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ORIGINAL RESEARCH

Willingness of CDC Staff to Participate in Continuing Education in China: A Bayesian Network Analysis

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Objective: To investigate the willingness of China Centers for Disease Control and Prevention (C-CDC) staff in Northeast China to participate in continuing education and identify the factors associated with such willingness.

Methods: This study adopted a cross-sectional design using stratified cluster sampling. Based on Expectancy-Value-Cost (EVC) and Job Demands-Resources (JD-R) theories, literature evidence, and study objectives, the survey variable system was constructed to cover multiple dimensions. Following multiple rounds of questionnaire revision, an online survey was administered to C-CDC staff at different administrative levels in Northeast China, yielding 11,912 valid responses. After identifying relevant variables through univariate analysis, a Bayesian network model was constructed to explore the association and their interrelationships.

Results: A total of 19 variables were identified by univariate analysis as being significantly associated with willingness to participate in continuing education. Bayesian network analysis showed that family support for job, rationality of career development opportunities, work fatigue, and team cohesion were directly associated with willingness to participate in continuing education. Sensitivity analysis further identified nine key nodes. The conditional probability table indicated that when low work fatigue, more rational career development opportunities, higher team cohesion, and stronger family support were present simultaneously, the conditional probability of high willingness to participate in continuing education among C-CDC staff increased to 94.2%.

Conclusion: Bayesian network analysis identified several professional identity related factors, particularly team cohesion, career development opportunities, and family support, as key factors associated with willingness to participate in continuing education. The analysis also revealed complex interrelationships among these factors.

Keywords: bayesian network, continuing education, disease control and prevention staff, interrelationships, willingness

Introduction

In recent years, the frequent emergence of novel infectious diseases has placed unprecedented challenges on disease control and prevention systems.[1–4] Since the 2003 SARS pandemic and COVID-19, China Centers for Disease Control and Prevention (C-CDC) have strengthened the functional capacity building and professional competency development. However, it also suggested that both the emergency response mechanisms of the C-CDC, and more broadly those of CDC systems worldwide still require further strengthening.[5–7] With the rapid development in artificial intelligence (AI) and digital transformation, the operation of CDC system is being profoundly reshaped.[8,9] The roles and responsibilities of CDC staff have undergone substantial changes. Beyond conventional responsibilities such as disease surveillance, epidemiological investigation, outbreak reporting, and health risk assessment, they are increasingly expected to fulfill pivotal roles in emergency responses to public health crises, interdisciplinary collaborations, and policy formulation.[10,11]

In China, the training currently provided for public health and primary healthcare personnel remains insufficient to meet the need for long-term and systematic capacity building. Moreover, some regional staff were experiencing brain

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drain.[12,13] In addition, more than 80% of participants in a survey indicated that the current ability of CDC needs to be improved.[14] As a key pathway to improve the capacity of CDC, continuing education is widely recognized as essential for maintaining competencies in the evolving post-pandemic public health landscape. However, the willingness to participate in continuing education among C-CDC staff remained suboptimal and uneven across regions, roles, and disciplines.[15] Also, studies showed that the actual effectiveness of current continuing education for C-CDC staff falls considerably short of expectations.[16,17] The effectiveness of continuing education implementation may depend on their perception of the effectiveness and value of participating in continuing education.

Previous studies have shown that the willingness to participate in continuing education is influenced by multi-dimensional relationships, including work conditions, continuing education cost, and professional identity.[18–24] The associations hindering medical workers' participation in continuing education included limited funds, insufficient time, high work pressure, and insufficient infrastructure.[19,25] In addition to the distinct professional functions, the CDC staff was characterized by diverse educational backgrounds and professional roles, encompassing fields such as epidemiology, health inspection, health education, and public health management. These occupational characteristics suggested that the determinants of willingness to participate in continuing education may differ from those of other professional groups. However, no research has yet been carried out on the willingness of CDC staff to participate in continuing education or the interactions between the relationships using a network perspective.

In this study, we aim to systematically analyze the factors associated with C-CDC staff's willingness to participate in continuing education and reveal the complex interrelationships among these associations by constructing a network model. We hope the study can provide policymakers with theoretical evidence to improve CDC staff's participation in continuing education and improve the work effectiveness of public health department.

Methods

Theoretical Framework

This study integrated the Expectancy-Value-Cost (EVC) and Job Demands-Resources (JD-R) theories to analyze the interaction among work conditions, continuing education cost, professional identity, and willingness to participate in continuing education.[26,27] According to the EVC theory, individuals' willingness to participate in continuing education is influenced by their overall judgment of the feasibility, subjective value, and perceived cost of the behavior.[27–29] In this framework, value is mainly reflected in individuals' evaluation of the career-related benefits of continuing education and the extent to which it is recognized as meaningful for their work, whereas cost is mainly reflected in the time, energy, workload, and financial investment required. By contrast, the JD-R theory focuses on the work context and emphasizes the role of job demands and job resources in shaping behavioral tendencies.[30–33] In the present study, job demands mainly included work intensity, work fatigue, and work time, whereas job resources mainly included organizational and team support, career development opportunities, and external support factors such as family support and societal recognition. The integrated framework facilitated a more comprehensive analysis of the factors associated with C-CDC staff's willingness to participate in continuing education from both the perspective of individual decision-making and the work context. The flow chart of the study framework was shown in Figure 1.

Research Design and Data Collection

In this study, a cross-sectional survey design was adopted. A stratified cluster sampling method was used to distribute an electronic questionnaire online in May 2023. The strata referred to the regions in Northeast China, whereas the clusters referred to C-CDC institutional units within each stratified region. The objects of this study were on-the-job staff of the C-CDC, including personnel engaged in a range of duties such as administrative management, health supervision, and emergency response. After the variables were preliminarily determined based on the theoretical framework and relevant literature, we further invited two senior experts in the field and several research professionals to discuss and determined the variable selection and questionnaire items. Data were collected through an anonymous online survey to protect participant privacy and improve the authenticity of responses. Before completing the questionnaire, participants were

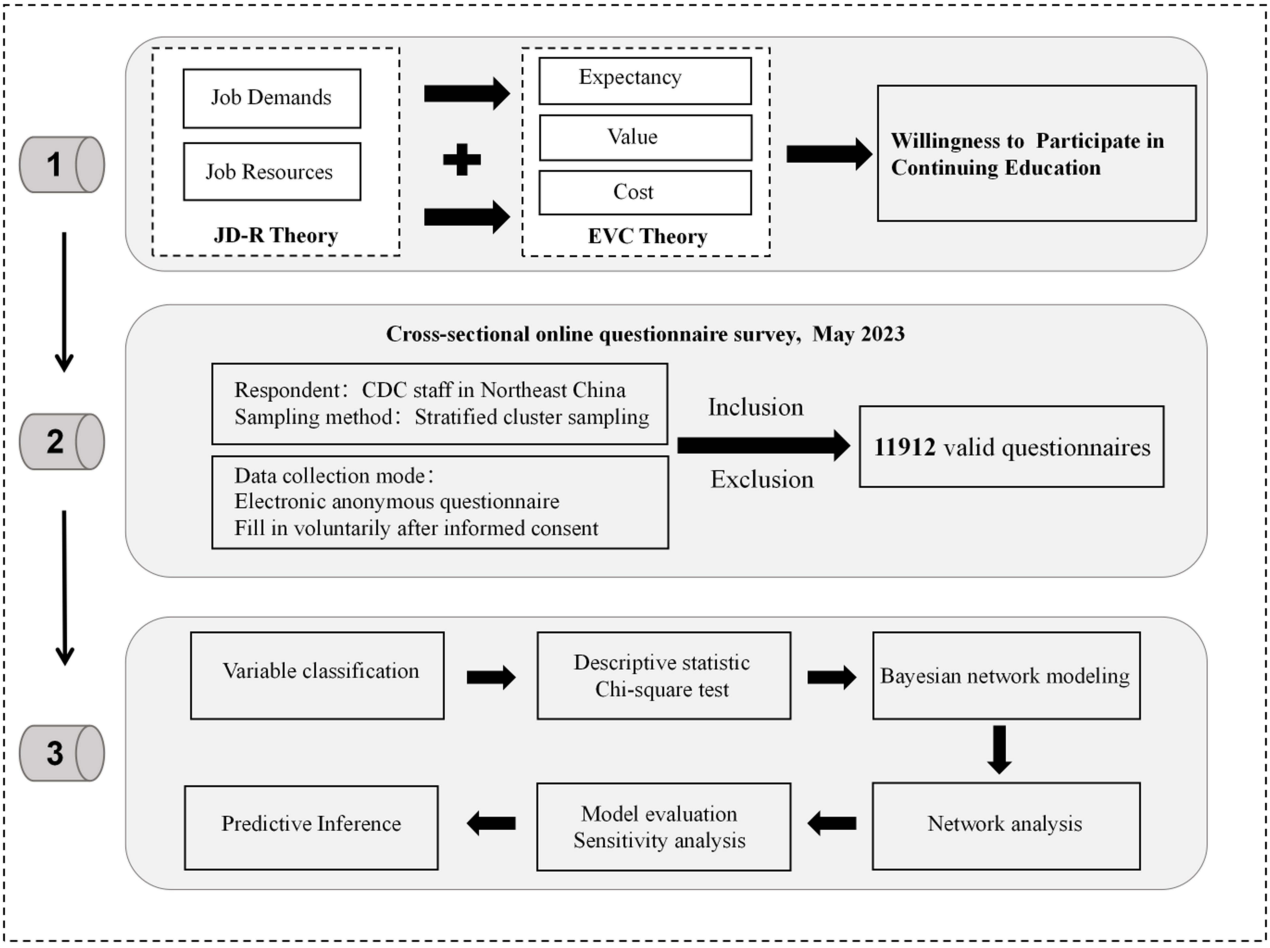

Figure 1 Flow chart of the study framework.

required to voluntarily provide informed consent on the front page of the online survey and confirm the authenticity and accuracy of the information provided.

The sample size in this study was estimated using the formula commonly applied for proportion estimation in cross-sectional surveys, with additional consideration of the stratified cluster sampling design. The formula is as follows:

$$n = deff \times \frac{Z^2_{1-\alpha/2} P(1-P)}{d^2}$$

The two-sided significance level was set at $\alpha = 0.05$, with $P = 0.50$, an allowable error of $d = 0.04$, and a design effect of 2.00. The estimated minimum required sample size was approximately 1,202 participants. A total of approximately 15,000 questionnaires were distributed through the electronic platform. With strong support from CDC institutions across different regions, 12,150 questionnaires were returned. To ensure data quality, questionnaires were excluded according to the following criteria: (1) participants completed the questionnaire in an excessively short time; (2) evidence of obvious patterned responding, such as selecting the same option throughout the questionnaire; (3) clear logical inconsistencies in the responses; (4) failure to provide informed consent or to complete the questionnaire. Finally, 11,912 were ultimately included, indicating that the sample size was sufficient for the statistical analyses.

The questionnaire demonstrated good internal consistency, with a Cronbach's α coefficient of 0.824. The KMO value was 0.877, and Bartlett's test of sphericity was statistically significant ($\chi 2 = 86{,}081.334$, $P < 0.001$), indicating that the data were suitable for factor analysis. A relatively clear three-factor structure was ultimately identified, with a cumulative variance contribution rate of 60.055%, suggesting acceptable structural validity of the questionnaire. Specifically, the

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three dimensions were work conditions, perceived cost of continuing education, and professional identity and support, which were generally consistent with the theoretical framework of the study.

Variable

Dependent Variable

The dependent variable in this study was a dichotomous measure of willingness to participate in continuing education. It was derived from the question: "Are you willing to participate in continuing education?" Response options were listed as (1) Completely unwilling (2) Unwilling (3) Moderate (4) Willing (5) Very willing. For analysis, very unwilling, unwilling, and moderate were classified as low willingness, whereas willing and very willing were classified as high willingness.

Independent Variables

All independent variables in this study were categorical variables, including Sex, Age, Educational level, Work year, Work fatigue, Family support for job, Rationality of career development opportunities, Continuing education cost, and Job achievement, etc. The specific questionnaire items, coding methods, and classification criteria for all variables were presented in Table S1.

Statistical Analysis

Statistical analyses were conducted utilizing R (version 4.4.2), with χ^2-tests performed to examine the associations between C-CDC staff's willingness to engage in continuing education and each predictor variable. The Bayesian network topology was constructed using R and GENIE software. Initially, the Bayesian network model was populated with variables that demonstrated statistical significance in the χ^2-tests, thereby illustrating the interrelationships and hierarchical structure among factors. The "bnlearn" package in R was used to implement the max-min hill-climbing algorithm for structural learning. This process resulted in the generation of an initial network structure. The refinement process was discussed by the research team and domain experts, and the manual refinement was restricted to arcs with directions that were clearly inconsistent with temporal order, theoretical assumptions, or practical interpretability. Subsequently, the refined network structure was visualized in GENIE software. A Delta p sensitivity analysis was then applied to rank the parameters. Finally, a 10-fold cross validation analysis was used to examine the model performance. In addition, we reported the results of the logistic regression analysis in Table S2A and B to better justify our choice of Bayesian network analysis.

Results

A total of 11,912 C-CDC staff members participated in this survey, 32.5% of whom were male and 67.5% were female. Table 1 presents the descriptive statistics and univariate analysis results. The age distribution of participants was relatively even, with the majority holding a bachelor's degree (62.1%), working at district/county-level C-CDC (65.9%), and holding a junior job title (56.3%). Additionally, 36.8% of participants had over 20 years of work experience, and 51.5% reported a post-tax monthly income between 3,000 and 5,000 RMB. The distribution of variables related to work conditions, continuing education costs, and professional identity, as well as their associations with willingness to participate in continuing education, are presented in Table 2.

Bayesian Network Model Construction

In this study, the Bayesian network model was constructed with 20 nodes, comprising 19 explanatory variables identified as significantly associated with continuing education willingness in the univariate analysis. In addition to these variables, continuing education willingness itself was designed as the dependent variable. The topological structure of the Bayesian network and the marginal probabilities of the studied variables are shown in Figure 2, which clearly illustrates the parameter relationships and the structural learning state of the model used to predict the willingness of C-CDC staff to engage in continuing education.

The Bayesian network analysis was used to describe the conditional correlation and joint distribution structure between variables. The edges and directions in the network are used to parameterize conditional probability tables and

Table 1 Sociodemographic characteristics of respondents and results of univariate analysis

Variable	Total N (%)	High Willingness to Participate in Continuing Education N (%)	χ^2	P
Sex			70.042	<0.001
Male	3876(32.5)	3196(31.1)		
Female	8036(67.5)	7079(68.9)		
Age			27.718	<0.001
≤ 30	3208(26.9)	2808(27.3)		
31-40	3332(28.0)	2913(28.5)		
41-50	3010(25.3)	2546(24.8)		
≥ 51	2362(19.8)	1990(19.4)		
Educational level			12.631	0.002
Below bachelor's degree	3472(29.1)	2938(28.6)		
Bachelor's degree	7400(62.1)	6420(62.5)		
Above bachelor's degree	1040(8.7)	917(8.9)		
Job title			4.813	0.090
Junior	6710(56.3)	5747(55.9)		
Intermediate	2272(19.1)	1978(19.3)		
Senior	2930(24.6)	2550(24.8)		
With an authorized establishment post			0.035	0.852
Yes	10374(87.1)	8946(87.1)		
No	1538(12.9)	1329(12.9)		
Institutional classification			5.548	0.062
Provincial or municipal level	708(5.9)	631(6.1)		
Prefectural level	3351(28.1)	2894(28.2)		
County or district level	7853(65.9)	6750(65.7)		
Income monthly			1.891	0.756
< 3000	1603(13.5)	1378(13.4)		
3000-5000	6138(51.5)	5291(51.5)		
5001-7000	2872(24.1)	2475(24.1)		
7001-8000	725(6.1)	625(6.1)		
> 8000	574(4.8)	506(4.9)		

perform predictive inference. The results demonstrated that family support for work, rationality of career development opportunities, work fatigue, and team cohesion were directly associated with willingness to participate in continuing education. Societal recognition of job, professional pride, and sense of job achievement were indirectly associated with willingness to participate in continuing education.

Subsequently, a sensitivity analysis was conducted to evaluate the model's results (Figure 3). The analysis identified nine key nodes as sensitive indicators for predicting C-CDC staff's willingness to participate in continuing education. These indicators include societal recognition of job, family support, team cohesion, sense of job achievement, team belonging, work intensity, rationality of career development opportunities, work fatigue, and professional pride.

Table 3 presented the influence values in the Bayesian model obtained after the above sensitivity analysis, including the interaction effects of the nine nodes associated with the final node factor. The association between sense of job achievement and team belonging (0.357), team belonging and team cohesion (0.461), team belonging and professional pride (0.398) were the most significant values respectively.

The validity and goodness of fit of the Bayesian network model were assessed by means of a receiver operating characteristic (ROC) curve analysis (Figure 4). The Area Under the Curve (AUC) value was 0.69, indicating a moderate discriminative ability and interpreting as a supplementary evaluation of model discrimination. The confusion matrix related to the willingness of C-CDC staff to participate in continuing education was also calculated (Table 4).

Table 2 Work conditions, cost and supporting factors of respondents and results of univariate analysis

Variable	Total N (%)	High Willingness to Participate in Continuing Education N (%)	χ^2	P
Work year			23.451	<0.001
≤ 5	3844(32.3)	3388(33.0)		
6-10	1532(12.9)	1326(12.9)		
11-20	2152(18.1)	1857(18.1)		
≥ 21	4384(36.8)	3703(36.0)		
Work time			1.408	0.235
> 8h	848(7.1)	720(7.0)		
≤ 8h	11064(92.9)	9555(93.0)		
Work intensity			11.515	0.003
Low	180(1.5)	154(1.5)		
Medium	6602(55.4)	5758(56.0)		
High	5130(43.1)	4363(42.5)		
Work fatigue			99.841	<0.001
Low	6929(58.2)	6162(60.0)		
High	4983(41.8)	4113(40.0)		
Time cost			40.458	<0.001
Low	1676(14.1)	1376(13.4)		
Medium	4027(33.8)	3560(34.6)		
High	6209(52.1)	5339(52.0)		
Money cost			4.574	0.032
Low	6317(53.0)	5489(53.4)		
High	5595(47.0)	4786(46.6)		
Workload			8.332	0.004
Low	5699(47.8)	4970(48.4)		
High	6213(52.2)	5305(51.6)		
Energy involved			8.201	0.004
Low	5484(46.0)	4784(46.6)		
High	6428(54.0)	5491(53.4)		
Job achievement			151.178	<0.001
Low	4888(41.0)	3989(38.8)		
High	7024(59.0)	6286(61.2)		
Team belonging			250.086	<0.001
Low	4082(34.3)	3239(31.5)		
High	7830(65.7)	7036(68.5)		
Team cohesion			216.933	<0.001
Low	4006(33.6)	3194(31.1)		
High	7906(66.4)	7081(68.9)		
Professional pride			228.119	<0.001
Low	4257(35.7)	3267(33.1)		
High	7655(64.3)	6875(66.9)		
Personal recognition of job			221.924	<0.001
Low	3614(30.3)	2860(27.8)		
High	8298(69.7)	7415(72.2)		
Family support for job			214.247	<0.001
Low	2710(22.8)	2107(20.5)		
High	9202(77.2)	8168(79.5)		
Societal recognition of job			178.557	<0.001
Low	6483(54.4)	5342(52.0)		
High	5429(45.6)	4933(48.0)		

(*Continued*)

Table 2 (Continued).

Variable	Total N (%)	High Willingness to Participate in Continuing Education N (%)	χ^2	P
Income satisfaction			23.288	<0.001
Low	10749(90.2)	9218(89.7)		
High	1163(9.8)	1057(10.3)		
Career development opportunities			153.718	<0.001
Low	7653(64.2)	6378(62.1)		
High	4259(35.8)	3897(37.9)		

Additionally, Table 5 is the conditional probability table of willingness to continue education, exhibiting the probabilistic dependence between work fatigue, rationality of career development opportunities, team cohesion, family support for job and willingness to continue education. The probability of participation in continuing education was increased to 94.2% for C-CDC staff who had lower work fatigue, more rational career development opportunities, better

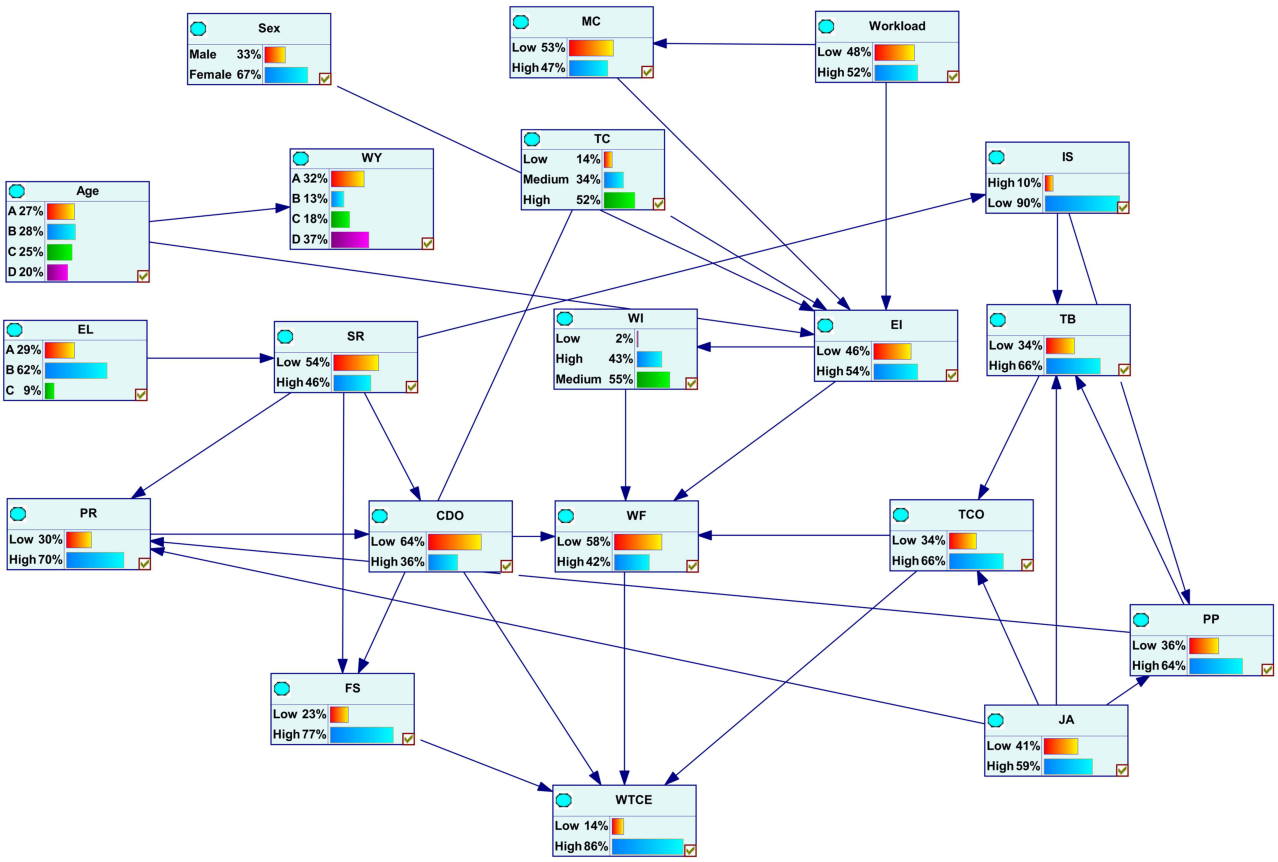

Figure 2 Bayesian networks of CDC staff's willingness to participate in continuing education. A tick marked in the lower-right corner of each node indicated that the node has been fully defined.

Notes: A (≤ 30), B (31–40), C (41–50), D (≥ 51) in Age node; A (≤5), B (6-10), C (11-20), D (≥21) in WY node; A (Below bachelor's degree), B (Bachelor's degree), C (Above bachelor's degree) in EL node.

Abbreviations: EL, Educational level; WY, Work year; WI, Work intensity; WF, Work fatigue; TC, Time cost; MC, Money cost; EI, Energy involved; JA, Job achievement; TB, Team belonging; TCO, Team cohesion; PP, Professional pride; PR, Personal recognition of job; FS, Family support for job; SR, Societal recognition of job; IS, Income satisfaction; CDO, Career development opportunities; WTCE, Willingness to continuing education.

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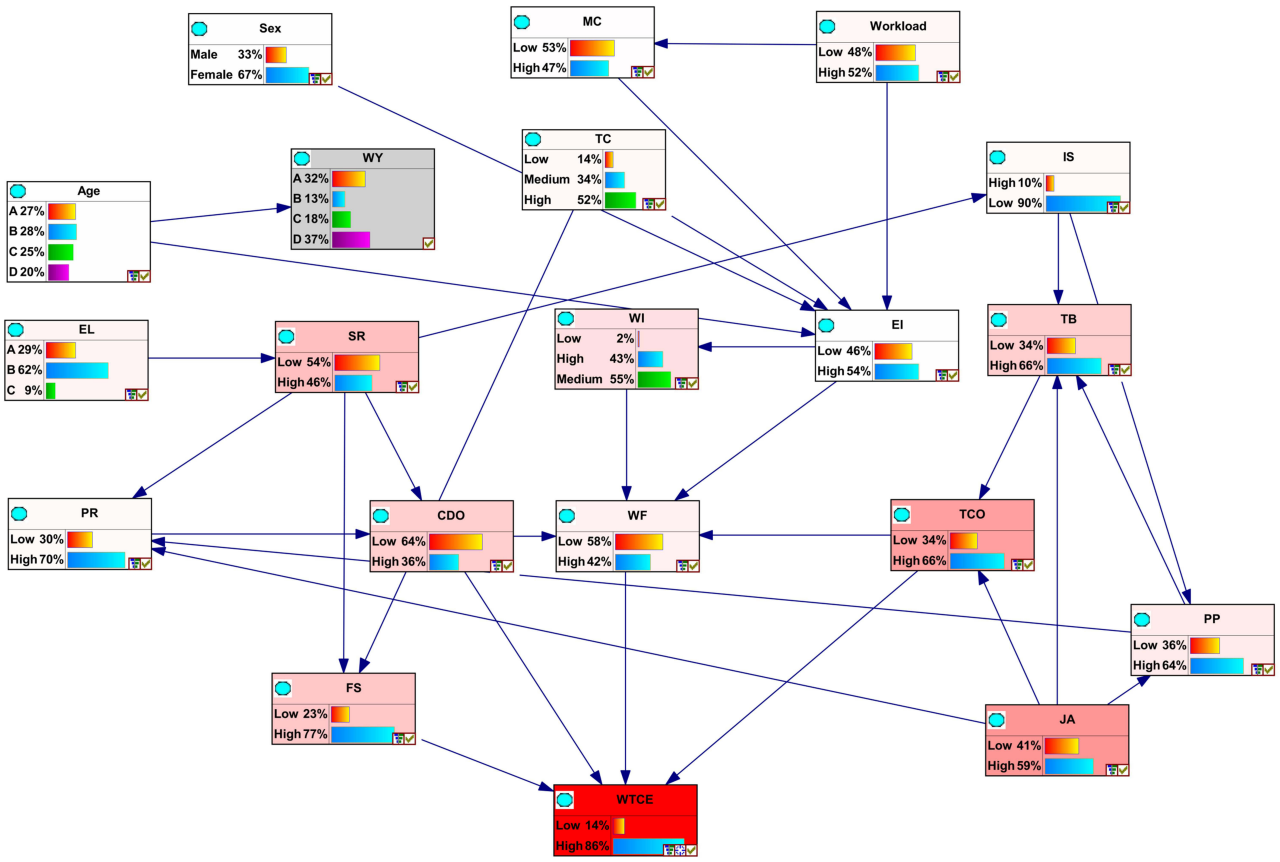

Figure 3 Sensitivity analysis of the Bayesian network model. A tick marked in the lower-right corner of each node indicated that the node has been fully defined.
Notes: A (≤ 30), B (31–40), C (41–50), D (≥ 51) in Age node; A (≤5), B (6-10), C (11-20), D (≥21) in WY node; A (Below bachelor's degree), B (Bachelor's degree), C (Above bachelor's degree) in EL node.
Abbreviations: EL, Educational level; WY, Work year; WI, Work intensity; WF, Work fatigue; TC, Time cost; MC, Money cost; EI, Energy involved; JA, Job achievement; TB, Team belonging; TCO, Team cohesion; PP, Professional pride; PR, Personal recognition of job, FS: Family support for job, SR: Societal recognition of job; IS, Income satisfaction; CDO, Career development opportunities; WTCE, Willingness to continuing education.

team cohesion and family support. However, the probability of participation in continuing education decreased to 72.2% under the opposite conditions.

Bayesian Network Predictive Inference

The Bayesian network model facilitates predictive inference, enabling the analysis of how various behavioral nodes relate to the final outcomes by establishing specific result states. By manipulating the outcome state, the model can determine the likely states of related variables, thereby providing insights into their joint probability with continuing education willingness. As shown in Figure 5(A), when the model was calibrated to reflect a 100% high level of willingness for C-CDC staff to participate in continuing education, a comparison with the original structure revealed varying degrees of increase in key related factors, including societal recognition of job, family support, and the rationality of career development opportunities. While these increases may be considered relatively minor, they nevertheless underscore the important associations these factors have with continuing education willingness.

As shown in Figure 5(B), when the model is calibrated to represent a 100% low willingness for C-CDC staff to participate in continuing education, a comparison with the original structure reveals substantial changes in key related factors. Notably, work fatigue increased by 10%, highlighting the correlation between work conditions and continuing education willingness. Additionally, several professional identity-related factors exhibited notable changes: team cohesion decreased by 11%, rationality of career development opportunities decreased by 10%, sense of job achievement decreased by 7%, family support for job decreased by 10%, team belonging decreased by 10%, societal recognition of

Table 3 The Influence Value From the Association of the Factors in the Bayesian Model

Parent	Child	Influence Value
SR	CDO	0.115
SR	FS	0.160
CDO	WTCE	0.038
CDO	WF	0.062
FS	WTCE	0.061
WI	WF	0.206
WF	WTCE	0.032
TB	TCO	0.461
TCO	WF	0.197
TCO	WTCE	0.049
JA	TCO	0.321
JA	PP	0.343
JA	TB	0.357
PP	TB	0.398

Abbreviations: WI, Work intensity; WF, Work fatigue; TC, Time cost; JA, Job achievement; TB, Team belonging; TCO, Team cohesion; PP, Professional pride; FS, Family support for job; SR, Societal recognition of job; CDO, Career development opportunities; WTCE, Willingness to continuing education.

job decreased by 7%, professional pride and personal recognition of job each decreased by 6%. These findings indicated the significant joint probability between professional identity and continuing education willingness. Based on the above results, several organization-related factors, including team cohesion, rationality of career development opportunities,

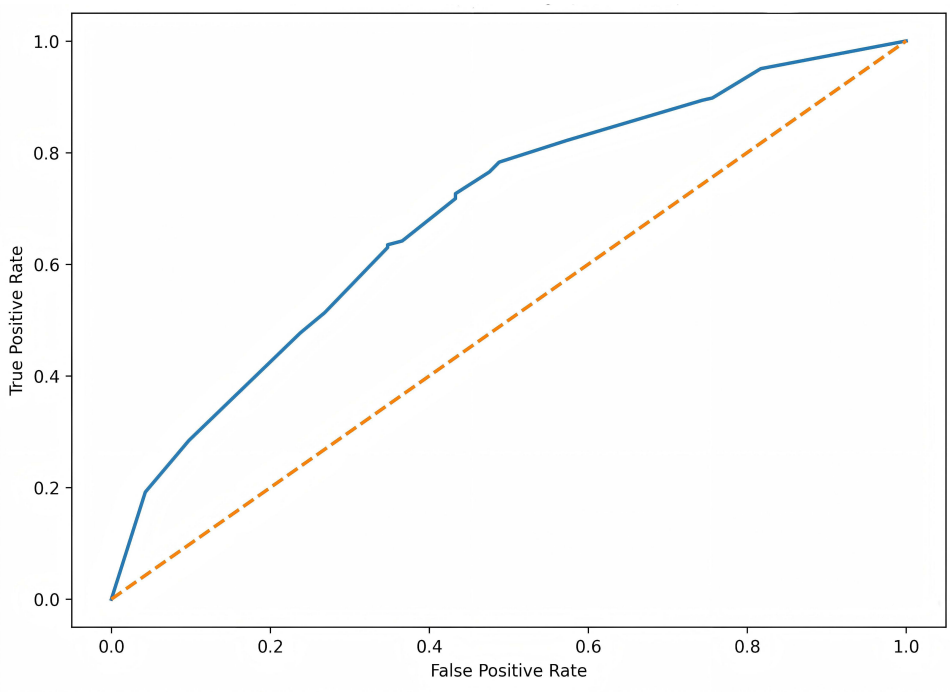

Figure 4 ROC curve (for Willingness to continuing education = High).

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Table 4 The Confusion Matrix Related to CDC Staff's Willingness to Continuing Education

		Predicted	
		Low	**High**
Actual	Low	965	672
	High	3654	6621

Table 5 Conditional Probability Table for Willingness to Continue Education

Work Fatigue	**Career Development Opportunities**	**Team Cohesion**	**Family Support for Work**	**Willingness to Continuing Education**	
				Low	**High**
Low	Low	Low	Low	0.250	0.750
Low	Low	Low	High	0.142	0.858
Low	Low	High	Low	0.170	0.830
Low	Low	High	High	0.102	0.898
Low	High	Low	Low	0.136	0.864
Low	High	Low	High	0.107	0.893
Low	High	High	Low	0.136	0.864
Low	High	High	High	0.058	0.942
High	Low	Low	Low	0.278	0.722
High	Low	Low	High	0.231	0.769
High	Low	High	Low	0.211	0.789
High	Low	High	High	0.127	0.893
High	High	Low	Low	0.238	0.762
High	High	Low	High	0.171	0.829
High	High	High	Low	0.164	0.836
High	High	High	High	0.087	0.913

team belonging, job achievement, and family support for job, and other factors, emerged as key drivers of employee engagement in continuing education. Collectively, these factors can be understood as reflecting the broader dimension of professional identity.

Discussion

Due to the unique advantages in handling nonlinear relationships and complex interactions among variables, the Bayesian network has been widely applied in occupational behavior decision analysis.[34] Previous study emphasized that Bayesian network inference to assess students' clinical reasoning abilities could help educators design clearer assessment frameworks, thereby improving medical education and providing a dynamic research pathway to improve clinical practice.[35] Therefore, we employed Bayesian network and the integrated theoretical framework of EVC and JD-R to explore the participation of C-CDC staff in continuing education, as well as the interactions among these factors.

The present study showed that professional identity–related factors were more prominently associated with willingness to participate in continuing education than other factors. Professional pride, personal recognition of job, and sense of job achievement may reflect individuals' subjective evaluation of professional competence and value. By contrast, team cohesion, team belonging, and rationality of career development opportunities may represent the

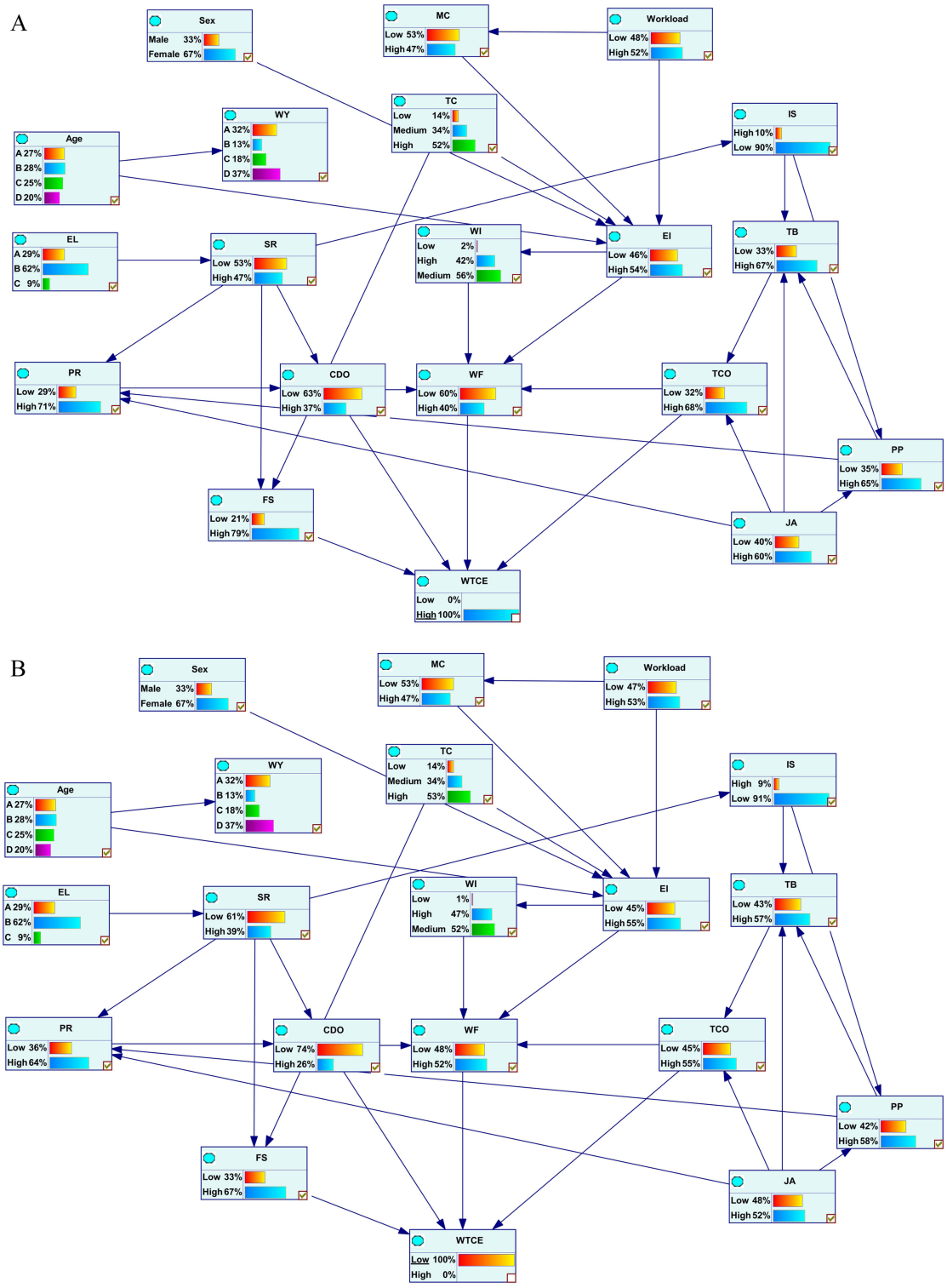

Figure 5 Predictive inference analysis of Bayesian network model when the model is calibrated to reflect a 100% high (**A**) and 100% low (**B**) level of willingness for CDC staff to participate in continuing education. A tick marked in the lower-right corner of each node indicated that the node has been fully defined and the blank marker indicated that the node is currently set as an evidence node. Underlining indicates the state that has been set as evidence during predictive inference.

Notes: A (≤ 30), B (31–40), C (41–50), D (≥ 51) in Age node; A (≤5), B (6-10), C (11-20), D (≥21) in WY node; A (Below bachelor's degree), B (Bachelor's degree), C (Above bachelor's degree) in EL node.

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organizational and contextual resources that support participation. These elements provided individuals with the necessary resources and a secure psychological environment, enabling them to transform their interests and intentions into concrete participation. Taken together, the findings highlighted the potential relevance of both individual perceptions and organizational contexts in promoting continuing education engagement.

Family support for work emerged as a critical factor associated with the participation of staff in continuing education. Previous studies have suggested that family-related support may facilitate participation in continuing education by factors such as family structural obligations, time availability, and social satisfaction brought to family members derived from societal recognition of job.[36–38] Meanwhile, social recognition and family support for work are closely intertwined. Positive societal evaluations and enhanced professional prestige have been shown to increase the level of family support.[39,40] The public's perception of the significance of a job is a key factor in determining the level of understanding shown by family members.[22,41,42] Most prior studies were conducted in broader educational or healthcare contexts and mainly provided descriptive accounts, without fully examining how social recognition and family support jointly operate within a broader occupational setting. Our study integrated and extended previous research by providing a more contextualized explanation of continuing education willingness, indicating the influences on willingness to participate in continuing education should be understood within a broader network of conditional dependencies, in which Societal recognition of job and Family support for job are structurally interconnected rather than operating as separate independent factors.

The network also suggested that team belonging, sense of job achievement, and professional pride were structurally linked to team cohesion, which in turn was directly associated with willingness to participate in continuing education. This pattern suggested that team cohesion may not operate as an isolated organizational attribute, but rather as part of a broader internal support structure associated with supportive environment for continuing education. The findings implied that continuing education policies may be more acceptable and sustainable when they were embedded in a supportive organizational climate and aligned with staff members' professional development needs.

The association between work conditions and willingness to participate in continuing education should not be overlooked. Job demands, characterized by high work intensity or work fatigue, consume staff's limited time and energy, thereby increasing burnout and reducing participation feasibility.[27] The negative correlation with work fatigue and educational participation has been validated in studies on the education sector, indicating that managing occupational stress is a common challenge across different fields of continuing education interventions.[43] A survey on continuing medical education participation among general practitioners in Denmark revealed that lack of time, high work intensity, and inadequate departmental infrastructure in hospitals were the primary barriers preventing staff from engaging in professional development training.[22] However, the existing evidence remains limited, as they were conducted in other professional groups or general educational settings and mainly identified these factors as independent barriers, without fully examining their interdependence with organizational and motivational factors. In this study, our findings were broadly consistent with this literature, while also suggesting a more structured pattern: work fatigue was associated with willingness to participate in continuing education, and work intensity and team cohesion were further connected to this pathway. This pattern indicated that work burden among C-CDC staff may be better understood in relation to both work resource and workplace support, rather than as a single standalone barrier.

Taken together, the findings suggested that efforts to improve continuing education participation among C-CDC staff need to address multiple levels simultaneously. Organizational strategies that strengthen team cohesion and clarify career development opportunities, together with supportive measures that reduce work-related burden and family-related constraints, may be particularly important. In addition, more flexible and need-based continuing education arrangements may help staff engage in professional development under demanding work conditions.

Limitations of the Study

In this study, although we used an anonymous survey and predefined criteria to reduce information bias, self-reported questionnaires remained vulnerable to reporting bias, social desirability bias, and common method bias. These sources of bias could not be fully eliminated. The Bayesian network model developed in this study helped clarify the key mechanisms associated with C-CDC staff's propensity to participate in continuing education. However, the cross-

sectional design meant that the findings primarily reflect conditional associations among variables and do not allow direct inference of strict causal effects. In addition, dichotomizing Likert-scale variables may facilitate Bayesian network modeling and improve the interpretability of the results, it may also reduce the granularity of the original scale information. The theory-informed modifications in Bayesian network are methodologically reasonable, yet they inevitably involve a degree of researcher judgment. Finally, the regional sampling strategy limits the generalizability of the findings to other CDC systems across different regions.

Conclusion

This study aimed to systematically examine factors associated with C-CDC staff's willingness to participate in continuing education and to reveal the complex interrelationships among these factors using a Bayesian network model, and the aims of this study were overall achieved. The findings revealed that professional identity–related factors were more prominently associated with willingness to participate in continuing education than other demographic variables, reflecting the complex interrelationships among the associated factors. Conversely, work fatigue and high-intensity workloads were found to be negatively associated with education willingness. Based on these findings, we recommend optimizing career development planning, reinforcing team cohesion, implementing family-friendly policies, reducing workload burdens, and designing need-based continuing education programs. These strategies may provide preliminary evidence for fostering a positive and supportive continuing education environment for C-CDC staff.

Ethics Statement

The study was reviewed and approved by the Ethics Committee of Harbin Medical University (Approval No: HMUIRB2025064PRE). All procedures were performed in accordance with the ethical standards of the institutional research committee and with the principles of the Declaration of Helsinki.

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Disclosure

The authors declare no conflicts of interest in this work.

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