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The relationship between diabetes distress and eHealth literacy among patients under 60 years of age with diabetes: a multicenter cross-sectional survey

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Abstract

Background Given the increasing prevalence of digital health management, eHealth literacy plays a crucial role in the self-management of diabetes. eHealth literacy refers to an individual's ability to use electronic devices and online resources to manage health issues. In diabetes self-care, the way patients effectively access and apply health information directly impacts disease management outcomes. However, limited research has examined eHealth literacy among diabetes patients, and there is insufficient evidence to show its specific impact on diabetes distress. Therefore, this study aims to assess the eHealth literacy of diabetes patients and explore its relationship with diabetes distress.

Methods This cross-sectional study was conducted from November 2022 to July 2023 and involved 260 diabetes patients from three tertiary hospitals in Nantong, China. The participants were selected using convenience sampling, and all participants were adults aged 60 years or younger who were capable of communicating in Chinese. Individuals with severe mental illness, hearing or visual impairments, or physical conditions that hindered their participation were excluded. The eHealth Literacy Scale (eHEALS) was used to assess the participants' eHealth literacy. Additionally, data were collected on social support, anxiety, depression, and diabetes distress (DDS). Structural equation modeling (SEM) was used to analyze the data and explore the pathways through which eHealth literacy influences diabetes distress.

Results eHealth literacy was significantly negatively correlated with anxiety, depression, and diabetes distress ($r = -0.408$, $p < 0.01$; $r = -0.294$, $p < 0.01$; and $r = -0.398$, $p < 0.01$, respectively). Additionally, eHealth literacy was significantly positively correlated with social support ($r = 0.346$, $p < 0.01$). The results of the mediation analysis revealed that social support and psychological factors (anxiety and depression) played mediating roles in the relationship between eHealth literacy and diabetes distress.

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Conclusions This study shows that eHealth literacy significantly influences the perception of distress among patients with diabetes, with social support and psychological status playing important mediating roles. Enhancing eHealth literacy, especially patients' ability to access and apply health information, may help reduce diabetes distress. Future research should explore more representative samples and long-term study designs to validate these findings and evaluate the effectiveness of various interventions.

Keywords eHealth, Depression, Anxiety, Social support, Distress, Diabetes

Background

Diabetes is a severe and chronic condition associated with various complications and an elevated risk of premature death. It imposes enormous financial pressure on national health care systems and economies. In addition to cardiovascular diseases, cancer, and chronic respiratory diseases, diabetes is estimated to account for more than 70% of the overall disease burden in China [1]. Youth-onset T2DM presents a significant clinical and socioeconomic burden because of its aggressive presentation and earlier appearance of complications. Additional research is needed on the cost of illness in this population [2]. The economic burden of diabetes on the Chinese health-care system is high, with direct costs for the prevention and treatment of diabetes and its complications projected to increase from US$190·2 billion in 2020 to $337·8 billion in 2030 [3]. Substantial disparities exist in health literacy, the quality and accessibility of diabetes care, and resource allocation across different regions of China. Despite the high prevalence of diabetes, public awareness of the disease, its risk factors, and the importance of prevention remains low, especially in rural and underdeveloped areas [4].

The effective management of patients under the age of 60 with diabetes is crucial for several reasons. First, there is a rising trend in diabetes prevalence among the younger age groups that has led to an increased proportion of patients under 60 years of age. This demographic shift is poised to have a significant impact on the future health of the population and the associated medical burden associated [5]. Second, patients under the age of 60 face higher levels of psychological stress in their lives and in the workplace due to societal expectations and lifestyle changes, making disease management and patient support increasingly urgent [6]. Finally, patients under the age of 60 are typically in the prime of life and have high productivity. The management and treatment of this cohort directly affects their families and society and has a vital impact on their societal and economic status. Consequently, prioritizing health management, disease prevention, early screening, and comprehensive treatment of people under the age of 60 with diabetes is crucial [7]. These measures not only improve the health of society as a whole but also reduce the overall medical burden to promote social and economic development.

With continuous advances in science and technology, electronic health (eHealth) literacy [8] has become a critical component of the modern health care system and offers the potential to improve diabetes management and its outcomes. eHealth literacy refers to individuals' ability to use information technology and communication skills to acquire, evaluate, manage, and apply health information to make health-related decisions. It includes a wide range of abilities, including the acquisition, evaluation, processing, and application of digital health information. eHealth literacy plays a vital role in diabetes management because this disease requires rigorous day-to-day management [9] involving a wealth of health information, such as blood glucose measurements, dietary details, and exercise routines. eHealth literacy helps people with diabetes manage their condition effectively. Research on eHealth literacy among undergraduate students in Nigeria, such as [10], has demonstrated that eHealth literacy can positively influence lifestyle behaviors. For patients under the age of 60, the significance of eHealth literacy becomes even more pronounced. Individuals in this age group are familiar with computer networks and information technology and maintain relatively good physical condition and cognitive ability, which enable them to use electronic health information for diabetes management.

The self-management and disease control of patients with diabetes are frequently enhanced through eHealth literacy because eHealth technologies offer an array of tools and services for monitoring and managing their condition. These technologies include wearable devices, mobile applications for diabetes management, and electronic medical records. In addition to eHealth literacy, patients must possess digital literacy and independent thinking skills to manage diabetes effectively using electronic devices, which fosters continuous disease control and improves their quality of life [11].

Patients with diabetes face numerous self-management tasks and inherent physical pain, leading to inevitable mental discomfort and stress. Without effective coping mechanisms, patients find it easy to abandon or ignore self-management of the disease when they face diabetes distress [12]. Mental health is therefore an important prerequisite for initiating changes in the management of diabetes.

Research has shown that health literacy, including diabetes health literacy, plays a crucial role in improving self-care behaviors, managing distress, and enhancing

overall well-being in diabetes patients. For example, a study by [13] highlighted the relationships among diabetes health literacy, distress, burnout, and complications and suggested that individuals with better health literacy are more likely to engage in effective self-care behaviors, which leads to improved health outcomes. Similarly, studies have indicated that social support can mediate the impact of health literacy on health outcomes, which further emphasizes the need for comprehensive health literacy initiatives.

Social support helps patients adapt to their illness by facilitating adherence to medical advice and raising awareness about their condition, which can lead to the development of long-term self-management strategies. Moreover, support from family, friends, and health care professionals can effectively reduce the burden of disease management, alleviate depression, and increase patients' motivation to manage their condition.

Diabetes distress persists over time and is associated with poor glycemic control and a deterioration in self-care and health-related quality of life [14]. A national study revealed that young adults with type 2 diabetes face a heavy economic burden and an increasing trend in diabetes-related distress [5]. This study aimed to explore the correlation between eHealth literacy and diabetes distress in patients under the age of 60 years. Additionally, we sought to examine the potential mediating effects of social support, anxiety, and depression on this correlation.

Methods

The data used in this study were collected via a multicenter cross-sectional survey conducted in Nantong, Jiangsu Province, China, from November 2022 to July 2023. The survey aimed to assess the eHealth literacy of patients with diabetes. The participants were selected via convenience sampling from three tertiary hospitals: the Second People's Hospital of Nantong, the Third People's Hospital of Nantong, and Rugao People's Hospital. The eligibility criteria for this study included adults aged ≤60 years who were capable of communicating in Chinese. We excluded individuals with severe mental illness, hearing or visual impairment, or physical illness that hindered their participation. Additionally, participants who dropped out during the study or submitted incomplete questionnaire responses were excluded from this study. The survey guide used in our study was the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (https://www.strobe-statement.org/).

Study variables

Demographic characteristics

The demographic characteristics of the participants included age, sex, education, health status, duration of diabetes, experience with mobile and internet use, and online health information-seeking habits. Additional measures included validated mobile eHealth literacy, knowledge and skills related to mobile phone applications, and internet use. Health outcomes, including self-rated health, diabetes self-care behaviors, and hemoglobin A1c (HbA1c) levels, were considered dependent variables.

eHealth literacy scale

We used the eHealth Literacy Scale (eHEALS) to measure patients' knowledge, comfort, and perceived skills in searching for, evaluating, and applying eHealth information to manage health problems [15, 16]. This scale consists of eight items rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and is structured into three dimensions: application ability (AB), decision-making ability (DMB), and judgment ability (JA). The total score ranges from 8 to 40, with a higher score indicating greater perceived eHealth literacy. Previous studies have demonstrated the reliability and validity of the eHEALS when used with older patients with cancer and older adults visiting medical clinics [17]. This study employed a modified Chinese version of the eHEALS [18]. The Cronbach's α coefficient of the Chinese version of the scale was 0.913 [16].

The hospital anxiety and depression scale

The Hospital Anxiety and Depression Scale (HADS) was designed by Zigmond and Snaith in 1983 as a screening instrument for anxiety and depression in hospitals [19, 20]. This scale comprises 14 items with multiple-choice questions, which are equally divided into two subscales: anxiety (HADS-A) and depression (HADS-D). The participants respond on a 4-point scale ranging from zero to three, and the total score ranges from 0 to 21. Scores of 0–7 are considered normal, scores of 8–14 indicate borderline anxiety, and scores of 15–21 indicate elevated levels of anxiety. HADS scores ≥8 indicate the presence of symptoms of anxiety and/or depression, although they do not provide an official diagnosis. Notably, scores >8 indicate a greater likelihood of developing anxiety or depressive disorders.

The social support self-rating scale

The Social Support Self-Rating Scale (SSRS) was developed by Xiao in 1994 to assess the type and level of social support [21]. It measures three dimensions of social relationships. The scale consists of 10 items divided into the following categories: (1) objective support, which reflects the actual support received by the patient (three items); (2) subjective support, which pertains to the emotional experience of being respected, supported, and understood (four items); and (3) the utilization of support, which focuses on the patient's use of distinct types of

social support, including confiding, asking for help, and participating in activities (three items). Subjective support and the utilization of support items are rated on a 4-point Likert scale. The assessment of objective support is based on the number of sources of social support. The total score ranges from 10 to 66, with higher scores indicating higher levels of social support.

The diabetes distress screening scale

The questionnaire used in this study was the Chinese version of the Diabetes Distress Screening Scale (DDS) [22, 23]. The validity and reliability of the translated version were confirmed in a separate study [24]. This scale consists of 17 questions divided into four domains: (1) Emotional Burden (EB), which consists of questions 1, 3, 8, 11, and 14 and assesses feelings of anger or the patient's fear of living with diabetes; (2) Interpersonal Distress (ID), which comprises questions 7, 13, and 17 and indicates the suffering experienced by patients due to a lack of understanding from friends or family; (3) Physician-related Distress (PD), which consists of questions 2, 4, 9, and 15 and indicates the patient's disappointment about not receiving consultation from a physician regarding treatment options; and (4) Regimen-related Distress (RD), which consists of questions 5, 6, 10, 12, and 16 and is linked to concerns about a lack of motivation for diabetes self-management.

Table 1 Demographic characteristics of the participants

Variable	*N*	%
Sex		
Male	161	61.9
Female	99	38.1
Age (years)		
18–30	46	17.7
31–45	111	42.7
46–60	103	39.6
Marital status		
Single	13	5
Married	185	71.2
Divorced	41	15.8
Widowed	15	5.8
Other	6	2.3
Education status		
Primary or no qualifications	95	36.5
Junior school and High school	129	49.6
Graduates and above	36	13.8
Years of DM		
< 5	182	70.1
5–10	51	19.6
> 10	27	10.3
Which range of blood glucose values does your most recent empty stomach blood glucose measurement fall under?		
4.4–6.1 mmol/L	61	23.5
6.2–7.0 mmol/L	107	41.2
> 7.0 mmol/L	63	24.2
Unclear	29	11.2
Which range of blood glucose values does your most recent post-meal blood glucose measurement fall under?		
4.4–8.0 mmol/L	53	20.4
8.1–10.0 mmol/L	109	41.9
> 10.0 mmol/L	62	23.8
Unclear	36	13.8
Which range does your most recent glycated hemoglobin value fall under?		
4.0–6.0%	86	33.1
6.1–6.9%	75	28.8
> 7.0%	64	24.6
Unclear	35	13.5

Abbreviations: *DM* diabetes mellitus

Statistical analysis

The data were analyzed via the IBM SPSS 24.0 and SPSS AMOS 24.0 (IBM Corp., Armonk, NY, USA) software packages. Categorical variables were assessed for frequency and percentage, whereas continuous variables were analyzed for the mean and standard deviation. Pearson's correlation analysis was performed to assess the relationships between variables. Structural equation modeling was conducted using AMOS 24.0 to test the mediation effects. Model fitness was evaluated using χ^2, χ^2/df, the goodness-of-fit index (GFI), the comparative fit index (CFI), the normed fit index (NFI), and the root mean square error of approximation (RMSEA). Additionally, the critical ratio (CR) and p value were employed. The SSRS and HADS mediation effects were tested using the bias-corrected nonparametric percentile bootstrap method with 5,000 bootstrap iterations.

Ethical approval

This study was approved by the Institutional Review Board of Nantong Second People's Hospital (approval number 2022 - 039). One of the researchers approached potential participants and provided a comprehensive explanation of the study's objectives and procedures.

Results

Sociodemographic characteristics

This study included 260 participants under the age of 60. Most participants were within the 31- to 45-year age group, and a significant proportion were married (71.2%). Among the participants, 61.9% (N= 161) were men, whereas 38.1% (N= 99) were women. Detailed demographic characteristics and blood glucose and glycated hemoglobin values are presented in Table 1.

Main variable (dependent or outcome) results

Our correlation analysis revealed that the eHEALS score was negatively correlated with anxiety (r =

Table 2 Mean scores and correlation matrix of main study variables ($n = 289$)

	MD	SD	eHEALS	SSRS	HADA	HADS	DDS
Application ability (AB)	15.52	3.982	0.916**	0.334**	−0.369**	−0.364**	−0.359**
Judgment ability (JA)	6.3	2.146	0.739**	0.221**	−0.339**	−0.320**	−0.311**
Decision-making ability (DMB)	3.57	1.252	0.623**	0.222**	−0.202**	−0.208**	−0.238**
eHEALS	25.38	6.01	1	0.346**	−0.408**	−0.399**	−0.398**
Subjective support	16.069	2.1352	0.250**	0.833**	−0.247**	−0.272**	−0.313**
Objective support	11.45	1.7601	0.258**	0.750**	−0.253**	−0.286**	−0.330**
Utilization of support	7.3	2.1709	0.317**	0.802**	−0.331**	−0.336**	−0.431**
SSRS	34.819	4.8373	0.346**	1	−0.350**	−0.375**	−0.452**
HAD-A	6.27	3.629	−0.408**	−0.350**	1	0.879**	0.465**
HAD-D	7.22	3.662	−0.294**	−0.310**	0.548**	0.881**	0.388**
Emotional burden (EB)	17.85	6.27	−0.296**	−0.337**	0.408**	0.397**	0.914**
Physician-related distress (PD)	14.55	5.421	−0.426**	−0.452**	0.435**	0.472**	0.902**
Regimen-related distress (RD)	15.4	4.265	−0.235**	−0.377**	0.334**	0.344**	0.727**
Interpersonal distress (ID)	10.92	4.068	−0.423**	−0.404**	0.417**	0.458**	0.880**
DDS	58.72	17.293	−0.398**	−0.452**	0.465**	0.485**	1

Abbreviations: *DDS* diabetes distress screening scale, *eHEALS* eHealth Literacy Scale, *HAD-A* Hospital Anxiety and Depression Scale-anxiety, *HAD-D* Hospital Anxiety and Depression Scale-depression, *SSSR* social support self-rating scale, *SD* Standard Deviation

**$p < 0.01$

Table 3 Model fitting results of the mediation effects

Fit index	χ^2/df	RMSEA	GIF	AGFI	NFI	CFI	TLI	IFI
Judgment criteria	< 3.00	< 0.08	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9
Analysis results	1.974	0.061	0.945	0.911	0.928	0.963	0.949	0.963

Abbreviations: *AGFI* adjusted goodness-of-fit index, *CFI* comparative fit index, *GFI* goodness-of-fit index, *IFI* incremental fit index, *NFI* normed fit index, *RMSEA* root mean square error of approximation, *TLI* Tucker-Lewis index

−0.408, $p < 0.01$), depression ($r = -0.294$, $p < 0.01$), and DDS ($r = -0.398$, $p < 0.01$). Conversely, the eHEALS score was positively correlated with SSRS ($r = 0.346$, $p < 0.01$) (Table 2).

Results for other variables (covariates)

Table 3 presents the results of the mediating effect analyses. The model fit indices were χ^2/df = 1.974, RMSEA = 0.061, GFI = 0.945, AGIF = 0.911, NFI = 0.928, CFI = 0.96, TLI = 0.949, and IFI = 0.963. These data indicate a good fit of the structural equation model.

The results of the significance tests for the mediation effects are displayed in Fig. 1. In the path of eHEALS →SSRS→DDS, the confidence interval (−0.260 to −0.045) did not include 0, indicating a mediating effect of SSRS between eHEALS and DDS with a magnitude of −0.139. Similarly, in the path of eHEALS →HADS→DDS, the confidence interval (−0.278 to −0.050) did not include 0, indicating a mediating effect of HADS between eHEALS and DDS with a magnitude of −0.138. In the path of eHEALS →SSRS→HADS→DDS, the confidence interval (−0.128 to −0.016) did not include 0, suggesting a chain mediation effect of SSRS and HADS between eHEALS and DDS with a magnitude of −0.052 (Table 4).

Discussion

The primary aim of this study was to deepen our understanding of the relationships among eHealth literacy, social support, psychological well-being, and diabetes distress among individuals under the age of 60 who are living with type 2 diabetes. Our results suggest that eHealth literacy plays a crucial role in diabetes-related distress and that social support and psychological well-being act as mediators. These findings contribute to our understanding of the complex interplay of factors that influence diabetes distress, particularly in the context of modern health care delivery where eHealth tools are increasingly utilized.

Meaning of the findings in the context of earlier studies

Our results align with several key studies in the literature that emphasize the importance of self-management in diabetes care. Specifically, previous studies have shown that individuals with higher levels of eHealth literacy tend to have better self-management practices, which in turn can lead to lower levels of diabetes distress [25]. Our study extends these findings by highlighting not only the direct relationship between eHealth literacy and diabetes distress but also the mediating role of social support and psychological well-being.

The mediation effects we found provide novel insights into the mechanisms underlying the impact of eHealth

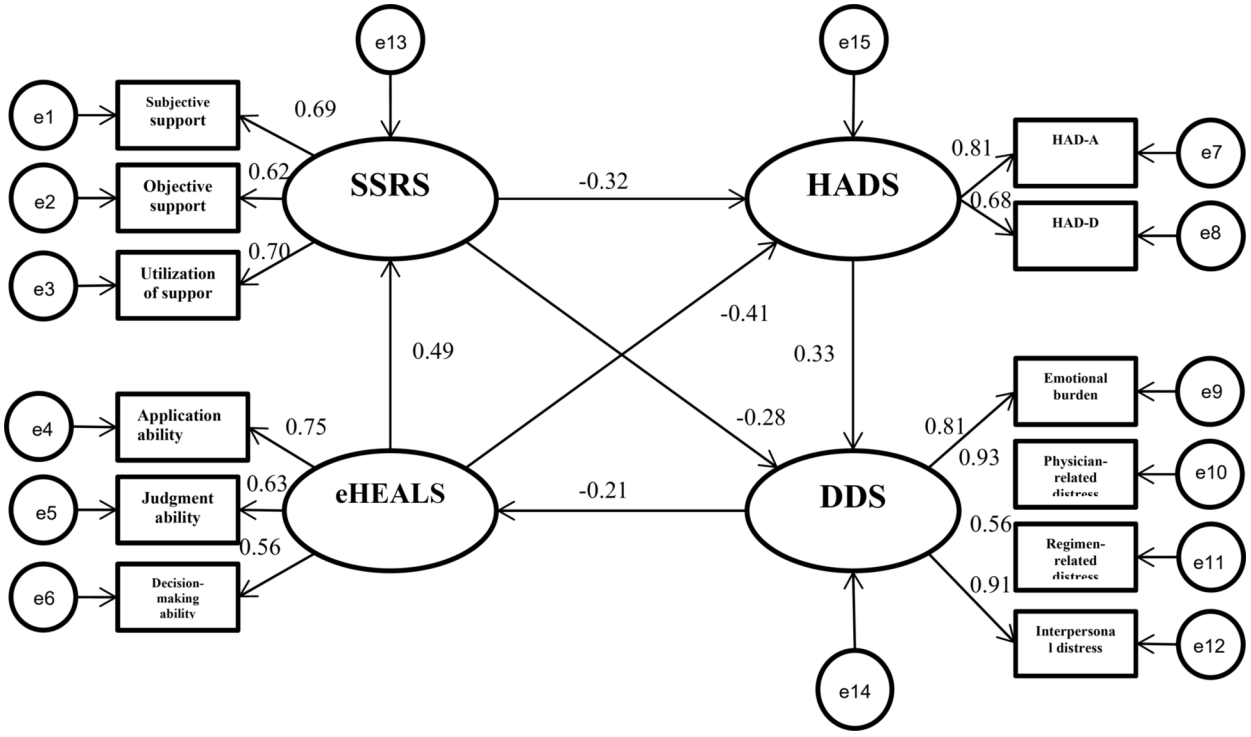

Fig. 1 Intermediary model diagram displaying results of the significance tests for mediation effects

Table 4 Test of mediating effects

Intermediary path	Intermediary effect	Bias-corrected 95% CI	
		Lower	Upper
ehealth→SSRS→DDS	− 0.139	− 0.260	−0.045
ehealth→HADS→DDS	− 0.138	− 0.278	−0.050
ehealth→SSRS→HADS→DDS	− 0.052	− 0.128	−0.050

literacy on diabetes distress. In particular, we observed that higher levels of eHealth literacy are associated with better social support (as measured by SSRS), which, in turn, reduces distress. This finding is consistent with the work of Salomé et al. [26], who argued that strong social networks can buffer the psychological impact of chronic conditions, including diabetes. Our study adds depth by demonstrating that this relationship is not merely additive but rather is synergistic, suggesting that individuals with higher eHealth literacy are more likely to seek and benefit from social support, which mitigates distress.

Furthermore, we found that psychological distress, particularly anxiety and depression, plays a critical role in mediating the relationship between eHealth literacy and diabetes distress. This finding resonates with earlier work by Shiu et al. [27], who demonstrated that psychological well-being is a crucial determinant of health outcomes in individuals with chronic illness. Our study reinforces this finding by showing that improving psychological well-being through increased eHealth literacy and social support can significantly alleviate distress. Notably, this study is one of the first to examine these psychosocial mechanisms in the context of diabetes distress and highlights the importance of addressing both emotional and informational needs in the care of patients with diabetes.

Practical implications

The implications of these findings for health care professionals and policy-makers are profound. Given the growing reliance on digital health tools, improving eHealth literacy should become a priority among diabetes management strategies. This can be achieved through educational programs that focus on improving patients' ability to navigate digital health resources effectively, which can foster greater engagement with their health and reduce distress. Our findings also underscore the importance of social support in diabetes care. Health care interventions that strengthen family or peer support networks in addition to digital health education can offer a holistic approach to managing diabetes distress.

As noted in earlier studies, psychological well-being is not only an important factor in diabetes management but also a modifiable target. The incorporation of mental health support, such as counseling or cognitive

behavioral therapy, can significantly reduce the burden of distress and improve self-management outcomes. This is particularly pertinent in the context of individuals under the age of 60 who have type 2 diabetes and who are often still active in family and work roles. The impact of diabetes on their daily functioning can be substantial, and addressing both their psychological needs and their informational needs can enhance their quality of life.

Limitations and future directions

While this study provides important insights, there are several limitations that must be considered. First, the cross-sectional design limits the ability to establish causal relationships. Longitudinal studies would be valuable to examine the directionality and long-term effects of eHealth literacy on diabetes distress, social support, and psychological well-being. Moreover, our sample consisted primarily of individuals who were homogeneous in terms of race, ethnicity, and socioeconomic status. Future research should explore more diverse populations to determine whether the findings are generalizable across different cultural and demographic groups.

Another limitation is the reliance on self-reported data, which may be subject to biases, including social desirability and recall bias. The use of more objective measures, such as clinical assessments of psychological distress or social support, would strengthen the validity of the findings. Additionally, exploring the role of technology more directly by assessing patients' actual usage of digital health tools could provide a more nuanced understanding of how eHealth literacy translates into real-world outcomes.

Conclusion

This study highlights the importance of eHealth literacy, social support, and psychological well-being for managing diabetes distress. Our findings contribute to the growing body of literature that underscores the need for integrated approaches to managing diabetes by addressing both informational and emotional needs. The study also indicates the potential for eHealth interventions to not only improve self-management but also provide a pathway to reduce distress through increased social support and psychological care. Future research should aim to validate these findings longitudinally in more diverse populations to further strengthen the evidence for eHealth-based interventions in diabetes care.

Authors' contributions

The contributions of the authors are as follows: HC was responsible for the methodology, QL for the methodological design, HC and BS for the software development, LY and BS for the formal analysis, HC, BW, YL, and JB for data curation, and LY, HC, and BS for writing (original draft preparation). All authors have read and agreed to the published version of this manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This study involved research on human participants and was conducted in accordance with the Declaration of Helsinki and with the approval of the Ethics Committee of the Nantong Second People's Hospital (Ethics Approval Number: 2022-039). The authors confirm that all research methods were carried out in accordance with the relevant guidelines and regulations. Informed consent was obtained from all participants and/or their legal guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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