance among among the T2DM patients: self-monitoring, hypoglycemia, exercise knowledge, exercise willingness, professional support, and self-efficacy (Table 2). The independent variables for self-monitoring were taken as hierarchical: "None"=1, "Less than once a month"=2, "2–4 times a month"=3, "5–8 times a month"=4, "9–16 times once a month"=5, and "More than 16 times a month"=6. The remaining variables were substituted into the original values. The final model significantly accounted for 71.0% of the variance of the exercise adherence and compliance score (F=34.317, P<0.001). A high level of exercise adherence and compliance significantly correlated with a high level of self-monitoring, less hypoglycemia, better exercise knowledge, better exercise willingness, more professional support, and better self-efficiency.

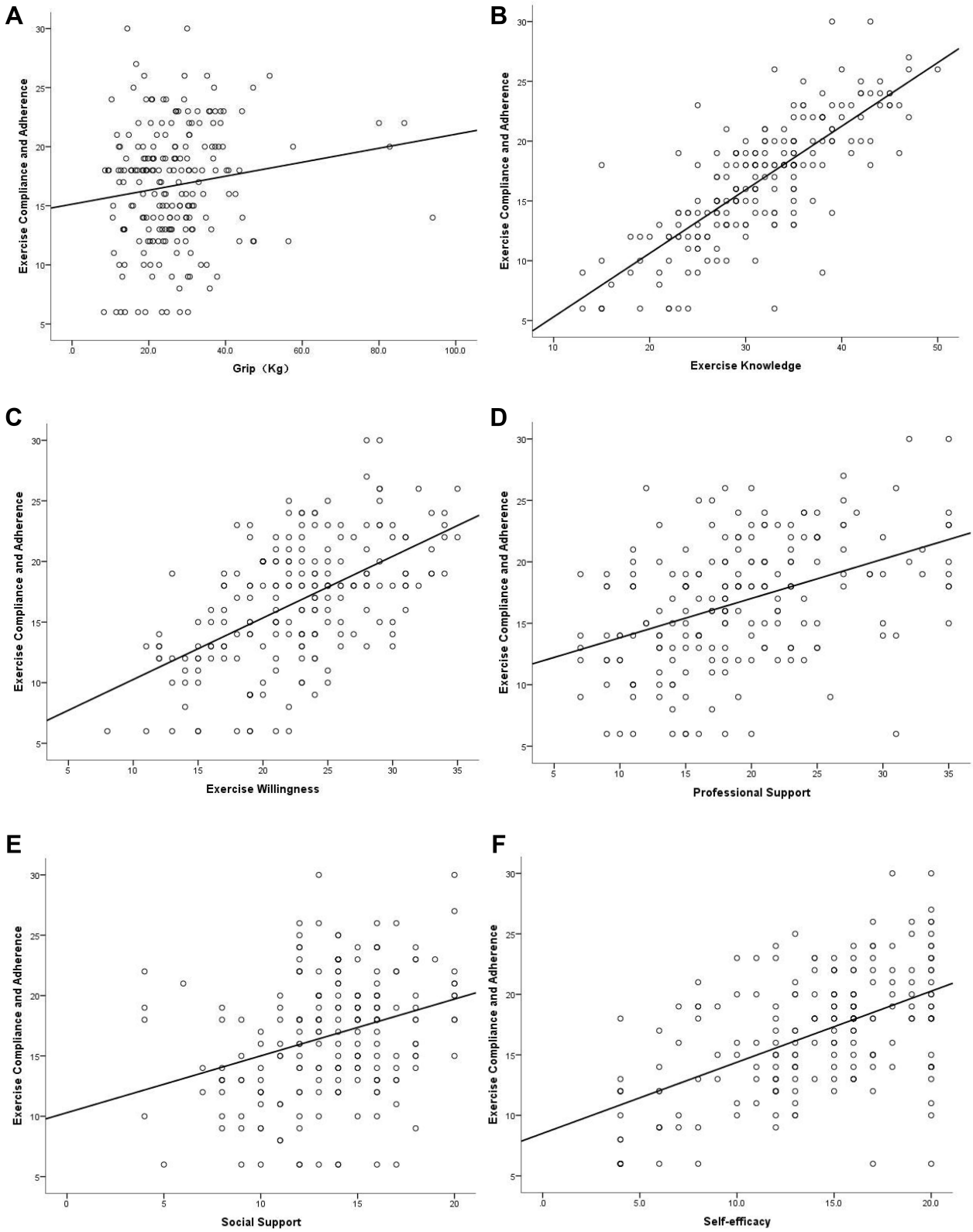

Figure 2 Bivariate correlation results showed exercise adherence and compliance were associated with grip (**A**), exercise knowledge (**B**), exercise willingness (**C**), professional support (**D**), social support (**E**), and self-efficacy (**F**).

Table 2 Multiple Regression Results of Factors Associated with Exercise Adherence and Compliance Among Elderly Patients with T2DM (n=205)

Variable	*B*	*SE*	*β*	t	*P*
Self-monitoring	0.398	0.144	0.109	2.757	0.006
Hypoglycemia	1.012	0.499	0.083	2.028	0.044
Exercise knowledge	0.301	0.041	0.444	7.419	<0.001
Exercise willingness	0.103	0.049	0.113	2.126	0.035
Professional support	0.122	0.036	0.162	3.383	0.001
Self-efficacy	0.314	0.060	0.288	5.258	<0.001

Notes: Adjusted R^2=0.710(F=34.317, P<0.001).

Discussion

Low Level of Exercise Adherence and Compliance in Elderly Patients with T2DM

The elderly subjects with T2DM assessed in the present study had a low level of exercise adherence with no significant difference in exercise adherence and compliance scores compared to a previous report (16.14±1.68 vs 16.72±5.08, p>0.05).[16] Both studies sampled people with T2DM in the Shanghai community, indicating that the results were regionally representative. We supposed that exercise compliance would improve in older diabetics after six years, but the results were not as expected. So the exercise adherence and compliance indicates low levels. The prevalence of COVID-19 may be one of the reasons for the low level of exercise adherence in elderly patients. Residents were required to avoid gathering and go out less, leading to an increase in sedentary time and reduced frequency of physical activity and walking.[20] It is also possible that patients were less willing to seek medical care during the epidemic,[20] so they may not have received timely professional support from medical staff for T2DM treatment.

Analysis of Intrinsic Motivation of Exercise Adherence and Compliance in Elderly Patients with T2DM

Intrinsic motivation refers to the spontaneous tendency to seek out novelty and challenges, to extend and exercise one's capacity as well as to explore and learn.[21] The present findings suggested that exercise adherence and compliance among elderly patients with T2DM were associated with intrinsic motivation. Self-efficacy may positively influence exercise adherence.[22] Patients with better self-efficacy tended to have a higher level of adherence, and as self-efficacy increased, the patient's ability to self-manage increased, which was consistent with previous findings on the association between self-efficacy and health behaviors.[22,23] The facilitative effect of self-efficacy on exercise adherence behavior is demonstrated by patients with higher self-efficacy having more confidence to face challenges that arise during exercise.[24] Difficulties include the lack of physical ability and psycho-emotional resistance to exercise,[25] and patients with a high degree of self-efficacy will tend to overcome these difficulties and force themselves to obtain a sense of the benefits of long-term exercise.[23]

We found that patients with better exercise willingness also had better exercise adherence and persistence. According to the Theory of Planned Behavior (TPB), patients' willingness to exercise is a precondition for engaging in exercise behavior, but willingness to exercise does not necessarily always lead to exercise behavior,[26] suggesting that patients' willingness to exercise is necessary but insufficient for generating exercise behavior. Various factors can influence the transformation of patients' exercise willingness to behavior. As described in the TPB, attitude towards the behavior, subjective norms, and perceived behavioral control all influence willingness. Thus, it is important to stimulate interest in exercise,[27] and promote the establishment of social support represented by doctors, peers, and parents,[28] It is also important to know the patients' motor skills, techniques, and abilities before motivating them to exercise,[27] making it less likely that their exercise willingness will run counter to their exercise behaviors.

The present results showed that lack of exercise knowledge was one of the barriers to exercise adherence and compliance, which was consistent with previous reports.[29] Because some patients believed that shortness of breath after exercise is a sign of illness, they stop exercising due to fear of worsening discomfort.[30] Lack of education of

proper post-exercise self-monitoring makes them less likely to comply with exercise behaviors.[31] The existence of misconceptions about exercise-related knowledge may be a contributing factor to reduced exercise compliance. Therefore, knowledge about diabetic exercise safety is essential.

The present findings suggested that exercise participation was lower in individuals with diabetes who have experienced hypoglycemia. A previous study has used a Chinese version of Hypoglycemia Fear Survey (HFS) to collect data and reported that the average total score on the HFS was higher than in some previous studies.[32] Adverse reactions, such as dizziness and weakness, caused by hypoglycemia may lead to exercise fear. It was described as an excessive, irrational fear of physical movement or activity due to a sense of vulnerability to injury or re-injury.[33] Previous studies have shown that some diabetic patients, especially individuals with type 1 diabetes (T1DM), are prone to hypoglycemic fear,[34] which may lead to reluctance to maintain treatment adherence and compliance of insulin administration.[35] The present study focused on exercise adherence, and we further validated that patients' fear of hypoglycemia, which may arise during exercise, led to a decrease in exercise-related treatment adherence. Therefore, it is essential to instruct patients on the prevention and early recognition of hypoglycemia, such as measuring glucose levels before exercise to reduce hypoglycemia risk and improve the participation rate and adherence to exercise rehabilitation.

Analysis of Extrinsic Motivation That Influences Exercise Adherence and Compliance in Elderly Patients with T2DM

Extrinsic motivation refers to pursuing a goal for reasons that are external to the activity itself.[21] The present findings suggested that lower levels of professional support led to lower exercise adherence and persistence, which was consistent with previous studies.[36] Low participation rates may be influenced by lack of effective physician-patient communication leading to reduced patient trust in medical staff,[37] negative consequences due to irrational design of an exercise rehabilitation program not tailored to the individual's physical condition,[38] difficulty sustaining the exercise program due to insufficient ongoing care in the hospital,[39] and inadequate community exercise rehabilitation efforts that hamper access to exercise education.[40]

We found that subjects who regularly monitored their blood glucose had higher exercise compliance than those who did not. Another study has reported that the average percentage of diabetics who monitor their blood glucose no more than once a year is 45.7%, indicating that many patients still lack awareness of blood glucose monitoring.[41] Economic reasons, workplace inconvenience, negative psychology, language barriers, and lifestyle are the main factors that affect blood glucose monitoring. However, obtaining feedback on physiological data may improve health self-awareness. With more frequent blood glucose monitoring, people can observe how their exercise behavior (eg, walking) immediately affects blood glucose levels.[42] Objective results obtained with these measurements may improve treatment adherence by demonstrating that their blood glucose is being effectively controlled, thus promoting compliance behaviors. Real-time blood glucose monitoring can serve as a form of persuasion to encourage patients to adhere to positive behaviors. Because too frequent or sparse monitoring may affect patient quality of life, blood glucose monitoring requires professional guidance.[43] Similarly, patient adherence and compliance during exercise often requires support from healthcare professionals. Effective patient-physician communication can help identify more appropriate exercise programs to avoid side effects, thereby increasing the patient's sense of benefit to improve exercise adherence; finding a program that meets the patient's needs can help them establish exercise habits, avoid possible adverse consequences of exercise, and improve exercise adherence and compliance durability.

Limitations

This cross-sectional study had several limitations. Firstly, because the present study was conducted in a Shanghai population and had small sample size, the generalizability of the results requires prospective cohort studies and evidence from randomized controlled trials in other regions. Secondly, we did not explore the relationship between the independent variables in-depth due to the limited sample size, resulting in a lack of investigation of the mediating variables.

Conclusion

Elderly patients with T2DM have low exercise adherence and compliance. It is important to note that both intrinsic motivation and extrinsic motivation should be emphasized during exercise interventions. The present study offered some insights into influencing factors for exercise compliance and adherence, especially in elderly patients with T2DM. In addition to focusing on the positive effect of self-efficacy, exercise willingness, professional support, and blood glucose monitoring on exercise adherence and compliance, attention should be focused on the prevention of hypoglycemia. Appropriate health education and psychological counseling on how to deal with hypoglycemia is required to avoid the negative influence of exercise fear caused by hypoglycemia on exercise compliance, especially for patients who have experienced hypoglycemia and those who are prone to hypoglycemia.

Ethics Approval

This study was conducted in accordance with the Declaration of Helsinki. This study was registered and approved by Tangzhen Community Healthcare Center (Ethical approval number 2019-01). Informed consent was signed by the participants after a brief description of the background, purpose, investigation, associated risks and benefits of the study. All information about the patients remained confidential during the study.

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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; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be

published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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