

Latent Profile Analysis of Medical Students' Science Popularization Ability and Its Relationship with eHealth Literacy and Volunteer Service Motivation: A Cross-sectional Study

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Abstract

Background

As the main force in future medical science popularization, cultivating medical students' science popularization ability plays a crucial role in improving public health literacy. However, current research mainly focuses on the overall level of medical students' science popularization ability and its relationship with other variables, ignoring the individual heterogeneity of medical students' science popularization ability.

Objective

To identify distinct latent profiles of medical students' science popularization ability, and to examine the associations of demographic and sociological variables, eHealth literacy, and volunteer service motivation with these profiles.

Methods

From January to April 2026, medical students from five medical colleges in Heilongjiang Province were recruited as participants. An online questionnaire survey was conducted using the General Information Questionnaire, the Medical Science Popularization Ability Scale, the eHealth Literacy Scale, and the Volunteer Service Motivation Scale. Latent profile analysis, univariate analysis, and logistic regression analysis were used to explore their associations with demographic and sociological variables, eHealth literacy, and volunteer service motivation.

Results

A total of 528 valid questionnaires were collected, with an effective response rate of 96.0%. Two latent profiles were identified: the low ability type (35.2%) and the moderate ability type (64.8%). The ability to transform complex professional knowledge into plain language, the communication ability with people of different cultural levels, and volunteer service motivation were independent predictors of the profile types.

Conclusion

Medical students' science popularization ability can be categorized into two latent profiles: low ability type and moderate ability type. Higher volunteer service motivation was associated with a greater likelihood of belonging to the moderate ability type. However, students who rated their ability to transform complex professional knowledge into plain language as moderate, and those who rated their communication ability with people of different cultural levels as moderate, had a lower likelihood of belonging to the moderate ability type, which may indicate a self-assessment bias in language ability among students. Targeted stratified training strategies, stimulating volunteer motivation, and establishing diversified language training may effectively improve medical students' science popularization ability.

Introduction

The "Healthy China 2030 Planning Outline" proposes adopting a people-centered approach to health, strengthening health promotion and education, and improving national health literacy[1]. Medical science popularization serves as a critical bridge linking professional medical knowledge with public health needs, playing a vital role in promoting healthy behaviors, raising disease prevention awareness, and advancing the Healthy China initiative[2, 3]. As an essential component of medical and health personnel, medical students represent a key group in conducting medical science popularization. Their level of science popularization ability is closely related to the development of medical science popularization in China and national health literacy[4, 5]. Therefore, clarifying the characteristics of medical students' science popularization ability and exploring its influencing factors are of great significance for advancing medical science popularization in China and enhancing national health literacy.

Medical science popularization ability refers to the comprehensive ability of individuals to transform professional medical knowledge into information that can be understood, accessed, and used by non-professional audiences for health decision-making, thereby promoting the improvement of public health literacy. It is also a multi-dimensional composite quality covering science popularization cognition, science popularization creation ability, etc. and there are obvious individual differences among different medical students. Existing research mostly focuses on the overall level of medical students' science popularization ability and the analysis of influencing factors, but has not fully explored its heterogeneous characteristics, making it difficult to accurately distinguish the characteristics and differences of medical student groups with different levels of science popularization ability, and unable to provide a reliable basis for hierarchical and targeted cultivation of medical students' science popularization ability. Therefore, exploring the latent profiles of medical students' science popularization ability and analyzing the related influencing factors are urgent problems to be solved in the current training of medical science popularization talents and the promotion of the Healthy China initiative.

eHealth literacy refers to the ability to seek, find, understand, and evaluate health information from electronic sources, and apply the acquired knowledge to solve health problems[6]. A nationwide Israeli study[7] found that individuals with high electronic media health literacy usually perform better in information processing and health management, and obtain richer health information benefits. Diviani et al. [8] showed that the ability to screen, identify, and integrate high-quality health information is highly correlated with science popularization ability. In this context, improving the ability to obtain and screen health information through electronic media has become the foundation for medical students to carry out medical science popularization work. However, most existing studies explore the role of eHealth literacy in health behavior change and disease self-management, and research on the relationship between eHealth literacy and medical science popularization ability is relatively limited[9]. Therefore, this study includes eHealth literacy in the research to explore its impact on the latent profiles of medical students' science popularization ability.

Volunteer service motivation refers to the psychological driving force that drives individuals to actively engage in and maintain volunteer service behavior[10]. Wang et al.[11] showed that whether people have altruistic and reciprocal social motivations determines whether they are willing to disseminate health science content, not just depending on their knowledge level. Luo et al.[5] stated that whether medical students have medical science popularization experience is one of the main influencing factors of medical science popularization ability. In this context, volunteer service motivation is closely related to medical students' medical science popularization ability. However, current research on volunteer service motivation mostly focuses on the status of volunteer service behavior and willingness to participate, and has not deeply explored its relationship with medical science popularization ability[12, 13]. Therefore, this study includes volunteer motivation to explore its impact on the latent profiles of medical students' science popularization ability.

Latent Profile Analysis (LPA) is a person-centered method that can reveal hidden group structures in data, discover different latent profiles or subgroups, and help to better understand the heterogeneity within the sample[14, 15]. In this study, we aim to use LPA to identify different latent profiles of medical students' science popularization ability, and further analyze the differences in demographic and sociological characteristics, eHealth literacy, and volunteer service motivation among different latent profiles, clarify the characteristics of medical students in different profiles, and provide an empirical basis for the subsequent development of hierarchical and precise training programs for medical students' science popularization ability and the promotion of medical science popularization in China.

Therefore, this study aims to: 1) use LPA to identify different latent profiles of medical students' science popularization ability; 2) explore the relationship between eHealth literacy, volunteer service motivation, demographic factors, and different science popularization ability profiles.

Methods

2.1 participants

This study is a cross-sectional study. Using convenience sampling, medical students from five medical colleges in Heilongjiang Province were recruited as participants from January to April 2026. The inclusion criteria were: (1) provided informed consent and participated voluntarily; (2) full-time students in medical-related majors (including clinical medicine, nursing, pharmacy, etc.); (3) able to understand the questionnaire content and complete it independently. The exclusion criteria were: (1) participation in similar studies; (2) incomplete questionnaire responses or logical inconsistencies.

The minimum sample size of this study should be at least 10–20 times the number of independent variables in the questionnaire [16]. This study included 23 independent variables. Considering a potential invalid response rate of 10%–15%, the required sample size ranged from 256 to 541 cases. Referring to the sample size recommendations of Ferguson et al.[17] and Nylund-Gibson et al.[18] for latent profile analysis(300–500 samples), a total of 550 questionnaires were distributed. Finally, 528 valid questionnaires were returned, yielding an effective response rate of 96.0%.

2.2 Measures

2.2.1 General information questionnaire

The demographic questionnaire was self-developed by the research team and comprised eight items:gender, age, major, current educational level, participation in science popularization activities, ability to transform complex professional knowledge into plain language, communication ability with people of different cultural levels, and personality tendency.

2.2.2 Medical Science Popularization Ability Scale

The Medical Science Popularization Ability Scale developed by Ye Siyang et al. [19]was used to assess participants' medical science popularization ability. This scale comprises six dimensions:: science popularization cognition (5 items), science popularization creation ability (7 items), science popularization communication ability (8 items), professional values and personality traits (9 items), quality of science popularization works (10 items), and science popularization effect and feedback (3 items), with a total of 42 items. Items were rated on a 5-point Likert scale,

ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The total score ranges from 42 to 210, with higher scores indicating a greater level of medical science popularization ability. Ye Siyang et al.[19] reported a Cronbach's α of 0.923 for this scale. In this study, The Cronbach's α is 0.906.

2.2.3 eHealth Literacy Scale

The scale was originally developed by Norman[20]. To account for cultural differences and the evolution of Web 2.0 technology, Tang Zeng et al.[21] adapted the scale for use in the Chinese context. The adapted scale comprises 20 items categorized into three dimensions: health information acquisition ability (7 items), health information evaluation ability (8 items), and health information practice ability (5 items). Each item is rated on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Total scores range from 20 to 100, with higher scores indicating greater eHealth literacy. Tang Zeng et al.[21] reported a Cronbach's α of 0.915 for the adapted scale. In this study, The Cronbach's α is 0.922.

2.2.4 Volunteer Service Motivation Scale

Based on the Volunteer Functions Inventory developed by Clary et al.[22], this scale was adapted by Jiang Wei[23]. It comprises six dimensions: understanding, career development, value expression, self-enhancement, protective, and social, with three items per dimension. Each item is rated on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Total scores range from 18 to 90, with higher scores indicating stronger volunteer motivation. Chen Meiling et al.[24] reported a Cronbach's α of 0.948 for this scale, in this study, The Cronbach's α is 0.925.

2.3 Data Collection

Data were collected using the online survey platform Questionnaire Star (<https://www.wjx.cn>). Before the formal survey, trained investigators sent electronic invitations to potential participants via counselors or student leaders from various colleges, detailing the research purpose, ethical principles, and intended academic use. The questionnaire was configured with a forced-response option to prevent missing data and restricted to one submission per IP address. A maximum response time of 30 minutes was set for each questionnaire. Participants completed the questionnaire anonymously and voluntarily after providing informed consent. Following data collection, two researchers independently screened all questionnaires. Questionnaires were excluded if they met any of the following criteria: (1) response time less than 200 seconds or more than 1800 seconds; (2) obvious patterned responding; (3) logical inconsistencies in demographic information. Of the 550 questionnaires distributed, 22 were excluded, yielding 528 valid responses (effective response rate: 96.0%).

2.4 Statistical Analysis

Data analysis was performed using SPSS 25.0 and Mplus 8.3. The skewness coefficients of the main variables in this study ranged from -1.043 to 0.360, and the kurtosis coefficients ranged from -0.903 to 2.340. The absolute values were all below 3, indicating an approximately normal distribution[25]. In descriptive analysis, continuous variables were expressed as mean $\pm$ standard deviation, and categorical variables were expressed as frequency and percentage. Chi-square test or Fisher's exact test was used to compare categorical variables, and independent sample t-test was used for continuous variables. A two-tailed significance level of $p < 0.05$ was considered statistically significant.

Latent Profile Analysis (LPA) was conducted using Mplus 8.3. The mean scores of the six dimensions of the Medical Science Popularization Ability Scale were used as manifest variables. Models with 1 to 5 latent profiles were sequentially specified. Model fit was evaluated using the Akaike Information Criterion (AIC), Bayesian

Information Criterion (BIC), adjusted Bayesian Information Criterion (aBIC), Entropy, Lo-Mendell-Rubin adjusted Likelihood Ratio Test (LMRT), and Bootstrap Likelihood Ratio Test (BLRT). Smaller AIC, BIC, and aBIC values indicate better model fit[26]. Entropy value > 0.8 indicates high classification accuracy[18, 27]. A significant LMRT and BLRT ($P < 0.05$) indicates that the k-class model provides a significantly better fit than the k-1 class model[28]. Additionally, to ensure model stability and interpretability, it was required that each latent class comprised at least 10% of the total sample[29]. The optimal latent profile model was determined by integrating the above indicators and theoretical interpretability.

After determining the optimal number of profiles, SPSS 25.0 was used to conduct univariate analyses to compare the differences across profile groups. Finally, binary logistic regression analysis was performed with the profile classification as the dependent variable, to examine the effects of eHealth literacy, volunteer motivation, and demographic factors on science popularization ability profiles. The significance level was set at $p < 0.05$.

2.5 Ethical considerations

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Harbin Medical University (Ethics Approval No.: SWYX-2024-344). The researchers explained the research purpose to the participants before data collection, emphasized the voluntary and anonymous nature of participation, and stated that all data would be used only by the research team.

3 Results

3.1 Demographic Characteristics of the Participants

As shown in Table 1, a total of 528 medical students were included in this study, Participants had a mean age of (19.45 ± 1.34) years, and the majority were female(88.8%). Most students majored in nursing (94.9%), and the current educational level was junior college (92.0%). More than half of the students (55.3%) had participated in science popularization activities. 63.6% of the students rated their ability to transform complex professional knowledge into plain language as moderate, and 58.3% of the students rated their communication ability with people of different cultural levels as moderate. 56.1% of the students had a personality between introversion and extroversion. The average score of eHealth literacy was (73.29 ± 15.16), and the average score of volunteer motivation was (35.65 ± 10.79).

Table 1
Characteristics of the participants and univariate analysis of different latent profiles

Variable	Total n(%)	Low ability n(%)	Moderate ability n(%)	t/χ²	P
Gender					
Male	59(11.2)	16(9.1)	43(12.2)	1.154	0.283
Female	469(88.8)	160(90.9)	309(87.8)		
Age (years,x ± s)	19.45 ± 1.34	19.31 ± 1.14	19.51 ± 1.42	-1.685	0.093
Major					
Clinical medicine (incl. anesthesia, pediatrics)	7(1.3)	0(0.0)	7(2.0)	5.737	0.057
Nursing (incl. midwifery)	501(94.9)	169(96.0)	332(94.3)		
Others (incl. pharmacy, imaging, etc.)	20(3.8)	7(4.0)	13(3.7)		
Current educational level					
Junior college	486(92.0)	163(92.6)	323(91.8)	0.403	0.817
Undergraduate	30(5.7)	10(5.7)	20(5.7)		
Postgraduate and above	12(2.3)	3(1.7)	9(2.6)		
Whether participated in science popularization activities					
Yes	292(55.3)	109(61.9)	183(52.0)	4.693	0.030
No	236(44.7)	67(38.1)	169(48.0)		
Ability to transform complex professional knowledge into plain language					
Weak	45(8.5)	5(2.8)	40(11.4)	64.704	0.000
Moderate	336(63.6)	84(47.7)	252(71.6)		
Strong	147(27.8)	87(49.4)	60(17.0)		
Communication ability with people of different cultural levels					
Weak	48(9.1)	5(2.8)	43(12.2)	61.643	0.000
Moderate	308(58.3)	75(42.6)	233(66.2)		
Strong	172(32.6)	96(54.5)	76(21.6)		
Personality tendency					
Introverted	148(28.0)	38(21.6)	110(31.3)	16.163	0.000

Variable	Total n(%)	Low ability n(%)	Moderate ability n(%)	t/ χ^2	P
Gender					
Extroverted	84(15.9)	43(24.4)	41(11.6)		
Intermediate	296(56.1)	95(54.0)	201(57.1)		
eHealth Literacy	73.29(15.16)	77.50(21.39)	71.19(10.19)	3.709	0.000
Volunteer Service Motivation	35.65(10.79)	27.86(10.00)	39.55(8.91)	-13.124	0.000

3.2 Latent Profiles of Medical Students' Science Popularization Ability

To identify latent profiles, models with 1 to 5 latent classes were fitted respectively. The fit indices of different profile models are shown in Table 2. As the number of profiles increased, the AIC, BIC, and aBIC values gradually decreased. For the 2-profile model, the entropy index reached 0.852 (> 0.8), the LMRT was significant ($P = 0.0118$), and the BLRT was significant ($P < 0.001$). Although the 3-profile model had a higher entropy index (0.927), the LMRT was not significant ($P = 0.1584$), and a smaller class (21.2%) appeared in the class probabilities. Considering the model fit indices, classification accuracy, and theoretical interpretability, the 2-profile model was selected as the optimal model.

To verify the reliability of the latent profile analysis results, the average posterior probabilities for each profile were calculated. The results showed that the average posterior probability for Profile 1 was 0.965 and for Profile 2 was 0.955, both close to 1, indicating high classification accuracy and reliable results for the 2-profile model. See Table 3 for details.

Table 2
Fit indices of latent profile models for medical students' science popularization ability

Model	AIC	BIC	aBIC	P		Entropy	Class probability
				LMRT	BLRT		
1	5710.618	5761.847	5723.756				1.000
2	4610.525	4691.637	4631.326	0.0118	<0.001	0.852	0.352/0.648
3	3895.218	4006.214	3923.683	0.1584	<0.001	0.927	0.244/0.544/0.212
4	3785.988	3926.868	3822.117	0.3936	<0.001	0.880	0.138/0.187/0.468/0.207
5	3662.234	3832.998	3706.027	0.0025	<0.001	0.903	0.058/0.117/0.475/0.142/0.208

Table 3
Average latent class probability matrix

Model	Latent class probability (%)	
	Profile 1	Profile 2
1	0.965	0.035
2	0.045	0.955

3.3 Naming of Each Latent Profile

The distribution characteristics of the latent profiles are shown in Fig. 1. Profile 1 included 176 medical students (35.2%). This group had lower scores on all 6 dimensions of science popularization ability, with a science popularization cognition dimension score of (1.259 ± 0.377) , a science popularization creation dimension score of (1.640 ± 0.504) , a science popularization communication dimension score of (1.689 ± 0.484) , a professional values dimension score of (1.270 ± 0.326) , a science popularization work quality dimension score of (1.450 ± 0.424) , and a science popularization effect feedback dimension score of (1.405 ± 0.483) . Therefore, this profile was named the "low science popularization ability group".

Profile 2 included 352 medical students (64.8%). This group had higher scores on all 6 dimensions than Profile 1, but did not reach a high level of science popularization ability. The scores on each dimension were in the moderate range, with a science popularization cognition dimension score of (1.957 ± 0.529) , a science popularization creation dimension score of (2.417 ± 0.456) , a science popularization communication dimension score of (2.449 ± 0.425) , a professional values dimension score of (2.121 ± 0.404) , a science popularization work quality dimension score of (2.343 ± 0.442) , and a science popularization effect feedback dimension score of (2.305 ± 0.514) . Therefore, this profile was named the "moderate science popularization ability group".

As shown in Table 4, the differences between the two groups in all dimensions of science popularization ability were statistically significant ($P < 0.001$). The moderate science popularization ability group performed better than the low science popularization ability group in all dimensions.

Table 4
Comparison of each dimension of medical science popularization ability between the two latent profiles

Variable	Low ability Mean(SE) n = 176	Moderate ability Mean(SE) n = 352	t	P	Pairwise comparison
S1(Science cognition)	1.259(0.377)	1.957(0.529)	-17.434	0.000	Moderate > Low
S2(Science creation)	1.640(0.504)	2.417(0.456)	-17.226	0.000	Moderate > Low
S3(Science communication)	1.689(0.484)	2.449(0.425)	-18.481	0.000	Moderate > Low
S4(Professional values)	1.270(0.326)	2.121(0.404)	-24.258	0.000	Moderate > Low
S5(Quality of works)	1.450(0.424)	2.343(0.442)	-22.182	0.000	Moderate > Low
S6(Effect feedback)	1.405(0.483)	2.305(0.514)	-19.345	0.000	Moderate > Low

3.4 Univariate Analysis of Latent Profiles

The results of chi-square test and t-test showed that there were significant differences between the two groups in whether they had participated in science popularization activities, ability to transform complex professional knowledge into plain language, communication ability with people of different cultural levels, personality tendency, eHealth literacy, and volunteer motivation ($P < 0.05$). However, there were no significant differences in gender, age, major, or current educational level. See Table 1 for detailed results.

3.5 Logistic Regression Analysis of Latent Profiles

With the profile classification result as the dependent variable (low ability type = 0, moderate ability type = 1), and the 8 variables that were statistically significant in the univariate analysis as independent variables, a binary logistic regression analysis was performed. The results (Table 5) showed that the ability to transform complex professional knowledge into plain language (OR = 0.198, 95% CI: 0.057–0.690, $P = 0.011$), communication ability with people of different cultural levels (OR = 0.305, 95% CI: 0.095–0.978, $P = 0.046$), and volunteer motivation (OR = 1.136, 95% CI: 1.104–1.169, $P < 0.001$) were independent predictors of the science popularization ability profile type.

Specifically, medical students with higher volunteer motivation were more likely to belong to the moderate science popularization ability type (OR = 1.136). That is, for each 1-point increase in volunteer motivation, the likelihood of belonging to the moderate science popularization ability type increased by 13.6%. Students with a moderate ability to transform complex professional knowledge into plain language had an 80.2% lower likelihood of belonging to the moderate science popularization ability type (OR = 0.198). Students with moderate communication ability with people of different cultural levels had a 69.5% lower likelihood of belonging to the moderate science popularization ability type (OR = 0.305). It is worth noting that whether they had participated in science popularization activities, personality tendency, and eHealth literacy did not reach statistical significance in the multivariate analysis, suggesting that these factors may indirectly affect the science popularization ability profile through other variables.

Table 5

Multivariate logistic regression analysis of latent profiles of medical students' science popularization ability

Variable	β	SE	Wald χ^2	P	OR(95%CI)
Participated in science popularization activities	-0.108	0.254	0.181	0.671	0.898(0.546,1.476)
Ability to transform complex professional knowledge into plain language					
Weak	-0.536	0.606	0.782	0.377	0.585(0.178,1.920)
Moderate	-1.618	0.636	6.464	0.011	0.198(0.057,0.690)
Communication ability with people of different cultural levels					
Weak	-0.573	0.576	0.991	0.320	0.564(0.182,1.743)
Moderate	-1.187	0.594	3.989	0.046	0.305(0.095,0.978)
Personality tendency					
Introverted	-0.416	0.391	1.137	0.286	0.659(0.307,1.418)
Extroverted	-0.066	0.294	0.050	0.823	0.936(0.526,1.665)
E-Health Literacy	-0.014	0.008	3.353	0.067	0.986(0.972,1.001)
Volunteer Motivation	0.128	0.015	74.862	0.000	1.136(1.104,1.169)

4. Discussion

Using a person-centered latent profile analysis approach, this study identified two distinct profiles of medical students' science popularization ability: the "low science popularization ability" group and the "moderate science popularization ability" group. The findings revealed that the ability to translate complex professional knowledge into plain language, communication ability with people of different cultural levels, and volunteer motivation were independent predictors of profile membership.

4.1 Latent Profile Characteristics of Medical Students' Science Popularization Ability

This study identified two latent profiles: low ability type (35.2%) and moderate ability type (64.8%). Most medical students belonged to the moderate ability type, which is similar to the results of Wang et al.[11], while Lu et al.[30] conducted a profile analysis of science popularization ability on 317 nurses in the obstetrics and gynecology department of a tertiary hospital and obtained three types of science popularization ability profiles: low, moderate, and high. However, this study did not identify a high science popularization ability type, which may be related to the characteristics of the study subjects. The sample of this study was mainly composed of nursing students at the junior college level, who did not have a comprehensive knowledge reserve. Luo et al.[5] showed that science popularization ability is closely related to the degree of professional knowledge reserve. Junior college nursing students have a short time to enter the clinic and have not accumulated enough clinical knowledge and science popularization practice experience, so they have not yet formed a high level of science popularization ability. In the future, medical science popularization courses can be offered, or early science popularization practice

opportunities can be increased to help junior college and lower grade medical students consolidate the basic knowledge of science popularization, thereby promoting their medical science popularization ability.

4.2 Relationship between Volunteer Service Motivation and Medical Science Popularization Ability Categories

This study found that medical students with higher volunteer motivation were more likely to belong to the moderate ability type. This finding is consistent with the self-determination theory[31]. The theory believes that intrinsic motivation is the core driving force for individuals to continuously engage in an activity and continuously improve their ability. Students with higher volunteer motivation are more inclined to participate in science popularization activities frequently, thus having higher science popularization ability[5]. It is worth noting that Chen et al.[24] investigated 357 medical student volunteers in a medical university and found that the total score of volunteer service motivation was (74.37 ± 9.16) , which was at a high level. However, the volunteer service motivation score of students with moderate ability in this study was (39.55 ± 8.91) , which was significantly lower than that of the above study. This difference may be related to the sample type: this study selected junior college nursing students as samples, rather than extracting from the volunteer team, and there were differences in the initial level of volunteer motivation. In the future, medical colleges can rely on theme lectures and other channels to popularize the social value of medical science popularization volunteer service, guide students to establish intrinsic recognition of science popularization work, improve students' motivation to participate in science popularization activities, and build a stable science popularization practice platform, so that students who have the willingness to participate can get sufficient practice opportunities, and promote the gradual transformation of volunteer motivation into the improvement of science popularization ability.

4.3 Relationship between Language Transformation Ability, Communication Ability and Medical Science Popularization Ability Categories

This study found that students with a moderate ability to transform complex professional knowledge into plain language and students with moderate communication ability with people of different cultural levels were less likely to belong to the moderate science popularization ability type. Beese et al.[32] concluded that one of the core health literacy skills of health professionals is to communicate health information understandably in oral and written forms, and professionals must transform complex medical content and professional terms into plain language. The reason for the difference from this study may be related to students' self-cognitive bias. Hildenbrand et al.[33] showed that medical students tend to overestimate their communication skills when self-evaluating, that is, some students with weak science popularization ability overestimate their language transformation ability due to the lack of objective feedback. Yufrizal et al.[34] also pointed out that there is a difference between students' language ability and actual performance; students may have cognitive bias when judging their language ability, thus unable to accurately evaluate their own language ability.

In the future, medical colleges can establish a diversified feedback mechanism for science popularization practice, invite audiences of different ages and cultural backgrounds to evaluate students' science popularization performance, help students form an objective understanding of their own language transformation and communication abilities, rely on training activities such as simulated science popularization to provide language training for students, and make up for the shortcomings of their abilities in a targeted manner, thereby improving the overall science popularization ability of medical students.

4.4 eHealth Literacy is Not an Independent Influencing Factor of Medical Science Popularization Ability

It is worth noting that participation in science popularization activities, personality tendency, and eHealth literacy were significant in the univariate analysis, suggesting that these factors may indirectly affect the science popularization ability profile through other variables. Zhang et al.[35] found that eHealth literacy plays a mediating role between mental health literacy and health self-management, and Li et al.[36] found that health promotion behavior plays a mediating role between eHealth literacy and health-related quality of life. It suggests that eHealth literacy may indirectly affect the development of science popularization ability through personal health-related behaviors. Future studies can use structural equation modeling and other methods to explore the relationship between eHealth literacy and science popularization ability.

4.5 Practical Implications for Improving Medical Students' Medical Science Popularization Ability

The findings of this study reveal distinct latent profiles of medical students' science popularization ability, with significant differences in volunteer service motivation, language transformation ability, and communication skills across different profile groups. This provides valuable insights for medical colleges to develop targeted training programs for science popularization competence.

Medical colleges can leverage the existing medical education system to establish specialized course modules on science popularization. These modules should integrate science popularization content creation, public communication skills, and new media strategies into daily teaching, with a specific focus on enhancing students' language transformation and interactive communication skills to address deficiencies in practical science popularization competence. Concurrently, institutions can utilize campus innovation activities and social practice projects to build a science popularization training platform. This encourages medical students to create science popularization materials aligned with their professional directions and to conduct public health lectures and free clinics, thereby accumulating practical experience and improving their science popularization capabilities.

For medical students with different latent profiles, stratified and tailored training should be implemented. For those in profiles characterized by weaker basic science popularization abilities, training should commence with foundational knowledge and basic skill development. Introductory guidance and one-on-one mentoring can help build their confidence and master core competencies. Conversely, for students with relatively stronger foundational abilities, institutions should encourage them to delve into specialized areas of science popularization, participate in advanced science popularization competitions, further hone their skills, and produce high-quality science popularization works. Additionally, the training process should emphasize stimulating students' motivation for science popularization volunteer service.

Enhancing their intrinsic motivation to engage in medical science popularization can guide students to deepen their understanding of the value of such work and proactively improve their own capabilities.

5.Limitations

This study has some limitations. This study is a cross-sectional survey, and a longitudinal follow-up design can be used in the future to explore the development trajectory and influence mechanism of science popularization ability. Secondly, the study subjects were mainly nursing students at the junior college level, and the sample representation

is limited. Future studies should expand the sample scope to include medical students of different levels and majors to improve the generalizability of the results. This study used self-rating scales to collect data, which may have social desirability bias. In the future, objective assessments and evaluations from others can be combined for comprehensive evaluation. Fourth, this study did not use the Bolck-Croon-Hagenaars (BCH) method or R3STEP when exploring the predictors of profiles, which may have estimation bias due to classification uncertainty. Future studies can use more advanced statistical methods such as BCH method or R3STEP to improve the accuracy of parameter estimation and the power of statistical tests. Fifth, this study only discussed two predictors, eHealth literacy and volunteer motivation. In the future, more potential influencing factors can be included to deeply explore the complex mechanism of the formation of science popularization ability.

6. Conclusion

This study identified two latent profiles of medical science popularization ability among medical students: the low ability type and the moderate ability type. Higher volunteer motivation was associated with a greater likelihood of belonging to the moderate type. In contrast, students who rated their ability to translate complex professional knowledge into plain language as moderate, and those who rated their communication skills with people of varying educational backgrounds as moderate, were less likely to belong to the moderate type—possibly reflecting a self-assessment bias in language-related abilities. In the future, medical colleges should develop stratified training programs tailored to students with different ability profiles, actively stimulate volunteer motivation, establish a diversified feedback mechanism for science popularization practice, help students develop an objective understanding of their own language transformation and communication competencies, and address specific ability gaps in a targeted manner. Such efforts would enhance the overall medical science popularization ability of medical students and contribute to improving the health literacy of the broader population.

Declarations

Ethics approval and consent to participate

.This study protocol has been approved by the Ethics Committee of Harbin Medical University (Approval No.:SWYX-2024-344).Written informed consent was obtained from all participants.

Consent for publication

All participants included in this study have consented to the publication

Competing interests

The authors declare no competing interests.

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Author Contribution

W: Responsible for drafting the initial manuscript; formulating research methods; data management; and conceptual construction. P: Responsible for investigation and data management. Z: Responsible for formal data analysis and data management. F: Verification and methodology.

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Not applicable.

Data Availability

Data from this study may be obtained upon reasonable request to the corresponding author, Pang Dong, subject to ethical and legal restrictions (in accordance with national law) and following a confidentiality assessment.

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Figures

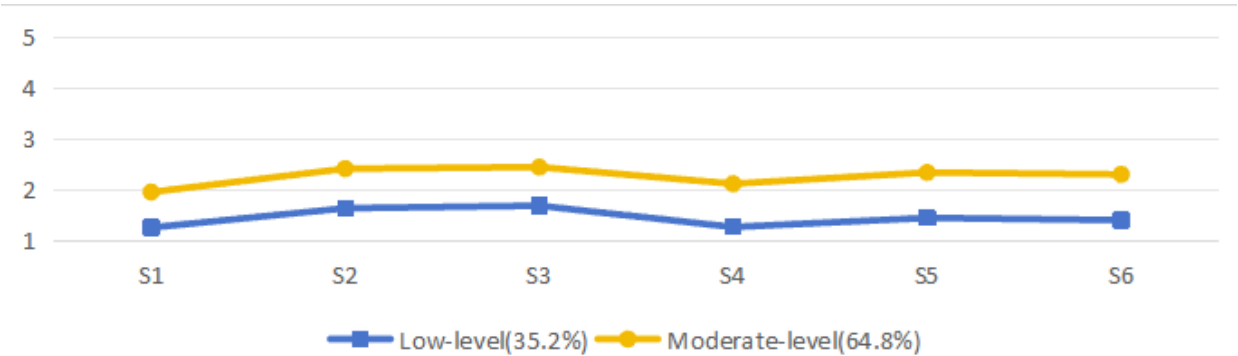


Figure 1

Distribution Characteristics of Latent Profiles of Medical Science Popularization Ability