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Measuring professional readiness in public health education: development and validation of a 27-item competency self-assessment instrument in China

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ABSTRACT

Background The capacity of the public health workforce is directly linked to the effectiveness of disease prevention and the resilience of the health system. However, China currently lacks theoretical and reliable assessment tools to measure the professional readiness of future frontline public health workers—undergraduate students majoring in preventive medicine.

Methods Following an extensive literature review, the content validity was assessed through expert focus groups (n=15) and pilot testing (n=30). The instrument was then administered to 906 undergraduate preventive medicine students at three medical colleges in Shandong Province, China. To examine the construct validity and construct reliability of the questionnaire, the sample was randomly divided into two subsamples: 453 participants were used for exploratory factor analysis (EFA), whilst the remaining 453 were used for confirmatory factor analysis (CFA).

Results EFA and CFA supported a 27-item, three-factor structure (χ^2/df=2.777, *CFI*=0.949, *TLI*=0.941, *RMSEA*=0.078, *SRMR*=0.050), explaining 69.4% of the variance. The factors were identified as: (1)Personal Traits and Self-Management (10 items), (2)Interpersonal Collaboration and Service Awareness (10 items), and (3)Psychological Resilience and Self-Control (7 items). The instrument demonstrated excellent reliability (overall Cronbach's $\alpha = 0.950$). Predictive validity was supported by strong positive correlations between all three professional readiness dimensions and students' overall professional satisfaction. ($r = 0.762 - 0.809$, $p < 0.001$).

Conclusions The three-factor structure of this questionnaire suggests that students organize their self-assessment of professional readiness by psychologically meaningful functional domains rather than curricular subjects. This 27-item instrument provides a practical, validated tool for monitoring students' self-perceived professional readiness, which can inform competency-based training and workforce development policy.

Keywords Competency assessment, Self-assessment, Public health workforce, Preventive medicine, Questionnaire validation, Psychometric properties

Introduction

The professional readiness of public health professionals is directly linked to the quality of public health services, the efficiency of responses to public health emergencies, and the overall performance of the health system [1]. Students specialising in preventive medicine form the backbone of China's public health workforce and are key drivers of disease prevention and control efforts; their understanding of professional readiness directly reflects the state of training for high-level preventive medicine professionals in China [2]. In recent years, with the frequent occurrence of global public

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health emergencies and the higher demands placed on public health systems against the backdrop of ‘new-quality productive forces’, the training of public health professionals with high levels of job competence has become a central issue in medical education reform [3]. Competence-oriented public health talent development emphasises a competency-based approach, systematically evaluating students’ comprehensive performance in terms of knowledge, skills, attitudes and cognitive characteristics [4,5]. However, how to scientifically and effectively assess the professional readiness of students specialising in preventive medicine remains a key issue that urgently needs to be addressed.

In this study, we employed the term "professional readiness", which refers to an individual's perception of their ability to mobilize and apply a comprehensive set of knowledge, skills, attitudes, and personal traits to meet the requirements of professional practice in the field of public health [6]. This concept goes beyond mere acquisition of academic knowledge or completion of courses, encompassing the cognitive, interpersonal, and internal resources that enable students to effectively transition from the educational environment to professional roles. Professional readiness is essentially a process of self-perception and development, reflecting the internalized cognition of learners' preparedness for entering the workplace [7].

In the field of medical education, the concept of ‘professional readiness’ is often used as a broad term, lacking clear guidance on its meaning, assessment methods and contexts of application. The World Health Organisation (WHO) and The Association of Schools of Public Health in the European Region (ASPHER) recommend strengthening the professional standards of public health practitioners through self-assessment of core public health competencies, in order to prepare them to meet future challenges [8]. Self-assessment is not only an integral part of competence evaluation but also a key means of promoting learners’ reflection and autonomous development [9]. However, the lack of self-assessment questionnaires that have been validated for reliability and validity has limited the systematic implementation of professional readiness evaluation in public health education.

Scholars both domestically and internationally have developed a variety of competency frameworks for public health professionals [2,4,10-12]. Hayes et al. in collaboration with six European public health institutions, developed and validated a self-assessment tool to evaluate the work capacity and skills of staff at national public health institutes in relation to public health emergency preparedness [11]. Optimised through a Delphi study, this tool is capable of identifying gaps in the competencies of Public Health Emergency Preparedness (PHEP) staff, thereby providing a basis for prioritising training and recruitment needs. Chang et al. conducted a study involving 3,809 public health workers from 249 community health service centres in Shanghai and developed a competency assessment scale comprising five factors: comprehensive competence, professional ethos, professional knowledge, professional skills and research and development capabilities [2]. The Cronbach’s α coefficient for the total scale reached 0.985, and confirmatory factor analysis indicated a good model fit, demonstrating that the model possesses a sound fit. Liu et al. developed a core competency model for medical students’ response to public health emergencies, comprising 43 core competency items categorised into four domains: intellectual abilities, practical abilities, behavioural abilities, and personal and motivational factors [4]. Furthermore, in response to public health emergency scenarios, a study has constructed a competency model for grassroots public health professionals, covering seven dimensions: technical skills, medical professionalism, specialist medical knowledge, cognitive and managerial abilities, public health service capabilities, emergency response capabilities, and physical and mental fitness [10]. These studies have laid an important foundation for the construction of theoretical frameworks and the development of tools for assessing the professional readiness of public

health professionals.

It is worth noting that most existing public health competency assessment tools focus on practising public health professionals or staff at community health service centres, with little attention paid to the self-assessment of competencies among undergraduate students specialising in preventive medicine [2,13]. At the same time, most existing tools employ external assessment or objective evaluation methods, with little attention paid to students' subjective self-assessment based on their own abilities. Furthermore, existing tools still require improvement in terms of the comprehensiveness of their self-assessment dimensions and the systematic testing of their reliability and validity; in particular, there is a lack of systematic assessment of non-technical aspects of professional readiness such as students' psychological resilience and service awareness [8].

Furthermore, most existing professional readiness frameworks are constructed around subject-centred dimensional structures. However, is the framework of students' self-perceived professional readiness truly structured according to this subject-based logic? Or do students spontaneously integrate their experiences according to competency types when conducting self-assessment? This question has not yet been directly addressed by existing research. If the latter is the case, it implies that self-assessment tools for competencies should not simply replicate the structure of the curriculum, but should instead reflect the actual organisation of competencies at the psychological level. Accordingly, beyond developing a measurement instrument, this study directly examines this theoretical question by employing factor analysis to investigate the latent structure underlying students' professional readiness self-assessments.

This study aims to develop and validate a self-assessment questionnaire for undergraduate preventive medicine students.Crucially, beyond psychometric evaluation, we use the factor structure as an empirical lens to examine whether students' self-perceived professional readiness is organised by curricular domains or by psychologically meaningful competency types. Should the latter emerge, it would suggest that self-assessment tools should capture the integrative, experience-based ways in which students construct their professional identities, thereby informing both curriculum design and workforce development policy.

Methods

Study context and Participants

The study was conducted in Shandong Province, China, a setting selected for its representative role in national public health education. Three medical universities were included, located respectively in the province's eastern, central and western regions. All three offer a five-year undergraduate programme in Preventive Medicine, and all follow the National Basic Requirements for Undergraduate Teaching in Preventive Medicine [14], which ensures comparability in core curriculum content across sites. The first year (Phase I) is devoted to the study of general foundation and basic medical courses. The second year (Phase 2) comprises core specialist modules, structured in accordance with the public health disciplinary framework. Case-based discussion and field-based practical training are the primary teaching strategies during this phase, with students analysing real-world public health incidents through group collaboration and conducting on-site community investigations. The Internship (Phase 3) include comprehensive medical and clinical science modules covering various body systems. The Practicum (Phase 4) comprises rotational placements at the Centers for Disease Control and Prevention (CDC), Health Inspection Institutes, Community Health Service Centers, and relevant hospital departments, culminating in a graduation thesis based on real-world public health issues. First-year students were

excluded from the study, as they had not yet taken core professional courses or participated in public health-related practical training, which made it difficult to validly assess their professional readiness.

Development of the questionnaire

The self-assessment questionnaire for the professional readiness of undergraduate students in preventive medicine used in this study was designed on the basis of a three-tier competency indicator system developed in a previous study. Through a systematic review of domestic and international literature on the competencies of public health professionals and an analysis of existing relevant assessment tools, we determined that the professional readiness of public health professionals should be regarded as a multidimensional construct [2,15-18]. Based on this theoretical framework, this study developed a preliminary tool to assess the competence levels of undergraduate graduates in preventive medicine. The preliminary questionnaire comprises 75 items, which can be categorised into five dimensions: (1) personal traits, (2) professionalism, (3) professional knowledge and skills, (4) fundamental professional competencies, (5) cognitive characteristics. The categorisation of this initial framework is primarily based on the logic of teaching content and knowledge domains, aiming to comprehensively cover the various professional readiness elements that students in the preventive medicine programme should acquire during their studies.

At each of the three selected medical schools, five experts with extensive teaching experience or public health practice experience were invited to participate in focus group discussions, totalling 15 experts. All participants possessed more than five years' work experience in public health education or related fields, ensuring a high level of professional expertise. At the start of each focus group discussion, participants first signed an informed consent form, followed by a 15-minute presentation by the study authors on relevant concepts, covering the conceptual framework of public health professional competence and the theoretical basis for the questionnaire design. A quantitative questionnaire comprising 75 items was then distributed, and a qualitative group discussion was conducted. Focus group participants first rated each item as 'essential' or 'non-essential' based on the degree of alignment between the item and the intended concept. In addition, participants were asked to evaluate the clarity of each item and to suggest any modifications where necessary. Participants' ratings of the questionnaire items were used to calculate the content validity index (CVI). Through the focus group discussions, the experts unanimously agreed to retain 52 items, with either minor modifications or no changes. Meanwhile, a total of 23 items were removed on the basis of a low content validity index (below 75%), issues with clarity, or expert recommendations for deletion or the inclusion of new items. Subsequently, all researchers evaluated the 52-item questionnaire through two rounds of online review meetings, reaching consensus through discussion. On this basis, the questionnaire was further optimised, with a further five items removed due to redundant wording, unclear dimensional affiliation or expert recommendations for consolidation. The revised 47-item questionnaire was pre-tested among public health students at three institutions, with 10 students selected from each institution, totalling 30 participants (n=30). The pilot test aimed to assess the suitability, clarity and relevance of the questionnaire items. Based on the feedback provided by the students, further modifications were made to the questionnaire to enhance its quality and usability. Furthermore, in accordance with the students' comments, 11 items were removed as they were deemed to be obscure, redundant or inconsistent with the practical circumstances of public health students. The post-pilot questionnaire comprised a total of 36 competency assessment items.

Study design and sampling

This study used a cross-sectional correlational design. To ensure geographical representativeness,

a stratified random cluster sampling method was adopted, with the specific steps as follows: first, Shandong Province was divided into three strata—eastern, central and western—on the basis of administrative division and economic homogeneity; Subsequently, following coordination with the Shandong Provincial Department of Education and the academic affairs departments of the respective universities, one representative medical university was randomly selected from each stratum to ensure that each selected university had an established public health programme and enrolled a sufficient number of final-year students. The choice of sites was deliberate rather than arbitrary. Shandong Province was selected because its public health education system is representative of the national landscape, and because medical education across the province spans institutions at different stages of development. Its undergraduate public health education follows the national curriculum framework set out in the Outline of the Plan for Building an Education Powerhouse (2024–2035). The three participating universities also vary in curriculum delivery, talent development models and research participation arrangements, which allows the study to capture the range of conditions under which preventive medicine students in China prepare for professional practice. These features support the internal validity of the study and make the findings informative about undergraduate public health education in public medical universities in China.

The questionnaire was distributed in paper form, and a total of 906 valid responses were collected (valid response rate = 83.66%). According to published guidelines on factor analysis, the sample size in this study was sufficient to yield reproducible factor analysis results. A sample size of 300 or more is generally considered adequate; 150–200 may be sufficient under specific conditions, whilst a sample size of less than 100 is typically considered inadequate [19]. Based on their subjective experiences, students were asked to rate the extent to which each item corresponded to their own level of competence. Items measuring public health professional readiness were scored using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = unsure, 4 = agree, 5 = strongly agree). A 5-point Likert scale was adopted to provide sufficient response options whilst retaining the 'unsure' option to reflect situations where students were unable to make a judgement. These responses were used in the factor analysis of the questionnaire, which aims to eliminate items that fail to effectively measure the construct of professional readiness.

Statistical analysis

SPSS 27.0 software was used to conduct descriptive statistical analyses of the participants' demographic characteristics and scores across the various dimensions. Continuous variables were described as mean ± standard deviation (Mean ± SD), whilst categorical variables were described in terms of frequency and percentage (n, %). Additionally, normality tests (including skewness and kurtosis) were conducted on the score distributions of the 36 competency assessment items.

The total sample of this study (906 participants) was divided into two subsamples using a random grouping method. Subsample A comprised 453 participants (50% of the total sample) and was included in the exploratory factor analysis (EFA) to assess the latent structural model of the Public Health Competency Assessment Questionnaire. Principal component analysis (PCA) was employed to extract new factors based on the Kaiser criterion (using an eigenvalue greater than 1 as the standard for determining factors). The adequacy of the sample was verified using Bartlett's sphericity test and the Kaiser-Meyer-Olkin (KMO) test. A combination of slope plots, factor loadings and theoretical analysis was used to determine which factors to retain [20]. Through an analysis of common factors and cross-loadings, we gained insights into the latent structure of the Public Health Talent Competency Assessment Questionnaire. The aforementioned analyses were carried out using the `psych` and

`factoextra` packages in R.

Subsequently, confirmatory factor analysis (CFA) was conducted using the maximum likelihood estimation method on the data from Sample B (comprising 453 participants, the remaining sample) to test the robustness of the factor structure identified by EFA. This was done to assess the degree of fit between the measurement model and the latent structural model (representing the latent factors of the various dimensions of public health professional competence).

The CFA analysis was conducted using the lavaan package in R, and multivariate normality was assessed using the MVN package to examine Mardia's normalised multivariate kurtosis estimates. This method is considered appropriate when the proportion of missing data does not exceed 5 per cent, as it minimises bias whilst maintaining the integrity of the analysis.A variety of fit indices were employed to evaluate the consistency between the measurement model and the underlying theoretical framework. The Comparative Fit Index (CFI) was used to measure the overall goodness of fit of the tested model relative to a baseline (independent) model. A CFI value of ≥0.95 is generally used as a criterion for model acceptability, indicating that the specified model is able to reproduce 95% of the covariance in the data [21,22]. The chi-squared (χ^2) test indicates the degree of consistency between the latent covariance matrix and the observed covariance matrix. A non-significant χ^2 value or a χ^2/df ratio < 5 indicates a satisfactory model fit [23]. The root mean square error of approximation (RMSEA) describes the average difference between the observed covariances and the predicted covariances; an RMSEA value ≤ 0.06 indicates a good model fit [22]. The standardised root mean square residual (SRMR) is defined as the standardised mean deviation between the observed correlation matrix and the model's latent correlation matrix [22]. An SRMR value < 0.06 indicates an acceptable fit, although this measure is influenced by sample size and model complexity. The Tucker-Lewis Index (TLI) or Non-Normative Fit Index (NNFI) is another commonly used measure for assessing model fit, with an acceptable value of 0.95 [22]. Finally, the Akaike Information Criterion (AIC) compares various potential models based on their ability to utilise all available data. A lower AIC value indicates a better fit. The selection of the optimal model requires a comprehensive consideration of the various fit indices. The aforementioned fit indices can be obtained directly using the `fitMeasures()` function in the `lavaan` package in R.

Common Method Variance(CMV)

As data collected via self-report methods are highly susceptible to common-method bias, this study implemented procedural measures such as anonymisation and reverse-scoring of certain items; participants were also explicitly informed in the questionnaire instructions that 'there are no right or wrong answers; please respond according to your genuine feelings'. At the statistical level, Harman's one-factor method was employed to test for common-method bias, and an unrotated principal component analysis was conducted on the final items. If a single factor explains less than 40% of the total variance—the critical threshold—this indicates that common-method bias does not pose a serious threat [24]. The aforementioned analyses were carried out using the `psych` package in R.

Construct reliability (CR)

Construct (or composite) reliability refers to a measure of the degree of internal consistency exhibited by the observed indicators reflecting a particular latent variable (construct). The method used in this study to calculate construct reliability has been reported in previous research [25]. The formula for calculating construct reliability is as follows:

$$CR=\frac{(\sum\lambda_i)^2}{(\sum\lambda_i)^2+(\sum\epsilon_i)^2}$$

Where λ_i (lambda) is the standardised factor loading for item i, and ε is respective error variance for item i. The error variance (ε) is estimated based on the value of the standardised loading (λ). The above analysis was performed using the `lavaan` package in R, and the CR value is calculated automatically from the standardised loads.

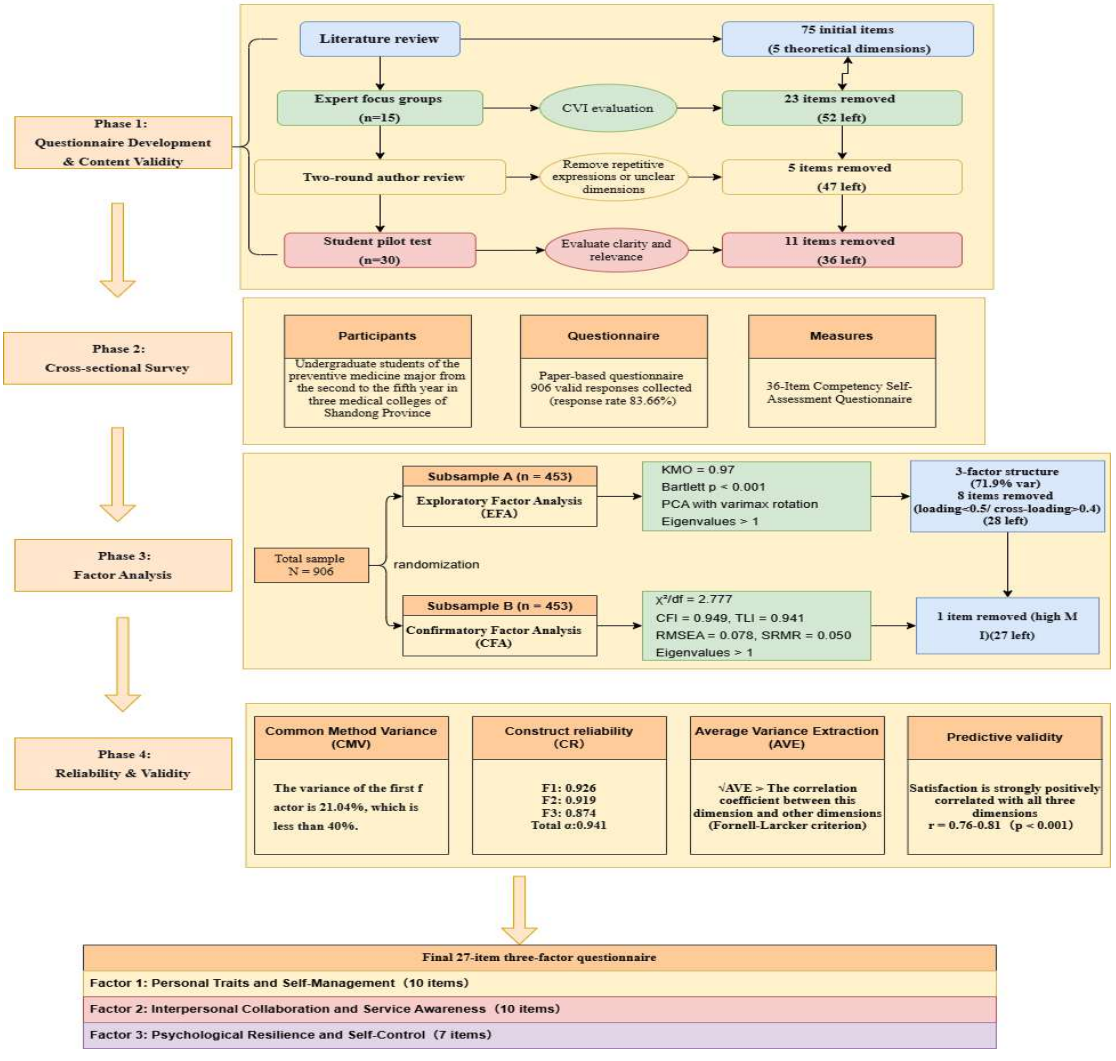
Predictive validity

The Pearson correlation coefficient was used to assess the correlation between the three factors of professional readiness and students' overall satisfaction with their programme. Furthermore, the Fornell–Larcker criterion was employed to evaluate the discriminant validity of each dimension; specifically, the square root of the average variance extraction (AVE) for each dimension should be greater than the correlation coefficient between that dimension and the other dimensions.

$$\sqrt{AVE}=\sqrt{\frac{\Sigma \lambda_i^2}{N}}$$

Where λ_i (lambda) is the standardised factor loading for item i, and N is the number of items included in that factor. The above analysis was carried out using the `psych` package in R.

Fig. 1 illustrates the methodological flowchart for the questionnaire development and validation process, with key decision points for item reduction marked at each stage.



Notes： This figure illustrates the four-phase process of developing and validating the competency self-evaluation questionnaire for preventive medicine undergraduates. Phase 1 involved item generation and content validity assessment through a literature review, expert focus groups (n=15), author reviews, and pilot testing (n=30). Phase 2 was a cross-sectional survey of 906 students from three medical universities in Shandong Province, China. Phase 3 comprised random splitting of the total sample into two subsamples (each n=453) for EFA and CFA, respectively, resulting in a final 27-item three-factor model. Phase 4 evaluated CMV, CR, AVE, and Predictive Validity (correlation with professional satisfaction).

Fig. 1 Methodological flow chart of the questionnaire development and validation process.

Results

Participant Demographics

The average age of the students was 20.62 ± 1.55; 69.32% were female and 30.68% were male. The study sample comprised students from the second year (32.23%), third year (27.59%), fourth year (27.15%) and fifth year (13.03%) of the Preventive Medicine programme (Table 1).

Through an iterative process of expert review and pilot testing, the initial 75 items were reduced to 36, and subsequently further optimised to the final version of 27 items based on the results of EFA and CFA (Fig. 1). The questionnaire was reviewed by a panel of experts with extensive teaching or public health practice experience and was found to have good content validity. During pilot testing, the questionnaire demonstrated good face validity, with all students finding the items clear and logically coherent. The remaining items were subsequently subjected to factor analysis to assess the construct validity of the scale. The final scale comprises 27 items and employs a 5-point Likert scale, with response options ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = unsure, 4 = agree, 5 = strongly agree).

Table 1. Demographic Characteristics of Participants

Characteristic	Total number(%)
Respondent	906(83.66)
Age	20.62±1.55
Gender	
Male	278(30.68)
Female	628(69.32)
Year of study	
Year 2	292(32.23)
Year 3	250(27.59)
Year 4	246(27.15)
Year 5	118(13.03)
School Attributes	
Subordinate departments	289(31.90)
Provincial-level institutions	617(68.10)
Comprehensive performance	
Excellent (ranked in the top 30% of the class)	294(32.45)
Medium	456(50.33)
Average (ranked in the bottom 30% of the class)	156(17.22)

EFA and CFA

The EFA analysis of the data from the 'Preventive Medicine Undergraduate Professional Readiness Self-Assessment Questionnaire' identified three independent factors: personal traits and self-management; interpersonal collaboration and service awareness; and psychological resilience and self-control (integrated outcomes).These factors collectively accounted for a substantial 69.4% of the variance within the dataset. The KMO test was 0.97, and the Bartlett's test was significant (χ^2 = 10,987.6, df = 630, $p < 0.001$) indicating excellent sampling adequacy and factorability of the variables (Beavers et al., 2013) Furthermore, the strong correlations between items within each factor further support the coherence and relevance of the identified components. By examining the rotated matrix, two items were deleted due to loadings<0.5. These items were "I possess the theoretical knowledge and skills required for this profession" and "I am able to complete the relevant documentation accurately and clearly". Another six items were deleted due to significant cross loading > 0.4 on more than one factor. These items were "I am willing to mentor subordinates and can motivate them in ways that suit their development", "I pay attention to the cost-benefit analysis and operational mechanisms of the system within which my profession operates, and possess the ability to formulate plans, coordinate, develop business, allocate resources and manage production", "I understand the tasks, responsibilities and authority of my organisation, as well as the effective functioning of its social, political and scientific and technological systems", "I am able to provide professional guidance, training, research and demonstrations to subordinates and relevant personnel", "I have a thorough and objective understanding of the career prospects in my profession and have a clear career plan" and "I am able to stand by my views at work and persuade, influence or motivate others to achieve set objectives".

CFA was conducted using the 36-item model from the questionnaire. The fit indices for the 36-item questionnaire are as follows: χ^2 = 2735.130, df = 519, χ^2/df = 5.270, CFI = 0.762, TLI = 0.752, RMSEA = 0.097, SRMR = 0.086, AIC = 38,954.

Clearly, the 36-item measurement model did not adequately fit the theoretical model. Based on the results of the EFA, it was recommended that eight items be removed and a CFA analysis be conducted using the 28-item questionnaire. The analysis results showed an improvement in model fit, but the various indices remained unsatisfactory. The results of this analysis are as follows: χ^2 = 1,246.062, df = 291, χ^2/df = 4.282, CFI = 0.936, TLI = 0.926, RMSEA = 0.085, SRMR = 0.051, AIC = 14214. Consequently, the item correction indices were examined further, revealing that one additional item had an excessively high correction index; this item was therefore removed. The item in question was: "I have a strong ability to cope with setbacks and can quickly shake off feelings of frustration when faced with them". Following this modification, the 27-item questionnaire model became the most parsimonious model and demonstrated a good fit with the original theoretical analysis. Consequently, subsequent analyses were based on this model. The fit indices for the 27-item questionnaire model are as follows: χ^2 = 741.459, df = 267, χ^2/df = 2.777; CFI = 0.949, TLI = 0.941, RMSEA = 0.078, SRMR = 0.050, AIC = 13,260 (Table 2). Model-fit indices were generally satisfactory. Although RMSEA was slightly higher than the strict 0.06 threshold, CFI, TLI and SRMR all met acceptable criteria, supporting adequate model fit.

The three latent factors identified were: (1) personal traits and self-management (10 items), (2) interpersonal collaboration and service awareness (10 items), and (3) psychological resilience and self-control (7 items). The factor loadings for each item ranged from 0.639 to 0.868 (all $p < 0.001$), and there was a strong correlation between the three latent factors (dimensions). Finally, 27 items were listed in the final questionnaire, as well as the three factors or constructs determined through factor analysis (Table 3 & Additional file 1).

Table 2. Fitness indices for measurement models of the competency-based self-evaluation questionnaire (N=453 for Subsample B)

	Measurement Model	χ^2	*df*	χ^2/df	CFI	TLI	RMSEA (90% CI)	SRMR	AIC
1	Three latent factors – 36 items	2735.130	519	5.270	0.762	0.752	0.097 (0.095-0.099)	0.086	38954
2	Three latent factors – 28 items	1246.062	291	4.282	0.936	0.926	0.085 (0.078-0.092)	0.051	14214
3	Three latent factors – 27 items	741.459	267	2.777	0.949	0.941	0.078(0.071-0.086)	0.050	13260

Table 3. Final factors with questionnaire items

Factor 1: Personal traits and self-management	
1	I am passionate about my chosen profession.
2	I aspire to become a leader in my field.
3	I am able to consciously and continuously update my knowledge and skill set, consistently applying effective learning techniques to acquire and master the latest theoretical knowledge and practical skills, thereby ensuring the adaptability of my professional capabilities.
4	I am able to assess my strengths and weaknesses objectively, consciously reflect on my experiences and lessons learnt, and comprehensively enhance my abilities by building on my strengths and addressing my weaknesses, enabling me to adapt swiftly to my current working environment.
5	In my work, I proactively seek ways to improve efficiency and complete tasks to a high standard.
6	I am able to apply various cognitive processes, methods and skills in accordance with specific objectives, and resolve problems through a series of mental processes.
7	I am able to break down complex problems into their constituent parts, and systematically and methodically identify, acquire, process, utilise and manage them.
8	I am able to identify the essence and key aspects of matters amidst a multitude of tasks or in complex environments, propose solutions, and formulate reasonable, comprehensive and objective decisions, thereby achieving objectives.
9	I am able to adapt and respond effectively, anticipate future changes and formulate plans, and manage both myself and others in order to maintain effective control and respond appropriately.
10	I am able to integrate practical work with research effectively, transforming problems encountered in practice into scientific hypotheses of research value, and successfully applying the latest research findings in practice.
Factor 2：Interpersonal collaboration and service awareness	
11	I am able to trust and respect my colleagues, partners and clients wholeheartedly.
12	I am able to be understanding, friendly, humble, tactful, attentive, helpful and courteous towards others; and to develop and maintain effective interpersonal relationships.
13	I am good at listening to and accepting others' suggestions and advice.
14	I am able to adhere to professional ethics, laws and regulations, as well as social and scientific ethics, and to respect others' privacy.
15	I place great importance on integrity and treat others and handle matters openly and fairly.
16	I am motivated to help and serve others, and to meet their needs.
17	I am able to put myself in others' shoes, consider matters from their perspective, and understand their feelings.

18	I am able to manage relationships with superiors, peers and collaborators effectively, share information and resources, and foster mutual understanding, thereby gaining support and cooperation.
19	I possess a strong sense of collective honour, prioritising the greater good and setting aside personal gains and losses.
20	I am able to communicate effectively with others, fostering harmonious working relationships and enhancing mutual trust, cooperation, understanding and support, thereby improving efficiency.
Factor 3：Psychological Resilience and Self-Control	
21	I have a strong ability to cope with pressure and can handle matters calmly and efficiently even under high-pressure situations, such as approaching deadlines or urgent crises.
22	I have a strong sense of time management; I am able to balance time commitments, organise my work effectively, and avoid wasting energy on aimless or meaningless activities.
23	I am able to move steadfastly towards set goals, pursue my endeavours with perseverance, and manage my emotions effectively.
24	I am able to set clear and realistic personal goals and work proactively to achieve them using appropriate methods.
25	I possess strong self-confidence and believe in my ability to complete tasks and resolve problems through effective means.
26	I approach life with a positive and optimistic attitude, whilst maintaining high levels of physical fitness and energy.
27	I recognise the importance of my work, proactively fulfil my responsibilities and obligations, and never shirk responsibility for mistakes I have made.

Common Method Variance

An unrotated principal component analysis was conducted on the final 27 items using Harman's one-factor test. The results showed that the first unrotated factor explained 21.04% of the total variance, which is below the recommended threshold of 40%, indicating that there was no serious common method bias in this study.

Construct reliability

The construct reliability coefficients for the three latent factors are as follows: "Personal Traits and Self-Management" 0.926, "Interpersonal Collaboration and Service Mindset" 0.919, and "Psychological Resilience and Self-Control" 0.874. The overall Cronbach's α coefficient for the 27-item questionnaire was 0.950 (*95% CI*: 0.944–0.956), indicating that the scale as a whole possesses good internal consistency reliability (Table 4).

Table 4. The construct reliability of the three potential factors (N = 453 for Subsample B)

Factor	Questionnaire items	Number of questions	$\sum\lambda$	$\sum(1-\lambda^2)$	CR
1	Personal traits and self-management	10	5.610	2.496	0.926
2	Interpersonal collaboration and service awareness	10	4.837	2.073	0.919
3	Psychological Resilience and Self-Control	7	3.796	2.086	0.874

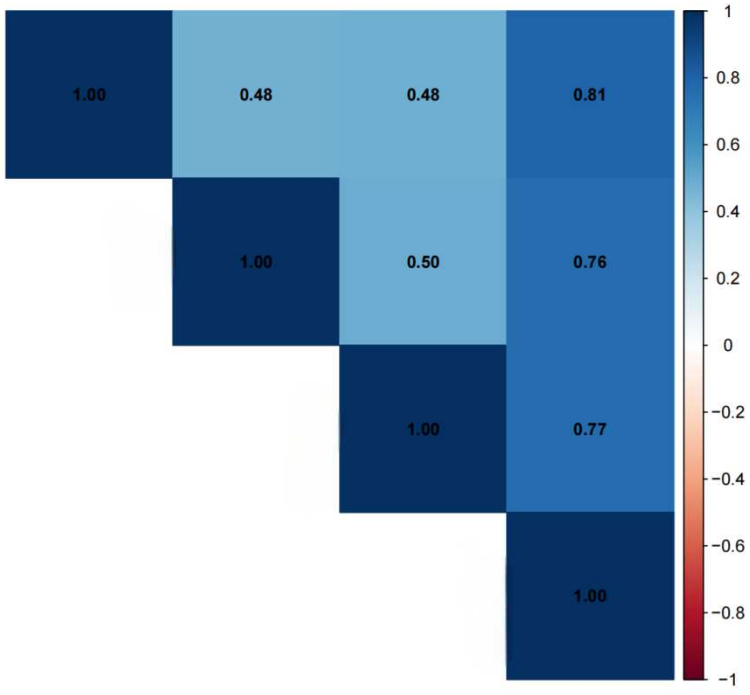
Predictive validity

There is a significant positive correlation between students' overall satisfaction with their degree programme and their self-assessed competence scores (Table 5). The correlation between student satisfaction and the "Personal Traits and Self-Management" dimension was 0.809 ($p < 0.001$), with the "Psychological Resilience and Self-Control" dimension it was 0.769 ($p < 0.001$), and with the "Interpersonal Collaboration and Service Awareness" dimension it was 0.762 ($p < 0.001$). The correlation coefficients between the three dimensions ranged from 0.478 to 0.498, indicating a moderate positive correlation ($r < 0.60$). The square roots of the AVE for each dimension were 0.866, 0.891 and 0.838 respectively, all of which were greater than their correlation coefficients with the other dimensions (0.478–0.498), indicating that the three dimensions possess good discriminant validity (Fig. 2).

Table 5. The correlation coefficient between students' overall satisfaction with their major and their self-assessment scores of competence (r)

	Students' overall satisfaction	**Personal traits and self-management**	**Interpersonal collaboration and service awareness**	**Psychological resilience and self-control**
Students' overall satisfaction	1.000			
Personal traits and self-management	0.809***	1.000		
Interpersonal collaboration and service awareness	0.762***	0.478***	1.000	
Psychological Resilience and Self-Control	0.769***	0.483***	0.498***	1.000

***$P<0.001$



The values in the figure represent Pearson correlation coefficients. The color gradation from light to dark indicates the correlation coefficients from low to high, with darker colors indicating stronger correlation. A value between 0 and 1 represents a positive correlation, while a value between 0 and -1 represents a negative correlation. Correlation does not imply causation. The three competency dimensions were moderately correlated with one another. Each dimension was strongly and positively correlated with students' overall professional satisfaction,

with the strongest correlation observed for Personal Traits and Self-Management.

Fig.2 Heatmap of the correlation matrix between competency dimensions and professional satisfaction (N=453)

Discussion

This study developed and validated a three-factor self-assessment questionnaire comprising 27 items, designed to assess students' self-perceived professional readiness among undergraduate students specialising in preventive medicine. The tool was developed through a systematic questionnaire development process, and its content validity, construct validity and predictive validity were assessed. Beyond establishing its reliability and validity, however, the findings carry a more consequential theoretical implication: the emergent factor structure challenges the default assumption that professional readiness self-assessment should be organised along curricular lines.

The professional readiness construct, as broadly defined in the literature, encompasses the integration of knowledge, skills, attitudes, and cognitive attributes that enable effective practice in complex health contexts [4,26,27] . While some frameworks emphasise behavioural outcomes aligned with competence-based education [28], others stress multidimensionality and situational adaptability [2]. Across these perspectives, however, a shared challenge persists: the conceptual breadth of competence demands assessment approaches that are equally multidimensional. Yet most existing tools, in operationalising this breadth, have defaulted to organising items according to disciplinary content domains—an approach that privileges curricular logic over the psychological processes underlying self-perception.

Our findings offer a different account. The three factors that emerged from our analysis—Personal Traits and Self-Management, Interpersonal Collaboration and Service Awareness, and Psychological Resilience and Self-Control—are not defined by subject-matter boundaries, but by distinct functional domains of personal, interpersonal, and adaptive capacity. This pattern suggests that when students assess their own competencies, they do not retrieve discrete blocks of curricular knowledge; rather, they appear to integrate their learning experiences into holistic, psychologically meaningful categories that reflect their perceived capacity to act effectively in professional roles. This distinction carries direct implications for competency-based education: if students' self-assessments are organised by professional readiness types rather than content areas, then curriculum mapping and instructional design should attend not only to what is taught, but also to how students internalise and synthesise their learning into usable professional repertoires.

Situating the Findings: Addressing a Gap in Competency Self-Assessment

Following a systematic literature review, our research team found that there is currently a lack of self-assessment tools capable of comprehensively evaluating the professional readiness of undergraduate students in preventive medicine. Although 13 different versions of public health-related competency assessment tools were identified in the systematic review by Nie et al. [16], most of these tools focus on peer assessment or objective assessment of practising professionals, with little attention paid to subjective self-assessment by undergraduate students based on their own competencies. This lack of appropriate tools has limited the systematic implementation of competence-based education in undergraduate public health programmes. Similar to our study, a representative example among existing tools is the ‘Infectious Disease Control and Prevention Competency Scale for Public Health Professionals (IDCCS)’. Based on the Competence Iceberg Model and the Public Health Leadership Framework, this scale establishes an evaluation system comprising four dimensions: knowledge,

practical skills, leadership and personal qualities [2]. However, as this tool is primarily designed for the specific field of infectious disease control and prevention, its dimensional structure and professional focus are not entirely suitable for the comprehensive assessment of the overall competencies of students in preventive medicine programmes. Another study is the 'Public Health Emergency Preparedness Workforce Self-Assessment Tool' developed by Hayes et al. [11]. This tool focuses on emergency response capabilities at the organisational level, with an emphasis on the assessment of specific functions among practising professionals; consequently, it is difficult to apply directly to the self-assessment of competence among students at the undergraduate level. Furthermore, most existing tools have been developed for community nurses or staff at community health service centres [29], whose service contexts and professional roles differ from the educational objectives and future career paths of students in preventive medicine. At the same time, existing tools still require improvement in terms of the comprehensiveness of their self-assessment dimensions and the systematic testing of their reliability and validity [16]; in particular, they lack a systematic assessment of students' non-technical aspects of students' professional readiness, such as psychological resilience and service awareness.

It is worth noting that this gap is not unique to China, but rather a common challenge facing public health education globally. The 'Global Competency and Outcomes Framework for the Essential Public Health Functions', published by the WHO in 2024, sets out six competency domains, 20 core competencies and 40 practice activities, covering dimensions such as community-centredness, decision-making, communication, collaboration, evidence-based practice and personal integrity [30, 31]. This framework provides an authoritative reference for the standardised assessment of public health professionals' competencies globally; however, as it is primarily geared towards the functional roles of practising professionals, it has not developed specific measurement tools for assessing self-perceived competencies among undergraduate students. Meanwhile, the competency inventory published by the ASPHER has been used in several European countries for curriculum mapping and competency assessment; however, Neumark et al. in their curriculum mapping of public health programmes at five Israeli universities, found that core curricula covered only 45% to 84% of the competency domains listed by ASPHER, with widespread gaps in areas such as environmental health, health policy, health promotion and health economics; furthermore, the assessment methods employed in these programmes failed to reflect students' actual perceived competency levels [32]. This finding resonates significantly with the starting point of the present study: curriculum coverage does not equate to the acquisition of competencies, which is precisely the fundamental distinction between competency-based education and traditional curriculum-based education. Based on this, the present study aims to develop and validate a competency-based self-assessment questionnaire for public health professionals, specifically designed to assess the multidimensional competency levels of undergraduate students specialising in preventive medicine. The three-factor self-assessment questionnaire developed in this study covers personal traits and self-management, interpersonal collaboration and service awareness, and psychological resilience and self-control, and possesses the following three significant advantages: firstly, the tool focuses on undergraduate students' self-perceived professional readiness, filling a gap in the application of existing tools within this student population; secondly, the three factors correspond respectively to the individual, interpersonal and situational response levels, forming a relatively comprehensive closed-loop competence assessment; third, the tool not only measures traditional dimensions of knowledge and skills but also systematically assesses non-technical aspects of professional readiness such as psychological resilience and service awareness; whilst these elements are often overlooked in existing evaluation systems, they are crucial for public health professionals in

addressing complex and ever-changing health challenges [8]. The questionnaire developed in this study provides a reliable self-assessment tool for monitoring students' self-perceived professional readiness among undergraduate preventive medicine students, supporting both competency-based curriculum reform and workforce development strategies.

Theoretical Refinement: From Content-Based to Competency-Based Framework

It is worth noting that this study found that the initial five-dimensional theoretical framework, categorised by teaching content, converged into a three-factor structure categorised by competency type during EFA. This phenomenon requires interpretation from the perspective of competency theory. According to McClelland's 'Iceberg Model of Competence', an individual's competence can be divided into 'above-the-waterline' explicit elements—namely, knowledge and skills—and 'below-the-waterline' implicit elements—namely, motivation, traits and self-concept [26]. At undergraduate level, students are largely exposed to relatively standardised curricula; individual differences in superficial elements such as professional knowledge and skills have not yet fully differentiated, whilst individual variation in deeper elements such as personal traits and self-concept is greater, making them more likely to be extracted as independent dimensions in factor analysis. This explains why the majority of items in the initial 'Professional Knowledge and Skills' and 'Basic Occupational Competencies' dimensions were deleted or merged during EFA. More importantly, this study has achieved a logical shift in professional readiness assessment, namely a transition from a discipline-centred to a professional readiness-centred approach. This shift is consistent with the theoretical mechanisms identified by Wang et al.[33], who, drawing on Social Cognitive Career Theory (SCCT), found that research participation enhances job competence by strengthening academic motivation.Whereas that earlier study[33] examined the relationship between research participation and professional competence using propensity-score matching, the present study focuses on the development and psychometric validation of the competency self-assessment instrument itself. The core composition of professional readiness is not a simple accumulation of knowledge, but rather an integrated expression of psychological attributes such as motivation, self-regulation and interpersonal interaction. Specifically, the dimensional convergence paths in this study are as follows: In the initial 'Professional Competence' dimension, items relating to deep-level traits such as integrity, service orientation and professional ethics were merged with items related to 'Interpersonal Collaboration' in the EFA to form the 'Interpersonal Collaboration and Service Orientation' factor. This is because service orientation is, in essence, a value orientation centred on others; psychologically, it falls within the category of relational competencies alongside interpersonal collaboration skills such as trust, respect and communication. Cognitive items in the initial 'Thinking Characteristics' dimension—such as problem-solving, systems thinking and decision-making ability—were merged with items from 'Personal Traits' such as self-management and learning motivation to form the 'Personal Traits and Self-Management' factor. This merger reflects the high degree of psychological overlap between 'the planning, monitoring and regulation of one's own cognitive processes' and 'the management of one's own behaviour and motivation'. Meanwhile, the 'Psychological Resilience and Self-Control' factor has been extracted as a distinct psychological resource dimension; together with the previous two factors, it constitutes a comprehensive competency framework of individual–interpersonal–situational coping.

From an international comparative perspective, this shift from a discipline-centred to a competency-centred approach aligns precisely with the cutting-edge consensus on global health professional education reform. *Advances in Health Sciences Education* indicates that contemporary health professional education urgently needs to shift from traditional knowledge-transfer models

towards socially responsive curricula, which aim to equip students not only with clinical competence but also with critical awareness of and adaptability to the social contexts, cultural backgrounds and health systems they serve[34]. At the operational level, the three-factor structure identified in this study provides concrete and measurable assessment dimensions for this transition: ‘Personal Traits and Self-Management’ corresponds to students’ capacity for autonomous and lifelong learning; ‘Interpersonal Collaboration and Service Mindset’ corresponds to interprofessional collaboration and community responsiveness; and ‘Psychological Resilience and Self-Regulation’ corresponds to the ability to adapt and persevere in complex health contexts. This positioning ensures that the research tool is not merely a regional assessment scale, but rather a practical tool for workforce monitoring aligned with the global agenda for reform in health professional education.

Unpacking the Three-Factor Model: Theoretical Grounding and Educational Relevance

Following an exploratory factor analysis of the questionnaire, a total of three factors were identified and nine items were removed. The 27 items ultimately retained are distributed across the following three constructs: (1) personal traits and self-management; (2) interpersonal collaboration and service orientation; and (3) psychological resilience and self-control. The results of the factor analysis confirmed the multidimensional structure of this self-assessment questionnaire. The three dimensions identified in this study are intrinsically consistent with the core dimensions of the classical theoretical framework for public health professional readiness.

The first factor, ‘Personal Traits and Self-Management’, captures self-awareness in goal-setting, autonomous learning, problem-solving, and career planning, aligning closely with the 'self-concept' and 'traits' strata of McClelland's Iceberg Model [26]. These deep-seated characteristics, more resistant to short-term training than surface-level knowledge, exert decisive influence on long-term professional performance [2]. Wang et al.'s recent finding that academic motivation mediates the relationship between research participation and competence further underscores self-management as a psychological mechanism through which learning experiences translate into perceived capability [33]. The second factor, ‘Interpersonal Collaboration and Service Awareness’, encompasses teamwork, communication, coordination, and client-centred professional behaviour, corresponding to the 'attitudes and values' layer of competence onion models. This factor's emergence as a distinct dimension resonates with Frenk et al.'s call for interprofessional, team-based education and with Iskandar et al.'s finding that communication and collaboration scored lowest among Lebanese public health practitioners, suggesting that this domain demands systematic pedagogical attention [8,35].The third factor, ‘Psychological Resilience and Self-Control’, addresses emotional regulation, setback coping, and self-efficacy under pressure, competencies that Cai et al. identified as indispensable in emergency response contexts [10]and that Zhou et al. found to be among the lowest-scoring domains in a nationwide Chinese survey [12]. Epstein and Krasner conceptualise psychological resilience not merely as adversity tolerance but as a cultivable psychological resource, making it a legitimate and valuable target for educational intervention [36].

The first factor, ‘Personal Traits and Self-Management’, accurately assesses the personal traits and self-management abilities possessed by public health professionals, as well as the extent to which these contribute to their professional readiness; it is an integral part of a readiness-based talent development and evaluation system. Consequently, the items included in the first factor of the questionnaire play a crucial role in assessing this core professional readiness dimension [26]. As deep-seated characteristics within the ‘iceberg model’ of competence, personal traits encompass implicit factors such as an individual’s motivation, self-concept and value orientations. Compared to the surface-level explicit

knowledge and skills, these characteristics are more difficult to acquire through short-term training, yet they have a decisive influence on the long-term professional performance of public health practitioners in complex public health emergency situations [2]. The second factor, 'interpersonal collaboration and service orientation', involves cultivating public health professionals' ability to collaborate and their service orientation. This is an indispensable component in the construction of an integrated public health service system. Should the public health education system fail to systematically cultivate students' teamwork abilities, communication skills and professional values oriented towards the needs of service users, this may result in graduates struggling to effectively carry out multi-sectoral collaboration and community mobilisation in primary healthcare practice, thereby affecting the effectiveness of public health interventions and population health outcomes [35]. The cultivation of a service-oriented mindset significantly influences students' professional identity and sense of mission. By shaping their understanding of the core values of public health services, their approach to community health promotion, and the extent to which they prioritise the needs of service users in practice, service-oriented education profoundly influences students' professional behaviour patterns [37,38]. Consequently, the content, approaches and evaluation methods of service-oriented education directly influence the development of interpersonal collaboration skills among students in preventive medicine. The third factor, 'psychological resilience and self-regulation', accurately assesses the level of psychological resilience and self-regulation among public health professionals, as well as the extent to which these contribute to their professional adaptation and development; it is likewise an indispensable core component of a readiness-based public health education evaluation system. Consequently, the items comprising the third factor of the questionnaire play an irreplaceable role in assessing this dimension of an individual's psychological resources. Psychological resilience, defined as an individual's capacity for positive adaptation in the face of adversity, trauma or sustained stress, has been confirmed by numerous studies as a key protective factor for public health practitioners in maintaining occupational stability and service quality. In high-pressure situations such as infectious disease pandemics and emergency responses to public health incidents, frontline public health workers are constantly confronted with intense workloads, the pressures of emergency response and the risk of occupational burnout. A lack of sufficient psychological resilience and emotional regulation skills may lead to diminished attention, decision-making biases and even occupational exhaustion, thereby affecting the overall operational effectiveness of the public health emergency response system [10]. The cultivation of psychological resilience significantly influences students' capacity for sustainable career development. By shaping their cognitive evaluation of work-related stressors, their choice of emotional regulation strategies in high-pressure situations, and their approach to constructing meaning in professional dilemmas, psychological resilience education profoundly influences the long-term occupational adaptation and developmental trajectories of public health practitioners [36]. Consequently, the content, training methods and effectiveness assessment mechanisms of psychological resilience education directly influence the self-regulation abilities and occupational mental health levels of students specialising in preventive medicine [39]. This process of learning and growth is also positively shaped by the professional feedback, psychological support and the exemplary role of mentors that individuals receive during clinical placements and professional training [37].

Predictive Validity: Professional Satisfaction as a Proxy for Professional Identity

Professional satisfaction, as the criterion variable, reflects students' sense of identity regarding the kind of person I am becoming, rather than their satisfaction with the course content. Therefore, the strong correlation in predictive validity indicates that this questionnaire measures the formation of

professional identity rather than the acquisition of knowledge. The results of the predictive validity analysis in this study show that all three professional readiness dimensions are significantly and strongly positively correlated with students' overall professional satisfaction, with the strongest correlation observed for the 'Personal Traits and Self-Management' dimension. This indicates that students place the greatest value on their development in intrinsically driven competencies such as goal-setting, self-directed learning and problem-solving, which are regarded as the core foundations of professional growth. This finding is consistent with the results of a survey conducted by Madadin et al.on the first cohort of graduates from the integrated curriculum in Saudi Arabia, in which students scored highly on self-efficacy in 'identifying their own abilities, weaknesses and educational needs', and graduates reported the highest levels of satisfaction with teamwork and multidisciplinary work [40]; this further supports the close association between self-management abilities and professional satisfaction. Furthermore, a large-scale survey by Zhang Chunhua et al. among staff at Chinese disease control institutions found that satisfaction with incentive mechanisms stood at only 71.0%, with satisfaction levels decreasing as years of service increased [41], this suggests that the cultivation of internal resources, such as psychological resilience, is crucial for maintaining long-term job satisfaction among public health professionals. The strong positive correlation between the 'psychological resilience and self-control' dimension and professional satisfaction in this study further supports this conclusion.

Strengths, Limitations, and Future Directions

This study has the following strengths. First, it systematically assessed the psychometric properties of the Public Health Professional Readiness Self-Assessment Questionnaire using multiple validation approaches, including content validity, construct validity, and predictive validity.Second, this was a multi-centre survey with participants drawn from three medical universities across eastern, central, and western Shandong Province, ensuring good geographical representativeness.

However, several limitations should be acknowledged. First, the cross-sectional design captures self-assessed competence at a single time point and cannot reveal the dynamic process of competence development or causal relationships.Second, the measurement relies on students' self-reports, which may be subject to subjective biases such as social desirability effects, self-confidence levels, and educational and cultural backgrounds. Although self-assessment is a valuable component of competence evaluation and promotes learner reflection and autonomous development, the exclusive reliance on self-report data means that the results reflect perceived rather than observed competence. Third, this study collected data solely from the student perspective and did not incorporate the views of other stakeholders, such as teachers, practicum supervisors, or employers. Future work could incorporate supervisor-rated or peer-rated competency assessment to triangulate against student self-reports, thereby providing a more comprehensive validation of the instrument.

Implications for Global Health Professions Education

Although this study is based on data from Shandong Province, China, the three-factor structure demonstrates cross-contextual consistency at a theoretical level with the six competency domains outlined by the WHO (2024) and the ASPHER competency inventory [30, 31]. This theoretical commonality lays the foundation for the adaptation and wider application of this tool in other countries and cultural contexts. The three-factor structure identified in this study provides a framework for competency-based curriculum design that is transferable across national borders. This framework deconstructs student competencies into three levels: individual self-management, interpersonal interaction and service provision, and situational adaptation and response. This classification logic is

not only applicable to preventive medicine education in China but can also serve as a reference for undergraduate public health education in other countries. Taking the practice at the Bloomberg School of Public Health at Johns Hopkins University as an example, the institution adopts a competency framework accredited by the Council on Education for Public Health (CEPH), covering seven major domains: evidence-based approaches, health systems, policy, leadership, communication, interprofessional practice and systems thinking. Its curriculum includes explicit competency-oriented self-assessment components; for instance, in the Public Health Practice Tools module, students are required to complete a competency self-assessment to identify their strengths and areas for development, and to incorporate the assessment results into the formulation of their individual learning plans. The self-assessment tool developed in this study can be directly adapted to such internationally recognised competency development plan teaching components, providing teachers with baseline assessment data and offering students a reference framework for self-monitoring. From a broader perspective, global public health education is currently undergoing a paradigm shift from knowledge transfer to competency development [34]. In this transition, assessment tools that capture students' self-perceived competence development have become critical infrastructure. The contribution of this study lies in providing a measurement scheme for the ‘student self-perceived competence’ dimension within this infrastructure. Within the Global Health Competence Model proposed by the Consortium of Universities for Global Health (CUGH) and the EPHF Competence Monitoring Study promoted by the International Consortium for Accreditation of Public Health Education (ICAPHE), this tool complements the aforementioned international frameworks: the former focuses on curriculum standards regarding ‘what should be learnt’, whilst the latter focuses on the assessment of learning outcomes regarding ‘what has been learnt’.

Conclusions

This study describes the process of developing and validating a competency-based self-assessment questionnaire for undergraduate students in preventive medicine. The results indicate that the questionnaire possesses good construct validity, with factor analysis identifying three constructs: (1) personal traits and self-management; (2) interpersonal collaboration and service orientation; and (3) psychological resilience and self-control. The three-factor structure suggests that students organise their self-perceived professional readiness by functional domains rather than curricular subjects. This instrument provides a practical tool for monitoring students' self-perceived professional readiness among the future public health workforce in China and potentially other LMICs.

Abbreviations

WHO:World Health Organisation; ASPHER:Association of Schools of Public Health in the European Region; PHEP:Public Health Emergency Preparedness; CDC:Centers for Disease Control and Prevention; CVI:content validity index; EFA:exploratory factor analysis; PCA:Principal component analysis; KMO:Kaiser-Meyer-Olkin; CFA:confirmatory factor analysis; CFI:Comparative Fit Index; RMSEA:root mean square error of approximation; SRMR:standardized root mean square residual; TLI:Tucker-Lewis index; NNFI:Non-Normative Fit Index; AIC:Akaike Information Criterion; CMV:Common Method Variance; CR:composite reliability; AVE:average variance extraction; IDCCS:Infectious Disease Control and Prevention Competency Scale for Public Health Professionals; SCCT:Social Cognitive Career Theory; CEPH:Council on Education for Public Health; CUGH:Consortium of Universities for Global Health; ICAPHE:International Consortium for

Accreditation of Public Health Education

Supplementary Information

Additional file 1. English version of the 27-item competency self-assessment questionnaire for undergraduate preventive medicine students.

Authors' contributions

L.Y.S.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft. J.F.W. and S.H.B.: Conceptualization, Writing - review & editing; J.H.Z. and J.B.S.: Conceptualization, Data curation, Investigation, Project administration, Writing - review & editing; C.P.W. and H.Q.A.: Conceptualization, Data curation, Investigation, Project administration, Resources, Supervision, Validation, Writing - review & editing.

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Data availability

The datasets generated and analysed during the current study are not publicly available due to the sensitive nature of the data and concerns regarding participant privacy. The data are stored at the School of Public Health, Shandong Second Medical University, and are available from the corresponding author on reasonable request, subject to approval by the institutional ethics committee.

Declaration

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Weifang Medical University (Approval No.: 2021YX130; Note: Weifang Medical University was renamed Shandong Second Medical University in December 2023). All participants were informed of the purpose and procedure of the study prior to the commencement of the survey, and each participant signed an informed consent. Participation was entirely voluntary, and all data were anonymised to ensure confidentiality.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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