



OPEN Association between eHealth literacy and anxiety and depression in Chinese patients scheduled for combined orthodontic and orthognathic treatment

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To investigate the level of eHealth literacy among patients scheduled for combined orthodontic and orthognathic treatment, and to explore its association with anxiety and depression, providing a basis for clinical interventions. A cross-sectional study was conducted with a final sample of 111 patients. Questionnaires including the eHealth Literacy Scale (eHEALS), Generalized Anxiety Disorder-7 (GAD-7), and Patient Health Questionnaire-9 (PHQ-9) were administered to patients scheduled for combined orthodontic and orthognathic treatment at a tertiary stomatological hospital from June 2023 to April 2025. The mean eHealth literacy score among patients was 25.76 ± 5.46 . The incidence rates for anxiety and depression symptoms were 16.2% and 13.5%, respectively. Logistic regression analysis revealed that lower per capita annual household income was significantly associated with an increased risk of anxiety (OR = 9.16, 95% CI [2.30–36.52], $p = 0.002$) and depression symptoms (OR = 8.83, 95% CI [1.08–72.46], $p = 0.042$). Additionally, eHealth literacy scores were negatively correlated with anxiety (OR = 0.82, 95% CI [0.73–0.93], $p < 0.001$) and depression symptoms (OR = 0.64, 95% CI [0.47–0.86], $p = 0.003$). Our findings demonstrate that patients scheduled for combined orthodontic and orthognathic treatment experience significant psychological distress, with lower-income individuals exhibiting more severe symptoms. Better eHealth literacy appears to reduce emotional issues. These findings indicate that healthcare providers should assess patients' ehealth literacy before treatment and focus on low-income patients.

Keywords Combined orthodontic and orthognathic treatment, eHealth literacy, Anxiety, Depression

Combined orthodontic and orthognathic treatment, a collaboration between oral surgery and orthodontics, is crucial for correcting facial asymmetry and malocclusion while enhancing aesthetics^{1,2}. This complex, lengthy process (2–3 years) involves coordinated orthodontic and surgical methods, posing certain risks and requiring patient patience and resilience^{3,4}. Prior to undergoing combined orthodontic and orthognathic treatment, patients often experience significant symptoms of anxiety and depression⁵. These negative emotions are primarily attributed to concerns regarding surgical risks, postoperative pain, recovery processes, treatment outcomes, and potential complications^{6–9}. Additionally, apprehensions about the impact on social and professional life further exacerbate this multifaceted psychological distress⁴.

Patients scheduled for combined orthodontic and orthognathic treatment represent a distinct population characterized by a prolonged history of concerns regarding facial appearance. These individuals have a strong need for information and often browse extensively on social media prior to pursuing professional intervention^{10,11}. They experience a complex interplay of anticipation and apprehension regarding the prospect of altering their appearance, which frequently results in protracted deliberations and decision-making challenges during the treatment planning phase. Additionally, their tendency to excessively gather online information can adversely affect their psychological state. Such conditions may contribute to delays in treatment decisions, diminished compliance during procedures, and suboptimal postoperative recovery^{12,13}. Furthermore, these psychological

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factors can complicate doctor-patient communication and elevate the risk of medical disputes^{14,15}. Chinese patients experience heightened psychological distress due to cultural pressures emphasizing appearance and commercially driven “appearance anxiety.”¹⁶ This is worsened by online misinformation and insufficient medical education^{17,18}, highlighting the need for pretreatment psychological assessment and intervention.

eHealth literacy is the ability to find, understand, assess, and use health information from digital sources to make informed health decisions. Introduced by Norman and Skinner in 2006¹⁹, eHealth literacy encompasses six key competencies: traditional health literacy, information literacy, scientific literacy, media literacy, computer literacy, and cultural literacy. The framework emphasizes that eHealth literacy is not a singular skill but rather a composite of multiple competencies, which collectively influence an individual's effectiveness in accessing and applying health information in the digital age^{20,21}.

eHealth literacy affects an individual's ability to access, understand, and assess health information, impacting disease management and health outcomes^{22–24}. In China, communication barriers between physicians and patients arise from information asymmetry²⁵ and patients' limited health information skills²⁶, compounded by digital divide issues²⁷. These challenges impede accurate understanding of treatment information. Improving eHealth literacy can help patients better grasp their medical conditions and treatment, reducing misinformation conflicts and enhancing treatment adherence, leading to more effective patient-physician interactions^{28,29}. Thus, examining eHealth literacy and its psychological effects on patients scheduled for combined orthodontic and orthognathic treatment is crucial.

While many studies have explored the link between eHealth literacy and psychological status, few have specifically examined this relationship in patients scheduled for combined orthodontic and orthognathic treatment^{30,31}. This cross-sectional study seeks to clarify the connection between eHealth literacy levels and anxiety/depression symptoms in these patients, offering insights and targeted strategies for psychological assessment during initial clinical consultations.

Methods

Participants

We surveyed 111 patients scheduled for combined orthodontic and orthognathic treatment at a tertiary stomatology hospital from June 2023 to April 2025. Inclusion criteria were a diagnosis requiring the combined treatment and consent to the plan. Exclusion criteria included any prior orthodontic or orthognathic treatment history.

Procedures

The ethics committee of Nanjing Stomatological Hospital approved the study (NJSH-2023NL-015). After confirming the need for combined orthodontic and orthognathic treatment and obtaining patient consent, we secured written informed consent before distributing the questionnaires. All methods were performed in accordance with the relevant guidelines and regulations.

Instruments

Demographic variables were: age (years), gender (male = 0, female = 1), education (associate degree or below = 0, bachelor's or higher = 1, where ‘associate degree or below’ encompasses all educational backgrounds from no formal education to associate degree, and ‘bachelor's or higher’ includes undergraduate and postgraduate degrees), annual household income per capita (below \$10,800 = 0, \$10,800 or more = 1), occupation (employed, student, unemployed; with “employed” as the reference), and marital status (married = 1, others = 0).

The eHealth literacy scale (eHEALS)¹⁹ was utilized to evaluate the eHealth literacy levels of patients. This instrument comprises eight items and employs a 5-point Likert scale, where 1 corresponds to “strongly disagree” and 5 to “strongly agree,” yielding total scores between 8 and 40. Higher scores reflect a greater proficiency in eHealth literacy. The scale has consistently shown good internal consistency and has established reliability and validity in numerous studies^{32,33}.

Anxiety symptoms were assessed using the Generalized Anxiety Disorder-7 (GAD-7) questionnaire³⁴. Scores range from 0 to 21, with a cutoff score of ≥ 7 indicating clinically significant anxiety symptoms^{34,35}. This scale has demonstrated excellent reliability and validity in diverse populations^{36–39}.

Depressive symptoms were screened using the Patient Health Questionnaire-9 (PHQ-9)⁴⁰. Total scores range from 0 to 27, and a cutoff score of ≥ 8 was used to indicate clinically significant symptoms for this study^{40,41}. This threshold was selected to optimize the balance between sensitivity and specificity and to focus on identifying cases most likely to require clinical intervention^{41,42}. The PHQ-9 is a well-validated tool with established reliability and validity^{31,37,42}.

Statistical analysis

Statistical analyses were performed with SPSS 26.0. Continuous variables were shown as mean $\pm$ SD, and categorical variables as frequencies (percentages). The GAD-7 score was split into two groups using a cutoff of 7, and the PHQ-9 score was split using a cutoff of 8. Univariate analyses used χ^2 tests, t-tests for normally distributed data, and Mann–Whitney U tests for non-normally distributed data. The normality of continuous data was assessed using the Shapiro–Wilk test. The link between e-health literacy and anxiety/depression was assessed with univariate logistic regression. Confounders like age and gender were controlled using stepwise binary logistic regression, with results given as adjusted odds ratios (aORs) and 95% confidence intervals (CIs). A *p*-value < 0.05 was deemed significant.

Results
Characteristics of demographic data and scale scores

A total of 111 participants were included in this study, with a mean age of 23.86 years (SD = 3.46), ranging from 18 to 34 years. The sample comprised 42 males (37.8%) and 69 females (62.2%). Educational attainment varied, with 24 individuals (21.6%) possessing a college degree or lower, and 87 individuals (78.4%) holding a bachelor's degree or higher. Additional demographic and clinical information is presented in Table 1. The eHEALS score for patients scheduled for combined orthodontic and orthognathic treatment was 25.76 (SD = 5.46). The mean anxiety scale score was 2.86 (SD = 3.81), with 18 participants (16.2%) exhibiting anxiety symptoms (GAD-7 score ≥ 7). The mean depression scale score was 3.32 (SD = 4.67), with 15 participants (13.5%) showing depressive symptoms (PHQ-9 score ≥ 8).

Univariate analysis of anxiety and depressive symptoms

Chi-square tests indicated a significant association between being a student or unemployed and increased prevalence rates of both anxiety ($p=0.020$) and depressive symptoms ($p<0.001$). A significant association was also observed for lower annual household income per capita with both anxiety ($p=0.001$) and depressive symptoms ($p=0.009$) (Table 2). Furthermore, univariate logistic regression analysis revealed that higher eHealth literacy scores were significantly associated with lower odds of anxiety symptoms (OR = 0.84, $p=0.002$) and depressive symptoms (OR = 0.65, $p<0.001$) (Table 3).

Factors associated with anxiety and depressive symptoms using binary logistic regression analysis

Binary logistic regression analysis revealed that: (1) a lower annual household income per capita was significantly correlated with an increased risk of both anxiety symptoms (OR = 9.16, 95% CI [2.30–36.52], $p=0.002$) and depressive symptoms (OR = 8.83, 95% CI [1.08–72.46], $p=0.042$); (2) higher eHealth literacy scores were associated with protective effects against anxiety (OR = 0.82, 95% CI [0.73–0.93], $p=0.001$) and depression (OR = 0.64, 95% CI [0.47–0.86], $p=0.003$) (Table 4.).

Discussion

This study constitutes the inaugural systematic examination of eHealth literacy and its correlations with anxiety and depression symptoms, in patients scheduled for combined orthodontic and orthognathic treatment. The principal findings are as follows: (1) eHealth literacy levels, as measured by the eHEALS score (25.76 ± 5.46), were significantly lower than the population norms (26.81 ± 5.83 , $p=0.045$)⁴³; (2) Employing cutoff scores of ≥ 7 for the Generalized Anxiety Disorder-7 (GAD-7) and ≥ 8 for the Patient Health Questionnaire-9 (PHQ-9), the prevalence rates of anxiety and depressive symptoms were determined to be 16.2% and 13.5%, respectively. In contrast, a psychological survey conducted on general orthodontic patients prior to treatment reported higher prevalence rates of 17.51% for anxiety and 17.71% for depression⁴⁴, utilizing lower cutoff scores (≥ 5) on the same assessment scales. The higher cutoff thresholds chosen for our study (GAD-7 ≥ 7, PHQ-9 ≥ 8) were justified by the following considerations: (a) These thresholds provide an improved balance between sensitivity and specificity, thereby enhancing the detection of clinically significant symptoms; (b) The elevated screening thresholds are intended to concentrate on cases that genuinely necessitate clinical intervention, thereby

Sociodemographic characteristics	
$\bar{x} \pm s$	
n(%)	
Age	23.86 ± 3.45
Gender	
Male	42(37.8)
Female	69(62.2)
Education	
Junior high school and below	24(21.6)
High school and above	87(78.4)
Occupation	
Employed	48(43.3)
Students	45(40.5)
Unemployed	18(16.2)
Annual household income per capita	
< \$10,900	54(48.6)
≥ \$10,900	57(51.4)
Marital status	
Unmarried	99(89.2)
Married	12(10.8)

Table 1. Sociodemographic characteristics in the whole sample.

Sociodemographic factors	Anxiety symptoms				Depressive symptoms			
	No	Yes	χ^2/Z	<i>P</i>	No	Yes	χ^2/Z	<i>P</i>
Gender			0.185	0.667			0.034	0.853
Male	36	6			36	6		
Female	57	12			60	9		
Education			1.739	0.187			3.457	0.063
Junior high school and below	18	6			18	6		
High school and above	75	12			78	9		
Occupation			7.865	0.020			28.004	<0.001
Employed	45	3			48	0		
Students	36	9			39	6		
Unemployed	12	6			9	9		
Annual household income per capita			10.346	0.001			6.824	0.009
< \$10,900	39	15			42	12		
≥ \$10,900	54	3			54	3		
Marital status			0.764	0.382			1.519	0.218
Unmarried	84	15			87	12		
Married	9	3			9	3		
			<i>t</i>	<i>P</i>			<i>t</i>	<i>P</i>
Age	24.00 ± 3.692	23.17 ± 1.724	0.935	0.352	23.91 ± 3.645	23.60 ± 1.920	0.318	0.751

Table 2. Sociodemographic factors associated with the depressive and anxiety symptoms of participants.

Dependent variable	Associated factors	OR	95% CI	Sig
Anxiety syptoms	eHEALS	0.84	0.75–0.94	0.002
Depression syptoms	eHEALS	0.65	0.52–0.81	<0.001

Table 3. Association of eHealth literacy scores with anxiety and depression symptoms: univariate logistic regression.

Dependent variable	Associated factors	Reference group	Compare group	OR	95% CI	Sig
Anxiety syptoms	Annual household income per capita	≥ \$10,900	< \$10,900	9.16	2.30–36.52	0.002
	eHEALS			0.82	0.73–0.93	0.001
Depression syptoms	Annual household income per capita	≥ \$10,900	< \$10,900	8.83	1.08–72.46	0.042
	eHEALS			0.64	0.47–0.86	0.003

Table 4. Association of sociodemographic factors and eHealth literacy with anxiety and depressive symptoms: logistic regression analysis.

mitigating the risk of over-medicalization of transient emotional fluctuations. It is plausible that, had uniform cutoff scores been applied, our prevalence rates might have surpassed those observed in the general orthodontic patient population.; and (3) binary logistic regression analysis revealed that lower household income was significantly associated with increased anxiety symptoms (OR=9.16) and depression symptoms (OR=8.83), whereas higher eHealth literacy was found to exert a protective effect against anxiety symptoms (OR=0.82) and depression symptoms (OR=0.64).

Among various demographic factors, lower income has been significantly associated with increased prevalence rates of both anxiety and depression symptoms. These findings are consistent with numerous domestic and international studies^{45,46}. The considerable out-of-pocket expenses for combined orthodontic and orthognathic treatment, which are currently not covered by medical insurance in China, place a direct financial burden on low-income individuals, exacerbating their decision-making stress. From a psychosocial perspective, economic pressures may negatively impact patients’ mental health through several pathways, including: (1) limited access to high-quality healthcare resources⁴⁷, (2) increased risk of treatment discontinuation due to financial vulnerability, which exacerbates psychological distress through prognostic uncertainty^{48,49}. Compared to their higher-income counterparts, low-income patients often lack sufficient social support networks to alleviate these stressors^{50,51}. These findings highlight the necessity for clinicians to prioritize psychological assessments for economically disadvantaged patients and to incorporate financial considerations, such as installment payment options, into treatment planning.

The findings indicate a significant negative correlation between eHealth literacy and the prevalence of anxiety and depressive symptoms. This protective relationship was quantified by univariate logistic regression, which showed that each one-unit increase in the eHEALS score was associated with 18% lower odds of anxiety symptoms (OR=0.82, 95% CI [0.73, 0.93]) and 36% lower odds of depressive symptoms (OR=0.64, 95% CI [0.47, 0.86]). The robustness of this inverse association was further supported by a series of sensitivity analyses. Varying the cutoff values for defining clinically significant anxiety (GAD-7) and depression (PHQ-9)—ranging from lower thresholds (e.g., ≥ 5) to the conventional standard (≥ 10)—did not alter the statistical significance of the relationship between eHealth literacy and psychological symptoms. This consistency confirms that the protective role of eHealth literacy is evident across different levels of symptom severity and is not an artifact of a specific diagnostic threshold. This suggests that eHealth literacy may function as a crucial psychological protective factor. This observation aligns with previous research³². Patients with higher levels of eHealth literacy are likely to benefit in several ways: (1) they possess an enhanced ability to access treatment information from authoritative sources, thereby reducing concerns related to uncertainty^{52,53}; (2) they demonstrate improved comprehension of treatment protocols and anticipated outcomes, which minimizes anxiety stemming from misinformation⁵⁴; and (3) they exhibit greater proficiency in utilizing digital health resources, such as teleconsultation platforms, for timely professional support²⁸. In the current information-rich digital healthcare landscape, eHealth literacy is particularly important in enabling patients to discern misleading commercial advertisements⁵⁵ and establish realistic treatment expectations⁵⁶. These findings underscore significant clinical implications. Integrating routine eHealth literacy assessment into preoperative psychological screening protocols can help identify patients at high risk for anxiety and depression. For those with low eHealth literacy, implementing targeted interventions—such as digital skill-building workshops, curated reliable online resource lists, and mediated navigation support—could empower patients to better access, understand, and evaluate health information. Such tailored education may not only alleviate preoperative psychological distress but also enhance postoperative compliance and recovery, ultimately fostering better doctor-patient communication and reducing potential conflicts.

While this study offers valuable insights into the relationship between eHealth literacy and psychological symptoms in patients undergoing orthognathic surgery, several limitations must be acknowledged. First, the cross-sectional design limits the ability to draw causal inferences, highlighting the need for longitudinal studies to explore how dynamic changes in eHealth literacy affect anxiety and depression symptoms throughout the treatment process. Second, the sampling strategy may introduce potential biases. The single-center design, confined to a tertiary hospital which typically treats more complex cases, may limit the generalizability of our findings to regions with diverse socioeconomic characteristics or different healthcare settings and may not be fully representative of all patients in general community settings. Third, the reliance on self-reported questionnaires for assessing eHealth literacy, anxiety, and depression may introduce potential response bias, such as social desirability bias or recall bias, which could have influenced the accuracy of the measurements. Fourth, the modest sample size ($n=111$) may limit the statistical power of the analyses, particularly for investigating subgroups or rarer outcomes. Future research should employ multicenter designs and incorporate qualitative methods to gain a deeper understanding of patients' eHealth literacy profiles and psychological distress. Despite these limitations, our findings provide a crucial foundation for developing targeted interventions aimed at enhancing both eHealth literacy competencies and mental health outcomes in this population.

Conclusions

This pioneering study is the first to systematically examine eHealth literacy and its links to anxiety and depression symptoms in Chinese patients scheduled for orthodontic and orthognathic treatment. This study identified higher eHealth literacy as a significant protective factor against anxiety and depressive symptoms, while lower annual household income per capita was associated with a higher risk of these psychological conditions in patients scheduled for orthodontic and orthognathic treatment. These findings underscore the dual importance of addressing socioeconomic disparities and promoting digital health competencies to safeguard mental well-being in this clinical population. Therefore, developing targeted interventions to enhance eHealth literacy is essential, with particular attention to patients from economically disadvantaged backgrounds. Healthcare providers should consider routine assessment of both socioeconomic factors and eHealth skills during treatment planning. Future research should employ longitudinal designs to confirm the causal relationships identified in this study. Furthermore, interventional studies are strongly warranted to develop and evaluate the effectiveness of tailored digital literacy training programs and structured educational modules specifically designed for orthodontic and orthognathic patients. Such initiatives could provide evidence-based strategies to enhance eHealth literacy and ultimately improve psychological outcomes in this clinical population.

Data availability

Data supporting this study are available from the corresponding author (Dr. Hongyuan Dai, dai.hongyuan@outlook.com) upon reasonable request.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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