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ORIGINAL RESEARCH

Assessing Medication Literacy and Its Determinants in Chinese Patients with Multimorbidity

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Purpose: To investigate the medication literacy and influencing factors among patients with multimorbidity.

Methods: A cross-sectional survey was conducted to assess medication literacy using the medication literacy scale in patients with multimorbidity. Data were collected between June 20 and August 31, 2023, using stratified and quota sampling methods. The Wilcoxon tests or Kruskal–Wallis tests, Pearson's correlation analysis, and multiple stepwise linear regression were employed for the analysis.

Results: 3,955 patients with multimorbidity were included, with the average medication literacy score of 18.56±4.52 (scale range: 6–30). Younger age groups (18–30, 31–44, 45–59 years) had higher medication literacy than those aged 60 years or older (β = 0.11, 0.14, 0.17 respectively; all P <0.01). Higher education levels (middle/secondary degree, college/university degree, postgraduate degree) correlated with higher medication literacy compared to primary or lower education (β =0.21, 0.28, 0.13 respectively; all P <0.01). Currently married (β =0.09, P <0.01), unmarried (β =0.15, P < 0.01), and divorced individuals (β =0.06, P < 0.01) all exhibited higher medication literacy compared to widowed individuals. Compared with people living in Eastern China, those in Central/Western China (β =–0.06, –0.07, respectively; all P <0.01) had lower medication literacy. People whose area was urban (β =0.07, P <0.01) showed higher medication literacy compared with the rural. A higher score of depressive symptoms (β =–0.20, P <0.01) was negatively correlated with medication literacy, and a higher level of social support (β = 0.17, P <0.01) was positively correlated with medication literacy.

Conclusion: It is critically important to improve medication literacy in patients with multimorbidity, particularly by optimizing medication instructions for understanding. Tailored interventions targeting older, less educated, rural, and central/western populations with emphasis on depression management and social support are needed.

Study Registration: ChiCTR2300072573.

Keywords: multimorbidity, medication literacy, status, influencing factor

Introduction

Multimorbidity has emerged as one of the greatest challenges for healthcare services worldwide.[1] The multimorbidity was usually defined as the coexistence of two or more chronic health conditions in an individual.[1] Previous studies have shown that the overall global prevalence of multimorbidity was 37.2%, with more than half of the population above 60 years of age experiencing multimorbidity[2] around the world.

As medication is the focus of disease management and prognosis, patients with multimorbidity might have a high potential for polypharmacy,[3,4] defined as the use of multiple medicines,[5] which ultimately increases the risk of drug-drug interactions[6] and inappropriate use of medicines, as well as the economic burden[7] and risk of death for patients.[8] Concurrently, medication literacy varies considerably among individuals and critically influences their decision-making.[9] Related to health literacy within the medication context, medication literacy encompasses the ability to acquire, understand,

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communicate, calculate, and process medication information to make informed decisions for safe and effective medication use.[10,11] This is often operationalized as the capacity to understand package inserts and follow pharmacy labels.[9]

Studies have shown that the medication literacy of patients with chronic diseases is highly associated with their medication adherence and medication safety.[12,13] Therefore, improving the level of medication literacy is essential to enhance the quality of life and clinical outcomes for patients with multimorbidity. Notably, patients primarily seek medication information from expert sources (healthcare professionals), followed by lay sources (family/friends), valuing digital sources less than interpersonal ones.[14] And tailored interventions towards a more patient-centered approach are also very important.[15]

Previous studies have explored the medication literacy in several chronic diseases, such as hypertension and diabetes, which showed the medication literacy of people with chronic diseases was poor.[16,17] Compared to people living with a single chronic health condition, people with multimorbidity would face more complex issues due to a greater probability of polypharmacy.[4] Although several studies have illustrated the medication literacy in older people with multimorbidity,[18,19] research exploring the current status of medication literacy and its associated factors[20–23] including demographics, social support, and depression levels among patients with multimorbidity in China using a domestic multi-center sample is still lacking.

Therefore, our study aimed to explore the status and influencing factors of medication literacy in patients with multimorbidity, in order to provide evidence for developing more targeted interventions to improve medication literacy among patients with multimorbidity.

Materials and Methods

Data Source and Study Populations

The current study used the data from Psychology and Behavior Investigation of Chinese Residents (PBICR)[24] conducted between June 20 and August 31, 2023. This study employed a multi-stage sampling approach. In the first stage, all provincial capital cities were included (Despite extensive coordination, we have been unable to obtain relevant statistical data in Taiwan Province of China), supplemented by 2–12 additional prefecture-level cities selected per province/autonomous region through convenience sampling weighted by provincial population size, resulting in 150 cities (each province included its capital). During the second stage, communities were sampled from these 150 cities based on the population size of their district-level administrative divisions, maintaining a 3:2 urban-to-rural community ratio per province to yield 800 communities. For the third stage, quota sampling of residents was conducted within communities using the 2021 "7th National Census" as a reference, balancing gender, age, and enforcing urban-rural residency quotas. To conduct the survey, the questionnaires were distributed face-to-face by trained surveyors. Supervisors conducted quality control during the distribution process and returned questionnaires, logically checked and cleaned them for data analysis. The cover page of the questionnaire will explicitly outline the study's objectives and ensure the preservation of anonymity, confidentiality, and the participants' right to decline participation.

The inclusion criteria of the survey: 1) people aged $\geq$18 years old; 2) people with the nationality of the People's Republic of China; 3) China's permanent population (migration time $\leq$1 month within one year; 4) people who volunteer to participate in the study with the informed consent form; 5) people who complete the questionnaire independently or with the help of the investigator; 6) people who understand the meaning of each item in the questionnaire. The exclusion criteria: 1) having mental impairment or disability; 2) having cognitive impairment; 3) participation in other similar research projects; and 4) unwillingness to cooperate. 45,830 participants were included in our study after logical checks. Of 45,830 participants, those who were outside mainland China for the past 3 months or did not complete the key scale of our study were excluded.

Definition of Multimorbidity

In this study, patients were included by self-reporting through the item "Have you been diagnosed by your doctor with any of the following chronic diseases". Patients with multimorbidity were defined as those with two or more chronic diseases.

Outcome Variables

Medication Literacy

The medication literacy scale used in this study[25] contains 6 items. These 6 items could be categorized into 3 dimensions: functional medication literacy, communicative medication literacy, and critical medication literacy, with each dimension containing 2 entries. These three dimensions can be used to assess different aspects of medication literacy including understanding the medication's instructions, having a way to find and understand the information, and critically analyzing whether the information is appropriate for their context.[11,26] Functional medication literacy includes two reverse-scored items: whether one finds it too difficult to read medication instructions, and whether one needs a long time to understand such content. Communicative medication literacy includes two items: when you are about to take or are taking a certain medication and do not have a good understanding of the relevant knowledge about it, whether you can obtain the medication information you need and whether you can understand the medication information you have obtained. Critical medication literacy includes two items: when you are about to take or are taking a certain medication and have relevant knowledge about it, whether you will consider the credibility of such medication information and whether you collect information to better make decisions related to medication use. Each item is scored on a 5-point Likert scale. The scale score ranges from 6 to 30 points, and each dimension ranges from 2 to 10 points. The Cronbach's α coefficient for the medication literacy scale was 0.7682, indicating good internal consistency of these measures. CFA fit indices (CFI = 0.996, RMSEA = 0.040, SRMR = 0.012) supported the 3-dimensional structure.

Patient Health Questionnaire-9 (PHQ-9)

In this study, depressive symptom in patients with multimorbidity was assessed by PHQ-9.[27] The PHQ-9 contains nine items, each of which is rated on a 4-point scale of 0, 1, 2, and 3. Less than or equal to 4 is no depression; 5–9 is possible mild depression; 10–14 is possible moderate depression; 15–19 is possible moderately severe depression; and greater than or equal to 20 is possible severe depression. The Cronbach's α coefficient for the PHQ-9 was 0.9104, indicating good internal consistency of these measures.

Short Version of the Perceived Social Support Scale (PSSS-SF)

The level of social support for patients with multimorbidity was assessed by using PSSS-SF,[28] which includes three dimensions: family, friends, and other social support, and is scored on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree). The total score of each dimension reflects the extent to which the individual feels social support in different dimensions, and the higher the score, the higher the level of social support felt by the individual. The Cronbach's α coefficients for the PSSS-SF were 0.8607, indicating good internal consistency of these measures.

Statistical Analysis

Descriptive statistics were performed for sociodemographic characteristics, depression, social support and medication literacy among patients with multimorbidity. For categorical data, the frequencies (percentages) were reported, and mean (SD) values were reported for continuous variables. Wilcoxon rank-sum tests (for 2 categories) or Kruskal–Wallis tests (for multiple categories) were used to compare the differences in medication literacy due to non-normality among patients with multimorbidity with different demographic characteristics, including age, gender, region, degree level, area and marital status. Pearson's correlation analysis was used to explore the correlation between medication literacy, depression and social support. Multiple stepwise linear regression was used to explore the influencing factors of

medication literacy, with standardized regression coefficients (β) used to explore the potential associations. This study was analyzed using Stata 17.0, with a statistical difference of $P < 0.05$.

Results

Participant Characteristics

The demographic characteristics of the participants are summarized in Table 1. A total of 3,955 individuals with multimorbidity were included in this study. The mean age was 57.17 ± 16.45 years, with females accounting for 47.13%. Among the participants, 1,576 (39.85%) were from Western China, 1,690 (42.73%) from Eastern China, and 689 (17.42%) from Central China. Regarding educational attainment, 1,626 (41.11%) had a middle/secondary school education, 1,220 (30.85%) had a primary or lower education level, 954 (24.12%) had a college or university degree, and 155 (3.92%) had completed postgraduate studies. In terms of area, 1,694 (42.83%) lived in rural areas while 2,261 (57.17%) resided in urban areas. Marital status distribution was as follows: 2,737 (69.20%) were currently married and living with a spouse, 594 (15.02%) were unmarried, 467 (11.81%) were widowed, and 157 (3.97%) were divorced.

The health conditions of participants with multimorbidity are depicted in Figure 1. Hypertension was the most common diagnosis, affecting 2,536 (64.12%) participants, followed by diabetes in 1,341 (33.91%) participants, osteoporosis in 1,267 (32.04%), hyperlipidemia in 1,233 (31.18%), and arthritis in 1,212 (30.64%). Other conditions included coronary heart disease (768, 19.42%), chronic digestive diseases (495, 12.52%), chronic respiratory diseases (478, 12.09%), stroke (272, 6.88%), chronic urinary system diseases (260, 6.57%), and cancer (120, 3.03%).

Table 1 Demographics of the Study Participants with Multimorbidity

Characteristics	Total Participants (N = 3,955)
Age, years	
Mean (SD)	57.17(16.45)
Age group, n (%)	
≥60	1,942(49.10)
45-59	1,162(29.38)
31-44	502(12.69)
18-30	349(8.82)
Gender, n (%)	
Female	1,864(47.13)
Male	2,091(52.87)
Region, n (%)	
Eastern China	1,690(42.73)
Central China	689(17.42)
Western China	1,576(39.85)
Degree level, n (%)	
None/ Primary	1,220(30.85)
Middle/ Secondary	1,626(41.11)
College/University	954(24.12)
Postgraduate	155(3.92)
Area, n (%)	
Rural	1,694(42.83)
Urban	2,261(57.17)
Marital status	
Widowed	467(11.81)
Currently married	2,737(69.20)
Unmarried	594(15.02)
Divorced	157(3.97)

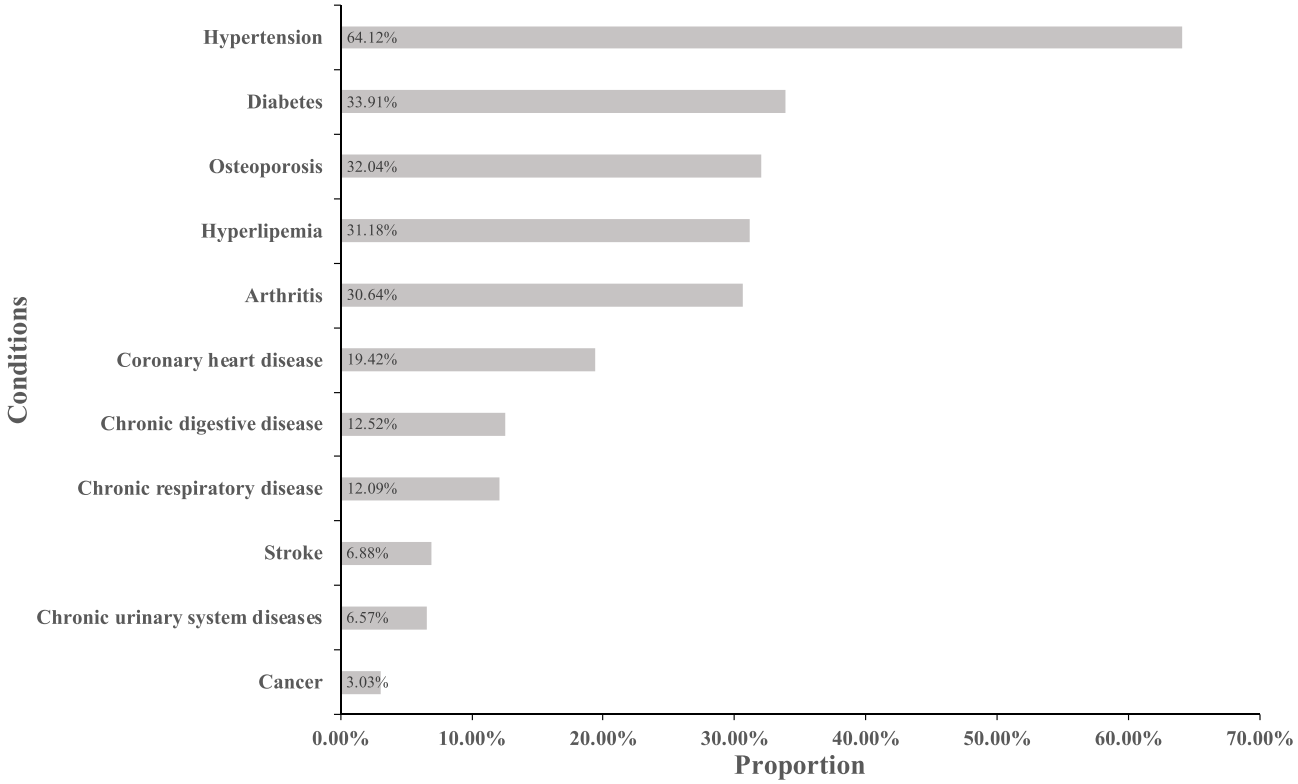

Figure 1 The conditions of participants with multimorbidity included in the study.

Characteristics of Measures

Table 2 presents the characteristics of three measures included in our study. The mean medication literacy score was 18.56, ranging from 6 to 30. And the mean scores for functional, communicative, and critical medication literacy were 5.40, 6.28 and 6.89, respectively. The mean score for depressive symptoms, measured by the PHQ-9 and ranging from 0 to 27, was 7.62, indicating possible mild depression among the participants. The mean score for social support, assessed by the PSSS-SF with a range of 3 to 21, was 14.50.

Table 2 Descriptive Statistics of the Variables Among Patients with Multimorbidity

Variables	Range	Mean	SD
Medication literacy			
Functional medication literacy	2-10	5.40	2.15
Communicative medication literacy	2-10	6.28	2.07
Critical medication literacy	2-10	6.89	1.90
Total score	6-30	18.56	4.52
PHQ-9			
Depression	0-27	7.62	5.74
PSSS-SF			
Social support	3-21	14.50	4.13

Notes: Functional Medication Literacy: Represents the ability to understand and follow medication instructions; Communicative Medication Literacy: Represents the ability to find medication information and communicate effectively about medication use; Critical Medication Literacy: Represents the ability to critically analyze and evaluate medication information.

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Factors Influencing Medication Literacy Among Patients with Multimorbidity

As shown in Table 3, participants differed significantly in medication literacy levels based on age, gender, region, educational background, residential area, and marital status ($P<0.01$). Specifically, patients with multimorbidity who were older, female, widowed, had a lower level of education, and lived in Western China or rural areas exhibited lower medication literacy levels.

The correlations among medication literacy, depressive symptoms, and social support are presented in Table 4. Medication literacy was negatively correlated with depressive symptoms and positively correlated with social support levels in patients with multimorbidity ($P<0.01$).

Multiple Regression Analysis of Influential Factors of Medication Literacy

Table 5 displays the outcomes of the linear regression analysis. Age, degree level, marital status, region, area, depressive symptoms, and social support of patients with multimorbidity were identified as influencing factors for medication literacy through multiple stepwise linear regression.

Table 3 Differences in Medication Literacy Across Demographic Characteristics

Variable	Medication Literacy Mean (SD)	Medication Literacy Median (IQR)	Z/H	*P*
Age, years			338.47	*P* < 0.01
≥60	17.22 (4.40)	18(14–20)		
45-59	19.65 (4.17)	20(17–23)		
31-44	20.01 (4.39)	20(17–23)		
18-30	20.34 (4.28)	21(17–24)		
Gender			−5.17	*P* < 0.01
Male	18.92 (4.38)	19(16–22)		
Female	18.16 (4.64)	18(15–22)		
Region			61.02	*P* < 0.01
Eastern China	19.19 (4.45)	19(16–23)		
Central China	18.27 (4.49)	18(15–21)		
Western China	18.02 (4.53)	18(15–21)		
Degree level			453.80	*P* <0.01
None/ Primary	16.33 (4.47)	16(13–19)		
Middle/ Secondary	19.01 (4.08)	19(16–22)		
College/University	20.40 (4.24)	20(18–24)		
Postgraduate	20.14(3.90)	20(18–22)		
Area			−10.42	*P* < 0.01
Urban	19.24 (4.40)	19(16–22)		
Rural	17.67 (4.53)	18(14–21)		
Marital status			186.77	*P* < 0.01
Widowed	16.20 (4.48)	16(13–19)		
Currently married	18.63 (4.51)	18(16–22)		
Unmarried	19.99 (4.01)	20(18–23)		
Divorced	19.08 (4.02)	19(16–22)		

Notes: 1. For multigroup comparisons (eg, age, region, degree level, marital status), the Kruskal–Wallis test was used (reported as H values). For two-group comparisons (eg, gender, area), the Wilcoxon rank-sum test was applied (reported as Z values). These nonparametric tests were chosen due to the distribution characteristics of medication literacy data. 2. $P < 0.01$ indicates statistical significance based on a two-tailed test.

Table 4 Correlation Among Medication Literacy, Depression and Social Support for Participants

Variables	Medication Literacy	Depression	Social Support
Medication literacy	1		
Depression	−0.13**	1	
Social Support	0.14**	−0.28**	1

Notes: **$P < 0.01$.

Table 5 Multiple Regression Analysis of Influential Factors for Medication Literacy

Variables	β	SE	*P*
Age group (reference: ≥60), y			
45-59	0.17	0.16	*P* < 0.01
31-44	0.14	0.22	*P* < 0.01
18-30	0.11	0.30	*P* < 0.01
Degree level (reference: None/Primary)			
Middle/ Secondary	0.21	0.16	*P* < 0.01
College/University	0.28	0.20	*P* < 0.01
Postgraduate	0.13	0.36	*P* < 0.01
Marital status (reference: Widowed)			
Currently married	0.09	0.21	*P* < 0.01
Unmarried	0.15	0.30	*P* < 0.01
Divorced	0.06	0.37	*P* < 0.01
Region (reference: Eastern China)			
Central China	–0.06	0.18	*P* < 0.01
Western China	–0.07	0.14	*P* < 0.01
Area (reference: Rural)			
Urban	0.07	0.13	*P* < 0.01
Depression	–0.20	0.01	*P* < 0.01
Social Support	0.17	0.02	*P* < 0.01

Abbreviation: SE standard error, β Standardized coefficient.

Compared with people aged 60 years or older, middle-aged older people (aged 45–59 years; β = 0.17, $P < 0.01$), middle-aged younger people (aged 31–44 years; β = 0.14, $P < 0.01$), and young people (aged 18–30 years; β = 0.11, $P < 0.01$) had higher level of medication literacy. Those who had a middle/ secondary degree (β = 0.21, $P < 0.01$), college/university degree (β = 0.28, $P < 0.01$) and postgraduate degree (β = 0.13, $P< 0.01$) had a higher level of medication literacy compared with people with a primary or lower degree. Those currently married (β = 0.09, $P < 0.01$), unmarried individuals (β = 0.15, $P < 0.01$), and divorced individuals (β = 0.06, $P < 0.01$) all had higher medication literacy levels than widowed individuals. In contrast to populations living in Eastern China, those living in Central China (β =–0.06, $P < 0.01$) and Western China (β =–0.07, $P < 0.01$) had a lower level of medication literacy. In addition, people whose area were urban (β = 0.07, $P < 0.01$) showed a significantly higher level of medication literacy compared with the rural. A higher score of depressive symptoms (β =–0.20, $P < 0.01$) was negatively correlated with medication literacy and a higher level of social support (β = 0.17, $P < 0.01$) was positively correlated with medication literacy.

Discussion

With the transition from chronic disease management to multimorbidity management, the importance of medication treatment for patients with multiple health conditions becomes increasingly significant.[29,30] An increase in the number of diseases is often associated with an increase in the types of medications prescribed, which in turn increases the risk of medication-related complications and decreases medication adherence.[31] Consequently, there is an urgent need to strengthen the understanding of medication use and improve medication adherence to medication regimens among patients with multimorbidity. This study, as the domestic and foreign investigation of medication literacy among patients with multimorbidity with a large and representative sample in China, not only discussed the current situation of medication literacy among patients with multimorbidity but also offered new insights and evidence for further intervention strategies through the analysis of influencing factors.

Consistent with previous researches,[32–35] our study demonstrated that the most common conditions in patients with multimorbidity were cardiovascular diseases, including hypertension, diabetes, hyperlipemia and so on. However, the

results of our study showed that the medication literacy is low, which showed similarity to previous findings,[36,37] indicating we should take effective measures to construct interventions on medication literacy.

Furthermore, our study illustrated that critical medication literacy demonstrated the highest proficiency among the three dimensions, whereas functional medication literacy scored lowest, which is consistent with the previous research.[38] This pattern may be explained by overly technical terminology in medication instructions. While patients exhibit competence in critically analyzing medication information, they encounter significant difficulties comprehending basic usage guidelines. This finding indicates that the easy-to-understand medication instructions are of great significance.

Our study also demonstrated that medication literacy levels among patients with multimorbidity are significantly influenced by demographic factors such as age, educational attainment, and marital status. In addition, although the Wilcoxon tests showed there was a significant gender difference among patients with multimorbidity, the stepwise logistic regression controlling for confounders found no significant effect of gender, which is consistent with previous study,[36] indicating that the initial difference was likely due to other factors. Notably, individuals with lower educational backgrounds tend to exhibit reduced medication literacy, which is likely attributable to limited reading comprehension and cognitive processing skills. This finding underscores the critical need for tailored medication education initiatives and efforts aimed at improving medication literacy among this population segment.[39] It is worth noting, however, that our analysis revealed an unexpected result where the β coefficient for the postgraduate group is lower than for middle/secondary and college/university education, which might be influenced by factors such as the relatively smaller sample size in the postgraduate subgroup, or the influence of unmeasured variables that modulate the relationship between advanced education and medication management skills, which warrants further investigation. Moreover, diminished medication literacy is particularly prevalent in older adults, a trend that can be explained by age-related physiological and cognitive changes including declines in cognitive function, sensory impairments such as reduced visual and auditory acuity, as well as impaired learning capacity and memory retention.[40,41] Additionally, our results indicate that widowed patients are especially vulnerable to lower medication literacy, potentially due to an accelerated decline in cognitive function associated with bereavement status.[42] Taken together, these findings emphasize the importance of prioritizing targeted medication education and literacy programs, particularly focusing on older adults, individuals with lower educational levels, and widowed patients.

Furthermore, our study revealed that individuals living in Eastern China demonstrated significantly higher levels of medication literacy compared to those in Central and Western regions. This geographical disparity is paralleled by the significant difference observed between urban and rural populations, with urban residents exhibiting greater medication literacy than those living in rural areas. These findings likely reflect the substantial disparities in the quality of healthcare services, disease management strategies, and health promotion efforts across different regions and between urban and rural settings in China. Previous research has documented these inequalities, highlighting gaps in healthcare access, resource allocation, and educational outreach that disproportionately affect rural and less developed areas.[43–45] Collectively, these disparities highlight the urgent need for targeted and comprehensive interventions aimed at narrowing regional and urban-rural gaps. Addressing these inequalities is critical not only for enhancing medication literacy but also for promoting equitable health outcomes and advancing public health initiatives on a broader scale.

This study identified a significant negative association between depressive symptoms and medication literacy among patients with multimorbidity, which aligns with prior research findings. Depressive symptoms may impair cognitive functions such as attention, memory, and information processing, thereby hindering patients' ability to comprehend and manage their medication regimens effectively.[46] Additionally, patients experiencing depressive states might exhibit reduced motivation and confidence towards self-management, ultimately decreasing their engagement with medication-related education. These findings emphasize the importance of assessing and addressing mental health conditions in clinical practice to enhance medication literacy and overall treatment adherence. Furthermore, the positive correlation observed between social support levels and medication literacy reinforces the critical role that social networks play in patient care.[20,21] Support from family, friends, and community resources not only provides practical assistance, such as medication reminders and healthcare navigation, but also offers emotional encouragement, which can increase patients' confidence and willingness to actively participate in treatment. Collectively, these results suggest that comprehensive interventions focusing on both psychological well-being and social support systems are necessary to improve medication literacy, especially among patients managing multiple chronic conditions.

Our study also has some strengths. While existing studies have made substantial progress in developing health literacy promotion strategies for multimorbidity populations, our investigation advances this field by systematically deconstructing the multidimensional determinants of medication literacy. The identification of modifiable factors (eg, educational disparities, geographical inequities, and psychosocial mediators) provides a novel evidence base for constructing personalized intervention frameworks. It not only describes the current status of medication literacy in this population but also provides new insights and evidence for intervention strategies through analyzing influencing factors, with clear clinical relevance.

This findings reveals that there is an urgent need for tailored, multifaceted interventions: these include developing simplified medication guides specifically designed for elderly individuals and those with lower educational attainment; integrating depression screening into routine healthcare services to address the interplay between mental health and medication management; implementing family support programs targeted at widowed individuals to strengthen their medication adherence and monitoring; prioritizing region-specific health education initiatives in Central and Western China to mitigate regional disparities; rolling out rural-focused outreach programs to improve access to medication-related information in underserved rural areas; and enhancing community-based social support systems to create a more enabling environment for proper medication use. Furthermore, the digital health revolution presents unprecedented opportunities, such as the potential for artificial intelligence (AI)-driven solutions to overcome traditional barriers through adaptive learning systems.[47] Future interventions should explore synergistic models combining human-centered care with AI-driven tools to create scalable, precision-oriented solutions for multimorbidity management.

The study has several limitations. Firstly, the study data were self-reported by the questionnaire participants and might introduce the possibility of recall bias during the information-gathering process. Additionally, the cross-sectional design of the study restricts our ability to conclude causality. Furthermore, despite efforts to balance regional and demographic representation by multi-stage sampling, convenience and quota sampling may restrict generalizability, particularly for understudied subgroups. In addition, the factors such as the number of comorbidities, types of chronic conditions, and number of routine medications, as these factors could indeed influence medication literacy, which is not included in our study, and future studies should aim to explore these variables in more detail to better understand their associations with medication literacy. Lastly, the exclusion of patients with mental disorders or disabilities from our study sample constrains the generalizability of our findings. Future research should explore including these populations to provide a more comprehensive understanding of medication literacy.

Conclusions

In conclusion, our study reveals a critical need to improve medication literacy in patients with multimorbidity, particularly by simplifying medication instructions and enhancing patients' ability to understand and adhere to them. Given the identified determinants including age, education, marital status, region, area, depression, and social support, we recommend developing tailored interventions aligned with these factors.

Data Sharing Statement

All data are available upon request to the corresponding author, Yibo Wu.

Ethics Approval and Informed Consent

This study strictly complies with the ethical principles outlined in the Declaration of Helsinki. The research protocol obtained ethical approval from the Ethics Research Committee of Shandong Provincial Hospital (SWYX:NO.2023-198) on May 5, 2023, and is registered in the Chinese Clinical Trial Registry (registration number ChiCTR2300072573) on June 16, 2023. Informed consent was obtained from all participants.

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

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