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The Chinese version of Defensive Medicine Scale (DMS): reliability and validity test among physicians

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Abstract

Background Physicians are inclined to resort to defensive medicine (DM) for self-protection due to the increasing potential risk of medical litigation. DM is globally prevalent and has become an impediment to the development of healthcare. However, there is a lack of validated tools specifically designed to assess DM in China. Therefore, this study aimed to evaluate the psychometric properties of the Chinese version of Defensive Medicine Scale (DMS) among clinicians to provide a practicable tool for relevant research.

Methods The present research consists of two phases. In Phase 1, DMS was administered to survey 327 physicians, and the collected data were obtained for item analysis and exploratory factor analysis. Phase 2 applied DMS to survey 323 physicians, from which the data was used for confirmatory factor analysis, and reliability and cross-cohort consistency tests. Moreover, the participants of Phase 2 were required to complete Workplace Well-Being Scale (WWBS), Career Commitment Scale (CCS), Occupational Disidentification Scale (ODS), Intent to Leave Scale (ILS), and Difficult Doctor-Patient Relationship Questionnaire (DDPRQ-10) to test the convergent validity of DMS.

Results The Chinese version of DMS consists of 10 items divided into 2 dimensions, Positive Defensive Medicine (PDM) and Negative Defensive Medicine (NDM). The confirmatory factor analysis showed that the two-factor model fitted well ($\chi^2/df = 2.540$, RMSEA = 0.069, CFI = 0.981, IFI = 0.981, TLI = 0.971, PNFI = 0.646, PCFI = 0.654, SRMR = 0.044). Furthermore, the total score and the score of each dimension for DMS had a significant negative correlation with WWBS and CCS scores, and a significant positive correlation with ODS, ILS, and DDPRQ-10 scores. The Cronbach's α coefficients for the total DMS and PDM and NDM dimensions were 0.917, 0.935, and 0.842, respectively; the split-half reliability coefficients were 0.922, 0.947, and 0.839, respectively. In addition, DMS showed cross-gender invariance.

Conclusion The Chinese version of DMS has been demonstrated to be an effective tool to assess defensive medicine among Chinese physicians with good psychometric properties.

Keywords Physicians, Defensive medicine, Reliability, Validity

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Introduction

Patients' doubts about the professional competence and ethical standards of physicians can lead to frequent medical disputes and potential non-professional behavior, which results in the tendency of physicians to adopt self-protective defensive medicine (DM) to avoid medical liability [1]. DM has been defined as a self-protective deviation from medical norms by healthcare professionals in response to criticisms, accusations, and complaints from patients and their families, and to avoid being involved in medical lawsuits and disputes [2].

In the majority of related literature, DM has been classified into two categories: Positive Defensive Medicine (PDM) and Negative Defensive Medicine (NDM) [3]. PDM refers to medical behaviors performed by physicians for self-protective purposes, such as overtreatment, over-medication, implementation of certain diagnostic measures when they are not clinically indicated, timely completion of medical records, and increased communication with patients and their families [4, 5]. NDM refers to behaviors applied to avoid medical risks such as avoiding admitting and caring for high-risk patients, avoiding applying effective high-risk procedures, stopping parenteral drugs, and performing unnecessary intervention surgery [6].

In the mid-1900s, DM evolved into a global issue as the potential risks of medical litigation loomed ever higher [7–9]. DM is especially prevalent in Africa, the Americas, the Western Pacific region, and in low-and-middle-income countries [10]. DM is also prevalent in China, which is affected by tensions between physicians and patients, medical disputes, and incidents of medical malpractice [11]. For instance, in a study by Zhu et al., it was found that 62.9% of Chinese obstetricians and gynecologists held an accepting and approving attitude toward DM [12].

Numerous studies have indicated that DM can seriously damage the physician-patient relationship, increase healthcare costs, lead to healthcare waste, and even jeopardize patients' health [13–16]. In addition, DM may also diminish the authority of medicine, exacerbate inequality in healthcare services, violate patients' rights, and increase medical risks [5, 17]. Moreover, over-diagnosis may increase the incidence of false negatives or false positives while causing higher healthcare costs, leading to misdiagnosis and adversely affecting treatment outcomes [18].

With reference to the analysis of the related literature, there have been researchers who adopted a quantitative approach to the study of DM. Some of these researchers have developed non-standardized questionnaires for analyzing the incidence of DM, its predictors, and its harms. For instance, Brateanu et al. examined the effect of litigation risk on physicians' DM and their treatment costs [19]. The questionnaire used in that study reflected DM-related content in only 1 item. In addition, in a study of physicians in orthopaedic, neurosurgery and surgeons, researchers analyzed the incidence of different types of DM and the factors influencing it [20–22]. However, the questionnaires used in the above-mentioned studies were not subjected to rigorous reliability and validity tests, and the reliability and validity of the instruments have not been verified. Furthermore, the use of non-standardized questionnaires for surveys makes it difficult to directly compare the results of diverse studies.

Several researchers have developed DM-related scales and conducted psychometric analyses. For instance, Benbassat et al. developed the Attitudes Toward Medical Error Scales (ATMES) [23]. The ATMES consists of 17 items categorized into four dimensions: Fear of Malpractice Litigation, Support for Self-Regulation, Tendency toward Defensive Practice, and Self-Disclosure of Errors. Among them, the Tendency toward Defensive Practice dimension measures physicians' attitudes and tendencies toward DM. However, this dimension consists of only 4 items and does not further differentiate between PDM and NDM. Moreover, ATMES is mainly adopted to assess DM taken by individuals out of concern for medical errors and does not reflect the full extent of DM. Furthermore, in another study, researchers developed the Turkish version of The Defensive Medicine Behaviour Scale (DMBS) [24]. The DMBS consists of 14 items divided into 2 dimensions, PDM and NDM. However, the DMBS was developed based on only 62 specialist physicians and physician assistants and the sample lacked representativeness. It is noted that the study only reported the results of Cronbach's α coefficient and exploratory factor analysis, and did not conduct other reliability and validity tests.

In a recent study, Ünal et al. developed the Defensive Medicine Scale (DMS) [25]. The DMS consists of 10 items out of which 6 items were used to measure PDM and 4 items were used to measure NDM. The results of semi-structured interviews and expert assessments are the basis of the generation of scale items. The study used a stratified random sampling method to recruit 1724 physicians as participants, which showed good representativeness. In addition, the study highlighted that the DMS exhibited favorable content validity, construct validity, and internal consistency. The results of the study suggested that the DMS is a valid tool for assessing DM in Turkish physicians.

DM is widespread in all countries and has risen as a common-sense problem that afflicts physicians in most departments [6]. At present, there is a lack of a validated instrument specifically designed to assess DM among physicians in China, and no study has examined the applicability of the DMS in the Chinese social context. To

this end, this study aimed to translate the DMS into Chinese and to test its applicability, providing a valid tool for developing relevant quantitative research.

Phase 1

Phase 1 aimed to translate the English version of DMS into Chinese and conduct surveys among Chinese physicians. The research data would be used for item analysis and exploratory factor analysis to test the quality of the questionnaire items.

Methods

Translation process

The authors agreed to translate the scale into Chinese after negotiation. Ünal et al. provided two versions of the scale in Turkey and English, and this study adopted the English version scale to revise into Chinese. First, 3 scholars independently translated the English version of the scale into Chinese, which included an associate professor who majored in thanatology, a postgraduate who majored in mental health education (English major in Bachelor), and a doctor who majored in Psychology. Second, 3 scholars completed first draft after discussing items one by one and refinement of suboptimal phrases or sentences. Third, an associate professor who majored in translation, who did not read the English version made independent back-translation of the first draft. The back-translation draft shared consistent meaning with the original English scale. Since both the English and Turk versions of the DMS were developed by Ünal and his colleagues, their equivalence is ensured. Therefore, this study did not compare the back-translated English version of the scale with the Turkey version. Fourth, 5 clinical physicians were invited to review the first draft and fine-tuned several sentences to better fit the medical context. For instance, to revise "将不符合住院指标的患者收治住院" into "收治无入院指征的患者住院 ". The translated initial questionnaire is consistent with the items and scoring methods of the original scale.

Procedures and ethical approval

The sample size should be over 300 to guarantee the stability of factor analysis results according to the calculation criteria of taking 10 times the item number as the minimum size [26, 27]. The survey was completed in a one-on-one format by systematically trained college students. Researchers recruited undergraduates from 1 medical school to serve as investigators, and students were required to have a home location in the same city as one of the hospitals. The involved students, during summer vacation, surveyed physicians in 11 hospitals in 8 provinces in China, including Jilin, Liaoning, Zhejiang, Guangdong, Hebei, Guizhou, Anhui, and Henan, of which the survey in two hospitals was completed by nurses because eligible college students were not recruited. The study followed the Declaration of Helsinki, obtained informed consent from the subjects, and was approved by the Ethics Committee of Jilin International Studies University.

The survey was processed under a non-medical context to avoid the social desirability effect. The researchers conducted one-on-one surveys of doctors during breaks or between work meetings. Before the survey, the investigators explained in detail to the physicians the anonymity, confidentiality, procedures, and approximate time required for the survey, and obtained informed consent. These explanations aimed to attain privacy protection, external pressure reduction, and encouragement of free expression of personal authentic views among physicians. The questionnaire was completed and answered independently by the physicians who volunteered to participate in this survey. The researchers kept a distance from the physicians and avoided monitoring their responses during the survey. At the end of the survey, the investigator reminded the physicians to check the questionnaire and expressed gratitude. To ensure anonymity, data entry was completed by three graduate students who did not participate in this survey. In this study, the following criteria were used to decide invalid data: (a) Responding the same way to all items, e.g., choosing the same option for both forward-scoring and backward-scoring items in the scale; (b) the same option being selected repeatedly (choosing the same option for 14 consecutive items); (c) careless or inattentive data, e.g., missing data or multiple-choice data [28, 29].

Participants

There were 341 questionnaires distributed and 327 valid questionnaires were returned. The minimum age of participants was 24 years old and the maximum age was 68 years old, with a mean age of 37.73 (SD=8.29) The detailed socio-demographic information is shown in Table 1.

Measures

Defensive medicine scale (DMS)

The DMS consists of 10 items categorized into Positive Defensive Medicine (PDM) and Negative Defensive Medicine (NDM) dimensions [25]. The scale was rated on a 5-point scale ranging from "1=strongly disagree" to "5=strongly agree". The sum of the scores for each item is the total score, with higher scores indicating that the individual is more likely to adopt DM.

Statistical analysis

The item analysis and exploratory factor analysis on collected data were performed in SPSS 20.0. Item analysis concluded the variability of individual items on high and

Table 1 Socio-demographic characteristics

Category	Phase 1($n=327$)		Phase 2($n=323$)	
	N	**%**	***N***	**%**
Gender				
Male	149	45.57	150	46.44
Female	178	54.43	173	53.56
Age (Mean, SD)	37.73	(8.29)	37.13	(9.87)
Years of experience (Mean, SD)	12.64	(8.94)	12.20	(10.25)
Category of Practice				
Western medicine physician	165	50.46	154	47.68
TCM physician	162	49.54	169	52.32
Education				
Bachelor's degree & below	229	70.03	193	59.75
Master	91	27.83	110	34.06
Doctor	7	2.14	20	6.19
Marital Status				
Unmarried	65	19.88	123	38.08
Married	257	78.59	195	60.37
Divorced	5	1.53	4	1.24
Widowed	0	0	1	0.31
Type of hospital				
Public hospitals	282	86.24	283	87.62
Private hospitals	45	13.76	40	12.38
Hospital level				
A third-class hospital	175	53.52	178	55.11
A second-class hospital	89	27.22	105	32.51
A first-class hospital	63	19.26	40	12.38

Table 2 The result of item analysis of DMS($N=327$)

Item	Low score group($N=88$)		High score group($N=88$)		t-value	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
	M	**SD**	**M**	**SD**			
1	1.14	0.43	3.64	0.66	29.57^{***}	0.81^{***}	0.925
2	1.10	0.31	3.55	0.79	27.17^{***}	0.81^{***}	0.924
3	1.10	0.31	3.58	0.81	26.78^{***}	0.87^{***}	0.921
4	1.07	0.25	3.34	0.92	22.32^{***}	0.84^{***}	0.922
5	1.01	0.11	3.44	0.86	26.45^{***}	0.85^{***}	0.922
6	1.40	0.81	3.52	0.77	17.81^{***}	0.73^{***}	0.930
7	1.35	0.63	3.24	0.80	17.39^{***}	0.77^{***}	0.927
8	1.84	1.00	3.49	0.75	13.17^{***}	0.67^{**}	0.933
9	1.07	0.25	3.20	0.96	20.17^{***}	0.83^{***}	0.923
10	1.50	0.88	3.41	0.84	14.69^{***}	0.73^{***}	0.930

$^{**}P<0.01$; $^{***}P<0.001$

low subgroups. Moreover, the correlation of individual items with the total score was calculated. Items with insignificant differences in high and low subgroups as well as correlation coefficients below 0.40 were removed [26]. The Cronbach's α coefficient of the initial questionnaire was calculated and items were deleted one by one. If the Cronbach's α coefficient of the questionnaire increased after deletion of any item, the homogeneity of the item was relatively poor and needed to be deleted [30]. In exploratory factor analysis, items with factor loading values below 0.40, commonality less than 0.30, and multiple loadings were removed.

Results

Item analysis

The results of the item analysis are shown in Table 2. The total score of the scale was calculated, and the top 27% with the highest score was used as the high group and the bottom 27% as the low group, and the differences between the two groups were examined [31]. The

results demonstrated that the high group scores for each item were significantly higher than the low group scores (t=13.17 to 29.57, p<0.001). The results of the total correlation of the questions showed that the value of the correlation coefficient between the items and the total score ranged from 0.67 to 0.87. The Cronbach's α coefficient for the questionnaire was 0.933, and the Cronbach's α coefficient value did not increase significantly after deleting any of the items.

Exploratory Factor Analysis(EFA)

The KMO value of the initial questionnaire was 0.919 and Bartlett's test of sphericity value was 2584.06 (df=45, p<0.001), indicating that the data were suitable for EFA. The results of the EFA showed (see Table 3) that two factors with eigenvalues of greater than 1 were extracted, with a total variance explained of 74.38%. The loadings of the factors ranged from 0.609 to 0.938 and the commonality ranged from 0.524 to 0.847. Among them, factor 1 included 6 items and factor 2 included 4 items. The Chinese version of the scale was consistent with the original scale in terms of the division of dimensions and the attribution of items. Referring to the nomenclature of the original scale, factor 1 and factor 2 were named Positive Defensive Medicine (PDM), and Negative Defensive Medicine (NDM), respectively.

Phase 2

Phase 2 further examined the reliability and validity of the DMS based on Phase 1. The confirmatory factor analysis was included in Phase 2 to test the rationality of the two-factor construct. In addition, the current study selected the Workplace Well-Being Scale (WWBS), Career Commitment Scale (CCS), Occupational Disidentification Scale (ODS), Intent to Leave Scale (ILS), and Difficult Doctor-Patient Relationship Questionnaire (DDPRQ-10) as validation tools to explain the validity of DMS. DM not only jeopardizes the health of patients, but also has the potential to bring about negative consequences for physicians' professional development. Previous studies have found that DM can undermine physicians' professional prestige and reduce professional identity, which in turn can lead to physicians actively working fewer hours or even making the decision to resign [32]. Al-Balas et al. highlighted that physicians' concerns about medical liability and litigation risks were one of the key sources of DM as well as professional stress [33]. As a result, physicians with high DM possessed lower levels of professional identity and well-being, and a higher willingness to leave their jobs.

As indicated, there was an interaction between DM and the physician-patient relationship [6, 34]. That is, a poor physician-patient relationship can increase the incidence of DM, and DM further undermines the relationship. The results of an experimental study by Daniels et al. discovered that physicians tended to adopt a self-protective DM when they perceived criticism and blame from their patients [35]. A qualitative study reached similar conclusions that experiences with patients and judgments about the risk of being subjected to complaints or lawsuits can influence physicians' perceptions of DM [36]. To this end, it was hypothesized that DMS would be significantly negatively correlated with WWBS and CCS, and significantly positively correlated with ODS, ILS, and DDPRQ-10. In addition, gender has been recognized as an important socio-demographic information influencing DM [12]. The equivalence of measurement instruments is a prerequisite for gender difference analysis. Therefore, the study needed to further test the cross-gender consistency of the Chinese version of the DMS. The study also proposed the hypothesis that the DMS has measurement equivalence among males and females.

Methods

Procedures and participants

The survey procedure of Phase 2 was processed like Phase 1. To avoid duplication of surveys, Phase 2 selected physicians in hospitals different from Phase 1 to conduct the survey. The data from Phase 2 were collected from 9 hospitals in 7 Chinese provinces including Jilin,

Table 3 The result of exploratory factor analysis of DMS(N=327)

Item	Original scale	Chinese version scale	PDM	NDM	Commonality
2	Asking for more tests than necessary.	要求患者做不必要的化验检查。	**0.938**	-0.112	0.745
3	Asking for unnecessary consultations.	要求患者做不必要的会诊。	**0.929**	-0.012	0.847
1	Asking for more screenings than necessary.	要求患者做不必要的疾病筛查。	**0.914**	-0.094	0.724
5	Performing invasive operations (e.g. biopsy) unnecessarily.	实施不必要的侵入性操作(如活检)。	**0.749**	0.136	0.722
9	Prescribing unnecessary medication to the patient.	给患者开具不必要的药物。	**0.658**	0.209	0.670
4	Hospitalizing the patient without indications.	收治无入院指征的患者住院。	**0.634**	0.260	0.702
8	Referring the patient.	不必要的转诊患者。	-0.145	**0.866**	0.595
6	Avoiding treating risky patients.	规避治疗高风险的患者。	0.002	**0.785**	0.619
7	Taking initiative less frequently.	较少的主动作为。	0.160	**0.669**	0.623
10	Avoiding new treatment methods.	避免采用新的治疗方法。	0.152	**0.609**	0.524

PDM, Positive Defensive Medicine; NDM, Negative Defensive Medicine

Heilongjiang, Zhejiang, Jiangsu, Hubei, Yunnan and Sichuan. A total of 351 questionnaires were distributed and 323 valid questionnaires were returned. the minimum age of participants was 25 years old and the maximum was 65 years old, with a mean age of 37.13 (SD=9.87). The further detailed socio-demographic information is shown in Table 1.

Measures

Defensive Medicine Scale (DMS)

The Chinese version of DMS translated in Phase 1 was used to measure physicians' defensive behavior as a valid tool. The number of items, division method of dimensions, and scoring methodology were consistent with the original English version scale.

Workplace Well-Being Scale (WWBS)

The scale was developed based on Chinese employees with good reliability and cross-cultural applicability [36]. WWBS consists of 6 items with a unidimensional structure. The scale adopts a 7-point rating system, and the sum of the scores of each item is the total score, with higher total scores indicating higher levels of job satisfaction and well-being of individuals. The Cronbach's α coefficient of the scale in this study was 0.94.

Career Commitment Scale (CCS)

CCS consists of 8 items with a unidimensional structure [37]. The validity of the Chinese version of the scale has been validated [38]. The scale is rated on a 5-point scale ranging from "1=strongly disagree" to "5=strongly agree". Items 1, 3, and 7 were reverse scored. The sum of the scores of each item is the total score, and the higher the total score, the more positive the individual's attitude towards his/her own occupation and the more inclined he/she is to continue to work in his/her current occupation. The Cronbach's α coefficient for the scale in this study was 0.80.

Occupational Disidentification Scale (ODS)

ODS consists of three items and has a unidimensional structure [39]. The Chinese version of the scale has been widely used to assess professional identity in different occupational groups, such as doctors and casino dealers [40, 41]. The scale adopts a 7-point scale, and the sum of the scores of each item is the total score, and the higher the total score, the higher the degree of disapproval of the individual's own career. The Cronbach's α coefficient for the scale in this study was 0.76.

Intent to leave scale (ILS)

ILS consists of four items and has a unidimensional structure [42]. The validity of the Chinese version of the scale has been validated among doctors, nurses, architectural workers, accountants, teachers, pharmaceutical representatives, and hotel attendants [43]. The scale is a 5-point Likert scale, and the sum of the scores for each item is the total score, with higher total scores indicating that the individual's propensity to resign is also higher. The Cronbach's α coefficient for the scale in this study was 0.73.

Difficult doctor-patient relationship questionnaire (DDPRQ-10)

DDPRQ-10 consists of 10 items categorized into Physician's Subjective Experience, Quasi-Objective Questions About the Patient's Behavior, and Symptoms-Combines Elements of the Patient's Behavior and of the Physician's Subjective Response dimensions [44]. Du et al. found that the Chinese version of DDPRQ-10 had satisfactory psychometric properties [45]. The scale is a 6-point Likert scale, and the sum of the score for each item is the total score, with higher total scores indicating that physicians perceive the physician-patient relationship to be worse. The Cronbach's α coefficient for the scale in this study was 0.80.

Statistical analysis

The SPSS 20.0 and AMOS 24.0 were adopted to analyze the collected data. In confirmatory factor analysis, the criteria for good model fit were as follows: $\chi^2/df<3$, RMSEA<0.08, CFI>0.90, IFI>0.90, and TLI>0.90, PNFI>0.50 and PCFI>0.50 [46]. Cronbach's α coefficients and split-half reliabilities of the scales were calculated. A reliability value greater than 0.70 was used as a criterion for good reliability [47]. In addition, using AMOS 24.0, cross-gender consistency tests were performed. The morphological equivalence model (M1), weak equivalence model (M2), strong equivalence model (M3), and strict equivalence model (M4) were established respectively. The difference of CFI of diverse models was calculated sequentially, and ΔCFI<0.01 was used as the criterion for equivalence to be established [48].

Results

Confirmatory Factor Analysis(CFA)

CFA was performed to examine the rationality of the two-factor model. The results showed that the fit indices were $\chi^2/df=2.540$, RMSEA=0.069, CFI=0.981, IFI=0.981, TLI=0971, PNFI=0.646, PCFI=0.654, and SRMR=0.044. In addition, considering that all items measured the same construct, it is necessary to continue to examine whether the one-way model was to be superior to the two-factor model. To this end, the study constructed a one-factor model as a competing model. The results showed that the one-factor model had poor fit indicators (χ2/df=13.634, RMSEA=0.198, CFI=0.837,

Table 4 The results of the convergent validity test($N=323$)

	1	2	3	4	5	6	7	8
1.DMS	-							
2.PDM	0.93***	-						
3.NDM	0.82***	0.56***	-					
4.WWBS	-0.38***	-0.26***	-0.46***	-				
5.CCS	-0.38***	-0.18***	-0.36***	0.56***	-			
6.ODS	0.41***	0.38***	0.35***	-0.30***	-0.40***	-		
7.ILS	0.42***	0.38***	0.37***	-0.41***	-0.65***	0.45***	-	
8.DDPRQ-10	0.60***	0.55***	0.50***	-0.41***	-0.36***	0.52***	0.49***	-
Mean	23.50	13.34	10.16	30.88	27.66	10.33	9.78	31.62
SD	8.25	5.73	3.55	7.53	6.17	4.27	3.55	7.35

***$P<0.001$; DMS, Defensive Medicine Scale; PDM, Positive Defensive Medicine; NDM, Negative Defensive Medicine; WWBS, Workplace Well-Being Scale; CCS, Career Commitment Scale; ODS, Occupational Disidentification Scale; ILS, Intent to Leave Scale; DDPRQ-10, Difficult Doctor-Patient Relationship Questionnaire; SD, Standard Deviation

Table 5 Comparative results of nested models for cross-gender equivalence analysis($N=323$)

Model	χ^2	df	χ^2/df	CFI	IFI	TLI	PNFI	PCFI	RMSEA (90%CI)	ΔCFI
M1	132.14	60	2.20	0.971	0.971	0.956	0.632	0.647	0.061 (0.047~0.075)	
M2	149.49	68	2.20	0.967	0.967	0.956	0.711	0.731	0.061 (0.049~0.074)	-0.004
M3	165.35	78	2.12	0.965	0.965	0.959	0.811	0.836	0.059 (0.047~0.072)	-0.002
M4	194.72	88	2.21	0.957	0.957	0.956	0.903	0.935	0.062 (0.050~0.073)	-0.008

M1: Configural Invariance model; M2: Weak Invariance model; M3: Strong Invariance model; M4: Strict Invariance model. CFI: Comparative Fit Index; IFI: Incremental Fit Index; TLI: Tucker-Lewis Index; PNFI: Parsimonious Normed Fit Index; PCFI: Parsimonious Comparative Fit Index; RMSEA: Root Mean Square Error Of Approximation; df: degree of freedom

IFI=0.838, TLI=0.763, PNFI=0.570, PCFI=0.576, SRMR=0.117).

Convergent validity test

The results of the correlation analysis (see Table 4) showed that the total DMS score and PDM and NDM dimension scores were significantly negatively correlated with total WWBS and CCS scores but significantly positively correlated with total ODS, ILS, and DDPRQ-10 scores.

Reliability test

The Cronbach's α coefficients for DMS total scale and PDM and NDM dimensions were 0.917, 0.935 and 0.842, respectively; the split-half reliability coefficients for DMS total scale and PDM and NDM dimensions were 0.922, 0.947 and 0.839, respectively.

Cross-group invariance test and gender difference analysis

The results of cross-gender consistency test showed (see Table 5) that all fit indices were psychometrically consistent in the models for M1, M2, M3, and M4. In addition, the ΔCFI was −0.004, -0.002, and −0.008 in the comparisons of M2 to M1, M3 to M2, and M4 to M3, respectively. All ΔCFI<0.01 suggested that the DMS was consistent across genders.

Independent samples t-tests were taken to analyze the gender differences in the total score and the score of each dimension for DMS. The results showed that the differences between males and females on DMS (t=0.28, $P=0.78$), PDM (t=0.06, $P=0.96$), and NDM (t=0.56, $P=0.58$) were not significant.

Discussion

The present study translated the Defensive Medicine Scale (DMS) into Chinese and examined the reliability and validity of the scale in the Chinese social context. After translation and back translation, the Chinese version of the scale is consistent with the original scale in terms of item content, number of items, and scoring method. In addition, the Chinese version of DMS has good construct validity, convergent validity test, internal consistency reliability, split-half reliability, and cross-gender consistency. This study found that the Chinese version of DMS showed favorable psychometric characteristics and could be used as an effective tool to evaluate defensive medicine in Chinese physicians. The results of this study are to test the effectiveness of DMS in the

context of Chinese society, indicating that DMS has certain cross-cultural applicability.

Item analysis demonstrated that all DMS items shared sound discriminative properties and measured the congruent constructs. In Exploratory factor analysis (EFA), it was discovered that two dimensions explained 74.38% of the total variance, which were Positive Defensive Medicine (PDM) and Negative Defensive Medicine (NDM). Further Confirmatory factor analysis (CFA) verified the rationality of the two-factor structure. The results of the factor analysis illustrated that the Chinese version of DMS possessed high construct validity [53]. In addition, the Chinese version of the scale was consistent with the original scale in terms of dimension delineation and item attribution.

In Ünal et al.'s study, 14 items were initially compiled for factor analysis [25]. In their exploratory factor analysis, it was found that some of the items, which should theoretically be attributed to PDM, such as "make more detailed explanations to patients" and "care more about patient consent", constituted a separate dimension. Since the three-factor structure differs from the theoretical assumptions and the way DM is categorized in most of the literature, Ünal et al. removed the relevant items. Eventually, DMS was categorized into two dimensions, PDM and NDM. The present study did not include the above deleted initial items in the factor analysis in order to replicate Ünal et al.'s study in Chinese social context. The study conducted an EFA on the 10 items of the original scale, exploring both dimensions again. The results of this study were the same as those of Ünal et al. However, DM may be a second-order factor model and PDM is composed of two related constructs. Therefore, the factor structure of DM needs to be further analyzed and validated in future studies.

The convergent validity test confirmed that the total score and the dimension scores were significantly negatively correlated with the total scores of the Workplace Well-Being Scale (WWBS), and Career Commitment Scale (CCS), but significantly positively correlated with the total scores of the Occupational Disidentification Scale (ODS), Intent to Leave Scale (ILS), and Difficult Doctor-Patient Relationship Questionnaire (DDPRQ-10). The relationship between DM and related scales can be explained from the perspective of conservation of resources theory. This theory suggests that people strive to acquire, cultivate, conserve, and protect resources that are valuable for their survival and development [49]. While acquiring and developing new resources, individuals need to avoid resource depletion [50]. Continuous resource depletion can negatively affect an individual's cognition, attitude, and behavior [51]. For physicians, poor physician-patient relationships and concerns about complaints, lawsuits, and medical disputes are important causes of their own resource depletion [52].

Physicians with high DM are more cautious in communicating with patients and their families and are more sensitive to potential medical risks, such as litigation or disputes [53]. Furthermore, the fear of treatment effectiveness and the fear of patient complaints and lawsuits further exacerbate the psychological pressure on physicians. As a result, physicians with high DM tend to experience intense psychological stress and lower levels of occupational well-being in their medical behaviors. In addition, according to resource conservation theory, to relieve psychological stress, individuals may adopt two behavioral patterns: invest new resources to obtain valuable resources or suspend resource consumption to conserve existing resources [54]. When resources are exhausted or about to be exhausted, individuals may adopt defensive patterns, such as reducing their commitment to their jobs or even choosing to resign [50]. In addition, previous studies have found that resource depletion is an important source of psychological stress for individuals, which can reduce professional identity and occupational well-being, or even lead to leaving and changing careers [55, 56]. The present study reached similar conclusions in the physician population. Doctors' risk perception of uncertain events and negative evaluation of the doctor-patient relationship can increase the frequency of DM and reduce the perception and identity of their profession.

Scales having cross-cohort equivalence is a prerequisite for explaining potential gender differences [57]. To this end, the study further examined the cross-gender consistency of DMS. It was found that the morphological equivalence model (M1), weak equivalence model (M2), strong equivalence model (M3), and strict equivalence model (M4) of DMS held. This result indicates that DMS is equivocal for cross-gender comparisons and can be analyzed for gender differences. There were no significant cohort differences between physicians of different genders in the total DMS scores and the scores of the dimensions. Previous studies on the existence of gender differences in DM have not reached the same conclusions. For instance, in a study of Belgian physicians by Vandersteegen et al., it was found that a higher proportion of men than women adopted DM [58]. In a survey of Chinese obstetricians and gynecologists by Zhu et al., the opposite result was found, i.e., women were more likely to use DM [12]. The results of this study are different from both Vandersteegen et al. and Zhu et al.

However, this study is equally supported by some empirical evidence. For instance, in a survey of Plastic and Aesthetic Surgeons in Israel by Silberstein et al., no gender differences in DM were found [59]. Ortashi et al. discovered that gender was not a predictor of DM in

a study of physicians in the United Kingdom [60]. The inconsistency between the findings of different studies may be due both to the fact that the respondents were from different countries and different departments, and measured by the different research tools. In addition, DM is influenced by both national healthcare policies as well as cultural attitudes, and by the physician's years of practice, title, level of hospital in which he or she is employed, and litigation experience [6].

The current study found no significant gender variation in DM, which may be due to the prevalence of a higher proportion of DM in the physician population. The systematic review and meta-analysis by Zheng et al. mentioned that nearly 90% of physicians experience DM in middle-low-income countries, and the determinants of DM, at the individual level, include years of service, age, job title, litigation experience, but do not include gender [10]. Moreover, there are other factors behind physicians' conducting DM, such as fear of patient dissatisfaction, fear of overlooking a severe diagnosis, fear of negative publicity, and unconscious defensive medicine. In particular, physicians no matter what kind of gender are inclined to resort to DM as a self-protective way in the current time with a high frequency of medical disputes and intense doctor-patient relationships [2].

The study has certain values. First, this study is the first time that the DMS has been adapted and verified in the context of Chinese society, which can provide a usable tool for conducting cross-cultural comparative studies of DM. Moreover, the study provides empirical evidence to show that the scale has cross-cultural applicability. Second, the study results are an enrichment of the literature related to DM and contribute to a better understanding of the harms and influencing factors of DM from a physician's perspective. Previous studies have focused more on the impact of DM on the physician-patient relationship, patient health, and treatment costs, but less on the relationship between DM and physicians' professional psychology and professional behavior. The results of this study suggest that DM is strongly associated with physicians' professional identity, well-being, career commitment, and willingness to leave. Third, the adapted DMS can be used not only to assess the type and extent of DM among Chinese physicians but also to identify key populations and evaluate the effectiveness of interventions.

Limitations and future research

There are some limitations of this study. First, the study did not adopt a strict random sampling approach, and there is a problem of under-representation of the sample. The sample met the criteria of minimum sample size, but it was less representative of Chinese physicians. In prospective studies, researchers should enlarge the sampling range and sample size to improve the representativeness of the sample. Meanwhile, previous studies have found that there are significant differences in the incidence and type of DM among physicians in different departments [24]. Therefore, in future studies, the applicability of DMS among physicians in different departments can also be further examined and comparative analysis can be performed. Second, other reliability and validity of the scale, such as retest reliability, predictive validity, and discriminant validity, need to be further examined in future studies. Third, DM has rich connotations and may exhibit different forms in different cultural backgrounds. In future studies, new items can be attempted to expand the concept of DM through qualitative interviews.

Fourth, the adoption of self-assessment makes it difficult to eliminate the influence of the social approval effect and may also cause common method bias. It is noticed that DM is a controversial topic. Although the current study made great efforts to control social desirability, its side effects on research results failed to be eliminated comprehensively. Therefore, it is possible to consider adding polygraph questions or reverse scoring questions to improve the reliability and validity of the scale in future studies. When identifying and intervening in DM among physicians, qualitative interviews, expert evaluations, or analyses based on medical costs can be combined to more accurately assess physicians' attitudes toward DM and the frequency of its use. Fifth, it is unclear whether the two-factor structure is the optimal structure, therefore, the higher-order structure of the scale needs to be further explored in future studies. At the same time, a tracking design can also be adopted to further analyze the dependent variables, outcome variables, or trends of physicians' DM.

Conclusion

The purpose of this study was to analyze the psychometric properties of the Chinese version of Defensive Medicine Scale (DMS). As to the result, the Chinese version of DMS has favorable reliability, validity, and cross-gender consistency, which suggests that the Chinese version of the DMS can be a valid tool for assessing Defensive Medicine (DM) among Chinese physicians. The conclusion of the study contributes to a better understanding of the impact of DM on doctors' occupational psychology, professional behavior, and physician-patient relationships. Moreover, the adapted Chinese version of the scale can be used to analyze the prevalencey of DM, its influencing factors, and its harms among Chinese physicians. In addition, the adaptation of the Chinese version of the scale provides instrumental support for the development of cross-cultural comparative studies of DM.

Abbreviations

M1	Configural Invariance Model
M2	Weak Invariance Model

M3	Strong Invariance Model
M4	Strict Invariance Model
DM	Defensive Medicine
DMS	Defensive Medicine Scale
WWBS	Workplace Well-Being Scale
CCS	Career Commitment Scale
ODS	Occupational Disidentification Scale
ILS	Intent to Leave Scale
DDPRQ-10	Difficult Doctor-Patient Relationship Questionnaire
PDM	Positive Defensive Medicine
NDM	Negative Defensive Medicine
ATMES	Attitudes Toward Medical Error Scales
DMBS	Turkish version of The Defensive Medicine Behaviour Scale
CFI	Comparative fit index
IFI	Incremental fit index
GFI	Goodness-of-fit index
TLI	Tucker-Lewis index
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
PNFI	Parsimony Normed Fit Index
PGFI	Parsimony Goodness-Of-Fit Index
SRMR	Speech-to-reverberation Modulation Energy Ratio
RMSEA	Root-mean-square Error of Approximation
df	Degree of freedom

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Author contributions
Zhiguang Fan, Xiaoli Shi, Minglu Xu, and Hongjuan Wen conceived and designed the study. Zhiguang Fan, Xiaoli Shi, and Minglu Xu helped with data collection. Zhiguang Fan, Xiaoli Shi, and Hongjuan Wen provided statistical advice on study design and performed data analysis. Zhiguang Fan, Xiaoli Shi, Minglu Xu, and Hongjuan Wen contributed to manuscript preparation and revision. All authors read and approved the final manuscript.

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Data availability
The datasets used or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study followed the Declaration of Helsinki and was approved by the Ethics Committee of Jilin International Studies University (approval number: JY202211003).
Written informed consent was obtained from individual or human participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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