Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

# The Patient Persona of Health Information Literacy in Patients with Cardiometabolic Multimorbidity: A Qualitative Study

**Guodong Xu**
the 960th Hospital of the People's Liberation Army Joint Logistics Support Force
**xiaoyan liu**
Shandong Corps Hospital of the Chinese People's Armed Police Forces
**wensi dong**
Jinan Rongjun Youfu Hospital
**haiping wang**
Jinzhou Medical University
**yanhong hui**
283968690@qq.com

the 960th Hospital of the People's Liberation Army Joint Logistics Support Force

**Research Article**

**Keywords:** Cardiometabolic multimorbidity, Health information literacy, Heterogeneity, User persona, Qualitative study

**Posted Date:** July 27th, 2026

**DOI:** https://doi.org/10.21203/rs.3.rs-10403921/v1

**License:** This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

**Additional Declarations:** No competing interests reported.

# Abstract

**Background** Cardiometabolic multimorbidity (CMM), defined as the coexistence of two or more cardiometabolic diseases (e.g., diabetes, heart disease, stroke), poses a major public health challenge globally and in China. It is associated with declined quality of life and increased healthcare utilization. Health information literacy (HIL) is essential for effective self-management of CMM, while patients exhibit significant heterogeneity in HIL-related needs and capabilities. Standardized interventions often fail to address such individual diversity. The persona approach serves as a promising strategy to depict diverse patient characteristics and deliver tailored support.

**Objective** To explore the multidimensional characteristics of HIL among patients with CMM, and to construct representative user personas so as to guide the development of personalized health information interventions.

**Methods** A descriptive qualitative study was conducted in a tertiary hospital in Shandong Province, China, from March to September 2025. Purposive sampling was adopted to recruit patients with CMM. Semi-structured interviews were carried out covering five HIL dimensions of CMM patients: disease knowledge, health beliefs, health behavior management, health risk perception, and health information competence. Content analysis was used to extract factual labels and construct the dimensional model. Patient personas were developed by categorizing participants based on the above dimensions, and labeled personas were adopted to visualize their health information literacy profiles. The personas were visualized by combining word clouds and statistical tables.

**Results** A total of 23 eligible patients with CMM were enrolled in this study. Four distinct patient personas were identified and developed, highlighting the heterogeneous health information literacy (HIL) among patients with CMM. These personas were categorized as follows: Information-Dependent Passive Care Recipients, Cognition-Compromised Biased Self-Regulators, Planning-Oriented Autonomous Precision Managers, and Experience-Deficient Anxious Health Seekers.

**Conclusion** Significant group differences exist in the level of health information literacy among CMM patients. Targeted and personalized interventions can be implemented according to patient personas. Future management systems can be developed based on user personas to improve the efficiency and precision of nursing care.


# 1. Introduction

Accelerating population aging and shifting lifestyles have rendered multimorbidity a formidable threat to human health [1, 2]. Cardiometabolic multimorbidity (CMM), defined as the coexistence of two or three cardiovascular metabolic diseases (CMD) including diabetes mellitus, heart disease, stroke, and hypertension [3–5], represents the most prevalent and severe form of multimorbidity. Its association with diminished quality of life, increased healthcare utilization, and heightened risks of disability and mortality has established CMM as a critical global public health challenge [6–9]. Epidemiological studies indicate that CMM prevalence in China ranges from 5.94% to 16.9%, with the condition increasingly affecting younger populations, thereby

exerting a substantial burden on patients' families and societal healthcare systems [10, 11]. Compared to single chronic conditions, CMM patients exhibit more rapid disease progression and carry elevated risks of complications [12–14], which necessitates enhanced precision and systematic approaches in clinical management strategies.

Health information literacy, a foundational competency for chronic disease self-management, refers to an individual's capacity to acquire, process, evaluate, and apply health information to maintain and enhance well-being [15–17]. Research substantiates that health information literacy significantly influences individuals' understanding of health and disease, engagement in preventive healthcare services and treatment decision-making, as well as the efficacy of patient self-management practices [18–19]. Individuals possessing higher levels of health literacy demonstrate an enhanced ability to promote health through appropriate self-management behaviors [20–22]. Consequently, the level of health information literacy directly impacts treatment adherence, complication prevention and control efficacy, and overall quality of life in CMM patients. However, the health information needs of CMM patients exhibit marked diversity. Patients of different ages, educational backgrounds, disease combinations, and management experiences display considerable variation in their preferences for information acquisition channels, specific information content requirements, and capabilities in information application [23–26]. Adopting a uniform, standardized model for health information interventions may fail to address these individualized needs, thus limiting the effectiveness of such interventions.

Patient Persona, as a precision research tool for constructing group profiles through the integration of multidimensional data, refers to a virtual user information model developed via systematic analysis of target population characteristics [27]. Its standardized development framework encompasses four core phases: data collection, role tag extraction, persona construction, and persona representation [28]. This methodology systematically synthesizes multidimensional information—including demographic attributes, behavioral preferences, psychological profiles, social relationships, and environmental factors—to establish a comprehensive and visually distinct group characteristic model [29–30]. Within chronic disease health management, particularly in geriatric chronic care, this approach demonstrates substantial practical utility [31–32]. Notably, patient personas derived from qualitative research excel in capturing individuals' authentic lived experiences and contextualized needs. By crystallizing multidimensional attributes, these models ensure high fidelity to actual clinical scenarios and patients' lived realities, thereby furnishing robust foundational support for precision-targeted interventions [33–34].

## 2. Methods

## 2.1. Research design

This study employs a descriptive qualitative research design, focusing on patients with cardiometabolic multimorbidity (CMM) as the target population. Data collection was conducted through semi-structured in-depth interviews to systematically explore patients' health information literacy characteristics and needs. The research rigorously adhered to the Consolidated Criteria for Reporting Qualitative Studies (COREQ) guidelines [35]. The primary objective is to utilize patient persona methodology to integrate multidimensional

characteristics to develop prototypical patient personas, thereby establishing an empirical foundation for personalized health information interventions.

## 2.2 Research team

The research team comprises three nursing specialists, one clinical medical expert, and one Master of Nursing Science candidate. Responsibilities were allocated as follows: two nursing specialists were tasked with research design, refinement of interview protocols, and data interpretation; the clinical medical expert identified clinical priorities, ensured clinical validity throughout interviews and data analysis, and verified persona characteristic authenticity; one nursing specialist and the graduate student managed participant recruitment, interview conduction, and primary data organization. Prior to study initiation, all members underwent standardized training covering CMM pathophysiology, core constructs of health information literacy, qualitative interviewing techniques, and ethical protocols to ensure methodological rigor and procedural consistency. Discrepancies in data interpretation were resolved through iterative team deliberations to achieve consensus, thereby safeguarding research reliability.

## 2.3 Environment and Participants

From March to September 2025, semi-structured interviews were conducted with 23 cardiometabolic multimorbidity (CMM) patients recruited from a tertiary Grade A hospital in Shandong, China. Participants were selected through purposive sampling coupled with maximum variation strategy to ensure representativeness across age, gender, educational attainment, disease combinations, and disease duration. Inclusion criteria comprised: 1) Fulfillment of CMM diagnostic criteria [3–5], defined as concurrent diagnosis of two or three cardiovascular metabolic diseases (diabetes, heart disease, stroke, and hypertension) confirmed by hospital records with disease duration ≥ 3 months; 2) Age ≥ 18 years; 3) Possession of basic literacy and communication competencies sufficient to articulate health information acquisition and application experiences; 4) Voluntary participation with signed informed consent. Exclusion criteria included: 1) Severe cognitive impairment, psychiatric disorders, or communication barriers precluding meaningful interviews; 2) Comorbidities involving vital organ failure (e.g., severe hepatic/renal insufficiency) or active malignancies. Sample size determination adhered to the principle of thematic saturation. Recruitment concluded after thematic saturation was achieved—evidenced by three consecutive interviews yielding no novel themes—with supplementary validation through two additional interviews, finalizing the sample at 23 participants.

## 2.4 Data collection

The interview protocol was developed through a systematic scoping review and iterative team deliberations. Following critical appraisal and revision by three CMM nursing specialists and two qualitative methodologists, a preliminary protocol was pilot-tested with three eligible patients (data excluded from formal analysis). Subsequent refinements to question phrasing and logical sequencing were implemented based on feedback, culminating in the finalized protocol presented in Table 1.

Table 1
Interview Framework

| |
|---|
| 1. Could you describe your understanding of the etiology, daily management considerations, and therapeutic priorities for your condition(s)? How would you characterize your overall confidence in disease control and treatment efficacy? |
| 2. What is your perspective on the effectiveness of lifestyle interventions (e.g., healthful nutrition, structured exercise) for disease management? What factors primarily shape this perspective—clinical recommendations, personal experience, or observed outcomes in others? |
| 3. What specific self-management strategies do you implement regarding medication adherence, dietary modifications, and physical activity regimens? To what extent are these measures consistently maintained over time? |
| 4. Are you aware of potential complications associated with your diagnosed condition(s)? Have you adopted preventive measures to mitigate these health risks? |
| 5.Through which primary channels do you access disease-related health information? When confronted with information from diverse sources (e.g., clinical guidance, digital platforms, peer networks), how do you assess its relevance and applicability to your personal context? |
| 6.How effectively can you translate acquired health information into practical disease management? What implementation barriers have you encountered, and what tailored support mechanisms would address these challenges?" |

Data were collected through semi-structured interviews. Prior to each session, researchers detailed the study objectives, methodology, and significance to participants, securing informed consent with guaranteed confidentiality. Interviews were scheduled flexibly according to participant availability in private meeting rooms ensuring undisrupted environments. Two trained investigators conducted all sessions, maintaining durations of 30–60 minutes. Interviewers employed neutral facilitation techniques to elicit comprehensive responses, utilizing probing and paraphrasing to clarify ambiguities while systematically documenting paralinguistic cues and behavioral observations. Audio recordings commenced after formal consent procedures. To preserve anonymity, participants were assigned identifiers A1 through A23.

# 2.5 Data analysis

# 2.5.1 Establishment of the dimensions of the portrait tags

Data analysis was performed using NVivo 12 Plus software, implementing Colaizzi's seven-step phenomenological methodology [36]. This structured approach progressed from raw data collection through fact labeling to dimensional modeling. The analytical procedure comprised: (1) iterative immersion in interview transcripts to achieve comprehensive data familiarity; (2) extraction of health information literacy-relevant statements for open coding, generating empirical descriptors; (3) interpretive synthesis of descriptors' essential meanings into emergent thematic dimensions constituting the patient persona framework.

# 2.5.2 Patient profile construction

Leveraging established dimensional labels, investigator-driven characterization of individual role attributes was conducted through contextual interpretation guided by research expertise. Sequential procedures included: (1) Case-by-case profiling of participants' dimensional manifestations to construct individualized

multidimensional feature matrices; (2) Iterative refinement of preliminary models through participant validation cycles ensuring descriptor accuracy; (3) Multidisciplinary team deliberations clustering participants with comparable multidimensional profiles, distilling archetypal characteristics for each cohort to formalize finalized health information literacy personas for CMM patients. External validation was secured through independent assessment by three domain experts.

### 2.5.3 Portrait expression

Representative descriptors were extracted from each persona archetype, undergoing weighted synthesis based on frequency metrics and clinical significance. Digital visualization was achieved through WordArt-generated semantic clouds. Concurrently, structured matrices delineated dimension-specific manifestations across all core domains, ensuring dual-mode presentation that optimizes visual immediacy and operational utility.

## 2.6 Rigor of the Study

To ensure methodological rigor, all researchers received standardized training in qualitative research principles, interview protocol development, and facilitation techniques. Pre-interview procedures included comprehensive study briefings and establishment of therapeutic rapport with participants. Dual principal investigators conducted each session: one facilitating dialogue while the other systematically documented nonverbal cues, ensuring triangulated data capture. Objectivity was maintained throughout data collection and analysis. Within 24 hours post-interview, audio recordings and field notes underwent verbatim transcription with cross-verification to minimize recall bias and maximize transcript fidelity. Member checking was performed by returning transcripts to participants for validation. Ad hoc expert consultation resolved analytical ambiguities during data interpretation.

## 2.7 Ethical considerations

This study received formal approval from the Research Ethics Committee of the 960th Hospital of the People's Liberation Army (Approval No. : 2026-062), conducted in strict accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants.

# 3. Results

## 3.1. General characteristics of the participants

The study cohort comprised 23 cardiometabolic multimorbidity (CMM) patients (Table 2), with a gender distribution of 12 males and 11 females, aged 45–75 years. Demographic characteristics revealed 86.96% were married, 56.52% had attained secondary education, while concurrent proportions of 47.83% were observed for active employment status, disease duration exceeding 5 years, and diagnosis with three chronic conditions.

Table 2
General characteristics of the participants (n = 23).

| Variable | | Frequ(n)ency(n) | Percentage(%) |
|---|---|---|---|
| Age (year) | < 60 | 11 | 47.83 |
| | 60 ~ 70 | 9 | 39.13 |
| | > 70 | 3 | 13.04 |
| Gender | Man | 12 | 52.17 |
| | Woman | 11 | 47.83 |
| Educational level | Primary education | 3 | 13.04 |
| | Secondary education | 13 | 56.52 |
| | Higher education | 7 | 30.43 |
| Marital status | Married | 20 | 86.96 |
| | Divorced | 1 | 4.35 |
| | Widowed | 2 | 8.70 |
| Employment status | Employed | 11 | 47.83 |
| | Unemployed | 7 | 30.43 |
| | Retired | 5 | 21.74 |
| Duration of disease (year) | < 1 | 6 | 26.09 |
| | 2 ~ 5 | 6 | 26.09 |
| | > 5 | 11 | 47.83 |
| Number of chronic diseases | Two | 8 | 34.78 |
| | Three | 11 | 47.83 |
| | ≥Four | 4 | 17.39 |

## 3.2 The label dimensions of the user role for health information literacy of CMM patients

Analysis of interview data revealed that health information literacy among CMM patients manifests across five distinct dimensions: disease knowledge acquisition, perception of health beliefs, health behavior management, health risk management, and health information competencies.

## 3.3The user roles of health information literacy for CMM patients

Through analytical characterization of label attributes, four distinct patient personas were identified: Information-Dependent Passive Care Recipients Cognition-Compromised Biased Self-Regulators Planning-Oriented Autonomous Precision Managers Experience-Deficient Anxious Health Navigators. Semantic topology visualizations generated via WordArt graphically depicted characteristic lexicons for each archetype, while dimensional profiles were delineated in structured matrices as presented in Table 3.

## 3.3.1Persona 1: Information-Dependent Passive Care Recipients

This patient archetype predominantly comprises older adults aged 68–75 years, characterized by sustained familial caregiving support from spouses or adult children. Their health management exhibits complete reliance on clinical guidance, with limited autonomous decision-making capacity and insufficient awareness of synergistic cardiometabolic risks. Health information acquisition primarily occurs through conventional offline channels (e.g., follow-up consultations, telephone advisories), while demonstrating marked skepticism toward digital health platforms due to medication safety concerns regarding potential misinformation exposure.

**3.3.1.1 Disease knowledge mastery** Patients can only remember basic disease symptoms such as dizziness, polydipsia and chest tightness, as well as the names of commonly used medications including nifedipine and metformin. They have incomplete grasp of the comorbidity mechanism and key points for complication prevention of cardiometabolic diseases, and cannot distinguish the core prevention priorities of different diseases.

Patient A21: I know I need to take antihypertensive drugs for high blood pressure and inject insulin for diabetes, and chest tightness means there is something wrong with my heart. But I can’t understand professional terms like "insulin resistance" explained by doctors. I also don’t know what special precautions I need to take with these three illnesses together, nor can I tell which symptoms are warning signs of an acute attack.

Patient A11: I have high blood pressure and high blood lipids. The doctor told me to control my diet and exercise more, but I can’t remember exactly what foods I should avoid. I also don’t know if having both illnesses together will make my blood vessels fragile. All I know is to take my medicine on time and go to the hospital regularly.

Patient A19: Every time I go for a follow-up visit, the doctor tells me a lot of things to pay attention to. I don’t have much education and can’t remember them all. I only know I shouldn’t eat food that’s too salty or too sweet. As for how to prevent serious problems like stroke and myocardial infarction, I don’t know anything at all.

**3.3.1.2 Health belief perception** The patient absolutely recognizes the professional authority of medical staff, and their health confidence is entirely built on medical intervention. They have an extremely low sense of self-efficacy, regarding cardiometabolic diseases as intractable illnesses that can only be maintained by medical treatment. They hold the belief that personal efforts make no difference, and lack awareness of the impact of dietary control, exercise and other self-management behaviors on disease progression.

Patient A3: I have three illnesses: high blood pressure, diabetes and coronary heart disease. I rely entirely on doctors for treatment. It's no use trying to figure things out on my own. I take all the medicine the doctor prescribes and come for follow-up visits as advised. I don't need to worry about anything else.

Patient A14:I think heart disease can never be cured. It can only be kept under control with medication. It hardly makes any difference whether I take good care of myself or not. After all, it's just an old chronic illness. I'll just follow the doctor's advice.

Patient A7: I don't believe I can manage these two conditions — diabetes and coronary heart disease — on my own. These illnesses are far too serious. I can only rely on doctors, and nothing I do myself will make any difference.

**3.3.1.3 Health behavior management** The patient can passively follow medical advice to complete core behaviors such as medication taking and follow-up visits. However, the patient shows poor compliance in self-management behaviors including low-salt and low-fat diet, regular exercise, and self-monitoring of blood glucose, blood pressure and blood lipids. Besides, the patient is easily influenced by the lifestyle and habits of family caregivers.

Patient A3: I can take my medicine and go to the hospital for rechecks on time. But I find it too much trouble to check my blood sugar and blood pressure by myself. Besides, my spouse always cooks food that's too salty, and I feel awkward to say anything, so I just eat it as it is. The doctor told me to take a walk every day, but I rarely do it. I don't feel like exercising if no one keeps me company.

Patient A14: I can take my antihypertensive and lipid-lowering medicine on time, but I can't control my diet. I tend to eat more when I see food I like. I also don't know which foods affect my blood pressure and blood lipids. As for exercise, I only do it occasionally, off and on.

Patient A7: I know I need to keep my blood sugar under control, but my grandson is always eating sweets. I can't help having some too. I've never done any self-monitoring. I don't know how to use the devices, and I don't think it's necessary anyway. I just wait for my regular follow-up appointments, and the doctor will check me then.

**3.3.1.4 Health risk management** The patient has weak risk identification ability, unable to detect early warning signs of the deterioration of comorbidities in a timely manner. He lacks knowledge on emergency management of acute cardiovascular and cerebrovascular symptoms such as myocardial infarction and cerebral infarction, and relies entirely on family caregivers for emergency treatment.

Patient A21: Sometimes I feel numbness in my hands and feet. I thought it was just a normal sign of aging and didn't know it was related to diabetes and high blood pressure. Last time I suddenly had severe chest tightness and was very scared. My son immediately called 120 for help.

Patient A11: I once felt dizzy and fell down. I just thought I lost my balance. Later the doctor told me it might be a warning sign of blood vessel blockage caused by a sudden rise in blood pressure and excessively high blood lipids. I had no idea it was a dangerous signal back then. If I suddenly had a heart attack, I definitely wouldn't know what to do at all.

Patient A7: Sometimes my vision gets a bit blurry, but I didn't take it seriously. Later, I mentioned it to the doctor during a follow-up visit. The doctor said it might be eye fundus problems caused by diabetes, and warned that if I don't pay attention, it could lead to a stroke. I had no idea these were warning signs of my condition getting worse.

**3.3.1.5Health information literacy** The patient has a single channel for obtaining health information, mainly relying on verbal guidance from medical staff and printed health manuals issued by the hospital. The patient lacks the ability to screen and evaluate health information, cannot distinguish the authenticity of information from informal sources, and has a sense of fear toward online health information. Meanwhile, the patient shows weak ability in information application, failing to translate acquired health knowledge into specific self-management behaviors for multiple chronic conditions.

Patient A3:I only get health information from what the doctor tells me during consultations and the leaflets given out by the hospital. I can't understand those health articles people send me on WeChat, and I have no way to tell whether they are true or false, so I dare not trust them.

Patient A14:I never look up health information online for fear of being cheated. I just wait until my follow-up visits to ask the doctor. I write down what the doctor says, but sometimes I can't remember everything. Besides, I don't know how to put the advice into daily life. For example, when the doctor tells me to control total calorie intake, I have no idea how exactly I should adjust my diet.

Patient A19:I don't have much education and can't understand complicated health materials. I just hope doctors can tell me what to pay attention to in simple plain language. I know online claims that hypertension and diabetes can be completely cured are fake, but I can't tell whether other online health information is true or false.

## 3.3.2Persona 2: Cognition-Compromised Biased Self-Regulators

Patients in this group have a wide age range, mainly aged from 48 to 69 years old. Some of them are elderly living alone or empty-nest seniors with limited care support resources.They attach importance to the management of cardiometabolic diseases but hold biased health cognition. They are susceptible to non-official information sources such as sharing from relatives and friends, online short videos, and health product sales personnel.Problems including blind medication, over-reliance on health supplements, and neglect of collaborative management of multiple comorbidities are common. Although they are willing to actively acquire health information, they lack scientific methods for information screening and application.

**3.3.2.1 Disease knowledge mastery** Patients have fragmented disease-related knowledge, mostly acquiring scattered information hrough informal channels with obvious cognitive misunderstandings. They only have a superficial understanding of the combined hazards and preventive measures of cardiometabolic comorbidities, and cannot translate relevant knowledge into daily practice.

Patient A20: My neighbor told me that people with diabetes can't eat any carbohydrates at all, so now I don't even dare to eat rice. I also saw online videos saying that once you start taking antihypertensive medicine,

you can never stop it. Because of that, I occasionally skip my medicine secretly. I also have high blood lipids. Someone said a certain health supplement can lower lipids, so I bought a lot of it.

Patient A4: I have high blood pressure and am overweight. A friend told me that a certain traditional Chinese medicine can lower blood pressure and help lose weight at the same time, so I bought it to try. As for how to prevent heart problems caused by hypertension, I only know I should smoke less, but sometimes I just can't help it.

Patient A15: I watched short videos online saying celery can lower blood pressure and onions can reduce blood lipids, so I eat these two vegetables every day. I don't know any other dietary precautions at all. All I know about diabetes prevention is what I heard from other patients, and the information is messy and hard to remember clearly.

**3.3.2.2 Health belief perception** Patients have unstable health beliefs and are susceptible to the experience of others and informal health information. Their confidence in standardized medical treatment fluctuates obviously. They hold misconceptions such as believing folk remedies can cure serious diseases and that health supplements can replace prescription drugs. Some patients refuse to take regularly prescribed medications or adjust the dosage without medical advice out of concern about drug side effects.

Patient A2: Sometimes I think the medicine the doctor prescribes works well, but when I hear other patients say some folk remedy is effective, I want to give it a try. I'm always worried that taking antihypertensive and hypoglycemic medicine for a long time will hurt my liver and kidneys, so I want to use health supplements to replace part of my regular medication.

Patient A4: My confidence in treatment fluctuates a lot. I once heard a fellow patient say that a certain proprietary Chinese medicine kept his blood pressure and blood lipids well controlled, so I also wanted to buy it and have a try. I hardly believe Western medicine can control my condition in the long run, and I am always worried about its severe side effects.

Patient A10: I think folk remedies sometimes work better than medicines prescribed by doctors. One of my relatives kept his blood sugar under control with folk remedies, so I'm trying them too now. I only take the doctor's hypoglycemic medicine occasionally, worrying that taking too much will harm my health, and I don't have enough confidence in standard formal treatment.

**3.3.2.3 Health behavior management** Patients' health behaviors lack sustainability and scientific rationality. They tend to take excessive exercise blindly after believing false online claims that certain sports can cure hypertension, or go on unreasonable diets and avoid food excessively due to rumors that some foods cause cancer. Medication adherence is poor, with behaviors such as arbitrarily adjusting dosage, switching drugs without medical advice, and replacing regular medicines with health supplements. In addition, they ignore the collaborative management of multiple comorbid chronic diseases.

Patient A 4:I watched short videos saying running could cure hypertension, so I ran every day. After a week, I felt exhausted and gave it up. Later, I saw claims that pork causes cancer, so I stopped eating pork

completely. I take my medicine whenever I remember and skip it when I forget, and I often take health supplements instead of hypoglycemic drugs.

Patient A 15:I heard from other patients that a certain medicine works well for lowering blood lipids, so I replaced the medicine prescribed by the doctor on my own. As for diet, if I hear a certain food is good, I eat it every day; a few days later if I hear it is bad, I stop eating it at once. My exercise is very irregular. I only pay attention to my blood lipids and seldom care about my blood pressure.

Patient A 18: I was worried about the side effects of medicine, so I reduced the dosage on my own. I once heard that fasting can improve diabetes and obesity, so I went on a three-day fast and almost fainted. I only join square dance occasionally with no regular exercise routine.

**3.3.2.4 Health risk management** Patients have biased cognition towards the risks of cardiometabolic comorbidities, showing either excessive anxiety or complete neglect of potential risks. They lack the ability of risk prediction, fail to adjust management strategies according to their own comorbid conditions, and have insufficient awareness of the risks of cardiovascular and cerebrovascular complications.

Patient A 20: I check my blood pressure more than a dozen times every day. Whenever it is a little high once, I get extremely nervous and cannot sleep well at night. I clearly know obesity will worsen my hypertension and diabetes, but I just can’t control my diet or stick to exercise.

Patient A 10: I don’t worry at all about my diabetes and hyperlipidemia and think they are no big deal. I still smoke and drink as usual. But when I suddenly see online that these diseases may cause myocardial infarction and cerebral infarction, I become extremely anxious and don’t know what to do.

Patient A 2: I know I have high blood pressure and abnormal blood lipids, but I think I’m fine as long as I don’t feel any pain. I don’t pay attention to controlling my diet in daily life. However, whenever I feel dizzy, I’m terribly afraid of having a stroke and have no idea how to prevent it.

**3.3.2.5 Health information literacy** Patients obtain health information from multiple but fragmented and disordered channels, mainly including short video platforms, sharing from relatives and friends, and promotion introduction by health product sales personnel. They are weak in information screening and unable to distinguish authoritative medical information from false rumors. Their ability to understand and apply health information is insufficient. They tend to directly apply one-sided fragmented information to the management of comorbidities, resulting in biased health behaviors in diet, exercise and medication.

Patient A 2:I mainly get health information from short videos and health product salespeople, and I believe whatever they say. Last time the salesman said a certain product could lower blood pressure, blood sugar and blood lipids at the same time, so I spent thousands of yuan buying it, but it had no effect at all.

Patient A 20: I only get health information from relatives and friends, and I follow whatever they say works. I also read information online, but I cannot tell which is true. Last time I saw someone online recommend a certain medicine, I bought and took it by myself, which caused great fluctuations in my blood pressure and blood glucose.

Patient A 18: I watch a lot of health-related short videos every day and think everything they say makes sense. Sometimes different videos give conflicting opinions, and I don't know which one to believe, so I just pick one at random and follow it. Once a video said cutting staple foods can lower blood sugar, so I tried it and ended up with hypoglycemia.

## 3.3.3Persona 3:Planning-Oriented Autonomous Precision Managers:

Patients in this category are mostly aged 48 to 59 years old, with college education or above. They are mainly retired cadres, teachers and in-service personnel, having a sound economic foundation and learning ability. They have a strong awareness of self-management, take the initiative to participate in disease management decision-making, and fully recognize the synergistic harms of cardiometabolic comorbidities. They have a high-level demand for health information, are adept at obtaining and integrating information from various authoritative channels, and serve as the core decision-makers of family health management.

**3.3.3.1 Disease knowledge mastery** Patients in this group can systematically master the basic knowledge, treatment principles and key points of complication prevention related to their comorbidities. They take the initiative to learn the latest disease management strategies, understand the advantages and disadvantages of different treatment regimens, and accurately distinguish between core preventive measures and auxiliary preventive measures.

Patient A16: I have hypertension, diabetes and high blood lipids. I often read interpretations on authoritative medical WeChat official accounts, know that insulin resistance is the common root cause of these three diseases, and also understand the advantages and disadvantages of different antihypertensive, hypoglycemic and lipid-lowering drugs. The core prevention measures I master are controlling weight and eating a low-salt, low-fat and low-sugar diet.

Patient A5: I am a teacher and suffer from hypertension and coronary heart disease. I regularly read some journals to learn about the latest treatment progress, and I also know the key points for preventing complications of coronary heart disease combined with hypertension. I understand that taking medicine regularly and accurately controlling blood pressure are the core, and exercise is an auxiliary preventive measure.

Patient A22: I am a teacher, suffering from type 2 diabetes, dyslipidemia, obesity, hypertension and coronary heart disease. I pay attention to live broadcasts of academic conferences to learn the latest comorbidity management concepts, and regularly read relevant medical journals to understand the latest treatment progress. I know the mechanism of how obesity affects blood sugar and blood lipids, and can distinguish which preventive measures are key (such as controlling total calorie intake) and which are auxiliary (such as TCM conditioning). I also understand the key points for preventing complications of coronary heart disease combined with hypertension, and know that taking medicine regularly and accurately controlling blood pressure are the core, while exercise is an auxiliary preventive measure.

**3.3.3.2 Health Belief Perception** Patients have a high sense of self-efficacy, firmly believing that active and precise management can effectively delay the progression of comorbidities and reduce the risk of

complications. They regard health management as an important part of life. For the suggestions from medical staff, they adopt a rational attitude of "reference-integration-decision", neither blindly following nor arbitrarily denying them.

Patient A 16: I firmly believe that as long as I take the initiative to carry out precise management, I can control my hypertension, diabetes and dyslipidemia well. Health management is an integral part of my life. I will analyze the doctor’s suggestions in combination with my own situation. For example, the doctor advised me to exercise for 1 hour every day, and I adjusted it to 40 minutes of aerobic exercise according to my work schedule.

Patient A 5: I think active management is more important than passive treatment. I have integrated the management of hypertension and coronary heart disease into my daily life. I will dynamically adjust my management plan according to the doctor’s suggestions and my own physical condition.

Patient A 13: I am very confident in my comorbidity management. I know that active intervention can reduce the risk of myocardial infarction and cerebral infarction. I will communicate with doctors regularly, but I will determine the final management plan after integrating information from various sources.

**3.3.3.3 Health Behavior Management** The patient has strong standardization and good continuity in health behaviors. He can formulate personalized diet, exercise and monitoring plans according to his own comorbid conditions, and regularly evaluate the effect of behaviors and make adjustments.

Patient A22: I am a patient with hypertension, type 2 diabetes and dyslipidemia. I use a professional health APP to record my diet and exercise, regularly measure blood pressure, blood glucose and blood lipids, and adjust my diet and exercise plan according to the results.

Patient A9: I have hypertension and coronary heart disease. To better manage my condition, I have made a detailed dietary record form, focusing on recording the daily intake of sodium and fat to avoid excessive intake that may affect my health. For exercise, I mainly take brisk walks and swim, adhering to 5000 steps of brisk walking or 20 minutes of swimming every day. At the same time, I monitor my blood pressure twice a day, summarize the effect of chronic disease management once a month, and adjust my health management plan according to the actual situation to ensure stable condition control.

Patient A13: For my type 2 diabetes and obesity, I have formulated a personalized management plan: I precisely control the total daily calorie intake in my diet, take a 40-minute walk and 15-minute strength training every night, monitor my blood sugar every day, measure my weight once a week, and evaluate my blood lipids once a month. I adjust my diet and exercise intensity according to the monitoring results to ensure the stable control of my condition.

**3.3.3.4 Health Risk Management** The patient has strong abilities in risk identification and prediction. He can timely detect potential health risks through self-monitoring data, take the initiative to learn knowledge about early screening of complications, conduct regular targeted inspections, possess basic emergency response capabilities, and effectively deal with common sudden symptoms.

Patient A16: Through regular monitoring, I found that my blood glucose has fluctuated greatly recently. Combining my recent dietary situation, I judged that it may be caused by excessive carbohydrate intake, so I adjusted the intake in a timely manner. I also regularly conduct carotid artery ultrasound and fundus examinations to prevent cardiovascular and cerebrovascular complications and diabetic retinopathy. If hypoglycemic symptoms occur, I know to supplement sugar in time.

Patient A9: I found that my blood pressure has been a bit high recently. Combining my recent exercise situation, I judged that it may be caused by insufficient exercise, so I increased the exercise time. I also regularly conduct electrocardiogram and cardiac ultrasound examinations to prevent the aggravation of coronary heart disease. If angina pectoris occurs, I know how to deal with it emergently (taking nitroglycerin sublingually).

Patient A13: I can timely detect signs of changes in my condition through self-monitoring data. For example, before my blood lipids rise, I will find myself easily sleepy, and then I will adjust my diet in advance. I have also learned various knowledge about screening for complications, conduct regular targeted inspections, and know how to deal with common sudden symptoms.

**3.3.3.5 Health Information Literacy** Patients obtain health information through diverse and authoritative channels, including official health platforms, professional medical APPs, and live broadcasts of academic conferences. They have strong abilities in information screening and evaluation, and can critically analyze the scientificity and applicability of information from different channels. They also have outstanding information application capabilities, being able to combine the cutting-edge information obtained with their own comorbid conditions to optimize health management plans.

Patient A13: I mainly obtain health information through professional health apps. I will critically analyze the scientificity of the information. For example, when I see a literature on the treatment of diabetes combined with hyperlipidemia, I will judge whether it is applicable according to my own situation, and then integrate the applicable content into my management plan.

Patient A9: When it comes to health information on the Internet, I will judge whether its source is authoritative first, and then apply the applicable content to my own health management in combination with my own situation, instead of blindly following all online health advice.

Patient A22: I obtain health information through professional medical apps and also pay attention to officially released guidelines. For health information from different channels, I conduct comparative analysis, screen out scientific and applicable content, and then optimize my health management plan based on my own situation.

## 3.3.4Persona 4:Experience-Deficient Anxious Health Navigators

Most of these patients are newly diagnosed with multiple cardiometabolic diseases, with their age concentrated in the range of 45–54 years old. Most patients seek medical treatment due to routine physical examinations or mild physical symptoms such as dizziness and fatigue, and then are diagnosed with multiple cardiometabolic diseases. Due to the sudden diagnosis of multiple cardiometabolic diseases, patients are

prone to significant anxiety and lack experience in managing the coexistence of multiple diseases (comorbidity management). They have an urgent demand for health-related information but lack a clear direction for obtaining such information. They are likely to experience information overload due to the excessive and complicated health information available, which may lead to decision-making difficulties. At the same time, they have a strong willingness to take the initiative to seek professional help.

**3.3.4.1 Disease knowledge mastery** The reserve of disease-related knowledge is almost zero. The understanding of the coexisting multiple diseases (comorbidity) they suffer from is only limited to the level that long-term treatment is required, and they are unable to understand the mutual influence between different diseases. They are completely unaware of the preventive measures for complications.

Patient A6: I have just been diagnosed with hypertension and diabetes. I only know that both diseases require long-term medication, but I have no other relevant knowledge. I do not understand the relationship between these two diseases, nor do I know how to prevent the condition from worsening or avoid more serious diseases caused by them.

Patient A12: I was diagnosed with diabetes and high blood lipids during a physical examination. I only know that both diseases require long-term treatment, but I have no idea about their specific causes or how to prevent them. I also don’t know if there is any interaction between these two conditions.

Patient A23: I just found out that I have hypertension and high blood lipids. The doctor said I need long-term treatment, but I have little knowledge about these two diseases. I don’t know how to prevent them or what harms they may bring to my body.

**3.3.4.2 Health Belief Perception** Patients have obvious anxiety, excessive worry about the prognosis of the disease, and insufficient confidence in their health. They are prone to negative perceptions, believing that a diagnosis of cardiometabolic comorbidity is equivalent to losing health and affecting work and life. Their degree of cooperation with treatment and management is greatly affected by their emotional fluctuations.

Patient A6: I was just diagnosed with diabetes and hypertension. I felt as if the sky had fallen, thinking that I would no longer be a healthy person. I have no confidence in the treatment at all, and sometimes I am so anxious that I can’t sleep. I even don’t want to take the medicine, and I’m always worried that this illness will affect my work.

Patient A8: After being diagnosed with diabetes and hypertension, I felt extremely anxious. I worried that my body would not recover well, and also feared that it would lead to more serious diseases like myocardial infarction and cerebral infarction. I even thought that once I was diagnosed with these two diseases, I would never get better. My compliance with treatment was also affected by my mood—I would take the medicine on time when I was in a good mood, but I didn’t want to take it at all when I was in a bad mood.

Patient A17: I just found out that I have hypertension and dyslipidemia, and I am extremely scared. I worry that it will lead to complications like stroke, and I feel that my quality of life will be very poor in the future. I have little confidence in the treatment, and when I am in a bad mood, I don’t want to go for a follow-up visit.

**3.3.4.3 Health behavior management** The patient has no basic foundation for managing comorbidities related to cardiac metabolism. They are unable to adapt to the healthy habits that need to be persisted in the long term, such as failing to quickly develop the habits of taking medicine regularly, following a low-salt, low-fat and low-sugar diet, and exercising regularly. During the process of adjusting their health behaviors, they are prone to feeling frustrated and giving up management due to the lack of obvious effects in the short term, resulting in poor compliance with health management.

Patient A 8: I have just been diagnosed with hypertension and diabetes. I had no prior experience in managing such conditions. I always forget to take the medicine regularly every day, and I am not used to a low-salt and low-fat diet. After taking the medicine and adjusting my diet for a few days, I didn't see any obvious effect, so I don't want to keep doing it anymore.

Patient A 1: After being diagnosed with diabetes and hyperlipidemia, I was told to take medicine regularly and control my diet. However, I always struggle to keep up with this routine. I am too busy with work, and after taking the medicine and controlling my diet for a period of time, I didn't see any obvious changes. This made me feel frustrated, and I no longer wanted to continue taking the medicine.

Patient A 23: I just found out that I have hyperlipidemia, hypertension, and I am also overweight. I was told to develop the habits of regular exercise and diet control. I had never paid attention to these things before. After persisting for a week, I felt tired and didn't see any effects, so I gave up. I also occasionally forget to take my medicine.

**3.3.4.4 Health Risk Management** There is vague cognition of risks. Patients neither understand the potential long-term harms caused by comorbidities nor the potential risks in daily management. They lack the ability to respond to sudden symptoms, and anxiety can exacerbate the stress response to sudden symptoms.

Patient A 6: I have just been diagnosed with diabetes and hypertension. I don't know what harms will occur if these two diseases are not controlled for a long time, nor do I know the risks of taking the medicine prescribed by the doctor. Last time I suddenly felt dizzy, which made me very scared. I had no idea what was wrong with me, and I felt extremely anxious.

Patient A 1: After being diagnosed with diabetes and hyperlipidemia, I am unclear about the long-term impacts these two diseases may bring, nor do I know the potential risks that need to be noted in daily management. If sudden symptoms occur, I have no idea what to do at all, which will definitely make me extremely anxious.

Patient A 17: I have no idea about the risks of hypertension, hyperlipidemia and obesity at all. I don't know what complications they may cause, nor do I know if there are any risks between taking medicine and diet. If I suddenly feel unwell, I will definitely panic and have no idea how to deal with it.

**3.3.4.5 Health Information Literacy** Patients mainly obtain health information through search engines and social media, which leads to the problem of information overload, making it difficult for them to screen key content from a large amount of information. They have insufficient ability in information evaluation, struggling to judge the scientificity and applicability of the information. In addition, their ability to apply

information is weak, and they cannot convert the obtained information into preliminary comorbidity management behaviors.

Patient A 6: I search for relevant information on Baidu every day, but a large number of results pop up. I can't tell which one is the key information, nor can I judge whether the information is true or not. Even after reading all the information, I still don't know how to follow it to manage my health.

Patient A 12: After being diagnosed with diabetes, I searched for relevant health information online. However, there are various opinions and claims about diabetes management on the Internet, and I cannot judge which one is scientific and which one is suitable for me. Moreover, I have no idea how to apply the information I obtained to my daily health management.

Patient A 17: After the physical examination, the doctor told me that I have high blood lipids and high blood pressure. I then frantically searched for relevant information online, but there was too much information, making it impossible for me to screen out useful content. I also couldn't tell if this information was authoritative. Even if I saw some suggestions, I didn't know how to put them into action.

# 4. Discussion

This study constructed four archetypal health information literacy profiles of cardiometabolic multimorbidity (CMM) patients, comprehensively capturing the heterogeneous characteristics within this population regarding health management. Current research on CMM patients predominantly focuses on physiological aspects such as pharmacotherapy and dietary-exercise interventions, while targeted investigations into their health information literacy remain comparatively scarce. Although some studies have explored the status of health information literacy in chronic comorbid populations, their broad participant scope and high disease heterogeneity prevent precise identification of the unique informational needs and competency profiles specific to CMM patients. Furthermore, existing research primarily relies on quantitative survey methodologies, lacking in-depth qualitative interviews that could systematically elucidate the multidimensional characteristics and underlying requirements of patients' health information literacy. Through a five-core dimensional framework encompassing disease knowledge acquisition, health belief perception, health behavior management, health risk mitigation, and health information competency, this research systematically delineates the multidimensional features of health information literacy among CMM patients.

This study delineates a cohort of information-dependent passive care recipient, predominantly comprising elderly individuals, whose health management is entirely contingent upon guidance from healthcare professionals. This group exhibits dual characteristics of "medical authority dependence" and "deficient self-efficacy," aligning with findings from Laura Vriese et al. indicating that patients with limited health literacy often passively accept decisions due to comprehension barriers [37]. Research demonstrates that such patients display insufficient awareness of synergistic comorbidity risks, possess inadequate knowledge of complication prevention [38], and primarily rely on traditional information sources while exhibiting skepticism toward digital health resources [39]. Their behavioral management manifests as "passive compliance"—while core medical activities like medication adherence and follow-up visits are maintained, autonomous

management capacity remains low, with behaviors being strongly coupled with family caregivers. These patients exhibit limited health risk response capabilities, depending entirely on caregivers for emergency symptom management, which correlates with clinical observations of elevated readmission risk among elderly comorbid patients [40].To address core needs of this population, healthcare professionals should provide geriatric-adapted, fragmented precision health support. This includes disseminating foundational knowledge on synergistic management of "hypertension + diabetes + coronary heart disease" through illustrated pamphlets and voice prompts. Establishing regular follow-up mechanisms via telephone or home visits can reinforce early complication recognition. Concurrent caregiver training should be implemented to develop family-participatory diet-exercise plans, compensating for patients' self-management deficits. Evidence confirms that tailored health education for elderly low-literacy groups significantly enhances disease cognition and behavioral adherence, providing empirical support for such interventions [41, 42]. Furthermore, simplified digital tools can progressively overcome resistance to online health information, thereby improving intervention accessibility.

The cohort of cognition-compromised biased self-regulators manifests a pathognomonic trait wherein "neurocognitive distortions precipitate behavioral nonconformity." Despite exhibiting proactive health engagement, these individuals demonstrate heightened susceptibility to non-credible information sources, frequently engaging in high-risk activities such as unsubstantiated nutraceutical dependence and non-prescribed pharmacotherapeutic modifications. This phenomenon corroborates the Health Belief Model's postulation regarding cognitive bias dominance over health decision-making [43], particularly when eroded confidence in evidence-based therapies increases receptivity to alternative interventions [44].Their disease comprehension exhibits fragmented misconception syndromes, exemplified by pseudoscientific constructs like "nutraceutical-pharmaceutical equivalence" and "pathological dietary restrictionism," directly attributable to infodemic susceptibility within social media ecosystems [45]. Behavioral patterns display asynchronous volatility, characterized by oscillating phases of impulsive trend adoption and chronic management inertia, resulting in recurrent cardiometabolic dysregulation [46].Evidence confirms that precision health literacy interventions targeting this cohort significantly improve therapeutic adherence and clinical outcomes [47,48]. Consequently, interventions must prioritize neurocognitive recalibration and information ecology purification through a tripartite approach: Implementing Cognitive Behavioral Therapy (CBT) to rectify maladaptive health schemata. Establishing credentialed information conduits via vetted medical applications to enhance health information discernment. Developing personalized comorbidity management algorithms with biomarker-informed lifestyle protocols, reinforced through longitudinal biofeedback to potentiate behavioral sustainability.The cohort of Planning-Oriented Autonomous Precision Managers exemplifies the optimal paradigm in cardiometabolic multimorbidity (CMM) management, demonstrating distinctive health information literacy characterized by authoritative sourcing, advanced competency, and precision-oriented execution. These patients proactively access information through diversified credentialed channels, critically appraise scientific validity, and integrate evidence into personalized management practices—capabilities strongly correlated with the knowledge synthesis proficiency of highly health-literate populations [49]. Regarding health beliefs, they exhibit sustained high-level self-efficacy, conceptualizing health stewardship as a life priority while maintaining a rational "reference-integrate-decision" approach toward clinical recommendations. This aligns with Jina Choo et al.'s framework of intrinsically motivated health behaviors

[50]. To address their advanced needs, healthcare professionals should deliver stratified personalized support:Disseminating cutting-edge CMM research and guideline updates to satisfy mechanistic comprehension demands; Optimizing personalized protocols via precision nutrition calculators and exercise intensity monitors; Establishing professional learning collaboratives for knowledge exchange among patients, clinicians, and peers Zhao Yunfeng et al. [51] substantiate that tiered health support significantly enhances disease control quality and quality of life in high-literacy cohorts, providing robust evidence-based justification for such interventions.

The cohort of Experience-Deficient Anxious Health Navigators epitomizes a quintessential predicament characterized by a vicious cycle of "cognitive voids and anxiety overload." These patients exhibit near-absent disease knowledge reserves, lacking comprehension of comorbidity interrelationships and complication risks. Constrained by information channels limited to search engines and social media, they experience profound information-filtering incapacities and decisional paralysis—paralleling findings in spinal cord injury studies documenting "compromised health literacy with prominent anxiety" among newly diagnosed patients [52]. Health belief analysis reveals excessive prognostic apprehension, with management adherence significantly modulated by emotional lability. This perpetuates an anxiety-behavioral dysregulation cascade, underscoring psychological status as a critical modulator of health management behaviors in treatment-naïve populations [53]. Information processing manifests disordered exploration patterns, wherein information overload environments impede critical content identification, resulting in failed information-to-action translation.Wang Tongtong et al. [54] demonstrate that integrated interventions incorporating didactic empowerment, affective reinforcement, and behavioral scaffolding significantly enhance self-management competence and therapeutic confidence in this cohort. Personalized support must adhere to a tripartite graduated framework:Foundational disease literacy enhancement through tiered education on comorbidity pathophysiology and complication prevention. Specialized psychosocial support to mitigate anxiety and cultivate longitudinal management resilience. Authoritative information navigation training with applied interpretation guidance to overcome infodemic challenges.

# 5. Research limitations

This study acknowledges several methodological limitations. First, while data saturation was achieved with a sample size of 23 participants, the homogeneous recruitment source may constrain generalizability. Future investigations should incorporate larger cohorts spanning diverse geographic regions and healthcare access profiles to enhance external validity. Second, the cross-sectional qualitative design precludes longitudinal assessment of health information literacy trajectory evolution and profile transition dynamics. Subsequent research employing prospective methodologies could elucidate population characteristic progression patterns. Finally, external determinants of profile formation—including social support networks and healthcare resource accessibility—were not mechanistically examined. Multimethod approaches integrating quantitative metrics are warranted to delineate contributing factors. Additionally, potential subjectivity-induced bias in interview data, despite mitigation through investigator and participant triangulation, necessitates further refinement of data collection and analytic protocols in future studies.

# 6. Conclusion

This study employs qualitative methodologies to systematically construct four distinct health information literacy profiles among cardiometabolic multimorbidity (CMM) patients, comprehensively elucidating heterogeneous characteristics and individualized needs across subgroups. These findings establish both theoretical foundations and practical frameworks for precision health delivery. Future clinical implementations should adopt the profile-informed "Identification-Needs Matching-Precision Intervention" integrated care cycle, coordinating multidisciplinary resources spanning medical, psychological, and social support domains to deliver tailored services. Moreover, continuous profile system refinement through mechanistic investigations of determinants and intervention efficacy is imperative to holistically advance health literacy and optimize clinical outcomes in CMM populations.

# Declarations

### CRediT authorship contribution statement

**Guodong Xu:** Writing -original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Wensi Dong:** Visualization, Software, Formal analysis, Data curation. **Xiaoyan Liu:** Validation, Formal analysis. **Haiping Wang:**Validation, Conceptualization. **Yanhong Hui:**Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

### Funding

No external funding.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgments

The authors are grateful to patients with cardiometabolic multimorbidity (CMM) who participated in this study.

### Data availability

Research data will be shared with reasonable requests.

### Author details

1.Department of General Medicine, the 960th Hospital of the People’s Liberation Army Joint Logistics Support Force, NO.25 Shifan Road, Jinan, Shandong 250031, People’s Republic of China

2.Department of Quality Control,Shandong Corps Hospital of the Chinese People's Armed Police Forces, Jinan Shandong,250031,People's Republic of China.

3.Department of Internal Medicine, Jinan Rongjun Youfu Hospital, No.734 Dayangzhuang Road, Jinan, Shandong 250117, People's Republic of China

4.School of Nursing,Jinzhou Medical University, No.40 Section 3 Songpo Road, Jinzhou City, Liaoning Province 121001, People's Republic of China

5.Combat Trauma Treatment Center ,the 960th Hospital of the People's Liberation Army Joint Logistics Support Force, NO.25 Shifan Road, Jinan, Shandong 250031, People's Republic of China

## References

1. Chowdhury SR, Chandra Das D, Sunna TC, Beyene J, Hossain A. Global and regional prevalence of multimorbidity in the adult population in community settings: a systematic review and meta-analysis. *EClinicalMedicine*. 2023;57:101860. Published 2023 Feb 16. doi:10.1016/j.eclinm.2023.101860.
2. Álvarez-Gálvez J, Ortega-Martín E, Carretero-Bravo J, Pérez-Muñoz C, Suárez-Lledó V, Ramos-Fiol B. Social determinants of multimorbidity patterns: A systematic review. *Front Public Health*. 2023;11:1081518. Published 2023 Mar 27. doi:10.3389/fpubh.2023.1081518.
3. Han Y, Hu Y, Yu C, et al. Lifestyle, cardiometabolic disease, and multimorbidity in a prospective Chinese study. Eur Heart J. 2021;42(34):3374-3384. doi:10.1093/eurheartj/ehab413
4. Qin X, Chen C, Wang J, et al. Association of adiposity indices with cardiometabolic multimorbidity among 101,973 chinese adults: a cross-sectional study. *BMC Cardiovasc Disord*. 2023;23(1):514. Published 2023 Oct 21. doi:10.1186/s12872-023-03543-x.
5. Emerging Risk Factors Collaboration, Di Angelantonio E, Kaptoge S, et al. Association of Cardiometabolic Multimorbidity With Mortality. *JAMA*. 2015;314(1):52-60. doi:10.1001/jama.2015.7008.
6. Canoy D, Tran J, Zottoli M, et al. Association between cardiometabolic disease multimorbidity and all-cause mortality in 2 million women and men registered in UK general practices. *BMC Med*. 2021;19(1):258. Published 2021 Oct 28. doi:10.1186/s12916-021-02126-x
7. Zhang S, Jiang Z, Zhang H, et al. Association of cigarette smoking, smoking cessation with the risk of cardiometabolic multimorbidity in the UK Biobank. *BMC Public Health*. 2024;24(1):1910. Published 2024 Jul 16. doi:10.1186/s12889-024-19457-y.
8. Jin Y, Liang J, Hong C, Liang R, Luo Y. Cardiometabolic multimorbidity, lifestyle behaviours, and cognitive function: a multicohort study. *Lancet Healthy Longev*. 2023;4(6):e265-e273. doi:10.1016/S2666-7568(23)00054-5.
9. Yu B, Jia S, Sun T, et al. Sarcopenic obesity is associated with cardiometabolic multimorbidity in Chinese middle-aged and older adults: a cross-sectional and longitudinal study. J Nutr Health Aging. 2024;28(10):100353. doi:10.1016/j.jnha.2024.100353
10. Zhang D, Tang X, Shen P, et al. Multimorbidity of cardiometabolic diseases: prevalence and risk for mortality from one million Chinese adults in a longitudinal cohort study. *BMJ Open*. 2019;9(3):e024476. Published 2019 Mar 3. doi:10.1136/bmjopen-2018-024476.
11. Lv L, Zhang P, Chen X, Gao Y. The association between triglyceride glucose-waist height ratio index and cardiometabolic multimorbidity among Chinese middle-aged and older adults: a national prospective

cohort study. *Cardiovasc Diabetol*. 2025;24(1):358. Published 2025 Sep 2. doi:10.1186/s12933-025-02919-x.

12. Fan J, Sun Z, Yu C, et al. Multimorbidity patterns and association with mortality in 0.5 million Chinese adults. *Chin Med J (Engl)*. 2022;135(6):648-657. Published 2022 Mar 20. doi:10.1097/CM9.0000000000001985.
13. Álvarez-Gálvez J, Ortega-Martín E, Carretero-Bravo J, Pérez-Muñoz C, Suárez-Lledó V, Ramos-Fiol B. Social determinants of multimorbidity patterns: A systematic review. *Front Public Health*. 2023;11:1081518. Published 2023 Mar 27. doi:10.3389/fpubh.2023.1081518.
14. Li D, Lin J, Yang H, et al. Causal association of modifiable factors with cardiometabolic multimorbidity: an exposome-wide Mendelian randomization investigation. Cardiovasc Diabetol. 2025;24(1):241. Published 2025 Jun 6. doi:10.1186/s12933-025-02790-wIF: 8.5.
15. MLA .What ls Health Information.Literacy [ R/OL ] .[ 2017 -05-20].https://www.mlanet.org/resources/healthlit/define.html.
16. De Gani SM, Alder E, Beese AS. Das Konzept Gesundheitskompetenz im Wandel [The concept of health literacy in transition]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*. 2025;68(3):240-246. doi:10.1007/s00103-024-04004-2.
17. Liu C, Wang D, Liu C, et al. What is the meaning of health literacy? A systematic review and qualitative synthesis. *Fam Med Community Health*. 2020;8(2):e000351. doi:10.1136/fmch-2020-000351.
18. Schrauben SJ, Cavanaugh KL, Fagerlin A, et al. The Relationship of Disease-Specific Knowledge and Health Literacy With the Uptake of Self-Care Behaviors in CKD. *Kidney Int Rep*. 2019;5(1):48-57. Published 2019 Oct 17. doi:10.1016/j.ekir.2019.10.004
19. Zeng M, Liu Y, He Y, Huang W. Relationship Between Stroke Knowledge, Health Information Literacy, and Health Self- Management Among Patients with Stroke: Multicenter Cross-Sectional Study. *JMIR Med Inform*. 2025;13:e63956. Published 2025 Jun 23. doi:10.2196/63956
20. Wu JH, Wu JM, Liu B, Wei LL. Latent Profile Analysis of Health Information Literacy in COPD Patients and Its Association with Quality of Life. *COPD*. 2025;22(1):2548422. doi:10.1080/15412555.2025.2548422
21. van der Gaag M, Heijmans M, Spoiala C, Rademakers J. The importance of health literacy for self-management: A scoping review of reviews. *Chronic Illn*. 2022;18(2):234-254. doi:10.1177/17423953211035472.
22. van der Gaag M, Heijmans M, Spoiala C, Rademakers J. The importance of health literacy for self-management: A scoping review of reviews. *Chronic Illn*. 2022;18(2):234-254. doi:10.1177/17423953211035472
23. Pagán CR, Schmitter-Edgecombe M. Health literacy in older adults: The newest vital sign and its relation to cognition and healthy lifestyle behaviors. *Appl Neuropsychol Adult*. Published online March 29, 2024. doi:10.1080/23279095.2024.2334348
24. Chen W, Wang X, Chen J, et al. Household air pollution, adherence to a healthy lifestyle, and risk of cardiometabolic multimorbidity: Results from the China health and retirement longitudinal study. *Sci Total Environ*. 2023;855:158896. doi:10.1016/j.scitotenv.2022.158896

25. Singh-Manoux A, Fayosse A, Sabia S, et al. Clinical, socioeconomic, and behavioural factors at age 50 years and risk of cardiometabolic multimorbidity and mortality: A cohort study. PLoS Med. 2018;15(5):e1002571. Published 2018 May 21. doi:10.1371/journal.pmed.1002571
26. Huang M, Fu R, Zhao X, Liu T, Li X, Jiang W. Life's Essential 8 and progression of cardiometabolic multimorbidity trajectory: a prospective study of UK Biobank. Eur J Prev Cardiol. Published online April 26, 2025. doi:10.1093/eurjpc/zwaf247
27. LeRouge C, Ma J, Sneha S, Tolle K. User profiles and personas in the design and development of consumer health technologies. *Int J Med Inform*. 2013;82(11):e251-e268. doi:10.1016/j.ijmedinf.2011.03.006
28. Huh J, Kwon BC, Kim SH, et al. Personas in online health communities. *J Biomed Inform*. 2016;63:212-225. doi:10.1016/j.jbi.2016.08.019
29. Dominello A, Cheek C, Clay-Williams R. The use of personas to involve consumers in healthcare co-design: a scoping review. *BMC Health Serv Res*. 2025;25(1):649. Published 2025 May 6. doi:10.1186/s12913-025-12786-7
30. Groos SS, Linn AJ, Kuiper JI, van Schoor NM, van der Velde N, van Weert JCM. Combining user-centered design and behavioral theory to enhance health technologies: A personas-based approach for a primary-care based multifactorial falls risk assessment tool. *Int J Med Inform*. 2024;186:105420. doi:10.1016/j.ijmedinf.2024.105420
31. Shi YH, Yan YJ, Lin R, et al.The application of user profiles in the health management of elderly patients with chronic diseases□a scoping review.Chin J Nurs. 2025;60(2):244-250.doi: 10.3761/j.issn.0254-1769.2025.02.018
32. Qiu X, Liang J, Luo L, et al. Patterns of social participation among older adults with chronic multimorbidity in the community: A qualitative study. *Int J Nurs Stud*. Published online November 7, 2025. doi:10.1016/j.ijnurstu.2025.105279
33. .Yang Z, Xu L, Gao Y, Zhang C, Wang A. Tailored personas for self-management in home-based cardiac rehabilitation for patients with coronary heart disease: A qualitative study. Int J Nurs Stud. 2025;163:105000. doi:10.1016/j.ijnurstu.2025.105000
34. Wang T, Sun Y, Guo P, Qi N, Zhang Q, Li L. The Patient Persona of the Self-Management Experience of Home-Based Rehabilitation for Spinal Cord Injury Patients: A Qualitative Study. Patient Prefer Adherence. 2025;19:3945-3959. Published 2025 Dec 8. doi:10.2147/PPA.S556569
35. Buus N, Perron A. The quality of quality criteria: Replicating the development of the Consolidated Criteria for Reporting Qualitative Research (COREQ). *Int J Nurs Stud*. 2020;102:103452. doi:10.1016/j.ijnurstu.2019.103452
36. Vignato J, Inman M, Patsais M, Conley V. Computer-Assisted Qualitative Data Analysis Software, Phenomenology, and Colaizzi's Method. *West J Nurs Res*. 2022;44(12):1117-1123. doi:10.1177/01939459211030335
37. Vriese L, Knottnerus B, Groenveld N, Rademakers J, van der Weijden T, Jansen J. Shared decision-making with patients with limited health literacy - experiences and needs of GPs regarding values clarification. *Scand J Prim Health Care*. Published online November 12, 2025. doi:10.1080/02813432.2025.2586416

38. van der Gaag M, Heijmans M, Spoiala C, Rademakers J. The importance of health literacy for self-management: A scoping review of reviews. *Chronic Illn*. 2022;18(2):234-254. doi:10.1177/17423953211035472
39. Arias López MDP, Ong BA, Borrat Frigola X, et al. Digital literacy as a new determinant of health: A scoping review. *PLOS Digit Health*. 2023;2(10):e0000279. Published 2023 Oct 12. doi:10.1371/journal.pdig.0000279
40. Habibzadeh H, Bagherzadi A, Didarloo A, Khalkhali H. The effect of patient education based on health belief model on hospital readmission preventive behaviors and readmission rate in patients with a primary diagnosis of acute coronary syndrome: a quasi-experimental study. BMC Cardiovasc Disord. 2021;21(1):595. Published 2021 Dec 16. doi:10.1186/s12872-021-02413-8
41. Nematzad P, Pourghane P, Besharati F, Gholami-Chaboki B. Effects of health belief model in promoting self-care behaviors among hypertensive older adults. *J Educ Health Promot*. 2023;12:208. Published 2023 Jun 30. doi:10.4103/jehp.jehp_689_22
42. Nematzad P, Pourghane P, Besharati F, Gholami-Chaboki B. Effects of health belief model in promoting self-care behaviors among hypertensive older adults. *J Educ Health Promot*. 2023;12:208. Published 2023 Jun 30. doi:10.4103/jehp.jehp_689_22
43. Delavande A, Del Bono E, Holford A. Imprecise health beliefs and health behavior. *J Health Econ*. 2025;102:103003. doi:10.1016/j.jhealeco.2025.103003
44. White RO, Osborn CY, Gebretsadik T, Kripalani S, Rothman RL. Health literacy, physician trust, and diabetes-related self-care activities in Hispanics with limited resources. *J Health Care Poor Underserved*. 2013;24(4):1756-1768. doi:10.1353/hpu.2013.0177
45. Lotto M ,Jorge S O ,Cruvinel A , et al. Implications of the health information pollution for society, health professionals, and science. [J]. Journal of applied oral science : revista FOB, 2024, 32 e20240222. DOI:10.1590/1678-7757-2024-0222.
46. Chen Q ,Jia Y ,Li H , et al. Self-perceived burden in elderly patients with chronic co-morbidities: a latent profile analysis [J]. Frontiers in Psychology, 2025, 16 1601198-1601198. DOI:10.3389/FPSYG.2025.1601198.
47. Zisopoulou S, Kazantzaki G, Adamakidou T, et al. Ehealth Literacy, Beliefs About Medication and Adherence in Older Adults with Chronic Diseases: A Cross-sectional Study. *Adv Exp Med Biol*. 2026;1489:187-196. doi:10.1007/978-3-032-03394-9_19
48. Wang X, Tian B, Zhang S, et al. Underlying mechanisms of diabetes knowledge influencing diabetes self-management behaviors among patients with type II diabetes in rural China: Based on health belief model. Patient Educ Couns. 2023;117:107986. doi:10.1016/j.pec.2023.107986
49. Fang L, Zhang Q, Zhou N, Chen J, Lou H. Influencing factors and mechanisms promoting proactive health behavior intention: an integration of the health belief model and the theory of planned behavior. Front Public Health. 2025;13:1629046. Published 2025 Jul 10. doi:10.3389/fpubh.2025.1629046
50. Choo J, Noh S, Shin Y. Intrinsic Motivation Inventory for Heart-Healthy Lifestyle (IMI-HeartLife) in Cardiovascular Disease Prevention: A Validation Study. *Nurs Open*. 2025;12(12):e70406. doi:10.1002/nop2.70406

51. Zhao YF, Liu R, Wu M, et al.Research on the current status and influencing factors of consumer health activation index in hospitalized elderly patients with multiple chronic conditions[J]. Chin J Nurs, 2025, 60(14):1716-1722.DOI: 10.3761/j.issn.0254-1769.2025.14.009
52. Bernard RM, Seijas V, Davis M, et al. Mobile Health Self-management Support for Spinal Cord Injury: Systematic Literature Review. JMIR Mhealth Uhealth. 2023;11:e42679. Published 2023 Apr 26. doi:10.2196/42679
53. Zhao Y, Zhao Y, Xie Z, Ziyadan P, Xiu Z, Qi M. The Relationship Between eHealth Literacy and Mental Health of Adult Workers: A Cross-Sectional Study. *J Psychosoc Nurs Ment Health Serv*. 2023;61(9):40-46. doi:10.3928/02793695-20230322-01
54. Wang T, Sun Y, Guo P, Qi N, Zhang Q, Li L. The Patient Persona of the Self-Management Experience of Home-Based Rehabilitation for Spinal Cord Injury Patients: A Qualitative Study. Patient Prefer Adherence. 2025;19:3945-3959. Published 2025 Dec 8. doi:10.2147/PPA.S556569

## Table

Table 3 is available in the Supplementary Files section.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table3ThePatientPersonaofHealthInformationLiteracyinPatientswithCardiometabolicMultimorbidity.docx