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Development and psychometric properties of the Chinese version of the Death Literacy Index-Revision (DLI-R) among Intensive Care Unit (ICU) nurses: A multi-center cross-sectional study

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Abstract

Background

Death literacy is essential for intensive care unit（ICU）nurses. The Death Literacy Index-Revision (DLI-R) is an instrument to assess death literacy levels. This study seeks to develop a Chinese version of DLI-R and evaluate its validity and reliability among ICU nurses.

Methods

This study recruited 766 ICU clinical nurses from Fujian Province, China, between October 2024 and March 2025. The Beaton recommendations were followed for translation and adaptation. Psychometric properties of the DLI-R were evaluated through content validity, item analysis, factor analysis, and reliability tests.

Results

All 29 items were retained after expert review. The Chinese version of DLI-R demonstrated good content validity, with content validity index (CVI) scores ranging from 0.83 to 1. A six-factor model was obtained by exploratory factor analysis (EFA). confirmatory factor analysis (CFA)results showed robust factorial validity, with fit indices as follows: $\chi^2/df = 3.246$ ($p < 0.001$), CFI = 0.938, TLI = 0.93, RMSEA = 0.079, and SRMR = 0.0576. Cronbach's alpha was 0.957, indicating satisfactory internal consistency reliability.

Conclusion

The Chinese version of DLI-R demonstrates robust psychometric properties, establishing it as a valid and reliable instrument for assessing death literacy among ICU nurses in Chinese healthcare contexts. This culturally adapted tool may inform targeted educational interventions and quality improvement initiatives in critical care settings.

Keywords: Death literacy, ICU Nurse, Validity, Reliability； Cross-cultural adaptation

1. Introduction

With the increasing global aging population and the rising burden of chronic diseases, the demand for palliative care continues to grow[1]. High-quality end-of-life care not only relies on advanced medical technology but also requires nurses to have the ability to access, understand, and apply knowledge related to end-of-life and death care—known as Death Literacy. Death Literacy[2] originated in the field of palliative care and is defined as a set of knowledge and skills that make it possible to gain access to, understand, and act upon end-of-life and death care options[3]. Death literacy includes four core elements:： knowledge, skills, experiential learning, and social action[4]. Death literacy levels may be related to factors such as exposure to death education and personal experiences with death. ICU nurses with high death literacy possess specific background knowledge about death systems and have the ability to apply this knowledge in practice[5]. They may improve the patient's end-of-life experience, alleviating emotional stress for family members, and enhancing their own psychological adjustment when facing frequent death events.

Intensive care units (ICUs) are critical for the treatment of severely ill patients, with a patient mortality rate of approximately 39.2%[6]. This highlights the urgent focus on the quality of end-of-life care in ICUs. Death literacy among ICU nurses plays a key role in end-of-life care [7]. ICU nurses, when dealing with patients nearing death, must not only address complex physiological issues accurately but also manage the emotional impact that follows[8]. Therefore, assessing ICU nurses' death literacy levels helps to understand their ability to cope with end-of-life care and provides scientific evidence for developing targeted training programs. This may improve the quality of care for terminal patients, reduce the psychological burden on patients and families, and optimize the overall end-of-life care practice in ICUs[9]. However, there is currently limited qualitative or quantitative research on death literacy among ICU nurses, which somewhat restricts a comprehensive understanding of their current situation and impacts the development and implementation of relevant training and intervention measures.

Since the concept of “death literacy” was first introduced by the Australian scholar Kerry Noonan's team in 2016[3], related research has continued to deepen, aiming to explore how individuals acquire and apply knowledge about end-of-life care. Based on this theory, Leonard et al.[10] developed the Death Literacy Index (DLI) in 2022, based on the four core elements of death literacy. The DLI consists of 29 items and is made up of four scales: practical knowledge, experiential knowledge, factual knowledge, and community knowledge. The DLI uses a 5-point Likert scale and demonstrates good psychometric properties, with a Cronbach's alpha coefficient ranging from 0.90 to 0.94. The DLI has been localized and translated in several countries, including Sweden, Turkey, China, and the UK, to fit the local cultural context, and its validity and reliability have been tested[11-14]. The results show that the DLI is a widely applicable instrument that can be used to assess death literacy levels in different research populations across various cultural and contextual settings worldwide. Che et al.[14] translated the DLI into Chinese, but the translation mainly focused on the population in the Guangdong-Hong Kong-Macau region. Some of the wording in the questionnaire differed from the expressions used in other regions of mainland China, which might affect the applicability and accuracy of the results across different regions[15].

To adapt to different cultural backgrounds and meet the need for more accurate and understandable assessments, Kerrie’s team[16] modified the original DLI to form the DLI-R (Death Literacy Index—Revised Version). The authors adjusted the wording of the instructions and items to improve the clarity of the scale, making it easier to use in different environments and languages. The DLI-R has the same number of items as the DLI, consisting of 4 scales and 29 items, and it did not fundamentally change the factor structure of the original DLI. The rewording did not significantly affect the psychometric properties of the DLI-R, with the DLI-R’s Cronbach's alpha slightly higher.

The DLI-R has advantages in wording adjustments and measurement clarity. However, there is currently no Chinese version of the scale suitable for use in China. Cultural and language differences may affect the adaptability and measurement validity of the DLI-

R. If the scale items do not fully reflect the concepts and practices of death care in the Chinese medical environment, cultural bias may arise, impacting the accuracy of the assessment. Therefore, during the translation process, it is essential to fully consider the social culture, language expressions, and medical environment of mainland China to ensure the scale's applicability and measurement accuracy.

This study aims to develop a Chinese version of DLI-R that aligns with the cultural and linguistic characteristics of mainland China and optimize its content through consultations with local experts to better fit the Chinese cultural context. Additionally, the study will systematically evaluate the reliability and validity of the scale among ICU nurses to provide a scientifically standardized death literacy assessment instrument, offering theoretical support for related research and practice.

2. Methods

2.1 Participants

This study employed a convenience sampling method to recruit ICU nurses from 30 tertiary grade-A hospitals across nine prefecture-level cities in Fujian Province, China. The inclusion criteria were as followed: (1) Must be registered and hold a valid Chinese Nursing Practice Certificate; (2) Must have at least 6 months of ICU work experience; and (3) Independently perform daily ICU nursing tasks. The exclusion criteria were as followed: Nurses who have been absent from work for more than 3 months due to reasons such as studying abroad or pregnancy during the survey period. Given that the DLI-R comprises 29 items, and following the guidelines provided by Kendall[17], the sample size should be 5-10 times the number of variables to be measured. Considering a 10% loss to follow-up rate, this study requires at least 161 participants.

2.2 Procedure

The study received approval from the Ethics Committee of Fuzhou University Affiliated Provincial Hospital (K2024-08-016) and was conducted between October 2024 and March 2025 using Questionnaire Star (https://www.wjx.cn) for questionnaire collection. Prior to the survey, a liaison was recruited at each tertiary grade-A hospital to assist with the distribution and collection of questionnaires. All liaisons received

standardized training, which informed them about the purpose of the study, the target population for sampling, and the procedures and considerations for data collection. Following the training, the liaison officer recruited participants who fulfilled the inclusion criteria. Once participants consented and signed the informed consent form, the liaison officer distributed the online questionnaires. Participants were required to complete and submit the questionnaire within 10 to 20 minutes using their mobile phones or computers. Any questions during the survey could be addressed by the liaison officer or the research team.

After obtaining permission from the original authors of the DLI-R via email, the Chinese translation of the scale commenced. The translation process followed Beaton's recommendations[18], involving forward-translation and back-translation of the instructions, items, and options in four distinct steps: (1) A master's student fluent in English and a bilingual non-specialist translator, both native Chinese speakers, independently translated the original scale items and response options into two Chinese versions, T1 and T2. (2) The first author, along with the translators compared T1 and T2, discussing and reviewing the differences between the independent translations and the original text, and selecting the most accurate translation to create the Chinese version T12. (3) A nursing Ph.D. who was unfamiliar with the scale content, along with a native English translator, conducted the back-translation, resulting in two English back-translations (BT1 and BT2). (4) Professionals familiar with the scale compared the two back-translations with the original version, identified differences, and resolved ambiguities until the final version (FT) was achieved. If consensus could not be reached, steps (1) to (4) were repeated until differences were eliminated.

To ensure that the language and cultural content of the scale align with the characteristics of the Chinese population, the translated version underwent a systematic cultural adaptation process. This study involved six experts from the fields of palliative care, death education, and intensive care nursing to consult on whether any items in the scale needed to be modified, deleted, or added. Based on the expert consultation feedback, all project members revised the Chinese version of the scale in a workshop

format and made adjustments to items with ambiguous semantics. For example:

(1) No.1 - “Talking about death, dying or grief to a close friend” is changed to “Talking about death or dying to close friends”.

(2) No.2 - “Talking about death, dying or grief to a child” is changed to “Talking about death or, dying to child”. Because “grief” in the first 2 questions does not seem necessary and it allows nurses to avoid actually speaking about death and dying. It does not invite the patients to voice their concerns.

(3) No.3 - The use of “bereaved person” instead of “grieving person” can more accurately express the individual who is grieving the loss of a loved one and avoid the ambiguity of understanding caused by the unclear source of grief.

(4) No.20 - “Cemetery staff” was revised to “cemetery/funeral staff” to more accurately reflect the current practice in which most deceased individuals are cremated and their remains are enshrined in religious facilities rather than buried in cemeteries.

(5) No.24 - “culturally appropriate” is changed to “Chinese culturally appropriate supports”.

(6) No.29 - “People who are grieving” is changed to “People who are bereaved”.

The questionnaire (FT1) was pretested with 52 ICU nurses from a tertiary grade-A general hospital in Xiamen, Fujian Province, who met the inclusion criteria. but did not participate in the formal study. After the participants completed the survey, interviews were conducted, followed by semantic analysis and modifications. The background of the scale's development was elucidated. The final Chinese version of the DLI-R is presented in Appendix 1.

2.3 Measures

2.3.1 General information questionnaire

Based on the literature, researchers independently complied a general information questionnaire, which includes the respondent's age, gender, marital status, current residence, highest level of completed education, ICU working years, experience of the death of a close family member, death education or training, religious belief and so on.

2.3.2 DLI-R

The DLI-R comprises 29 items and is structured into four distinct domains[10]:

1. **Practical Knowledge** – This domain reflects an individual's perceived ability to engage in conversations with family and friends about death, dying, and loss, as well as to participate in hands-on caregiving for someone at the end of life. It includes two subcomponents: *Talking Support* and *Hands-On Support*.
2. **Experiential Knowledge** – This domain captures the insight and competencies gained through direct experiences with end-of-life care and/or through death education.
3. **Factual Knowledge** – This refers to an individual's understanding of the broader death system, including essential information required to make informed plans for dying, caregiving, and post-death arrangements.
4. **Community Knowledge** – This domain pertains to awareness of available end-of-life and bereavement services and supports within the community setting.

There are nine items with two subscales - Accessing Help and Support Groups. The DLI-R uses a 5-point Likert scale, where 1 means "do not agree at all and 5" and 5 means "strongly agree". The DLI-R is scored by calculating the average score after transformation, with scores ranging from 0 to 10. A higher DLI-R score indicates a higher level of death literacy. The DLI-R demonstrates good psychometric properties, with high reliability and internal consistency for its four scales and subscales. The scale's reliability coefficient Cronbach's alpha in this study is 0.957.

2.4 Statistical analyses

This study used IBM SPSS Statistics 27.0 and AMOS 24.0 to analyze the questionnaires, using descriptive statistics to summarize demographic characteristics.

2.4.1 Content validity

Content validity is assessed using the content validity index (CVI), where six experts evaluate the relevance of each item in the DLI-R to the scale's theme. The CVI uses a 4-point Likert scale to assess item relevance, with 1 to 4 indicating "not relevant", "somewhat relevant","quite relevant" and "highly relevant". The item-level content validity index (I-CVI) is calculated by dividing the number of experts who rated the

item as “quite relevant” and “highly relevant” by the total number of experts [19]. The scale-level content validity index (S-CVI) is computed to assess the overall content validity of the scale. Items with an I-CVI of 0.8 or higher and an S-CVI of 0.9 or higher are considered acceptable[20].

2.4.2 Item analysis

Item analysis methods included the correlation coefficient method and Cronbach's alpha coefficient method. First, the item quality was assessed by calculating the item-total correlation (ITC) for each item, with ITC $\geq$ 0.40 indicating excellent item discrimination, 0.30 $\leq$ ITC < 0.40 being acceptable, and ITC < 0.30 suggesting the item should be deleted. Second, the Cronbach's alpha coefficient change test was used. If the overall alpha coefficient of the scale significantly improves after deleting an item, it indicates that the item affects internal consistency and should be removed.

2.4.3 Factor analysis

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to explore the factor structure of the Chinese version of DLI-R. The total Sample (714) is divided into two subsamples by a random number generator, Sample 1 (357 people) was used for EFA, and Sample 2 (357 people) was used for CFA. The suitability of the instrument for factor analysis was evaluated using the Kaiser-Mayer-Olkin (KMO) value ($\geq$ 0.7) and Bartlett's test of sphericity ($p < 0.05$)[21]。EFA was conducted using maximum likelihood estimation and oblique (promax) rotation. Factors with eigenvalues greater than 1 were retained, and parallel analysis was used to further determine the number of factors to retain [22]. Items with factor loadings greater than 0.5 were retained. CFA was then used to validate the factor structure obtained from the CFA. Model fit was assessed using five indices: chi-square to degrees of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). According to existing research standards, a model is considered a good fit if $\chi^2/df < 5$, CFI and TLI $\geq$ 0.90, RMSEA $\leq$ 0.08, and SRMR $\leq$ 0.08[23, 24].

2.4.4 Reliability

Cronbach's alpha was employed to evaluate the reliability of the DLI-R. This statistical

measure is utilized to determine the acceptable level of internal consistency, ensuring that it surpasses the recommended threshold of 0.70. A value above this threshold indicates that the instrument reliably measures the intended construct[25].

2.4.5 Normal distribution

Skewness and kurtosis tests, as well as the Shapiro-Wilk test, are employed to assess univariate normality. Some references indicate that skewness and kurtosis values within the ±8 range are deemed acceptable[26].

3 Results

3.1 Demographic characters

Due to the mandatory response system in the online survey, which required answering all items to proceed, there were no missing values in the data. Among the 714 ICU nurses，mean age is 31.52±7.07；85.71% (n=612) were female, and 14.29% (n=102) were male. Regarding marital status, 45.80% (n=327) were unmarried, 53.22% (n=380) were married, and 0.98% (n=7) were divorced or widowed. 52.10% (n=372) were from rural areas, and 47.9% (n=342) were from urban areas. The majority had an undergraduate education, accounting for 84.6% (n=408), while 38.98% (n=278) had a diploma or lower, and 3.92% (n=28) had a master's degree or higher.（36.7% (n=262) had worked in ICU for <3 years, 36.97% (n=264) for 3-5 years, and 26.33% (n=188) for >10 years; most had experienced the death of a loved one, 78.85% (n=563), and fewer nurses, 32.07% (n=229), had been educated or trained in death had a religious beliefs were 28.43% (n=203) of the nurses. See Table 1.）

Table 1 Demographic characteristics of participants ($N = 714$)

Variables	Category	*N* (%)
Age	＜25	155（21.71）
	26—30	205（28.71）
	31—35	173（24.23）
	36—40	125（17.51）
	＞40	56（7.84）
Gender	Male	102（14.29）
	Female	612（85.71）
Marital status	Unmarried	327（45.80）
	Be married	380（53.22）
	Divorced and widowed	7（0.98）
Current residence	Rural	372（52.10）
	Urban	342（47.90）
Highest level of completed education	Associate degree or below	278（38.94）
	Undergraduate degree	408（57.14）
	Master’s degree or more	28（3.92）
ICU Working years	＜3	262（36.70）
	3—10	264（36.97）
	＞10	188（26.33）
Experience of the death of a close family member	Yes	563（78.85）
	No	151（21.15）
Death education or training	Yes	229（32.07）
	No	485（67.93）
Religious belief	Yes	203（28.43）
	No	511（71.57）

3.2 Item analysis

The results of the item analysis showed that all items demonstrated good homogeneity. Item-level descriptions are presented in Table 2.

Table 2 Item analysis and Content validity evaluation of the translated DLI-R (N =714)

Items	Mean	SD	Cronbach' α if item deleted	Corrected item-total correlation coefficients	I-CVI
1. Talking about death or dying to close friends	7.76	2.13	0.957	0.489**	
2. Talking about death or dying to child	6.93	2.37	0.958	0.476**	1.00
3. Talking to bereaved person about their loss	6.47	2.38	0.957	0.501**	1.00
4. Talk with health professionals about supporting the dying person where they live	7.58	2.09	0.957	0.560**	1.00
5. Feeding or assisting with eating	8.48	1.81	0.957	0.512**	0.83
6. Helping with bathing	7.95	2.07	0.957	0.520**	1.00
7. Lifting or assisting with position changes	8.51	1.81	0.957	0.497**	1.00
8. Administering injections	8.56	1.84	0.957	0.470**	1.00
9. Made me more emotionally prepared to help others face death, dying and bereavement	7.57	1.83	0.956	0.610**	0.83
10. Made me think about what is important and not important in life	7.96	1.70	0.957	0.563**	1.00
11. Increased my insights and cognitive wisdom	8.10	1.65	0.957	0.566**	1.00
12. Made me more compassionate toward myself	8.10	1.63	0.957	0.526**	1.00
13. Made me more prepared to face similar challenges in the future	7.94	1.68	0.956	0.606**	1.00
14.I know the laws and regulations regarding dying at home	6.22	2.38	0.956	0.693**	1.00
15.I know what documents are needed to prepare for death	6.44	2.39	0.955	0.712**	1.00
16. I know enough about the health care system to provide a dying person with the support they need	7.02	2.19	0.955	0.743**	1.00
17.I know enough to make decisions about funeral or burial services and options	6.15	2.40	0.955	0.728**	1.00
18. I know how to access palliative/hospice services in my area	6.21	2.35	0.955	0.733**	1.00
19.I know enough about the progression of illness to make decisions about medical treatment at the end of life	6.84	2.24	0.955	0.738**	0.83
20.I know that funeral/burial staff can provide the helping at funerals	6.66	2.37	0.955	0.731**	0.83

Items	Mean	SD	Cronbach' α if item deleted	Corrected item-total correlation coefficients	I-CVI
21. Receive support from where I live, e.g. from clubs, groups or volunteer organizations	6.79	2.24	0.955	0.785**	0.83
22. Provide daily caregiving for the dying person	6.92	2.22	0.955	0.786**	0.83
23. Access to equipment required for care	6.91	2.21	0.955	0.783**	0.83
24. Access to culturally appropriate supports for a person	7.04	2.13	0.955	0.766**	0.83
25. Seeking emotional supports for themselves	7.08	2.11	0.955	0.768**	0.83
26. People with critical illnesses	6.66	2.39	0.955	0.708**	0.83
27. People who are dying	6.58	2.41	0.955	0.704**	1
28. Caregivers of the dying	6.61	2.41	0.955	0.723**	1
29.People who are bereaved	6.59	2.37	0.955	0.711**	0.83
					0.83

**, $P < 0.01$

3.3 Content validity

The CVI for each item ranged from 0.833 to 1, with all items exceeding the acceptable validity threshold of 0.78. This indicates that there was consensus among the experts in the evaluation, and the items have satisfactory content validity. Furthermore, the S-CVI score was 0.9, demonstrating that the overall evaluation items have good consistency in both content coverage and relevance, accurately reflecting the concept being measured (see Table 2).

3.4 Factor analysis

Based on the results of the item analysis, all items met the retention criteria and no deletions were necessary.

3.4.1 Exploratory factor analysis

The results indicated that the Kaiser-Meyer-Olkin (KMO) value was 0.908, and Bartlett's test of sphericity was 128087.026 ($p < 0.001$), suggesting that the data was appropriate for factor analysis. The results of parallel analysis indicated that six factors should be retained. These six factors cumulatively explained 83.5% of the total variance. Furthermore, the factor loadings for each item were exceeded 0.5 (Table3).

Table 3 The result of EFA on DLI-R (N = 357)

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1. Talking about death or dying to close friends						0.786
2. Talking about death or dying to child						0.981
3. Talking to bereaved person about their loss						0.779
4. Talk with health professionals about supporting the dying person where they live						0.602
5. Feeding or assisting with eating					0.925	
6. Helping with bathing					0.714	
7. Lifting or assisting with position changes					0.969	
8. Administering injections					0.943	
9. Made me more emotionally prepared to help others face death, dying and bereavement		0.614				
10. Made me think about what is important and not important in life		0.953				
11. Increased my insights and cognitive wisdom		0.981				
12. Made me more compassionate toward myself		0.891				
13. Made me more prepared to face similar challenges in the future		0.877				
14.I know the laws and regulations regarding dying at home	0.870					
15.I know what documents are needed to prepare for death	0.863					
16. I know enough about the health care system to provide a dying person with the support they need	0.714					
17.I know enough to make decisions about funeral or burial services and options	0.951					
18. I know how to access palliative/hospice services in my area	0.881					
19.I know enough about the progression of illness to make decisions about medical treatment at the end of life	0.785					
20.I know that funeral/burial staff can provide the helping at funerals	0.690					
21. Receive support from where I live, e.g. from clubs, groups or volunteer organizations				0.821		

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
22. Provide daily caregiving for the dying person				0.986		
23. Access to equipment required for care				1.008		
24. Access to culturally appropriate supports for a person				0.675		
25. Seeking emotional supports for themselves				0.801		
26. People with critical illnesses			0.897			
27. People who are dying			0.955			
28. Caregivers of the dying			0.951			
29.People who are bereaved			0.928			
CVCR	39.979	56.837	61.209	67.082	74.463	79.398

Note: F1=Factual knowledge; F2=Experiential knowledge; F3=Community support; F4=Accessing help; F5=Hands-on care; F6=Talking support; CVCR=Cumulative Variance Contribution Rate

3.4.2 Confirmatory Factor Analysis

The results of the CFA showed that the six-factor model of the DLI scale had adequate goodness of fit (see Table 4). The specific fit indices were: $\chi^2/df = 3.246$ ($p < 0.001$), CFI = 0.938, TLI = 0.93, RMSEA = 0.079, SRMR = 0.0576 (Figure 1)

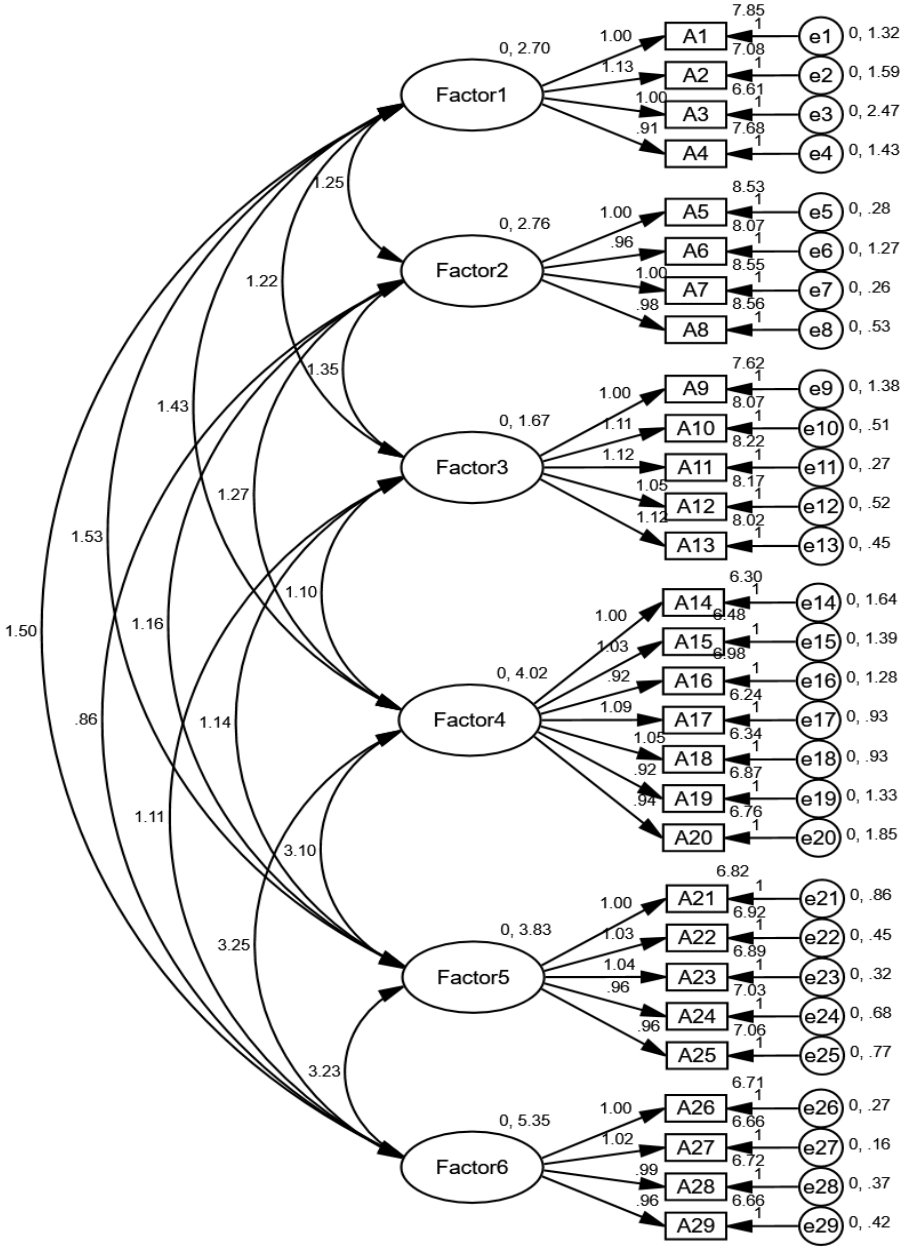


Figure 1 Results of CFA for the Chinese version of the DLI-R

Table 4 Index of goodness of fit of the model

Index	χ^2/df	RMSEA	SRMR	CFI	TLI
Initial model	3.246	0.079	0.0576	0.938	0.93
Standard	＜5	＜0.08	＜0.08	＞0.9	＞0.9

Note： χ^2/df=Chi-square degree of freedom ratio； RMSEA=Root mean squared error of approximation；SRMR=Standardized Root Mean Square Residual；CFI=Comparative Fit Index；TLI=Tucker-Lewis Index

3.5 Reliability

The Chinese version of DLI-R demonstrates good internal consistency reliability, with a Cronbach's alpha coefficient of 0.957, and an intraclass correlation coefficient of 0.908. Additionally, the Cronbach's alpha coefficients for the subscales ranged from 0.873 to 0.984. (Table 5)

Table 5 Reliability Analysis of the Chinese version of the DLI-R

Subscales	Mean	SD	Cronbach' α
DLI-R	7.19	1.45	0.957
Practical knowledge	7.78	1.54	0.883
Talking support	7.18	1.91	0.873
Hands-on care	8.37	1.73	0.938
Experiential knowledge	7.93	1.53	0.939
Factual knowledge	6.50	2.04	0.949
Community knowledge	6.80	2.01	0.964
Accessing help	6.95	2.05	0.968
Community support	6.61	2.34	0.984

4 Discussion

In this study, we aimed to comprehensively assess the psychometric properties of the Chinese version of the Death Literacy Index (DLI-R). Our findings contribute significantly to the existing literature in this field. First, the translated scale can be utilized to measure death literacy among nursing staff across various regions of mainland China, thereby promoting the localization of death literacy within nursing practice in China. Second, the study adopted a multi-center cross-sectional design, which enhances the representativeness of the results. Notably, the translated scale demonstrated good psychometric properties in terms of validity and reliability, indicating its applicability within the Chinese cultural context and providing a solid foundation for further promotion and application in other populations. The development of the simplified Chinese version meets the needs of a broad range of

Mandarin-speaking individuals and Chinese researchers. It has been creatively applied to ICU nurses, offering a valuable reference for future studies. Overall, the study successfully achieved its intended outcomes.

This study followed a strict cross-cultural adaptation process, including forward-translation, back-translation, expert consultation, pre-tests and cognitive interviews, resulting in the final Chinese version of the Death Literacy Index (DLI-R). A convenience sampling method was used, and questionnaires were distributed to ICU nurses at nine tertiary hospitals in Fujian Province, with 714 valid responses collected following inclusion and exclusion criteria. Content validity analysis showed that the CVI for all items ranged from 0.833 to 1, exceeding the acceptable threshold of 0.78, and the S-CVI score was 0.9, indicating good expert consensus and theoretical coverage of the scale. The ITC values were all above 0.4, meeting the acceptance standard, and showing good discrimination and measurement efficiency, therefore all items were retained for further analysis.

Based on prior revisions and pretest results, EFA and CFA were further used to explore and validate the factorial validity of the Chinese version of the DLI-R. Since the original DIL was developed based on research conducted among the Australian population, the survey items were revised and refined to facilitate international validation, leading to the creation of the DLI-R version. The factorial validity of DLI-R was tested on the basis of cross-cultural revision. The EFA showed that the KMO value was 0.908, and Bartlett's test of sphericity was 128087.026 ($p < 0.001$), indicating that the data was suitable for factor analysis. Parallel analysis confirmed that our extraction criteria were reliable and not randomly derived, and the extracted factor structure was consistent with the original scale. The Chinese version exhibits a similar six-factor structure to the Swiss version of the DLI. Confirmatory factor analysis showed good fit indices for the Chinese version of DLI-R, and the χ^2/df, CFI, TLI, RMSEA, and SRMR values indicated that the model's fit indices met the recommended standards. The original DLI-R reported CFI = 0.933, TLI = 0.927, RMSEA = 0.064, and SRMR = 0.065. The

corresponding indices for the Chinese version were slightly better, indicating that it achieved a comparable theoretical structure, thereby demonstrating good cross-cultural stability and applicability.

In this study, the Cronbach's alpha reliability coefficient was 0.957, and the four scales and subscales of the DLI-R demonstrated good reliability and internal consistency. This indicates that the revised Chinese version of the DLI-R is well-suited to the Chinese cultural context and can effectively assess ICU nurses' levels of death literacy. To ensure that the language expression and cultural content of the scale fit the characteristics of the Chinese population, the translation process underwent a systematic cultural adjustment to better align with the work context and cultural understanding of Chinese ICU nurses. Since most of the research team members are from mainland China, this also helped ensure the linguistic appropriateness of the items in the Chinese version.

The results indicated that the overall death literacy score for ICU nurses was (7.19±1.45), reflecting a relatively high level of knowledge, attitudes, and coping abilities when facing death-related issues. Compared with the death literacy scores of the general population in the Guangdong-Hong Kong-Macao Greater Bay Area averaged (6.74 ± 1.50), while individuals with parental bereavement experience scored (6.92 ± 1.38), and general nurses in mainland China scored (6.29 ± 1.42)[27, 28], ICU nurses exhibited higher levels of death literacy. This difference may be closely related to ICU nurses being on the frontline of end-of-life and critical care, where they frequently encounter terminal patients, death events, and family communications. This exposure likely enhances their knowledge and coping skills regarding death-related topics in practice.

Among the four dimensions, Practical knowledge and Experiential knowledge had relatively high scores of (7.78±1.54) and (7.93±1.53) respectively, indicating that ICU nurses have a certain advantage in practical care and personal experience accumulation in death care. Practical knowledge had the highest score, which is similar to the findings

of death literacy studies in the UK and Australia[10, 29].The Hands-on care subscale in this dimension scored (8.37±1.73), reflecting nurses' solid mastery of basic operational skills in end-of-life care. This result is highly consistent with the characteristics of ICU work, as nurses frequently face critically ill and dying patients in their daily work, and related care operations are a basic requirement of their position, with high repetition in clinical practice, leading to stronger skills in this area. Conversely, Factual knowledge had the lowest score (6.50±2.04), reflecting ICU nurses' insufficient knowledge in areas such as death-related laws and regulations, funeral service choices and decisions, and access to end-of-life/palliative care services, as well as limited information channels[30]. Additionally, Community knowledge also had a low score (6.80±2.01), which reflects the underdeveloped community-based death care system, limited resources, and difficulties in effectively supporting the subsequent needs of terminal patients and their families[27]. It also highlights the lack of systematic training for ICU nurses in this area and their limited knowledge and ability to utilize community resources. ICU nurses need to acquire sufficient community knowledge to provide scientific advice and transitional support for post-discharge care arrangements for patients. Overall, ICU nurses have clear advantages in practical skills and experience accumulation, but there is still room for improvement in factual knowledge and awareness of community resources. Future training should focus on addressing these knowledge gaps.

The demographic results notably showed that fewer ICU nurses had received death education or training, compared to a larger proportion who had not. This finding suggests that the extent of death education or training for ICU nurses in China's healthcare system may not be ideal. This phenomenon reflects the lack of death education in the clinical nursing education system and may also result in ICU nurses' insufficient ability to cope with death-related issues[9]. The promotion and application of the Chinese version of DLI-R will help promote the deep quantitative development of death education and the implementation of end-of-life care concepts in clinical

nursing, which has significant practical implications and long-term value for improving critical care and overall life education levels in China.

5 Strengths and limitations

5.1 Strengths

This study strictly followed the cross-cultural scale translation process, adopting the "translation-back translation-expert evaluation-preliminary survey" procedure to ensure the equivalence of the Chinese version of DLI-R in both language expression and cultural context. Content validity was assessed through expert panel evaluations to ensure the rationality of the item wording. A small-scale pre-survey was then conducted to collect feedback and further optimize the scale items, enhancing the instrument's applicability and comprehensibility. For the statistical analysis of the scale's structural validity, an approach that combines Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) was utilized to explore and validate its potential factor structure, maximizing the reliability and validity of the instrument within the Chinese context.

5.2 Limitations

1. This study focused on ICU nurses from certain tertiary hospitals in Fujian Province, China, which introduces a regional concentration. While this provides valuable preliminary evidence for exploring the applicability of the DLI-R in the Chinese context, the representativeness of the results on a national scale still requires further validation due to cultural differences across regions. The research team is conducting a broader multi-center study to enhance the generalizability and applicability of the conclusions.

2. The study employed non-probability sampling, which limits the representativeness of the sample. Future studies could employ probability sampling methods such as stratified sampling or cluster sampling to recruit samples.

3. This study did not perform a test of test-retest reliability. However, a longitudinal study on ICU nurses' death literacy, planned by the research team, may

address this limitation.

4. Although the results suggest that the developed Chinese version of DLI-R is suitable for ICU nurses in China, the study did not conduct semi-structured interviews to supplement or adjust the items, and this limitation must be acknowledged.

6 Conclusion

In conclusion, the Chinese version of the DLI-R comprises 4 dimensions, 6 factors, and 29 items, and demonstrates good psychometric properties. These findings indicate that the Chinese version of the DLI-R is a valid and reliable instrument for evaluating death literacy among ICU nurses. For future research, it is recommended to explore the application of the DLI-R in different populations to further establish its practicality and validity.

Declarations

Ethics approval and consent to participate

The study received approval from the Ethics Committee of Fuzhou University Affiliated Provincial Hospital (K2024-08-016). All methods were carried out in accordance with relevant guidelines and regulations, and all participants submitted an informed consent form after being informed of the aims of the study. The study data were kept confidential All procedures were followed in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ML and LS conceptualized the study. ML, KZ and LS analyzed, interpreted the data and wrote the main manuscript. ML reviewed the related literature and wrote the manuscript. ML, KZ, YFH, DXZ, YYC, LS collected and curated the data. YYC edited figures. ML and HNM contributed to analysis and interpretation. LS got project-administrated, supervised the study, and reviewed the manuscript critically. The authors have read and approved the final manuscript.

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Availability of data and materials

The datasets used and analyzed in the current study are available from the corresponding author upon reasonable request.

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