Evidence Grading and Translation Consistency of Functional Antimicrobial Textile Terminology

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ABSTRACT The lack of evidence grading and translation standards for functional antimicrobial textile terminology has led to ambiguous definitions, inconsistent sources, and confusing translations, which hinders technology dissemination, standard mutual recognition, and international market compliance. This problem is particularly important for functional textiles, where antimicrobial performance, material structure, testing methods, and related technical terms need to be accurately expressed in international standards and engineering communication. In addition, with the development of multifunctional textiles, including electromagnetic shielding fabrics and wearable antenna substrates, terminology consistency has become increasingly relevant to interdisciplinary technical exchange. Focusing on these issues, this study constructs a GRADE (Grading of Recommendations Assessment, Development, and Evaluation) evidence grading analysis model to assess the authority of 187 core terms and conduct a quantitative analysis of their Chinese-English translation consistency. The results show that high-evidence terms, accounting for 37.97%, exhibit significantly greater translation stability, with a Mainstream Translation Coverage (MTC) of 91.3%, a Kappa consistency coefficient of 0.82, and a variation rate of only 2.1%. In contrast, low and very-low-evidence terms, accounting for 30.2%, have an MTC of only 42.6%, a Kappa value of 0.35, and a variation rate of 7.8%. The difference is highly significant according to an independent samples t-test. Spearman correlation analysis confirms a strong positive correlation between evidence grade and translation consistency ($\rho = 0.68$, $p < 0.001$), indicating that term authority is a key structural variable driving translation standardization. This study fills the gap in empirical research on terminology standardization and provides a quantifiable evaluation tool for functional textile terminology translation.

INDEX TERMS functional antimicrobial textiles, terminology standardization, evidence grading, electromagnetic shielding textiles, translation consistency

I. INTRODUCTION

Antimicrobial textiles are an important part of the global health industry, and the market size is showing a significant growth trend [1,2]. The global antimicrobial textile market is expected to grow from US$10.7 billion to US$14.7 billion by 2026, with a compound annual growth rate of 6.5% from 2021 to 2026 [3]. This growth trend is a testament to the increased health awareness and expanded healthcare needs of global consumers after the COVID-19 pandemic, and the application of nanotechnology in antimicrobial materials [4]. However, the contradiction between the rapid development of the industry and the lagging standardization of terminology is becoming increasingly prominent [5,6]. The fuzzy definition of terminology and the confusion in translation have become key bottlenecks restricting technology dissemination, international compliance and consumer awareness [7]. The misuse of terminology has a negative impact on the actual performance of products and the serious deviation from the promotional claims, which increases the cost of compliance. At the level of grade definition, there are significant differences between different standards, such as the industry standard FZ/T 73023-2006 and international standards ISO 20743:2021 lacking a unified threshold for the grading of "antimicrobial performance" [8,9]; the Chinese translations of "antibacterial" (targeting bacteria) [10] and "antimicrobial" (covering bacteria, fungi, viruses, etc.) [11] are often confused. In marketing, "antimicrobial spray" that kills a variety of microorganisms is mistakenly labeled as "antibacterial spray", causing consumers to misjudge the product's function. This confusion in grading standards and translation definitions affects product quality control and weakens the international market's trust in Chinese antimicrobial textiles. The field of international terminology is centered on Sager's "Term Generation Principles" and ISO 1087's terminology classification system, proposing that terminology must meet the characteristics of "decontextualization" and "written priority" [12,13]. In China, although the group standard "Antibacterial Textiles" attempts to standardize the scope of application of terms, China has not yet established a national standard system for antibacterial textiles covering the entire industry chain. The existing binding documents are still mainly FZ/T industry standards (FZ/T 73023-2006, FZ/T 01071-2008, FZ/T 70006-2022, etc.) [14-16]. The existing national standards system does not cover the entire industry chain, and there are problems such as mixed terminology, inconsistent indicators, and inconsistent translations. Furthermore, it lacks interdisciplinary theoretical integration and a systematic quantitative evaluation framework for the scientific nature of terminology and translation quality. This study draws on the GRADE evidence grading concept and framework widely used in evidence-based medicine and adapts it to the field of terminology [17]. At the same time, the Delphi method [18,19] provides a scientific tool for terminology grading. A quantitative index system is constructed to measure the consistency of its translation, supplemented by quantitative indicators such as the Kappa coefficient [20,21]. This study aims to construct an integrated GRADE evidence grading analysis model, clarify the evidence strength and translation adaptability of antimicrobial textile terms through evidence-based methods, and provide a theoretical framework and empirical basis for the formulation of industry standards. This study draws on the concept of evidence grading in evidence-based medicine and applies it systematically to terminology research in the textile field, constructing an analytical framework centered on the strength of evidence, thereby providing verifiable evidence-based basis for terminology standardization. Based on the systematic evaluation of 187 core terms, only 37.97% of the terms reach a high level (Evidence Level 4), and the translation consistency is significantly better than that of low-level terms (91.3% vs. 42.6%). The practical significance is reflected in providing an operational evaluation tool for corporate compliance publicity, consumer rights protection and international standard docking.

II. DESIGN AND METHODS

This study adopts an interdisciplinary approach of evidence-based medicine and terminology. The research framework is shown in Figure 1.

Figure 1 details the technical approach of this paper. The first phase constructs a four-tiered evidence grading system based on authority, citation frequency, and standard adoption, drawing on the GRADE evaluation system and the Delphi expert scoring method. The second phase constructs a bilingual terminology corpus covering international standards, academic literature, and industry texts. The third phase uses Natural Language Processing (NLP) technology to identify terminology translation variants, combining semantic clustering with expert verification to calculate translation consistency indicators. In the fourth phase, Spearman rank correlation analysis is used to verify the core assumption that "the higher the level of evidence, the more consistent the translation", and stratification and robustness tests are performed. Finally, a list of standardized terms, translation guidelines, and policy recommendations are output.

A. CONSTRUCTION OF GRADE-BASED FRAMEWORK FOR GRADING EVIDENCE

1) Classification of Evidence Sources

The classification of sources of evidence follows a three-level standard:

(1) International/national standards: including officially published industry or national standard documents such as ISO, AATCC (American Association of Textile Chemists and Colorists), GB/T, and FZ/T, which are considered the highest level of evidence sources because of their mandatory or recommended regulatory effect;

(2) Peer-reviewed academic literature: including journal articles, dissertations and authoritative textbooks indexed by SCI/EI (Science Citation Index/Engineering Index), reflecting academic consensus and cutting-edge knowledge, serving as mid- to high-level evidence support;

(3) Industry application texts: including company product manuals, technical white papers, patent documents, industry association reports and government regulatory announcements, etc. Although their authority is lower than that of standards and academic literature, they reflect the actual industry usage context and serve as a supplementary source of evidence.

The above three types of sources together constitute a multidimensional evidence pool, which is used for subsequent term definition extraction, evidence level assessment, and translation consistency analysis to ensure that the research has both theoretical rigor and practical applicability.

2) Evidence Level Assessment Criteria

The quality of evidence was assessed using the GRADE standard, combined with the Delphi method to calculate expert authority. All assessments were based on the "Functional Antimicrobial Textiles" corpus constructed in this study. This corpus system includes core standards, high-level journal articles, patents, and industry white papers closely related to the field, while excluding texts with low relevance, representing a carefully selected collection of texts within the field. Based on this, terminology authority was categorized into four levels, as shown in Table 1.

As shown in Table 1, the authority score is calculated as follows: Score=Authoritativeness$\times$0.4+Citation Frequency$\times$0.3+ Standard Adoption Degree$\times$0.3. Four levels of evidence are defined:

high level (average score $\geq$ 4.5): such as "antibacterial rate" adopted by ISO 20743, with a citation frequency $>$ 70%;

medium level (3.5-4.4): such as "long-lasting antibacterial" adopted by industry white papers, with a citation frequency of 30%-70%;

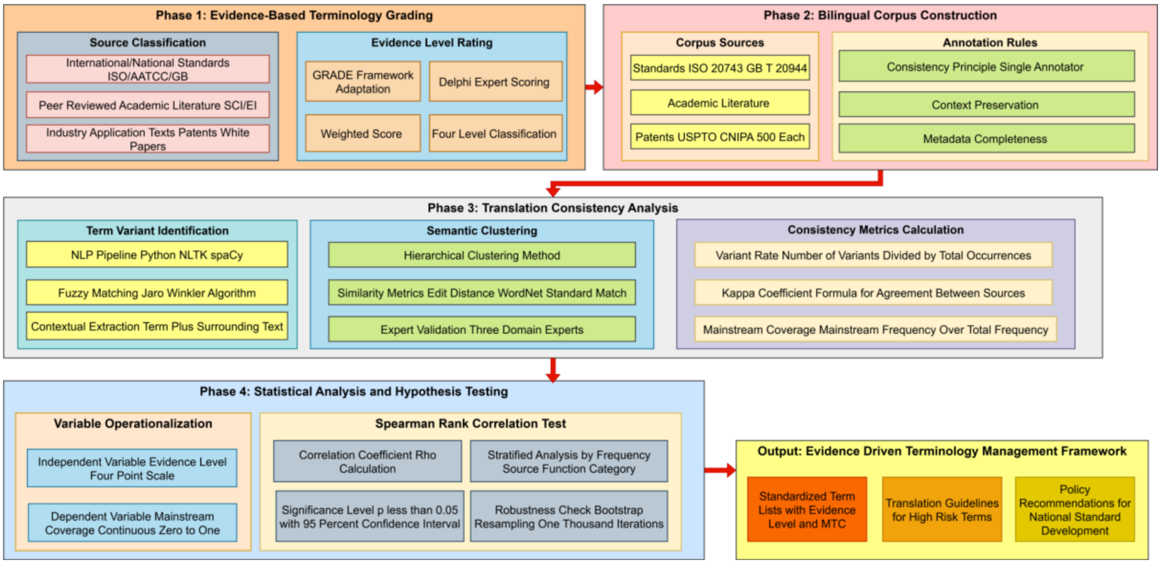

FIGURE 1. Research framework and technical route

TABLE 1. Rules for determining the authority of terms

Evaluation Dimension	High (4-5points)	Medium (3 points)	Low (2 points)	Very Low (1 point)
Authoritativeness	Clearly derived from formal standards at the international or national level, with stable and explicit normative binding	Derived from authoritative industry organization documents or high-level peer-reviewed journals, with strong professional recognition	Mainly from general academic journals or technical patents, with limited authority	Mainly from commercial promotional materials or non-professional information sources
Citation Frequency	Used in over 50% of the comprehensive retrieval corpus, showing stable recurrence across different sources	Used in 20%–50% of the comprehensive retrieval corpus, showing relatively concentrated usage in some literature	Used in 5%–20% of the comprehensive retrieval corpus, usage is scattered and context-dependent	Used in less than 5% of the comprehensive retrieval corpus, appearing sporadically or occasionally
Standard Adoption Degree	Clearly defined and continuously adopted in two or more international or national-level standards	Formally adopted by a single standard or multiple authoritative industry organizations	Not yet adopted in normative standards, only discussed at the academic or technical level	Not adopted in any normative documents, appearing only in individual texts or promotional materials

low level (2.5-3.4): such as "intelligent antibacterial" only used in general journals;

very low level (<2.5): such as "ultra-broad-spectrum antibacterial" in commercial publicity.

All eligible participants signed an informed consent form.

B. CONSTRUCTION AND PROCESSING OF BILINGUAL PARALLEL CORPUS

To unify terminology identification boundaries and annotation formats and ensure corpus comparability, the following principles are usually followed.

Consistency principle [22]: all annotations are completed by the same person or follow the same set of criteria, or cross-checked by multiple people to ensure the consistency and reliability of the annotation results;

Context preservation principle [23]: when extracting a term, the original sentence or paragraph in which it is located must be retained as context, which is crucial for determining the exact meaning of the term and the accuracy of the translation;

Metadata integrity principle [24]: all annotation fields of each term entry should be filled in as completely as possible to provide a data basis for subsequent statistical analysis and correlation testing.

1) Corpus Sources and Selection Criteria

The corpus sources include multiple types of authoritative texts: international standards (ISO 20743:2021, AATCC 100-2020), national standards (GB/T 20944.2-2007), academic literature (300 Web of Science papers), and patent literature (500 patents each from the USPTO (United States Patent and Trademark Office) and CNIPA (China National Intellectual Property Administration)). The annotation rules follow two principles: the context retention principle (retaining the original sentence when extracting terms) and the metadata integrity principle, including fields such as source type, publication year, and text type. Corpus selection is based on the quantitative evaluation method for antimicrobial properties in the ISO 20743:2021 international standard to ensure that the terms are directly related to the antimicrobial function.

2) Term Extraction and Standardized Annotation Process

The term extraction targets semantic units that express complete technical concepts in the field of functional antibacterial textiles, mainly including: noun phrases (such as "antibacterial efficacy"), adjective + noun structures (such as "durable antibacterial function"), gerunds or verb phrases (such as "inhibiting bacterial growth"), and abbreviations such as standard numbers (such as "GB/T 20944"). When extracting, it is necessary to ensure that the terms are independent and clearly expressed semantic entities, and avoid extracting fragments. For example, "antibacterial textile" should be extracted instead of "antibacterial", or "quantitative antibacterial test method" should be extracted instead of isolated "quantitative" or "test method" [25]. Table 2 shows the standardized annotation specifications of the term corpus, which defines 12 core fields and their data types, mandatory fields, uses, and annotation rules.

C. QUANTITATIVE EVALUATION MODEL FOR TRANSLATION CONSISTENCY

1) Term Variant Identification and Clustering Strategy

Based on the collected Chinese-English bilingual texts, the term extraction process integrates rule-based methods with adapted named entity recognition technology. In the specific implementation, the NLTK and spaCy tool libraries are first called through the Python environment for basic text processing [26]. The initial localization of terms relies on rule-based methods, including keyword matching, part-of-speech tagging, and dependency parsing, to accurately capture terms and their contextual information. Subsequently, by combining regular expressions and the Jaro-Winkler similarity algorithm, different Chinese translation variants that may correspond to the same English term are systematically identified. After completing the initial variant identification, semantic clustering is required to distinguish between "substantially synonymous variants" and "semantic deviation variants". A hierarchical clustering algorithm is used, with "semantic similarity" as the core clustering basis. Semantic similarity calculation integrates the following dimensions: literal similarity (edit distance and character overlap rate); semantic field relevance through WordNet whether it belongs to the same concept domain [27]; authoritative definition comparison. Although "broad-spectrum antibacterial" and "wide-spectrum antibacterial" use different words, their core semantics both point to "covering a variety of microbial types" and can be used interchangeably in some literature, so they are classified into the same semantic cluster; while "extensive antibacterial" is similar in wording, but "broad" focuses on the breadth of scope rather than the diversity of microbial species, which is easy to cause ambiguity, so it is classified as an independent cluster. The clustering results are marked with Cluster_ID, and each cluster represents a relatively independent set of translation variants in terms of semantics, which facilitates the subsequent consistency analysis by cluster. After clustering, each cluster's translations are semantically annotated and assessed for mainstream significance. Three terminologists with backgrounds in textile materials science provide semantic interpretation, authority rating, and mainstream assessment for each cluster's translations. Each translation is accompanied by a "semantic annotation" detailing its accuracy, applicable context, and potential misleading effects. Consumers may misinterpret "broadly antimicrobial" as "applicable to all scenarios", a term that lacks professional definition. The results of term variant identification and clustering serve as the basis for the subsequent calculation of consistency metrics. The variant rate measures the degree of dispersion in term translations, i.e., the average number of Chinese translations corresponding to an English term. The mainstream translation coverage rate reflects the dominance of mainstream translations in actual usage.

2) Definition and Calculation of Core Consistency Indicators

Defining and calculating key indicators reflecting translation uniformity, Table 3 is used to quantitatively analyze the clustered terms, which is the key to verifying the core hypothesis of the paper.

Note: the pinyin of Guangpu Kangjun stands for broad-spectrum antibacterial; the pinyin of Kuanpu Kangjun stands for wide-spectrum antibacterial; the pinyin of Guangfan Kangjun stands for extensive antibacterial.

Table 3 shows the number of Chinese translations for each English term (three in this example). A higher coverage rate of mainstream translations indicates higher translation consistency (86.5% in this example, indicating high consistency). Using Source_Type, the sources of systematic bias can be analyzed. The results show that non-mainstream translations (e.g., "broad-spectrum antibacterial") mainly originate from academic literature. These variants may have similar core semantics to mainstream translations, but because they have not been adopted by authoritative standards or have not formed a consensus in the normative context, they are defined as non-standard variants in the standardization assessment. This reflects the diversity in translation practice and the practical tension faced in seeking

TABLE 2. Example table of terminology corpus

Field	Data Type	Required	Explanation	Annotation Rules
ID	Number	Yes	Unique identifier.	Auto-increment.
Source_File	Text	Yes	Source file name.	For tracing original context.
Source_Type	Text	Yes	Evidence Source Classification.	Standard/ Academic Literature/Industry Text
Pub_Year	Number	Yes	Publication year.	For analyzing term evolution over time
Text_Type	Text	Yes	Detailed text type.	International Standard/National Standard/ Research Article/Review/ Patent/Product Datasheet/Technical White Paper
Original_Term	Text	Yes	Term in source language.	Broad-spectrum antimicrobial,Extract precisely
Original_Context	Text	Yes	Sentence or paragraph where the term appears in the source language.	-
Translation	Text	Yes	Corresponding translation in target language.	Obtained from official translations
Translated_Context	Text	No	Sentence or paragraph where the translated term appears in the target language.	-
Mainstream	Boolen	Yes	Flag indicating whether translation is recognized as mainstream.	Yes/No
Evidence_Level	Text	Yes	Evidence Level Rating.	High/Medium/Low/Very Low
Note	Text	No	Semantic notes.	-

TABLE 3. Translation variant analysis table

Cluster_ID	Canonical English Term	Chinese Translations & Semantic Details	Mainstream Translation Coverage
C001	broad-spectrum antimicrobial	1. Guangpu Kangjun - Frequency: 45 occurrences - Source Type: Standards, Academic Literature - Mainstream: Yes - [Note]:Standard medical term(directly aligns with the canonical English term; most accurate and widely accepted in formal contexts). 2. Kuanpu Kangjun - Frequency: 5 occurrences - Source Type: Academic Literature - Mainstream: No - [Note]:Similar in core semantics to “broad spectrum”, but not used in authoritative standard documents, it is a non-standard variant. standards). 3. Guangfan Kangjun - Frequency: 2 occurrences - Source Type: Industry Texts - Mainstream: No - [Note]:The literal translation, which emphasizes coverage, lacks the precision of definition in professional contexts..	0.865

uniformity within a professional terminology system.

(1) Variant rate

The variant rate is defined as the ratio of the number of different Chinese translations of an English term in the corpus to the total frequency of the term, VR (Variant Rate), and is calculated as follows:

$$\mathrm{VR} = \frac{N_{\text{variants}}}{N_{\text{total terms}}} \tag{1}$$

In Formula 1, N_{variants} is the total number of unique Chinese translations identified for a term; $N_{\text{total terms}}$ is the total number of occurrences of the term in the corpus. For example, “broad-spectrum antimicrobial” corresponds to three Chinese translations, $3/52 \approx 0.058$. A lower variant rate indicates more concentrated and stable translations; a higher variant rate indicates confusion and a lack of consensus in terminology usage. This metric intuitively reflects the degree of fragmentation in the terminology system and is an effective means of initially screening for high-risk terms.

(2) Kappa consistency coefficient (κ)

The Kappa coefficient is used to evaluate the consistency of the translation choices of the same term by multiple translators or multiple text sources. It is particularly suitable for determining whether the translation of a term is affected by subjective factors. Its calculation formula is:

$$\kappa = \frac{P_o - P_e}{1 - P_e} \tag{2}$$

In Formula 2, P_o is the observed agreement rate, that is, the actual proportion of the same translation method for the same term in different texts; P_e is the expected agreement rate, that is, the expected probability of reaching an agreement under the premise of randomly selecting a translation method.

The κ value ranges from -1 to +1: $\kappa > 0.8$ indicates "extremely strong agreement", 0.6-0.8 "strong agreement", 0.4-0.6 "moderate agreement", and below 0.4 "weak or no agreement". This study uses "term-translation" pairs as the unit, treating each English term's translation in different source texts as the "evaluator" and calculating its cross-text agreement.

(3) Mainstream translation coverage (MTC)

The mainstream translation coverage rate is defined as the frequency ratio of the mainstream Chinese translation of a term (the translation determined by experts to be mainstream, authoritative and in line with standards) among all translations.

In this study, MTC and translation consistency are different ways of expressing the same concept. MTC, as a quantifiable operational indicator, represents the translation concentration and stability of a term in actual use. A higher value indicates a greater proportion of the term being translated uniformly across different texts and sources, and a more consistent translation. In subsequent analyses, MTC is equivalent to the translation consistency score, calculated as:

$$\text{MTC} = \frac{\text{Mainstream Freq.}}{\text{Total Freq. of All Variants}} \tag{3}$$

In Formula 3, Mainstream Freq. represents the frequency of mainstream translations, and Total Freq. of All Variants represents the total frequency of all translations of the term. This metric directly reflects the degree of standardization of term translation. A higher value indicates a strong consensus within the industry or academia on the translation of the term, facilitating international dissemination and alignment with standards.

3) Data Analysis Strategy

The independent variable, evidence level, is defined as a four-level ordinal categorical variable (high=4, medium=3, low=2, very low=1). The grading results are derived from the established GRADE evidence framework and are independently assessed by three experts under the same scoring criteria. The mean of the results is taken as the evidence level of the term. The consistency of the scores is verified by the Krippendorff reliability coefficient [28]. The dependent variable, MTC, is a continuous variable with a value range of [0, 1]. Its numerical change reflects the concentration and standardization of translation use. Since the evidence level is an ordinal categorical variable, while translation consistency has a continuous distribution characteristic, and the overall data distribution has the risk of skewness and extreme values, the parametric statistical method based on the normality assumption is difficult to meet the analysis premise. The linear correlation model and the test method that depends on the normal distribution have uncertainty in statistical validity. Under these conditions, the Spearman rank correlation coefficient based on rank information is used to test the relationship between evidence level and translation consistency in order to ensure that the analysis results still have robustness and explanatory validity under the condition of asymmetric distribution. It is used as the core test tool [29]. Referring to the study by Rokicki et al. [30], the Spearman rank correlation coefficient ρ calculation formula is:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \tag{4}$$

In Formula 4, d_i is the rank difference of the observations; n is the sample size; ρ value ranges from -1 to +1. The larger the absolute value, the stronger the correlation.

Inspection process and step design: first, data preprocessing is performed to eliminate records with missing evidence levels or MTC values.

Then, a preliminary correlation test is conducted to calculate the Spearman ρ value, two-tailed p value (α=0.05), and 95% CI (Confidence Interval) of all terms.

To control for potential confounding variables such as term frequency, source type, and functional category, a stratified Spearman correlation analysis is further performed to calculate the intra-group ρ values by term frequency interval (<10, 10-50, >50), source type (standard/academic/industry), and functional category (performance indicator/material process/test method).

III. RESULTS AND FINDINGS

A. EVIDENCE LEVEL DISTRIBUTION CHARACTERISTICS OF CORE TERMS

This study systematically evaluates the evidence levels of 187 core terms in the field of functional antimicrobial textiles. The distribution of evidence levels is shown in Figure 2.

Figure 2 shows that the evidence level of terms presents a typical "pyramid-shaped" distribution feature:

high-level terms (Evidence Level = 4) account for 37.97 % (n=71);

medium-level terms (Level = 3) account for 31.55 % (n=59);

low-level terms (Level = 2) account for 19.78 % (n=37);

very low-level terms (Level = 1) account for 10.70 % (n=20).

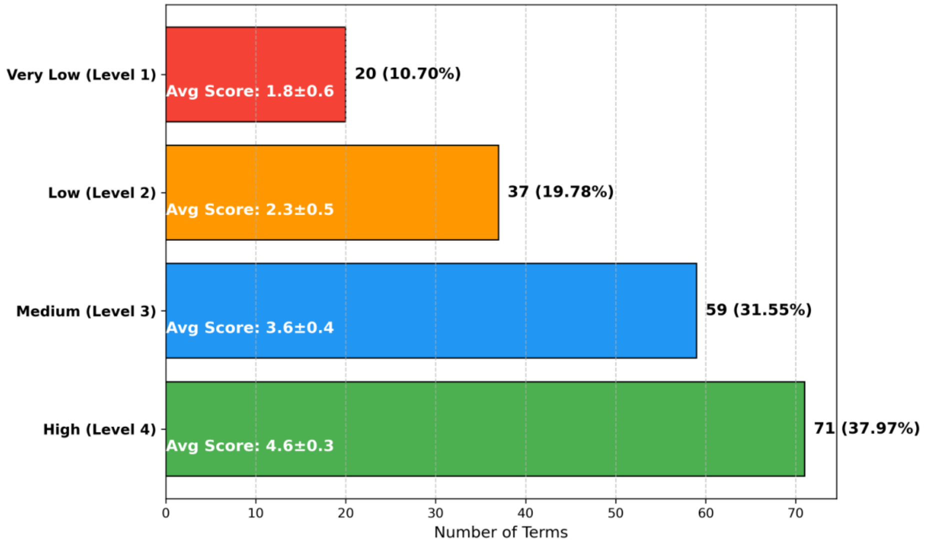

FIGURE 2. Distribution of evidence levels

B. TRANSLATION CONSISTENCY CORRELATION BETWEEN HIGH/LOW LEVEL OF EVIDENCE TERMS

By quantitatively comparing the performance differences in translation consistency between high- and low-evidence level terms, the core hypothesis that "higher term authority leads to more uniform translations" is validated. The analysis is based on a sample of 187 core terms, divided into a high-evidence group (n=71) and a low- and very-low-evidence group (n=57). Three core metrics, including translation variant rate, Kappa consistency coefficient, and mainstream translation coverage, are calculated for each term. Independent sample t-tests are used to assess the statistical significance of differences between the groups. The consistency comparison of high-level/low-level evidence terminology translation is shown in Table 4:

Table 4 shows that the average variation rate of high-level terms is 2.1%, which means that each term has only about two Chinese translations on average; while the average variation rate of low/very low-level terms is 7.8%, indicating that their translations are highly dispersed, and there are a large number of non-standard or self-created translations.

The average Kappa value for the high-level terminology group is 0.82 (standard deviation 0.09), placing it in the "strong consistency" category, indicating a high degree of convergence in the choice of translation for the same term across different text sources. In contrast, the average Kappa value for the low/very low-level terminology group is only 0.35 (standard deviation 0.14), placing it in the "weak consistency" category, suggesting that translation choice is significantly influenced by subjective factors or context, lacking objective constraints. This difference is confirmed to be highly statistically significant by an independent samples t-test ($t= 13.87$, $df= 126$, $p< 0.001$), indicating that evidence level is a key structural variable determining translation consistency.

The average MTC of high-level terms is 91.3% (standard deviation 0.07), which means that their mainstream translation method occupies an absolute dominant position among all translation methods; while the average MTC of low-level terms is only 42.6% (standard deviation 0.16), reflecting that their mainstream translation method has not formed a broad consensus and is often marginalized or replaced.

C. EXAMPLES OF CROSS-LANGUAGE MAPPING PATTERNS OF TYPICAL TERMS

Typical terminology examples are shown in Table 5.

Case 1: "broad-spectrum antimicrobial" [31,32]: this term refers to the ability to inhibit or kill a wide range of microorganisms (such as bacteria, fungi, and some viruses). It is widely used in international standards (such as ISO 20743) and academic literature. Three Chinese translations are identified in the corpus:

(1) "Guangpu Kangjun": frequency 45, coverage rate 86.5%, marked as the mainstream translation, widely seen in national standards (GB/T 20944), SCI journals and authoritative textbooks, and its semantics accurately correspond to the original English meaning.

"Kuanpu Kangjun": frequency 5, coverage rate 9.6%, all originated from non-core Chinese journals or corporate technical documents. They are creative translations based on the literal meaning of "broad" ("kuan" = wide), not found in any formal standards, and there is a risk of semantic narrowing.

"Guangfan Kangjun": frequency 2, coverage rate 3.8 %, mostly appears in promotional copy on e-commerce platforms. It is a popular expression that emphasizes "wide coverage", but lacks professional definition and can easily cause misunderstanding among consumers.

"Guangpu Kangjun" is a high-evidence term (score 4.7), and its translation is highly concentrated; while "Kuanpu

TABLE 4. Comparison of translation consistency of high/low level of evidence terms

Metric	High-Evidence Terms (n=71)	Low/Very Low-Evidence Terms (n=57)	Statistical Significance (Independent t-test)
Variant Rate (%)	2.1% ± 0.8	7.8% ± 1.5	t = −15.21, df = 126, p < 0.001
Kappa Coefficient (κ)	0.82 ± 0.09	0.35 ± 0.14	t = 13.87, df = 126, p < 0.001
Mainstream Translation Coverage (MTC)	91.3% ± 7.0%	42.6% ± 16.0%	t = 12.45, df = 126, p < 0.001

TABLE 5. Typical case analysis

Term	Evidence level	Translations and Frequency	Main-stream	Coverage	Source Type
Broad-spectrum antimicrobial	High (4.7)	1.Guangpu Kangjun 45 occurrences 2.Kuanpu Kangjun 5 occurrences 3. Guangfan Kangjun 2 occurrences	Yes / No / No	86.5% / 9.6% / 3.8%	Standards, Academic Literature / Academic Literature / Industry Texts
Contact killing rate	Medium (4.2)	1.Jiechu Shamielv 38 occurrences 2.Jiechu Shajunlv 12 occurrences 3.Jiechu Yijunlv 3 occurrences	Yes / No /No	71.7% / 22.6% / 5.7%	Standards (ISO 20743), Academic Literature / Industry Reports / GB/T 20944-related texts
Antimicrobial durability	Medium (3.5)	1.KangjunNaijiuxing 29 occurrences 2. Kangjun Chijiuxing 18 occurrences 3. Kangjun Naixixing 6 occurrences	Yes / No / No	54.7% / 34.0% / 11.3%	Academic Literature, Standards / Academic Literature / Washing Test Reports

Kangjun", although semantically similar, has become a marginalized mistranslation due to the lack of standard support, reflecting that low-evidence terms are easily influenced by subjective creativity during the translation process, forming systematic deviations.

(2) Case 2: "contact killing rate" [33]: this term describes the efficiency of a material surface in killing microorganisms after direct contact with the surface. It is a core indicator for evaluating contact antimicrobial textiles. Three main translations are extracted from the corpus:

"Jiechu Shamielv": frequency 38, coverage 71.7 %, which is a translation clearly defined in the ISO 20743 standard, emphasizing the "killing" process and is suitable for medical-grade antibacterial products.

"Jiechu Shajunlv": frequency 12, coverage 22.6 %, often seen in China's industry reports and product manuals. Semantically, "killing" is simplified to "sterilization". Although it is popular, it is not rigorous, because "sterilization" often refers to "inhibition + killing", which weakens the core mechanism of "lethality".

"Jiechu Yijunlv": frequency 3, coverage rate 5.7 %, mainly appears in the relevant text of GB/T 20944. This standard does not strictly distinguish between "antibacterial" and "bactericidal", resulting in some test data being classified as "contact antibacterial", thus confusing the concept.

Even if a term has a high level of evidence (a score of 4.2), different definitions of the same concept across different standards can still lead to translation discrepancies. This suggests that terminology standardization requires strengthened cross-standard coordination to avoid compliance risks caused by "same word, different meaning".

(3) Case 3: "antimicrobial durability" [34,35]: this term describes the ability of the antimicrobial function to remain stable during use or washing, and is a key parameter for measuring the life of the product. Three translations are identified in the corpus:

"KangjunNaijiuxing": frequency 29, coverage rate 54.7 %, which is the standard translation method adopted in academic literature and some standard documents, covering various failure modes such as time aging, mechanical wear, and chemical corrosion.

"Kangjun Chijiuxing": frequency 18, coverage 34.0 %, similar in semantics, but in some contexts it focuses more on the "time dimension", slightly weaker than the comprehensive anti-aging ability of "durability".

"Kangjun Naixixing": frequency 6, coverage rate 11.3 %, only found in the test report of washing textiles, specifically referring to the "antibacterial performance retention rate after multiple washes", which is completely unapplicable in medical protective clothing or long-term wear products, and is a serious scenario mismatch.

Although the term has a medium level of evidence (score of 3.5), its diverse application scenarios have led to "domain differentiation" in translation. The low-evidence translation of "washability" has been incorrectly transferred to other fields, exposing a lack of "contextual adaptation" in term translation. Translations haven't been dynamically adjusted to the application environment, leading to functional misjudgments and technical misdirection.

D. STATISTICAL VERIFICATION OF THE CORRELATION BETWEEN EVIDENCE LEVEL AND MTC

The test results show that there is a significant positive correlation between the level of evidence and MTC. As the level of evidence of a term increases, the MTC shows a stable increasing trend. The evidence level and MTC analysis are shown in Figure 3.

Figure 3 demonstrates a strong positive correlation between the level of evidence for functional antimicrobial textile terminology and MTC.

Figure 3(a) shows the distribution characteristics of MTC across four levels of evidence: high-level terms (Level 4) have a high mean of 0.913 and low dispersion, indicating a high degree of translation stability; whereas very low-level terms (Level 1) have a mean of only 0.426 and high dispersion, reflecting confusion and a lack of consensus in translation.

Figure 3(b) shows the natural distribution of 187 terms across four levels of evidence. The regression trend line shows a significant upward trend, demonstrating that terminology authority is a key variable driving translation standardization. A linear regression model is fitted to generate a regression equation MTC = 0.175 × Evidence Level + 0.196. This equation indicates that for every one-unit increase in the evidence level, the MTC increases by an average of 0.175 units. Stratified analysis is shown in Figure 4.

Figure 4 further reinforces the universality of this conclusion through stratified analysis.

Overall correlation across all 187 functional antimicrobial textile terms: a strong positive correlation is found between the level of evidence and the MTC, ρ= 0.68 (95% CI: [0.59, 0.76]), indicating that higher-authority terms are associated with more uniform and standardized translations.

Grouped by term frequency: in the high-frequency term group (>50 times), ρ= 0.62; in the low-frequency term group (<10 times), ρ= 0.71, indicating that even in sparsely used terms, the level of evidence still has a stronger constraint on MTC;

Grouped by source type: in the "standard text" group, ρ= 0.75; in the "industry text" group, ρ= 0.58, reflecting that institutional authority (standard documents) is more effective in guiding translation consistency than market-driven texts;

Grouped by functional category: "Test method" terms ρ= 0.72, "material process" terms ρ= 0.59, indicating that terminology with a high degree of standardization is more likely to form a translation consensus.

These results support the view that the evidence level of a term is an upstream variable regulating translation consistency. High-level-of-evidence terms typically possess clear boundaries, stable usage contexts, and authoritative citation sources, reducing translator discretion and the risk of multiple translations and mistranslations. Low-level-of-evidence terms, on the other hand, lack a standardized anchor and are susceptible to subjective interpretation, commercial advertising, or contextual shifts, leading to fragmented and uncontrollable translation.

IV. CONCLUSIONS

This study, integrating the GRADE framework for evidence grading analysis, establishes a quantitative correlation model between term authority and translation consistency in the field of functional antimicrobial textiles, confirming that term evidence level is a core structural variable influencing translation consistency. Based on a systematic analysis of 187 core terms, high-evidence level (Level 4) terms have a Mainstream Translation Coverage (MTC) of 91.3%, a Kappa consistency coefficient of 0.82, and a variation rate of only 2.1%. In contrast, low/very low-evidence level (Level 2/Level 1) terms have an MTC of only 42.6%, a Kappa value of 0.35, and a variation rate of 7.8%. The difference is highly significant using an independent-samples t-test. Spearman correlation analysis further confirms a strong positive correlation between the two terms (ρ=0.68, p<0.001), demonstrating that clearer term definitions and more authoritative sources are associated with more stable and consistent translation behavior. This addresses key industry issues such as ambiguous term definitions, conflicting standards, and multiple mistranslations.

AUTHOR CONTRIBUTIONS

Ning Han designed, collected and analyzed the data, and drafted the manuscript. Ning Han conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ning Han participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

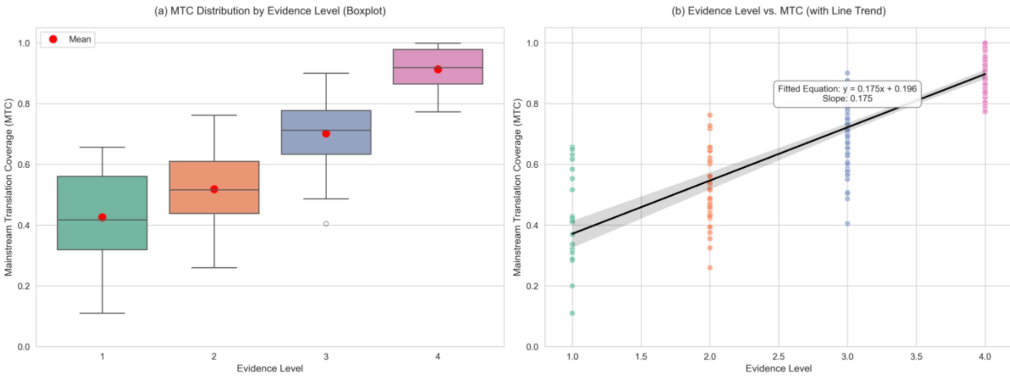

FIGURE 3. Evidence level and MTC analysis

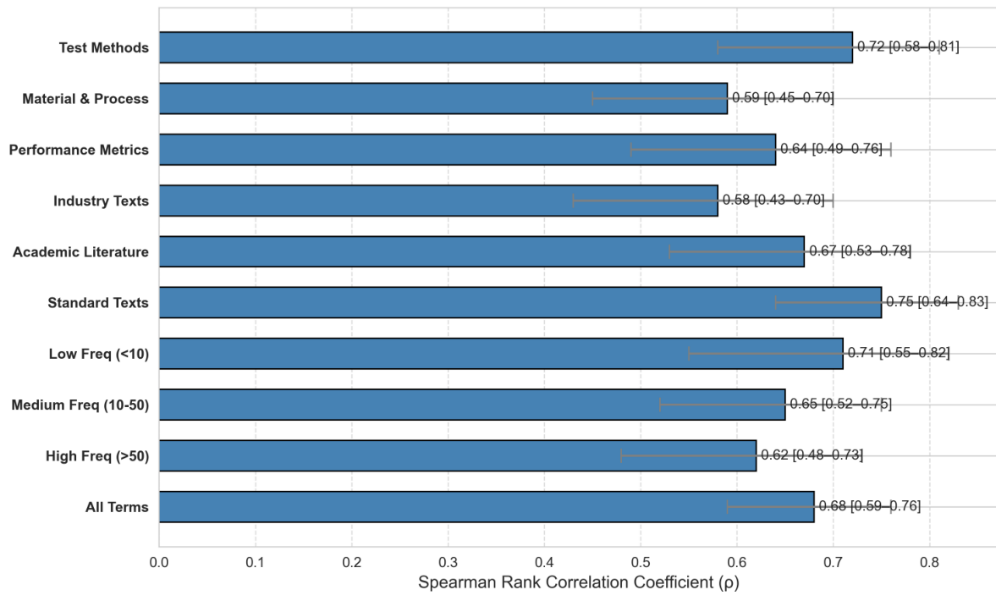

FIGURE 4. Stratified analysis

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