Research Square

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Fear of Hypoglycaemia and Its Associated Factors Among Empty-Nest Older Adults With Diabetes: A Cross-Sectional Study

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Research Article

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Abstract

Background

As population aging accelerates and family structures become increasingly nuclear, living separately from adult children has become commonplace among older people. Against this backdrop, empty-nest older adults with diabetes represent a distinct and increasingly important population in diabetes management.Fear of hypoglycaemia can interfere with glycaemic management in empty-nest older adults with diabetes and may, in turn, compromise their quality of life.

Aims

This study investigated the prevalence of, and factors associated with fear of hypoglycaemia (FOH) among empty-nest older adults with diabetes, with the aim of providing a theoretical basis for the development and implementation of targeted interventions.

Methods

A total of 217 empty-nest older adults with diabetes were recruited. A cross-sectional survey was conducted using the General Information Questionnaire, the Chinese version of the Chinese version of the Hypoglycaemia Fear Survey II - Worry Scale (CHFSII-WS), the Multidimensional Scale of Perceived Social Support (MSPSS), the Trait Coping Style Questionnaire (TCSQ), the Self-Rating Anxiety Scale (SAS), the Diabetes Distress Scale (DDS), and the Gold score. Descriptive analysis, univariate and correlation analyses, and multiple linear regression were used for data analysis.

Results

The mean CHFSII-WS score among empty-nest older adults with diabetes was 9.30 ± 10.85. Having children, the frequency of visits from relatives/children, positive/negative coping styles, and the severity of diabetes distress were significantly associated with FOH in empty-nest older adults with diabetes (all $p < 0.05$).

Conclusion

FOH among empty-nest older adults with diabetes was generally moderate. Being alone when hypoglycaemia occurred was the situation that caused the greatest concern. Healthcare professionals and family members should pay particular attention to factors that may exacerbate FOH, support patients in adopting more active coping strategies, and strengthen their confidence in managing hypoglycaemic episodes.

Introduction

China has the largest population of older adults with diabetes worldwide, accounting for approximately one-quarter of the global population of older adults with diabetes, and this number continues to rise [1]. Against the backdrop of rapid population aging and the increasing prevalence of nuclear family structures in China, living separately from adult children has become increasingly common among older people, resulting in a growing proportion of empty-nest households. More than half of older adults in China are estimated to be empty nesters, accounting for 51.3% of the older population [2]. By 2030, the proportion of older adults living in empty-nest households is projected to reach 90%. Previous research has shown that diabetes is more prevalent among empty-nest older adults than among their non-empty-nest counterparts and ranks among the three most common chronic non-communicable diseases in this population [3]. Limited access to disease-related knowledge and healthcare information in the absence of adequate family and social support may contribute to poorer quality of life, self-management, and emotional well-being among empty-nest older adults with diabetes than among other older adults [4]. These disadvantages can substantially compromise their overall quality of life, highlighting the need for greater attention to this vulnerable population.

Hypoglycaemia is a common treatment-related complication in people with diabetes. For older adults with diabetes, and particularly those living alone, an episode of hypoglycaemia can be a particularly distressing and potentially dangerous experience. In addition to advanced age, impaired awareness of hypoglycaemia and diminished ability to self-regulate and respond appropriately after an episode, together with cognitive decline and multiple comorbidities, make older adults with diabetes more susceptible to hypoglycaemia unawareness, nocturnal hypoglycaemia, and severe hypoglycaemia. These events may result in adverse outcomes such as cardiovascular and cerebrovascular events, falls, loss of consciousness, and even death [5, 6]. For empty-nest older adults, living alone presents an additional challenge: a hypoglycaemic episode requiring urgent intervention may go unnoticed, and the individual may be unable to manage it independently, potentially worsening its consequences. Fear of hypoglycaemia (FOH) refers to the negative emotional experience arising from the perceived threat of hypoglycaemia during diabetes self-management, together with the behavioural changes that may follow. Previous studies have suggested that more than half of people with diabetes experience some degree of fear related to hypoglycaemia [7, 8]. Patients with FOH may also engage in overcompensatory behaviours, such as reducing insulin doses, increasing food intake as a precaution, avoiding physical activity, or declining work-related tasks [9]. Some may deliberately maintain higher-than-recommended blood glucose levels to minimize the perceived risk of hypoglycaemia. Although such behaviours may provide short-term reassurance, they can obscure the longer-term risk of diabetes-related complications. Consequently, FOH may interfere substantially with effective diabetes management and adversely affect patients' quality of life.

Previous research has identified associations between FOH and psychosocial factors, including social support, coping style, and diabetes distress. The level of social support received by patients appears to influence the severity of FOH, with lower perceived social support being associated with greater fear [10]. Adequate social support may, in turn, alleviate negative emotional responses to diabetes management. Coping style has also been closely linked to FOH [11]. Positive coping strategies, such as learning to recognize and manage hypoglycaemia, monitoring blood glucose regularly, carrying fast-acting carbohydrates, and maintaining effective communication with healthcare professionals, may help patients develop greater confidence in managing hypoglycaemia and thereby reduce FOH. In contrast, negative coping, such as denial, avoidance, or excessive reliance on others, may discourage patients from seeking or accepting necessary medical care and consequently intensify their fear. Liu *et al.* [12] reported a direct positive association between diabetes distress and FOH, and both factors exert negative effects on diabetes self-management, forming a self-perpetuating cycle.

To date, research on FOH has focused predominantly on adults with diabetes, children with diabetes, gestational diabetes, and family members of people with diabetes [13–16]. Comparatively little attention has been paid to FOH among empty-nest older adults with diabetes. In particular, the roles of social support, coping style, and diabetes distress in shaping FOH in this population remain insufficiently understood. Therefore, this study investigated the prevalence and severity of FOH among empty-nest older adults with diabetes and examined its associated factors, aiming to inform the development of targeted interventions to reduce FOH in the affected population.

Methods

Aims

This study aimed to assess the current level of FOH among empty-nest older adults with diabetes and to identify factors associated with FOH in this population, including sociodemographic characteristics, disease- and treatment-related factors, social support, coping style, anxiety, and diabetes distress.

Design

This was a cross-sectional study that included a descriptive survey. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies.

Participants and Eligibility Criteria

A convenience sampling approach was used to recruit 217 empty-nest older adults with diabetes who attended the Department of Endocrinology at the First Affiliated Hospital of Zhejiang University School of Medicine between June 2023 and January 2024. Participants were deemed eligible if they met all of the following criteria: (1) a definitive diagnosis of diabetes for at least 1 year; (2) age ≥ 60 years; (3) meeting the definition of an empty-nest older adult; (4) history of at least one episode of hypoglycaemia; and (5) ability to communicate verbally or in writing and voluntary participation in the study. Participants were excluded if they met any of the following criteria: (1) in an acute phase of illness; (2) failure to complete the survey due to any severe psychiatric disorder or physical impairment; or (3) concurrent participation in another clinical trial.

Sampling

Sample size was estimated using Kendall's rule of thumb, according to which the required sample size should be approximately 5–10 times the number of variables. An additional 10% was allowed for potential non-response. With 19 variables included in the present study, the estimated sample size ranged from 105 to 209 participants. Ultimately, 217 participants were enrolled.

Outcome Variable and Assessment Instruments

Patient Information Questionnaire

A questionnaire was developed by the research team to collect participants' sociodemographic and disease- and treatment-related information. Sociodemographic variables included gender, age, education level, and marital status. Disease- and treatment-related variables included diabetes duration, diabetes type, current treatment modality, and the most recent glycated haemoglobin (HbA1c) level.

Chinese version of the Hypoglycaemia Fear Survey II - Worry Scale (CHFSII-WS)

The Hypoglycaemia Fear Survey (HFS), originally developed by Cox *et al.* [17], was designed to assess adults with diabetes regarding their concerns about hypoglycaemia and the behaviours adopted to avoid it. Mu *et al.* [18] translated and culturally adapted the Worry subscale of the HFS (i.e., the CHFSII-WS) for use in Chinese populations. The CHFSII-WS scale comprises 13 items rated on a 5-point Likert scale, yielding a total score ranging from 0 to 52. Higher scores indicate a greater degree of FOH. In the present study, the scale demonstrated excellent internal consistency, with a Cronbach's α coefficient of 0.959.

Multidimensional Scale of Perceived Social Support (MSPSS)

The MSPSS, originally developed by Zimet *et al.* [19], is designed to assess individuals' subjective perceptions of the social support available to them. The scale was introduced into China by Huang *et al.* [20]. It comprises three dimensions, including family support, friend support, and significant other support, with 12 items in total. Each item is rated on a 7-point Likert scale ranging from "very strongly disagree" to "very strongly agree," scored from 1 to 7. The sum of all item scores represents the overall level of perceived social support, with total scores ranging from 12 to 84. Scores of 12–36, 37–60, and 61–84 indicate low, moderate, and high levels of perceived social support, respectively. Higher scores indicate greater perceived social support. In the present study, the MSPSS demonstrated high internal consistency, with an overall Cronbach's α coefficient of 0.943. The corresponding coefficients were 0.909 for family support, 0.935 for friend support, and 0.908 for significant other support.

Trait Coping Style Questionnaire (TCSQ)

The TCSQ, developed by the Chinese scholar Jiang Qianjin [21], measures individuals' habitual cognitive responses and coping strategies when dealing with various events and stressors encountered in daily life. The questionnaire is split evenly into two dimensions: positive coping (10 items) and negative coping (10 items). Each item is rated on a 5-point Likert scale, ranging from 1 ("definitely not") to 5 ("definitely yes"). The positive and negative coping scores reflect an individual's predominant coping tendencies when facing stress and challenges. In the present study, the TCSQ showed satisfactory internal consistency, with an

overall Cronbach's α coefficient of 0.796. The Cronbach's α coefficients were 0.809 for positive coping and 0.867 for negative coping.

Self-Rating Anxiety Scale (SAS)

Zung's SAS [22] was employed to assess participants' anxiety symptoms during the preceding 7 days. The scale consists of 20 items, each rated on a 4-point Likert scale. The raw scores for all items are summed and multiplied by 1.25, with the integer portion taken as the final standardized score. The standardized score ranges from 25 to 100, with 50 used as the threshold for clinically relevant anxiety. A score below 50 indicates no clinically significant anxiety, whereas a score of ≥ 50 indicates an anxious state. Scores of 50–59, 60–69, and ≥ 70 indicate mild, moderate, and severe anxiety, respectively. Higher scores indicate greater anxiety severity. The Cronbach's α coefficient of the SAS in the present study was 0.805.

Diabetes Distress Scale (DDS)

The DDS, developed by Polonsky *et al.* [23], is a standardized instrument specifically designed to assess diabetes-related emotional distress. Yang *et al.* [24] translated and culturally adapted the scale for use in Chinese populations. The DDS measures emotional distress across four main dimensions (17 items), including emotional burden, physician-related distress, regimen-related distress, and interpersonal distress. Items are rated on a 6-point Likert scale ranging from 1 ("not a problem") to 6 ("a very serious problem"). Higher scores indicate a greater psychological burden and level of distress associated with diabetes-related problems. Fisher *et al.* [25] subsequently proposed a scoring framework for classifying diabetes distress based on the mean item score. A mean score of < 2.0 indicates little or no diabetes distress, 2.0 to < 3.0 indicates moderate distress, and ≥ 3.0 indicates high distress. In our study, the DDS demonstrated excellent internal consistency, with an overall Cronbach's α coefficient of 0.943. The Cronbach's α coefficients were 0.864 for emotional burden, 0.775 for physician-related distress, 0.832 for regimen-related distress, and 0.816 for interpersonal distress.

Data Collection

To ensure methodological consistency and data quality, all members of the research team received standardized training before the formal survey was initiated. Particular attention was given to ensuring a consistent interpretation of participants' responses to the questionnaires.

In clinical settings, endocrinologists screened patients against the predefined inclusion and exclusion criteria. Eligible patients were approached by members of the research team and provided with an explanation of the study. Questionnaires were completed anonymously. Participants received RMB 50 yuan upon completion of the questionnaire. A total of 240 questionnaires were distributed, of which 225 were returned. Eight questionnaires were excluded because they did not meet the predefined quality criteria, leaving 217 valid questionnaires for analysis. The valid response rate was 96.4%.

Ethical Considerations

The study was approved by the Clinical Research Ethics Committee of the First Affiliated Hospital of Zhejiang University School of Medicine(FAHZU.2024 Res. No. 1244). All participants provided written informed consent before taking part in the study.

Statistical Analysis

All statistical analyses were performed using SPSS 25.0 and Mplus 8.0. Descriptive statistics were presented as frequencies and percentages [*n*(%)] for categorical variables, and as means and standard deviations ($\bar{x}\pm s$) or medians and interquartile ranges [M (P25, P75)] for continuous variables, as appropriate. Between-group differences were assessed using the Mann-Whitney U test or Kruskal-Wallis H test. Associations between variables were examined using Spearman's rank correlation analysis. A multiple linear regression model was subsequently fitted for multivariable analysis. Multicollinearity diagnostics were performed to ensure the robustness and reliability of the findings. All statistical tests were two-sided, with $\alpha = 0.05$ defined as the significance threshold. A *p*-value < 0.05 was considered statistically significant.

Results

General Characteristics of Participants

Among the 217 empty-nest older adults with diabetes included in the study, 112 (51.61%) were women and 105 (48.39%) were men. Most participants had children (96.31%), and weekly visits from relatives, children, or other family members were the most common pattern (43.78%). A total of 141 participants (64.98%) reported no family history of diabetes. For the most recent HbA1c measurement, 43.32% of participants had an HbA1c level of ≥ 8.0%. More than half of the participants (54.38%) were receiving combined injectable and oral glucose-lowering therapy. A total of 143 participants (65.90%) had previously received education on hypoglycaemia, and 84.79% reported knowing how to manage a hypoglycaemic episode. Comparisons of total FOH scores according to gender, having children, frequency of visits from relatives/children, family history of diabetes, most recent HbA1c level, current treatment regimen, previous hypoglycaemia education, and knowledge of hypoglycaemia management showed statistically significant differences (all $p < 0.05$). See Table 1.

TABLE 1 | Participants' general characteristics and differences in FOH (N = 217)

Variable	Group	*n* (%)	Total FOH score		
			M (P25, P75)	*U*/*H*	*p*
Gender	Female	112 (51.61%)	7.00 (1.0, 16.0)	4922.50a	0.036*
	Male	105 (48.39%)	3.00 (0.0, 13.5)		
Age (years)	60–70	107 (49.31%)	5.00 (0.0, 15.0)	1.692b	0.639
	70–80	83 (38.25%)	4.00 (0.0, 14.0)		
	80–90	24 (11.06%)	10.50 (0.0, 23.0)		
	≥90	3 (1.38%)	6.00 (4.0, 26.0)		
Body mass index (kg/m²)	<18.5	13 (5.99%)	17.00 (0.0, 24.0)	3.094b	0.377
	18.5≤BMI<24.0	85 (39.17%)	6.00 (0.5, 15.5)		
	24.0≤BMI<28.0	91 (41.94%)	4.00 (0.0, 13.0)		
	≥28.0	28 (12.90%)	7.00 (1.0, 15.8)		
Marital status	Unmarried	3 (1.38%)	13.00 (9.0, 18.0)	2.367b	0.500
	Married	172 (79.26%)	4.50 (0.0, 15.0)		
	Divorced or separated	7 (3.23%)	15.00 (2.0, 16.0)		
	Widowed	35 (16.13%)	4.00 (1.0, 14.0)		
Education level	Elementary school and below	92 (42.40%)	7.50 (0.0, 15.8)	5.565b	0.135
	Middle school	69 (31.80%)	4.00 (0.0, 15.0)		
	High school or junior college	35 (16.13%)	3.00 (0.0, 9.0)		
	College and above	21 (9.68%)	11.00 (2.5, 22.5)		
Monthly personal income (yuan)	<1000	35 (16.13%)	4.00 (0.0,17.0)	2.097b	0.553
	1000–3000	63 (29.03%)	4.00 (0.0, 13.0)		
	3000–5000	74 (34.10%)	6.00 (1.0, 18.5)		
	≥5000	45 (20.74%)	5.00 (0.0, 14.5)		
Living arrangement	Living alone	52 (23.96%)	6.50 (1.0,15.0)	3966.500a	0.407

	Living with spouse	165 (76.04%)	5.00 (0.0,15.5)		
Having children	Yes	209 (96.31%)	4.00 (0.0,15.0)	375.000a	0.007**
	No	8 (3.69%)	18.50 (10.0,30.3)		
Frequency of visits from relatives/children	Daily	56 (25.81%)	1.00 (0.0,8.8)	20.523b	0.005**
	Weekly	95 (43.78%)	8.00 (2.0,21.0)		
	Every 2 weeks	13 (5.99%)	12.00 (0.0,25.5)		
	Monthly	28 (12.90%)	2.50 (0.0,14.8)		
	Every 3 months	4 (1.84%)	14.50 (4.8,36.3)		
	Every 6 months	11 (5.07%)	6.00 (0.0,26.0)		
	Annually	9 (4.15%)	4.00 (0.5,11.5)		
	Never	1 (0.46%)	9.00 (9.0,9.0)		
Family history of diabetes	Yes	76 (35.02%)	9.00 (1.0,17.5)	4380.500a	0.025*
	No	141 (64.98%)	4.00 (0.0,14.0)		
Diabetes type	Type 2	215 (99.08%)	5.00 (0.0,15.0)	70.500a	0.098
	Type 1	2 (0.92%)	20.50 (17.0,24.0)		
Diabetes duration (years)	1–10	105 (48.39%)	5.00 (0.0,17.0)	0.536b	0.765
	11–20	82 (37.79%)	4.00 (0.0,13.3)		
	≥21	30 (13.83%)	6.50 (0.0,15.5)		
Number of diabetes-related complications	None	60 (27.65%)	3.50 (0.0,16.8)	2.241b	0.524
	1	65 (29.95%)	6.00 (1.5,14.5)		
	2	45 (20.74%)	4.00 (0.0,13.0)		
	≥3	47 (21.66%)	5.00 (0.0,19.0)		
Most recent HbA1c	<7.5%	82 (37.79%)	4.50 (0.0,15.3)	9.255b	0.010**
	7.5%–8.0%	41 (18.89%)	10.00 (2.5,24.5)		
	≥8.0%	94 (43.32%)	2.50 (0.0,13.0)		

Current treatment regimen	Oral glucose-lowering drugs only	65 (29.95%)	3.00 (0.0,14.5)	9.098b	0.011*
	Injectable therapy only	34 (15.67%)	13.50 (3.8,22.5)		
	Combination therapy (injectable therapy + oral glucose-lowering drugs)	118 (54.38%)	4.50 (0.0,14.0)		

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

 For categorical variables with two categories, the Mann-Whitney U test was employed.

 For categorical variables with three or more categories, the Kruskal-Wallis H test was used.

FOH Scores Among Empty-Nest Older Adults With Diabetes

In this study, the mean FOH score among empty-nest older adults with diabetes was 9.30 ± 10.85, with a median of 5.00 and an interquartile range of 15.00. Among the individual items, CHSFII-WS4 had the highest mean score (1.09 ± 1.12). In contrast, CHSFII-WS3, CHSFII-WS5, and CHSFII-WS9 had relatively low mean scores of 0.44 ± 0.82, 0.45 ± 0.82, and 0.39 ± 0.81, respectively. See Table 2.

TABLE 2 | FOH scores among empty-nest older adults with diabetes (*N* = 217)

FOH item	Number of items	Score			
		Score range (min. – max.)	$\bar{x}\pm s$	M	IQR
Total FOH score	13	0–52	9.30±10.85	5.00	15.00
CHSFII-WS1	1	0–4	0.89±1.06	1.00	1.00
CHSFII-WS2	1	0–4	0.76±1.00	0.00	1.00
CHSFII-WS3	1	0–4	0.44±0.82	0.00	1.00
CHSFII-WS4	1	0–4	1.09±1.12	1.00	2.00
CHSFII-WS5	1	0–4	0.45±0.82	0.00	1.00
CHSFII-WS6	1	0–4	0.69±1.01	0.00	1.00
CHSFII-WS7	1	0–4	0.93±1.14	0.00	2.00
CHSFII-WS8	1	0–4	0.85±1.16	0.00	1.50
CHSFII-WS9	1	0–4	0.39±0.81	0.00	0.50
CHSFII-WS10	1	0–4	0.59±0.89	0.00	1.00
CHSFII-WS11	1	0–4	0.61±1.04	0.00	1.00
CHSFII-WS12	1	0–4	0.88±1.21	0.00	2.00
CHSFII-WS13	1	0–4	0.72±1.06	0.00	1.00

Correlations Between FOH and Social Support, Coping Style, Anxiety, and Diabetes Distress

Spearman's rank correlation analysis was performed to examine the associations of FOH with the three dimensions of social support, overall perceived social support, the two coping styles, anxiety, and diabetes distress. FOH was significantly and

negatively correlated with family support, friend support, significant other support, overall perceived social support, positive coping, and diabetes distress (r_1 = −0.214, r_2 = −0.271, r_3 = −0.304, r_4 = −0.260, r_5 = −0.346, r_8 = −0.211, respectively; all $p < 0.01$). In contrast, FOH showed a significant positive correlation with negative coping (r_6 = 0.276, $p < 0.01$). See Table 3.

Table 3
Spearman rank correlations between FOH and study variables among empty-nest older adults with diabetes

FOH	FOH	Family support	Friend support	Significant other support	Perceived social support	Positive coping	Negative coping	Anxiety	Diabetes distress
	1								
Family support	−0.214**	1							
Friend support	−0.271***	0.626***	1						
Significant other support	−0.304***	0.691***	0.761***	1					
Perceived social support	−0.260***	0.669***	0.714***	0.748***	1				
Positive coping	−0.346***	0.309***	0.306***	0.346***	0.308***	1			
Negative coping	0.276***	−0.261***	−0.208**	−0.264***	−0.291***	−0.272***	1		
Anxiety	0.131	0.023	0.020	−0.012	0.027	−0.151*	0.233***	1	
Diabetes distress	−0.211**	0.085	0.153*	0.175**	0.086	0.027	−0.164*	−0.178**	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Multiple Linear Regression Analysis of Factors Associated With FOH Among Empty-Nest Older Adults With Diabetes

A multiple linear regression model was constructed with the FOH score as the dependent variable. Variables identified as significant in the univariate and correlation analyses were entered as independent variables. The entry and removal criteria were set at $\alpha_{in} = 0.05$ and $\alpha_{out} = 0.10$, respectively. Before the regression analysis, the independent variables were examined for multicollinearity and autocorrelation. The multicollinearity diagnostics indicated no substantial multicollinearity among the independent variables (Table 4). The Durbin-Watson test further indicated that the residuals were independent. The multiple linear regression analysis showed that having children, frequency of visits from relatives/children, positive coping, negative coping, and diabetes distress were significantly associated with FOH among empty-nest older adults with diabetes ($p < 0.05$, respectively). Specifically, not having children, weekly visits from relatives or children, greater use of negative coping strategies, and greater diabetes distress were associated with higher FOH scores. In contrast, greater use of positive coping strategies was associated with lower FOH scores. See Table 5.

Table 4
Summary of the multiple linear regression model for FOH and assessment of model assumptions among empty-nest older adults with diabetes

Analysis of variance, *F*	*p*	Adjusted R^2	Durbin-Waston statistic	Tolerance range	Variance inflation factor (VIF) range
4.862	<0.001	0.243	1.777	0.121–0.950	1.053–2.662

Table 5
Results of the multiple linear regression analysis of factors associated with FOH among empty-nest older adults with diabetes

Variable	*β*	95% CI[1]	*p*[2]	Overall *p*[3]	Collinearity	
					VIF	Tolerance
Gender				0.146	1.134	0.882
Female (reference)	—	—				
Male	−2.652	−5.301,−0.004	0.051			
Having children				0.041*	1.188	0.842
No (reference)	—	—				
Yes	−7.352	−15.070, 0.365	0.063			
Frequency of visits (overall)				0.038*	1.053	0.950
Daily (reference)	—	—				
Weekly	5.312	2.190, 8.434	0.001**			
Every 2 weeks	4.899	−1.062, 10.860	0.109			
Monthly	−0.216	−4.508, 4.075	0.921			
Every 3 months	8.900	−0.949, 18.749	0.078			
Every 6 months	2.799	−3.434, 9.032	0.380			
Annually	0.876	−5.768, 7.520	0.796			
Never	−8.510	−28.715, 11.695	0.410			
Family history of diabetes				0.100	1.172	0.853
No (reference)	—	—				
Yes	2.563	−0.341, 5.466	0.085			
Most recent HbA1c				0.923	1.109	0.902
< 7.5% (reference)	—	—				
7.5%≤<8.0%	0.931	−2.751, 4.614	0.621			
≥ 8.0%	−2.606	−5.591, 0.379	0.089			
Current treatment regimen				0.175	1.185	0.844
Oral glucose-lowering drugs only (reference)	—	—				
Injectable therapy only	2.082	−2.180, 6.344	0.340			
Combination therapy (injectable therapy + oral glucose-lowering drugs)	−0.973	−4.157, 2.211	0.550			
Friend support	−0.077	−0.604, 0.138	-	0.426	2.662	0.376
Significant other support	−0.032	−0.406, 0.468	-	0.759	3.067	0.326
Perceived social support				0.266	2.614	0.383
Low (reference)	—	—				
Moderate	1.139	−8.402, 10.680	0.815			

[3] Overall *p*-value assessing whether the variable has a statistically significant effect on the dependent variable: *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$ indicate statistically significant effects.

Variable	β	95% CI[1]	p[2]	Overall p[3]	Collinearity	
					VIF	Tolerance
High	−0.482	−11.545, 10.582	0.932			
Positive coping	−0.152	−0.460, 0.015	-	0.018*	1.171	0.854
Negative coping	0.177	−0.057, 0.314	-	0.007**	1.210	0.827
Anxiety				0.264	1.182	0.846
Normal (reference)	—	—				
Mild	1.870	−2.425, 6.165	0.395			
Moderate	5.818	−2.058, 13.694	0.149			
Severe	11.893	0.013, 23.773	0.051			
Diabetes distress				0.049*	1.147	0.872
Absent/mild (reference)	—	—				
Moderate	3.077	−0.702, 6.856	0.112			
Severe	2.681	−4.960, 10.321	0.493			

[1] CI, confidence interval.

[2] *P*-value for comparison between groups: *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$ indicate statistically significant between-group differences.

[3] Overall *p*-value assessing whether the variable has a statistically significant effect on the dependent variable: *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$ indicate statistically significant effects.

Discussion

FOH Among Empty-Nest Older Adults With Diabetes Warrants Greater Attention

Our findings showed that the mean total FOH score among empty-nest older adults with diabetes was 9.30 ± 10.85, indicating an overall moderate level of FOH. This score was slightly lower than that reported in previous studies [26]. One possible explanation is that a relatively large proportion of participants in the present study reported a high level of perceived social support. Adequate social support may help alleviate FOH and other negative emotional experiences, including distress related to diabetes complications and depressive symptoms. These observations suggest that strengthening patients' social support networks, together with providing tailored psychological support and diabetes-related health education, may be useful approaches to maintaining emotional well-being and reducing FOH.

In the present study, participants were particularly concerned about experiencing hypoglycaemia when they were alone, which was broadly consistent with the findings reported by Zhao *et al.* [27]. One possible explanation is that empty-nest older adults with diabetes have limited companionship in their daily lives and may worry that, should hypoglycaemia occur, they would be unable to obtain food promptly to correct the episode. Importantly, their concern may not be directed at hypoglycaemia itself, but rather at the uncertainty surrounding what might happen if it occurred. Declining physical function with age may lead patients to worry that they would be unable to obtain timely assistance or support during a hypoglycaemic episode, leaving them to cope alone with its potential consequences (*e.g.*, falls) or even more serious adverse events. Accordingly, during routine care for empty-nest older adults with diabetes, healthcare professionals should encourage family members or community workers to arrange appropriate companionship or supervision whenever possible and minimize prolonged periods spent alone. Patients should also be encouraged to carry a readily available source of fast-acting carbohydrate, such as glucose-containing sweets, when going out so that hypoglycaemia can be treated promptly when symptoms are recognized. Additionally, healthcare professionals should provide comprehensive and practical education on blood glucose monitoring, including appropriate use of wearable glucose-monitoring

devices where available, to improve patients' ability to recognize and prevent hypoglycaemic episodes. Such measures may help reduce uncertainty and, ultimately, alleviate FOH.

Having Children and Frequency of Visits Are Important Factors Associated With FOH

The current study found that empty-nest older adults with diabetes who had no children had higher FOH scores than those who had raised children. This might be explained by greater psychological distress due to the absence of support and companionship from adult children and limited resources for diabetes management.

We also found that, compared with participants who were visited daily by relatives or children, those whose visits occurred approximately once a week had significantly higher FOH scores. Several factors may account for this finding. Older adults who have retired and spend more time at home may take on additional household responsibilities after relatives or children visit. Changes in daily routines, meal timing, food intake, or the types of food consumed may also contribute to fluctuations in blood glucose levels, potentially heightening concerns about hypoglycaemia. This finding further suggests that the quality of social support may be more important than the quantity of social contacts. Although a patient may have frequent interactions with relatives or children, the crucial issue is whether those interactions provide the type of support the patient needs. Close, supportive relationships characterized by meaningful emotional connection may be more effective in reducing psychological stress than simply increasing the frequency of social contact.

Greater Use of Positive Coping Is Associated With Lower FOH

The present study also demonstrated that coping style was associated with FOH. Positive coping exhibited a significantly negative association with FOH, whereas negative coping had a significantly positive association with FOH. From a clinical perspective, healthcare professionals should pay closer attention to maladaptive coping patterns and help patients respond more actively to hypoglycaemia-related concerns and reduce FOH associated with these experiences.

Greater Diabetes Distress Is Associated With Higher FOH

Our analysis showed that diabetes distress was positively associated with FOH among empty-nest older adults with diabetes, consistent with the findings reported by Li *et al.* [28]. As a negative emotional state, diabetes distress may place a considerable psychological burden on patients and directly induce FOH. At the same time, distress may interfere with effective self-management, potentially contributing to fluctuations in blood glucose and creating a vicious cycle in which psychological distress and FOH reinforce one another. From a clinical perspective, particular attention should therefore be paid to the psychological well-being of empty-nest older adults with diabetes who experience diabetes distress. Healthcare professionals should strengthen communication with patients, identify negative emotional states at an early stage, and provide timely support to address them. For patients experiencing more severe distress, available family, community, and professional resources should be mobilized to facilitate early psychological intervention and minimize the potential adverse consequences.

Conclusions

FOH among empty-nest older adults with diabetes warrants greater clinical attention. Having children, frequency of visits from relatives/children, coping style, and diabetes distress were identified as important factors associated with FOH in this population. Therefore, healthcare professionals should develop targeted interventions based on patients' individual risk factors for FOH. Strengthening social support, promoting positive coping with diabetes, and alleviating diabetes distress may help reduce FOH.

Limitations

Several limitations of this study should be acknowledged. First, the convenience sampling method used in this study may have introduced selection bias. Second, the study was conducted at a single tertiary general hospital in Hangzhou, and the participants were predominantly urban empty-nest older adults with diabetes from Zhejiang Province. Therefore, the findings may not be generalizable to empty-nest older adults with diabetes across other regions of China. Finally, the cross-sectional design precludes

conclusions about temporal or causal relationships between FOH and its associated factors in the affected population, warranting longitudinal studies to elucidate the temporal trajectories and potential relationships.

Declarations

Author Contributions

ZJ: methodology, investigation, software analysis, data curation, writing original draft. **FY**: resources, methodology, validation. **YL**: investigation, data curation. **ZL**: validation, investigation, data curation. **XYT**: investigation, data curation. **GCH**: project administration, resources. **SLW**: conceptualization, resources, writing–review and editing, supervision, funding acquisition.

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Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Competing interests

There are no conflict of interests to declare.

Ethics Statement

The study was conducted in strict accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang University School of Medicine. Written informed consent was obtained from all participants.

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