

ARTICLE



<https://doi.org/10.1057/s41599-026-08902-5>

OPEN

Psychosocial predictors and justification patterns of traditional and alternative medicine in Peru

Angelo Fasce^{1,2,3✉}, Jose Rosales-Trabuco⁴, Javier Rodriguez-Ferreiro⁵, Itxaso Barberia⁵,
Elvis Pinedo-Yzaguirre⁶, Juan Manuel Espinoza Nunez⁷, Wilson Marcos Ortiz-Treviños⁸,
Christian David Pizarro-Moncada⁹, Mario Reyes-Bossio¹⁰, Carlos Carbajal-León¹¹ & Ezequiel Lopez-Lopez^{12,13}

This mixed-methods study investigates the prevalence, attitudes, psychological predictors, and reasons for perceived effectiveness of traditional and alternative medicine in Peru. A representative national sample ($N = 805$) reported their experiences with 16 unconventional medical techniques, alongside psychometric measures of pseudoscientific beliefs, ideological traditionalism, and trust in the medical profession. Traditional medicine was more widely used, while alternative medicine elicited more favorable attitudinal responses. Pseudoscientific beliefs predicted greater endorsement of both modalities, with traditionalism specifically linked to traditional medicine. To enrich the psychometric findings, we applied natural language processing techniques to 2716 reasons for perceived effectiveness extracted from spontaneous open-ended responses, revealing distinct rhetorical patterns: alternative medicine was more often justified through pseudoscientific and biomedical-sounding arguments, whereas traditional medicine drew on cultural, spiritual, and experiential narratives. Network and co-occurrence analyses confirmed that both modalities follow distinctive general combinatory logics of justification. However, subgroups mixing traditional and alternative medicine also emerged, such as spiritually oriented practices and techniques pivoting traditionalist conceptions. These findings reflect the interplay between global health discourses and local belief systems. Overall, this study highlights the value of integrating cultural and linguistic analyses to understand public engagement with unconventional health practices.

¹ Institute for Planetary Health Behaviour, Universität Erfurt, Erfurt, Germany. ² Instituto de Investigación Científica, Universidad de Lima, Lima, Peru. ³ Health Communication Working Group, Bernhard-Nocht-Institut für Tropenmedizin, Hamburg, Germany. ⁴ Programa de Estudios Generales, Universidad de Lima, Lima, Peru. ⁵ Grup de Recerca en Cognició i Llenguatge, Departament de Cognició, Desenvolupament i Psicologia de l'Educació, Secció Processos Cognitius, Institut de Neurociències, Universitat de Barcelona, Barcelona, Spain. ⁶ Departamento Académico de Cursos Básicos, Universidad Científica del Sur, Lima, Peru. ⁷ Departamento de Humanidades, Universidad Privada del Norte, Trujillo, Peru. ⁸ Departamento de Educación, Facultad de Educación, Universidad Nacional Mayor de San Marcos, Lima, Peru. ⁹ Facultad de Ingeniería Geológica, Minera y Metalúrgica, Universidad Nacional de Ingeniería, Lima, Peru. ¹⁰ Facultad de Psicología, Universidad Peruana de Ciencias Aplicadas, Lima, Peru. ¹¹ Facultad de Ciencias de la Comunicación, Turismo y Psicología, Universidad de San Martín de Porres, Lima, Peru. ¹² Center for Adaptive Rationality, Max Planck Institute for Human Development, Berlin, Germany. ¹³ Center Synergy of Systems, TUD Dresden University of Technology, Dresden, Germany. ✉email: angelo.fasce@uni-erfurt.de

Introduction

Even though the prevalence of health interventions presented as therapeutic without adequate scientific evidence of clinical effectiveness is substantial in developed countries, their incidence in developing countries such as Peru tends to be even higher (Ernst, 2022). This heightened prevalence reflects multiple structural and cultural factors, including the general educational level of the population, the influence of mass media, the strong impact of local traditions and belief systems, and limited access to conventional medicines and treatments (Mejía Gálvez et al., 2017; Santiváñez-Acosta et al., 2020). Unconventional medical techniques are usually grouped into two broad categories. On the one hand, *alternative medicine*—typically of foreign origin in the Peruvian context—is defined by the World Health Organization (2019) as “a broad set of healthcare practices that are not part of that country’s own traditional or conventional medicine and are not fully integrated into the dominant healthcare system,” encompassing techniques such as homeopathy, acupuncture, energy and crystal healing, reflexology, magnet therapy, or anthroposophic medicine. On the other hand, *traditional medicine* is defined by the World Health Organization (2019) as “the sum total of knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explainable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness.” In Peru, traditional medical practices include egg cleanse, alum rub, guinea pig rub, and coca payment, which are deeply rooted in local cosmologies and cultural heritage. Although this distinction is analytically useful, the boundary between traditional and alternative medicine is not always clear-cut, as some techniques occupy hybrid positions and draw on overlapping repertoires of justification.

The use of traditional and alternative medicine is a relevant issue for clinical practice due to its associated risks (Niggemann and Grüber, 2003; Wardle and Adams, 2014), and the spread of CAM-related misinformation during events such as the COVID-19 pandemic (Recuero et al., 2021). Despite these risks, interventions originating outside conventional medicine are often integrated into or accepted within mainstream healthcare (Fasce et al., 2023; Stussman et al., 2022). In a comprehensive systematic review, Tangkiatkumjai et al. (2020) described a wide range of reasons for using unconventional treatments, including expectations of health benefits, dissatisfaction with conventional medicine, and perceived safety. These reasons vary across cultural settings: internal locus of control is more common in Western populations, social networks are more salient among Asian populations, and affordability and tradition are particularly relevant in African countries. Moreover, reasons for opting for traditional versus alternative medicine also differ. First, perceptions of deficient or inaccessible public healthcare tend to be more prominent among users of traditional medicine, who are more prevalent in rural and indigenous communities (León Montoya et al., 2023). Second, the relatively low cost and strong trust in its efficacy make traditional medicine the preferred option for low-income individuals with limited educational attainment, whereas users of more expensive alternative medicine tend to have access to private healthcare services (Villena-Tejada et al., 2021; Santiváñez-Acosta et al., 2020). Third, cultural tradition is a prominent reason for relying on traditional medicine (Córdova and Velásquez, 2023), while users of alternative medicine often seek it after actively learning about its potential benefits (Topaloglu Ören et al., 2024).

Peru is a pluricultural and multiethnic country where each ethnic group expresses its culture in diverse ways (Campos Briceño and Condor Iturrizaga, 2022). This diversity includes indigenous peoples from coastal, Andean, and Amazonian regions. Although Western perspectives are dominant, they coexist with

pre-Hispanic worldviews, giving rise to diverse understandings of the human life cycle and the conceptions of health and illness (Flores Rojas, 2020; Santa María, 2017), as well as childbirth and newborn care practices (Del Mastro et al., 2021). Internal migrations have generated complex dynamics between indigenous and non-indigenous populations, reflecting deeply rooted historical and geographical interactions (Barrón, 2008). In response to this reality, the Peruvian state integrates unconventional medicine through public policies (Devoto Bazán, 2016), and the Peruvian public health system offers alternative treatments such as phytotherapy, acupuncture, and yoga (García, 2019). However, these practices are viewed with skepticism by some sectors of Peruvian society, possibly due to the association of traditional medicine with folk healing and ritual practices (Luján-Carpio et al., 2014; García, 2019).

Overview of the present study

This comprehensive mixed-methods study aims to advance understanding of the prevalence, attitudes, psychological predictors, and reasons for the use of unconventional treatments in Peru. To this end, we recruited a representative sample of the Peruvian population to complete a questionnaire on the prevalence of use of eight alternative and eight traditional medicine techniques, as well as other attitudinal variables (i.e., frequency of use, belief in clinical effectiveness, willingness to use in the future, and preference over conventional medicine). We also included three psychological variables as predictors of use and attitudes toward traditional and alternative medicine: trust in the medical profession, general pseudoscientific beliefs, and ideological traditionalism. Finally, natural language processing algorithms were employed to identify thematic patterns in spontaneous reasons for using traditional and alternative medicine expressed in an open-ended question.

Methods

Sample. The sample was recruited through NetQuest, a panel provider operating in Peru. It was designed to approximate the Peruvian population in terms of age and gender. Detailed sample characteristics are presented in Table S1. A total of 805 participants completed the questionnaire and passed all attention checks.

Measures. We assessed variables related to eight traditional Peruvian medicine techniques (egg cleanse, bone healer, flowering baths, alum rub, use of mud or clay, healer cleanse, guinea pig rub, and coca payment) and eight alternative medicine techniques (music therapy, reflexology, chiropractic, acupuncture, hydrotherapy, homeopathy, reiki, and trophotherapy). These techniques were selected based on prevalence rates reported by Mejía Gálvez et al. (2017) for the Lima region, which indicate that they are particularly common in the Peruvian context.

- *Prevalence of use.* Participants indicated whether they had ever used each technique for the treatment of a disease (response options: yes or no).
- *Frequency of use.* For each technique previously used, participants reported how regularly they had used it to treat diseases, using a Likert scale from 1 (“very rarely”) to 7 (“very frequently”) (Cronbach’s α : traditional medicine = 0.87; alternative medicine = 0.91).
- *Belief in effectiveness.* Participants rated their belief in the effectiveness of each technique for the diagnosis and/or treatment of diseases, on a Likert scale from 1 (“not at all effective”) to 7 (“totally effective”) (Cronbach’s α : traditional medicine = 0.90; alternative medicine = 0.91).

- *Future use.* Participants indicated their willingness to use each technique in the future for diagnosis and/or treatment, on a scale from 1 (“not at all willing”) to 7 (“completely willing”) (Cronbach’s α : traditional medicine = 0.90; alternative medicine = 0.91).
- *Preference over medicine.* Participants indicated whether they preferred the use of each technique over conventional medical treatments, on a scale from 1 (“prefer this technique”) to 7 (“prefer conventional medicine”) (Cronbach’s α : traditional medicine = 0.92; alternative medicine = 0.91). The scores were reversed to indicate preference for the unconventional medical technique over conventional medicine.

Following completion of the first questions, participants responded to an open-ended question designed to elicit their spontaneous reasoning in support of one unconventional medical technique. They were first presented with the prompt: “If you could only choose one technique, which of the following techniques do you consider the most effective?” After selecting their preferred technique from the list, participants were instructed to justify their choice in a free-text box with the instruction: “Please explain your reasons for choosing [selected technique] in the previous question. Take your time to write your reasoning in a coherent and well-structured manner. This phase will last for 5 min, after which the survey will automatically continue.” Therefore, these responses should be interpreted as reasons for perceived effectiveness rather than direct reports of actual use. Acupuncture was the most frequently chosen technique (18.8%), followed by chiropractic (14.5%), egg cleanse (13.2%), and bone healer (9.3%). The selection frequencies for all techniques are presented in Fig. S2. This procedure enabled the collection of relatively rich and focused textual data under controlled time conditions, complementing the structured psychometric measures with naturalistic justifications expressed in participants’ own terms.

Finally, we administered well-established psychological scales as predictors of attitudes toward and use of traditional and alternative medicine:

- *Trust in the medical profession.* Measured using five items from Dugan et al. (2005), rated on a Likert scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree).
- *Pseudoscientific Beliefs.* Assessed with the eight-item short version of the Pseudoscientific Belief Scale (Fasce et al., 2021), using a 1–5 Likert scale (1 = strongly disagree, 5 = strongly agree). Three items directly related to alternative medicine (i.e., chiropractic, reflexology, and emotional carcinogenesis) were excluded to avoid semantic overlap with dependent variables.
- *Traditionalism.* Measured using the six-item conventionalism factor of the Aggression-Submission-Conventionalism Scale (Dunwoody and Funke, 2016), rated on a scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree). One item (“People emphasize tradition too much”) was removed due to its low corrected item–total correlation ($r = 0.05$) and because its exclusion improved internal consistency.

The wording, descriptive statistics, and psychometric properties of all psychological scales are detailed in Table S2.

Use of and attitudes toward traditional and alternative medicine techniques. Results on the prevalence of use and mean scores for attitudinal variables across the sixteen traditional and alternative medicine techniques included in the study are presented in Table S3. Overall, traditional medicine was more widely

used than alternative medicine: the mean use rate across traditional techniques was 39.75%, with 85.8% of participants having used at least one traditional medicine technique. In contrast, the mean use rate for alternative techniques was 26.38%, with 68.1% of participants having used at least one alternative technique. The most frequently used technique overall was egg cleanse (69.9%), followed by bone healer (46.5%) and alum rub (41.1%). Music therapy was the most used alternative medicine technique (40.5%), followed by reflexology (34.4%), chiropractic (34.2%), and acupuncture (28%).

Traditional medicine exhibited a statistically significant higher prevalence of use than alternative medicine ($t = 9.83$, $p < 0.001$, Hedges’ $g = 0.35$). However, alternative medicine techniques received higher mean ratings for belief in effectiveness ($t = -7.22$, $p < 0.001$, Hedges’ $g = 0.25$), future use ($t = -9.66$, $p < 0.001$, Hedges’ $g = -0.34$), and preference over conventional medicine ($t = -6.38$, $p < 0.001$, Hedges’ $g = -0.23$). These results suggest that although traditional medicine techniques are used more frequently, participants tend to hold more positive attitudinal evaluations toward alternative medicine.

Differences between users and non-users of traditional and alternative medicine. Comparisons between users and non-users of traditional and alternative medicine on sociodemographic variables (i.e., age, gender, religiosity, and political orientation) and psychological variables (i.e., trust in the medical profession, pseudoscientific beliefs, and traditionalism) revealed that users of both types of techniques held significantly higher levels of pseudoscientific beliefs than non-users (Table 1). Traditionalism emerged as a differential factor: only users of traditional medicine reported significantly higher levels of traditionalism compared to non-users, whereas no such difference was observed for alternative medicine users.

Psychological predictors of positive attitudes toward traditional and alternative medicine. Psychological predictors of positive attitudes toward traditional and alternative medicine. To further assess the role of psychological factors in predicting attitudes toward traditional and alternative medicine, we conducted a series of regression analyses controlling for sociodemographic variables (i.e., age, gender, education, religiosity, and political orientation). The models examined the predictive power of trust in the medical profession, pseudoscientific beliefs, and traditionalism on attitudinal outcomes (i.e., frequency of use, belief in effectiveness, future use, and preference over conventional medicine). Results for traditional and alternative medicine are reported in Tables 2 and 3, respectively. Collinearity diagnostics indicated acceptable levels across all models. Consistent with previous analyses (Table 1), pseudoscientific beliefs emerged as a robust positive predictor of attitudes toward both traditional and alternative medicine. Traditionalism, in contrast, was a positive predictor of belief in effectiveness and future use only for traditional medicine techniques.

Classification of spontaneous reasons for perceived effectiveness. Given the open-ended and highly variable nature of participants’ spontaneous expressions of reasons for perceived effectiveness, our methodological design emphasized iterative refinement, combining automated natural language processing techniques with human-in-the-loop validation. The full process involved four main stages: (1) extraction of discrete reasons for perceived effectiveness (Lopez-Lopez and Herzog, 2025), (2) curation of the extracted data, (3) development of a taxonomy of reasons for perceived effectiveness (Fasce et al., 2023; Holford et al., 2024), and (4) statistical and semantic analysis. The full

Table 1 Differences in sociodemographic and psychological variables between users and non-users of traditional and alternative medicine.									
Traditional medicine	Alternative medicine					t	Mean difference	Hedges' g	t
	Non-users M (SD)	Users M (SD)	Non-users M (SD)	Users M (SD)	Mean difference				
Age	42.47(16.10)	38.17 (14.38)	37.38 (14.91)	39.44 (14.57)	-2.06	-186	-0.14	-186	-0.14
Gender	1.42 (0.50)	1.53 (0.50)	1.49 (0.50)	1.53 (0.50)	-0.03	-0.83	-0.06	-0.83	-0.06
Education	3.83 (1.49)	3.67 (1.36)	3.52 (1.39)	3.77 (1.37)	0.17	-2.37	-0.18	-2.37	-0.18
Religiosity	2.91 (0.90)	3.09 (0.70)	2.95 (0.79)	3.12 (0.71)	-0.18	-316*	-0.24	-316*	-0.24
Political orientation	4.78 (1.59)	4.48 (1.49)	4.44 (1.51)	4.56 (1.51)	0.30	-1.09	-0.08	-1.09	-0.08
Trust in the medical profession	2.89 (0.59)	2.83 (0.64)	2.88 (0.59)	2.83 (0.65)	0.56	0.99	0.08	0.99	0.08
Pseudoscientific beliefs	3.32 (0.64)	3.65 (0.61)	3.45 (0.64)	3.67 (0.61)	-0.33	-4.75**	-0.36	-4.75**	-0.36
Traditionalism	3.36 (0.63)	3.53 (0.56)	3.46 (0.59)	3.53 (0.56)	-0.17	-158	-0.12	-158	-0.12
*p < 0.01. **p < 0.001.									

pipeline, including prompts, classification procedures, and validation metrics, is described in detail in Supplementary Material.

To address stage (1), we developed a reason extraction prompt for the OpenAI GPT-4o model (Hurst et al., 2024, Rathje et al., 2024), which was applied to the original 805 open-ended responses to extract discrete reasons for perceived effectiveness of the selected unconventional medical technique (see Prompts section in Supplementary Material for a full description). The goal of this extraction was to generate an initial set of unique reasons for perceived effectiveness to enable subsequent analyses of differences and similarities among them (Lopez-Lopez and Herzog, 2025). The extraction resulted in an average of three reasons for perceived effectiveness per response, formatted as individual phrases—for example, the response “because through reflexology you relax and the ailments you suffer are healed” yielded [“relaxation,” “relief of ailments”] (see Tables S6 and S7 for illustrative nominalized reasons across categories).

This provided a starting point for stage (2), during which two domain experts (AF and JRT) assessed the granularity and semantic validity of all 805 pairs of responses and their corresponding extracted reasons through a series of collaborative meetings. They reached consensus on necessary modifications, eliminations, and additions. This refinement resulted in approximately 30% of extracted reasons being modified relative to the original model output, and seven open-ended responses were discarded due to the absence of identifiable reasons for perceived effectiveness. The final curated dataset comprised $N = 2716$ individual reasons derived from 798 open-ended responses.

For stage (3), we developed a theoretical taxonomy aimed at classifying reasons for perceived effectiveness based on their shared underlying psychological constructs. The initial version of the taxonomy included eight thematic categories, grounded in domain-specific literature and informed by previous classification frameworks in health behavior research (e.g., vaccine hesitancy; Tangkiatkumjai et al., 2020; Fasce et al., 2023; Holford et al., 2024). This initial taxonomy was independently applied by the two domain experts (AF and JRT) to a set of 300 reasons. However, certain reasons did not fit neatly into the initial categories (e.g., paranormal beliefs). These outliers were discussed in depth and used to refine the taxonomy, resulting in a revised version with clearer conceptual boundaries, ultimately comprising nine distinct categories plus a miscellaneous category for vague or incoherent reasons. The final version of the taxonomy is presented in Table 4.

We employed the finalized taxonomy to classify all extracted reasons for perceived effectiveness. To ensure accuracy and consistency, we adopted an iterative process combining model-based classification with expert evaluation until performance metrics indicated sufficient reliability. This approach integrated human annotation with model-assisted classification using structured prompts (see Prompts in Supplementary Material for details). In the first round, a random sample of 300 reasons was independently annotated by two domain experts (AF and JRT) and classified by OpenAI’s GPT-4o model using prompt engineering. The task was implemented via zero-shot classification (Wang et al., 2023), providing the model with natural language descriptions of each category without labeled examples. This strategy allowed rapid testing and refinement of the taxonomy while leveraging the model’s general language capabilities without requiring supervised training or curated datasets. Inter-annotator agreement between human coders was moderate (Krippendorff’s $\alpha = 0.67$). Disagreements were resolved through discussion to establish a consensus, which served as the reference standard for evaluating model performance.

The initial prompt achieved strong classification metrics across most categories, with F1 scores (Christen et al., 2023) exceeding

Table 2 Linear multiple regressions controlling for sociodemographic variables with traditional medicine as dependent variable.

	Frequency of use R = 0.20 Adjusted R² = 0.04	Belief in effectiveness R = 0.33 Adjusted R² = 0.10	Future use R = 0.32 Adjusted R² = 0.09	Preference over medicine R = 0.23 Adjusted R² = 0.04
Age	−0.07	−0.08	−0.11*	−0.12**
Gender	0.09	0.03	0.05	−0.04
Education	−0.09	−0.09	−0.07	−0.13**
Religiosity	0.02	0.05	0.05	0.09*
Political Orientation	0.04	−0.05	−0.03	−0.05
Trust in the medical profession	−0.02	−0.04	−0.03	−0.08
Pseudoscientific beliefs	0.11	0.22**	0.20**	0.08
Traditionalism	0.02	0.18**	0.16**	0.03
F	3.52**	12.51**	11.11**	5.54**

R² displays the adjusted value. All regression coefficients are standardized β .
* $p < 0.01$, ** $p < 0.001$.

Table 3 Linear multiple regressions controlling for sociodemographic variables with alternative medicine as dependent variable.

	Frequency of use R = 0.15 Adjusted R² = 0.01	Belief in effectiveness R = 0.34 Adjusted R² = 0.11	Future use R = 0.39 Adjusted R² = 0.14	Preference over medicine R = 0.24 Adjusted R² = 0.05
Age	0	0.10*	0.09	−0.02
Gender	0.06	0.06	0.07	−0.04
Education	0.01	0.08	0.05	−0.05
Religiosity	0.09	0.06	0.07	0.13**
Political Orientation	0.02	−0.01	−0.02	−0.09
Trust in the medical profession	−0.02	−0.01	−0.02	−0.09*
Pseudoscientific beliefs	0.07	0.28**	0.32**	0.17**
Traditionalism	0.04	0.01	0.06	−0.05
F	1.46	12.93**	17.27**	6.16

R² displays the adjusted value. All regression coefficients are standardized β .
* $p < 0.01$, ** $p < 0.001$.

Table 4 Taxonomy of reasons for perceived effectiveness for alternative or traditional medicine.

Code	Category	Description
1	Paranormal beliefs	Refers to supernatural, spiritual, energetic, or religious entities and processes. Includes trust in shamans or healers, belief in vital energy, the evil eye, envy, and diagnostic techniques like reading guinea pigs or eggs.
2	Distrust in conventional medicine	Expresses criticism or distrust toward conventional treatments, including concerns over inefficacy, superficiality, or commercial interests.
3	Use of natural products	Preference for natural remedies perceived as chemical-free, healing, and more connected to nature.
4	Benefits and effectiveness	Mentions both clinical effects (e.g., pain relief) and personal benefits (e.g., relaxation, stress reduction) of alternative and traditional therapies.
5	Testimonies and personal experiences	Justification based on personal or close others' experiences, reputation, or media exposure.
6	Traditionalism	Preference for ancestral or culturally traditional practices passed down through generations.
7	Comfort and accessibility	Practical advantages like lower cost, easier scheduling, or proximity compared to conventional care.
8	Professional and scientific credentials	Belief that alternative medicine is supported by scientific evidence or professional endorsement.
9	Lack of side effects	Reasons related to safety, non-invasiveness, and minimal adverse effects.
10	Miscellaneous	Reasons that could not be categorized clearly, often due to vagueness or incoherence.

0.77 in all but two: category 8 (scientific and professional credentials, $F1 = 0.48$) and category 10 (miscellaneous, $F1 = 0.27$). The overall weighted average F1 score was 0.80 (see Table S4). Agreement between the model and the human consensus was $\alpha = 0.61$, increasing to $\alpha = 0.85$ when the miscellaneous category was excluded. Figure S1 (left) shows the normalized confusion matrix for Round 1. Most categories were classified with high precision and recall. The main

misclassification occurred for professional and scientific credentials, which were often confused with benefits and effectiveness or miscellaneous. Benefits and effectiveness, the most common and semantically broad category, also showed some dispersion into miscellaneous. However, the overall matrix indicated promising category separability.

Given the intentionally broad design of the miscellaneous category as a residual class, we prioritized optimizing

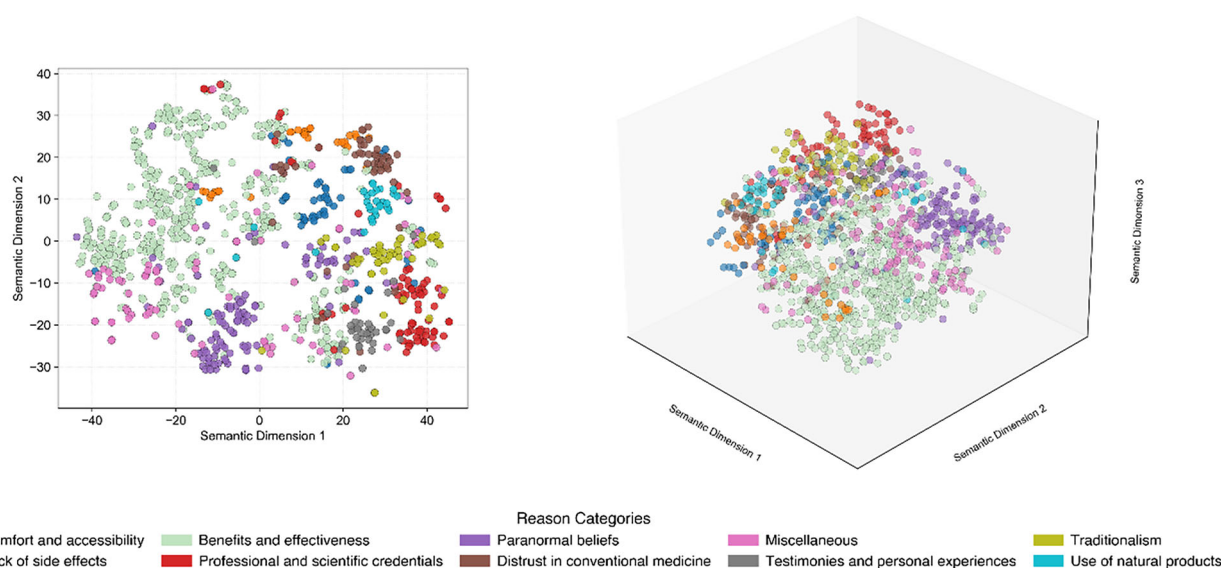


Fig. 1 Semantic clustering of reasons for perceived effectiveness aligned with independently constructed taxonomy. Each point represents a reason, embedded in a 768-dimensional semantic space using a language model. Dimensionality reduction reveals unsupervised clusters of semantically similar reason units. These clusters emerged independently of the taxonomy, which was developed through an inductive iterative process combining machine classification with human-in-the-loop refinement. Coloring by taxonomic category reveals strong alignment. Benefits and effectiveness spans a broad region capturing both technique-specific outcomes (e.g., pain relief, sleep, relaxation) and general perceptions of efficacy. Other categories, such as paranormal beliefs and distrust in conventional medicine, occupy more distinct, compact regions. The convergence between model-inferred structure and human-derived taxonomy supports its conceptual robustness. Axes represent abstract semantic dimensions and are not directly interpretable.

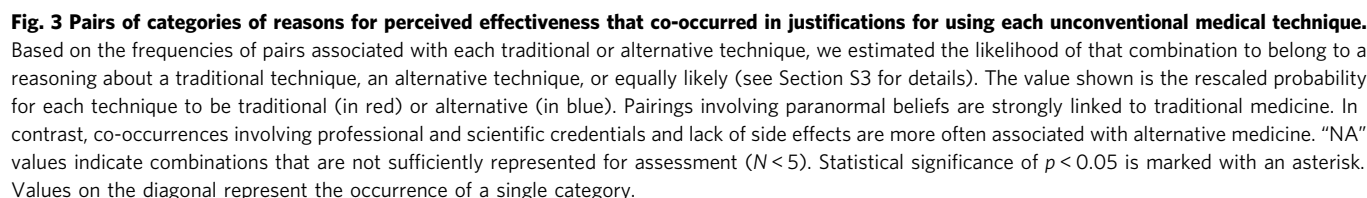
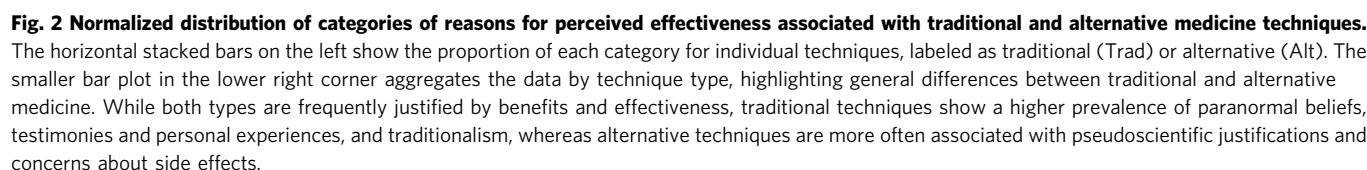
performance on the core conceptual categories, even if that meant assigning ambiguous responses to miscellaneous. Based on these observations, we refined both the prompt and the taxonomy to reduce conceptual overlap and clarify boundaries between adjacent categories. The revised prompt (see Prompts in Supplementary Material) provided more explicit distinctions between categories that previously showed confusion, such as testimonies and personal experiences, benefits and effectiveness, and professional and scientific credentials. In the second round, a new random sample of 300 reasons was classified using the updated setup. Human inter-annotator agreement increased to $\alpha = 0.75$, and the updated model achieved F1 scores above 0.74 across all non-miscellaneous categories, with a weighted average F1 of 0.82. As expected, performance on miscellaneous remained low ($F1 = 0.14$), consistent with its residual role. Model-human agreement rose to $\alpha = 0.81$ across all categories and remained $\alpha = 0.85$ when miscellaneous was excluded. Although the miscellaneous category showed lower classification performance due to its heterogeneous nature, it was retained in all subsequent analyses—including the semantic map (Fig. 1), the composition plots (Figs. 2 and 3), and the rhetorical-proximity network (Fig. 4)—to preserve the naturalistic variability of participants' responses; these responses often take the form of affective states, personal dispositions, or social framings rather than articulated rationales for effectiveness (see Table S7 for examples). The updated confusion matrix from Round 2 (Fig. S1, right) confirmed these gains. Notably, benefits and effectiveness achieved a recall of 0.92 and an F1 score of 0.90, improving over Round 1 (recall = 0.79, $F1 = 0.85$; see Table S5 for full metrics). Professional and scientific credentials, previously the weakest performer, improved from an F1 score of 0.48 to 0.74.

Given these improvements, the clarity of category boundaries, and the diminishing returns of further iteration, we considered the system sufficiently robust to proceed to full-scale classification. The remaining 2116 reasons were then classified using the updated model. As shown in Fig. S3, the most frequent category was benefits and effectiveness, followed by testimonies and

personal experiences, paranormal beliefs, and scientific and professional credentials.

Semantic coherence of reasons for perceived effectiveness and their taxonomy. To assess whether the taxonomy developed through expert consensus and iterative model refinement accurately reflects the underlying structure of how people naturally articulate their motivations, we conducted an unsupervised clustering using HDBSCAN (Malzer and Baum, 2020; see Section S1 for details) of the semantic landscape of reasons using language model embeddings. This analysis served as an independent validation step: if the categories capture meaningful conceptual distinctions, they should align with patterns of similarity in the linguistic expression of responses. Each individual reason for perceived effectiveness derived from the open-ended responses was embedded as a 768-dimensional feature vector using the DistilBERT multilingual model (Sanh et al., 2019). Dimensionality reduction was then applied for visualization purposes only, producing two- and three-dimensional projections presented in Fig. 1. Importantly, this semantic representation was generated entirely independently of the classification process—no category labels were used to produce the clusters.

Despite being fully unsupervised, the visualizations reveal semantically coherent groupings that align closely with the predefined taxonomic categories. When colored by category assignments, distinct patterns emerge. The benefits and effectiveness category spans a broad and diffuse region, reflecting its conceptual generality and the diverse ways in which therapeutic outcomes are articulated. In contrast, more narrowly scoped categories—such as paranormal beliefs, distrust in conventional medicine, and traditionalism—form compact, well-differentiated clusters. This pattern does not necessarily imply greater linguistic uniformity within these categories, but rather indicates that these motivations occupy more bounded regions in semantic space, suggesting that participants express them using relatively consistent conceptual framings. The convergence between the



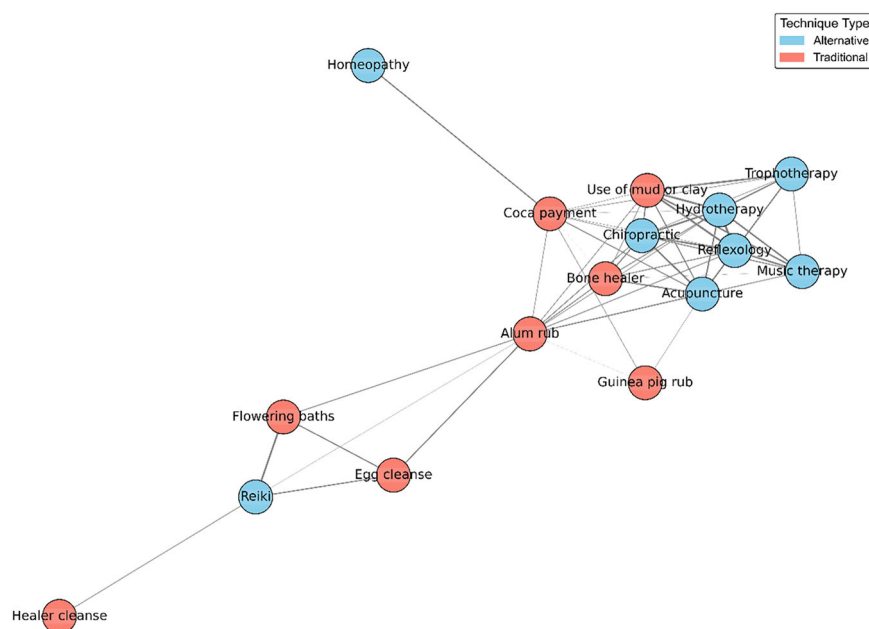


Fig. 4 Similarity network based on the internal composition of reasons for perceived effectiveness for each unconventional medical technique. Nodes represent individual techniques, colored by type (red = traditional, blue = alternative), and edge thickness reflects similarity in reason profiles. While traditional and alternative medicine form partially distinct clusters, traditional techniques display greater internal diversity. Two subclusters emerge within traditional medicine: one based on spiritual justifications, and another rooted in cultural traditionalism and Andean ritual practices. Intermediate cases include a spiritually oriented alternative practice such as reiki, traditional Chinese medicine such as acupuncture, and industrially or biomedically marketed traditional products such as the use of mud or clay and bone healer, which cluster closer to alternative medicine techniques. Homeopathy appears highly isolated, suggesting a unique rhetorical profile centered on safety and scientific-sounding legitimacy.

inductively derived semantic structure and the taxonomical classification supports both the internal coherence and cultural validity of the classification system, reinforcing its suitability for subsequent quantitative and qualitative analyses.

Similarities and differences in composition of reasons for perceived effectiveness between traditional and alternative medicine. Having established the reliability and semantic coherence of the taxonomy, we sought to determine whether users describe traditional and alternative medicine using similar or divergent patterns of reasoning. Although both types of unconventional medicine lie outside conventional biomedical systems, the ways in which they are framed may reflect distinct cultural logics and motivational structures. Figure 2 displays the normalized distribution of reasons across individual techniques (left panel) and aggregated by type: traditional and alternative medicine (right panel). Perceived benefits and effectiveness emerged as the most common justification across both groups, but notable differences were observed beyond this shared theme. Paranormal beliefs accounted for approximately 25% of reasons associated with traditional techniques, compared to just 5% for alternative ones. Practices such as flowering baths, egg cleanse, and coca payment were frequently linked to notions of energy cleansing, spiritual forces, or Andean cosmological concepts. Similarly, traditionalism and personal experiences and testimonies were more prominent in the justification of traditional practices, highlighting their rootedness in cultural heritage and community knowledge. By contrast, alternative medicine was more often framed using biomedical or scientific-sounding language, even in the absence of scientific validation. This reflects what has been described as pseudoscientific rhetoric—language that mimics scientific authority without adhering to its evidentiary standards (Blancke et al., 2017; Fasce, 2022). Categories

such as scientific and professional credentials (8 vs. near 0%) and lack of side effects (12 vs. 5%) were significantly more common in alternative medicine, with users frequently citing anatomical legitimacy, clinical safety, or professional endorsement to frame their choices in terms of evidence-based effectiveness. While both types of unconventional medical techniques exist outside the biomedical mainstream, they are justified through different rhetorical repertoires: one grounded in symbolic and experiential meanings, the other in science-adjacent claims of credibility.

Although Fig. 2 illustrates the prevalence of individual reasons, real-world justifications often involve multiple motives. To better understand how reasons for perceived effectiveness combine, we analyzed pairwise co-occurrences of taxonomical categories and their association with either traditional or alternative techniques. Figure 3 presents this analysis, where each cell in the matrix indicates the likelihood that a given pair of reasons corresponds to a traditional (red) or alternative (blue) technique. Diagonal cells reflect the predictive value of individual categories, while off-diagonal values capture their combined rhetorical effects. The results revealed distinct constellations of reasoning. Combinations involving paranormal beliefs—particularly when paired with traditionalism, testimonies, or benefits and effectiveness—strongly predicted traditional medicine. These associations reflect a symbolic and experiential logic in which healing is embedded in ritual, ancestral knowledge, and metaphysical causality. Paranormal beliefs emerged as particularly diagnostic: regardless of the accompanying reason, their presence strongly signaled a traditional medical practice. This suggests that paranormal beliefs are not peripheral but central to the way traditional medicine is conceptualized and communicated. In contrast, combinations involving scientific and professional credentials and lack of side effects were highly predictive of alternative medicine. These co-occurrences support a more rationalized style of reasoning, focused on expertise, clinical safety, and perceived alignment with

biomedical discourse. Like paranormal beliefs in traditional medicine, these categories anchor the way users articulate the value of alternative medicine techniques, exemplifying pseudoscientific rhetoric by leveraging scientific language to confer legitimacy (Blancke et al., 2017; Fasce, 2022). This divergence in rhetorical structure provides a foundation for the next section, where we examine how techniques themselves cluster based on their justification profiles, highlighting points of overlap and divergence across the traditional–alternative divide.

Rhetorical proximity among techniques: a network of justification profiles. To understand how unconventional medical techniques relate to one another in terms of how people explain their use, we constructed a similarity network based on their rhetorical profiles: each technique was represented as a vector reflecting the ratios of reasons for perceived effectiveness for each category across the taxonomy (Fig. 2, left panel). Pairwise similarity was calculated using cosine similarity (Singhal, 2001), and techniques sharing at least 90% similarity were connected by an edge (Siew and Guru, 2023). Figure 4 displays the resulting network, with nodes representing individual techniques colored by type (red = traditional, blue = alternative), and edges indicating high rhetorical similarity. This network provides a high-level view of how techniques cluster based on the composition of spontaneous reasons people give for their perceived effectiveness.

As expected, traditional and alternative medicine generally formed separate clusters. However, the structure revealed notable nuances. Most alternative techniques formed a cohesive and tightly interconnected cluster, suggesting a relatively standardized rhetorical style emphasizing biomedical-adjacent concepts such as effectiveness, safety, and professional legitimacy. For example, users citing chiropractic often used reasoning overlapping substantially with reflexology, hydrotherapy, or music therapy. Homeopathy stood out as a clear outlier. Despite being a canonical alternative technique, it was rhetorically distant from all other unconventional techniques. Its justification profile was dominated by references to safety, professional endorsement, and distrust in conventional medicine, often expressed in scientific-sounding language detached from cultural embeddedness. This supports longstanding critiques of homeopathy as a paradigmatic pseudoscience mimicking biomedical discourse with a focus on lack of side effects (Ernst, 2022; Schulz et al., 2023).

Traditional medicine, in contrast, displayed greater internal diversity, forming three subgroups. The first included practices such as the use of mud or clay, bone healer, and alum rub. Although rooted in local traditions, these techniques were frequently explained in ways overlapping with alternative medicine, with users citing therapeutic effectiveness, convenience, or perceived scientific grounding. Such reasoning may reflect the commodification of these practices within urban and industrialized wellness contexts. Bone healer, for instance, is sometimes interpreted in physiotherapeutic terms, aligning it rhetorically with chiropractic or acupuncture, while also invoking local accessibility and traditionalism. The second subgroup comprised traditional techniques with explicit spiritual orientations, including egg cleanse, flowering baths, and healer cleanse. These were often described in terms of energy flows, ritual cleansing, or metaphysical causation. While culturally embedded in Peru, similar practices are common across Latin America, drawing on broadly shared Hispanic American symbolic repertoires rather than specifically Andean traditions. Reiki, though typically classified as an alternative technique, aligned closely with this group, as its emphasis on a “universal life force” mirrors the metaphysical language of traditional spiritual healing (Ernst, 2022). Coca payment and guinea pig rub formed a distinct third

subgroup. These techniques were characterized by a mix of traditionalism, distrust in conventional medicine, and personal testimony, and shared strong symbolic connections to Andean cosmologies and ritual practices. Interestingly, acupuncture appeared linked to this cluster shaped by traditionalism, with recurring reasons for perceived effectiveness highlighting its origins in ancient Chinese culture (Zhu et al., 2021).

Taken together, these patterns suggest that the divide between traditional and alternative medicine is not defined merely by content or institutional status, but by the ways in which people make sense of them. Rather than reflecting a unified counterpoint to biomedical authority, each group of techniques tends to draw on a distinct repertoire of reasoning—one grounded in symbolic, spiritual, and cultural traditions, the other in science-like language and appeals to professional credibility. Some techniques bridge these repertoires, while others remain rhetorically isolated. What emerges is not a single alternative logic, but multiple, coexisting frameworks through which people express, justify, and experience health practices beyond conventional medicine. Recognizing this diversity is essential for understanding how non-conventional medicine persists, adapts, and resonates within different social and cultural contexts.

Discussion

This study provides comprehensive evidence on the prevalence, sociodemographic and psychological predictors, and spontaneous reasons for perceived effectiveness of traditional and alternative medicine in Peru. We found that traditional techniques were more prevalent than alternative techniques within the Peruvian context. While 85.8% of participants reported having used at least one traditional technique, only 68.1% reported using an alternative technique. Practices such as egg cleansing (69.9%), bone healer (46.5%), and alum rubbing (41.1%) emerged as the most popular, reflecting the deep cultural roots of these practices in Peru (Campos Briceño and Condor Iturrizaga, 2022; Flores Rojas, 2020). These findings are consistent with prior studies on non-representative Peruvian samples, where the most common traditional therapies were egg cleanse, bone healer consultations, and guinea pig rub (Mostacero León et al., 2017; Mejía Gálvez et al., 2017). Despite the lower use of alternative techniques, participants exhibited higher levels of belief in their effectiveness, willingness to use them in the future, and preference over conventional medicine compared to traditional techniques. This suggests that although traditional medicine remains more integrated into everyday practices, alternative medicine is particularly appealing, likely influenced by the global circulation of alternative health discourses (Tangkiatkumjai et al., 2020; Topaloğlu Ören et al., 2024).

The psychometric results indicate that participants’ general endorsement of pseudoscientific beliefs is the strongest predictor of favorable attitudes toward both traditional and alternative medicine. This finding reinforces previous evidence that adherence to non-scientific belief systems plays a central role in the adoption of unconventional medical practices (Fasce et al., 2023; Čavojová et al., 2024). Ideological traditionalism emerged as a distinguishing factor, significantly predicting positive attitudes toward traditional medicine but not toward alternative medicine. This pattern aligns with the interpretation that, within the Peruvian context, traditional medicine is more anchored in local cultural values, while alternative medicine reflects an active search for new therapeutic options detached from local tradition (Santa María, 2017; Barrón, 2008; Córdova and Velásquez, 2023). In contrast, neither trust in the medical profession nor political orientation was associated with attitudes toward either type of unconventional medicine. This suggests that, in Peru, the use of

traditional and alternative medicine is broadly normalized and not strongly linked to ideological polarization or distrust in healthcare professionals, in contrast to patterns frequently observed in Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies (Stussman et al., 2022; Fournier and Varet, 2024; Mukerji and Ernst, 2022).

Our integration of natural language processing techniques provided crucial insight into how individuals spontaneously articulate their motivations for using traditional and alternative medicine. This component of the study revealed a structured taxonomy of reasons for perceived effectiveness—ranging from paranormal beliefs to personal experiences and professional credentials—that complements and extends attitudinal patterns observed in the psychometric scales. Three major findings emerge from these analyses. First, reason types are not exclusive to specific techniques but are shared across practices in varying proportions. Second, despite the diversity of rhetorical fingerprints in each technique's justificatory logic, clear macro-level differences separate traditional and alternative medicine: traditionalism and paranormal beliefs are more prevalent in justifications for traditional practices, whereas lack of side effects, scientific or professional credentials, and other forms of science-adjacent reasoning dominate in alternative medicine. Importantly, it is not just the presence of individual reasons that matters but also how they co-occur. Pairwise co-occurrence analyses revealed that paranormal beliefs, when combined with other categories—particularly traditionalism and personal experiences or testimonies—strongly predict a traditional practice. Many traditional techniques are thus positioned beyond the rhetoric of science, embedded in spiritual and cultural logic, whereas alternative medicine relies more on biomedical language and perceived safety.

Third, despite this overall separation, specific techniques from both groups exhibit rhetorical affinities. Some alternative techniques, such as reiki—spiritually framed but not embedded in local tradition—and traditional techniques like the use of mud or bone healers—often presented as industrial products or confused with conventional medicine—as well as acupuncture—rooted in traditionalism, though Chinese rather than Peruvian—emerged as overlaps between traditional and alternative medicine. Another example is homeopathy and coca payment, which share similar proportions of reasons for perceived effectiveness, characterized by lower-than-average references to benefits and effectiveness, alongside comparable levels of distrust in conventional medicine, concern with side effects, appeals to professional legitimacy, and use of natural products. However, coca payment uniquely incorporates traditionalism and paranormal beliefs. This divergence suggests that while their rhetorical frameworks target similar psychological dispositions, only coca payment draws on local cultural meaning. Such compatibility may explain why globally circulating techniques like reiki or acupuncture integrate so readily into culturally embedded healing landscapes: their rationales resonate with those of local traditional practices. These findings highlight the importance of examining non-conventional medicine not only as a set of techniques but as repertoires of culturally and psychologically resonant reasoning styles. This perspective raises further questions about how unconventional medical techniques circulate, hybridize, and gain legitimacy across diverse sociocultural contexts. Future research might explore whether generational differences, media exposure, or urbanization influence the uptake of techniques with mimetic rhetorical profiles.

This study has several strengths, including the use of a representative sample from the Peruvian population, thus incorporating participants from a sociocultural context underrepresented in international scientific literature. Psychometrically validated measures ensured high reliability and were combined with natural

language processing techniques to explore spontaneous reasons, capturing specific cultural perspectives and mapping them onto theoretical constructs. This approach offers a richer and more grounded understanding of public engagement with unconventional medical practices and can serve as a model for future studies on health beliefs and behaviors, particularly in multi-cultural and underrepresented settings, where predetermined psychological variables based on WEIRD populations may constrain assessments of local cultural dynamics. However, certain limitations should be considered. First, the cross-sectional design prevents causal inferences between psychometric variables. Accordingly, references to predictors throughout the manuscript should be interpreted in a statistical rather than causal sense. Second, although participants were encouraged to express spontaneous reasons for perceived effectiveness, not all actively used the selected technique, which may affect interpretation regarding adherence to expressed reasons. Third, some techniques may have been misinterpreted. For example, some participants confused chiropractic with physical therapy or equated listening to music with music therapy, potentially inflating prevalence rates, a common limitation in prevalence studies of alternative medicine (Bishop and Lewith, 2010).

Concluding remarks

This study contributes to a deeper understanding of traditional and alternative medicine in Peru by integrating psychometric, sociodemographic, and linguistic data within a representative national sample. The quantitative analyses identified pseudoscientific beliefs as a shared predictor of positive attitudes toward both modalities of unconventional medicine and traditionalism as a specific predictor of traditional medicine. The exploratory analysis of spontaneous justifications places these associations against a rhetorical landscape in which a pseudoscientific rhetoric circulates across the alternative medicine cluster and into commodified traditional medicine, while traditionalism concentrates on spiritually and culturally embedded subgroups of traditional medicine. Traditional medicine in Peru thus appears deeply embedded in spiritual and local worldviews, while alternative medicine aligns more closely with modern health-seeking behaviors that borrow the appearance of scientific legitimacy. These insights, descriptive rather than confirmatory, suggest that public health interventions and science communication efforts must be sensitive not only to local traditions but also to the persuasive strategies employed by alternative health discourses. Future research should continue exploring these dynamics across time and cultural contexts, ideally combining longitudinal and ethnographic methods with computational tools, targeted prompts, pre-specified sub-schemas, and cross-cultural replication, to track how meanings, practices, and beliefs evolve in response to social and institutional change.

Data availability

All data and codes used in the study are available at <https://osf.io/cxw5u/>.

Received: 22 July 2025; Accepted: 25 August 2026;

Published online: 03 September 2026

References

- Barrón M (2008) Exclusion and Discrimination as Sources of Inter-Ethnic Inequality in Peru. *Economía* 31(61). <https://doi.org/10.18800/economia.200801.003>
- Bishop FL, Lewith GT (2010) Who Uses CAM? A narrative review of demographic characteristics and health factors associated with CAM use. *Evid-based Complement Altern Med* 7(1):11–28. <https://doi.org/10.1093/ecam/nen023>

- Blancke S, Boudry M, Pigliucci M (2017) Why do irrational beliefs mimic science? The cultural evolution of pseudoscience. *Theoria* 83(1):78–97. <https://doi.org/10.1111/theo.12109>
- Campos Briceño GR, Condor Iturrizaga RM (2022) La etnicidad en el Perú y su naturaleza multidimensional: una propuesta de medición. *Desde Sur* 14(1). <https://doi.org/10.21142/des-1401-2022-0012>
- Čavojová V, Kaššaiová Z, Šrol J, Ballová Mikušková E (2024) Thinking magically or thinking scientifically: cognitive and belief predictors of complementary and alternative medicine use in women with and without cancer diagnosis. *Curr Psychol* 43:7667–7678. <https://doi.org/10.1007/s12144-023-04911-8>
- Christen P, Hand DJ, Kirielle N (2023) A review of the F-measure: its history, properties, criticism, and alternatives. *ACM Comput Surv* 56(3):1–24. <https://doi.org/10.1145/3606367>
- Córdova, Velásquez D (2023) Ancestral knowledge the midwives of traditional medicine, immemorial learnings that are still preserved. *Techno Rev Int Technol Sci Soc Rev* 13(3):1–10. <https://doi.org/10.37467/revtechno.v13.4797>
- Del Mastro I, Tejada-Llaca P, Reinders S, Pérez R, Solís Y, Alva I, Blas M (2021) Home birth preference, childbirth, and newborn care practices in rural Peruvian Amazon. *PLoS ONE* 16(5):e0250702. <https://doi.org/10.1371/journal.pone.0250702>
- Devoto Bazán E (2016) Apuntes para la elaboración de una historia de la medicina tradicional andina. *Rev del Inst Riva-Agüero* 1(2):79–116. <https://doi.org/10.18800/revistaira.201602.003>
- Dugan E, Trachtenberg F, Hall MA (2005) Development of abbreviated measures to assess patient trust in a physician, a health insurer, and the medical profession. *BMC Health Serv Res* 5(64). <https://doi.org/10.1186/1472-6963-5-64>
- Dunwoody PT, Funke F (2016) The Aggression-Submission-Conventionalism Scale: testing a new three factor measure of authoritarianism. *J Soc Polit Psychol* 4(2):571–600. <https://doi.org/10.5964/jssp.v4i2.168>
- Ernst E (2022) Alternative medicine: a critical assessment of 202 modalities. Copernicus Books, Cham, Switzerland
- Fasce A (2022) The explanation-polarisation model: pseudoscience spreads through explanatory satisfaction and group polarisation. *J Soc Polit Psychol* 10(2):693–705. <https://doi.org/10.5964/jssp.8051>
- Fasce A, Avendaño D, Adrián-Ventura J (2021) Revised and short versions of the pseudoscientific belief scale. *Appl Cogn Psychol* 35(3):828–832. <https://doi.org/10.1002/acp.3811>
- Fasce A, Karlsson LC, Verger P, Mäki O, Taubert F, Garrison A, Schmid P, Holford DL, Lewandowsky S, Rodrigues F, Betsch C, Soveri A (2023) Endorsement of alternative medicine and vaccine hesitancy among physicians: a cross-sectional study in four European countries. *Hum Vaccines Immunother* 19(1):2242748. <https://doi.org/10.1080/108012645515.2023.2242748>
- Fasce A, Schmid P, Holford DL, Bates L, Gurevych I, Lewandowsky S (2023) A taxonomy of anti-vaccination arguments from a systematic literature review and text modelling. *Nat Hum Behav* 7:1462–1480. <https://doi.org/10.1038/s41562-023-01644-3>
- Flores Rojas MX (2020) VIH/sida awajún: nociones y experiencias de enfermedad y daño en un contexto de epidemia en la Amazonía Peruana. *Anthropologica* 38(44). <https://doi.org/10.18800/anthropologica.202001.010>
- Fournier V, Varet F (2024) Conspiracy beliefs and intention to use conventional, complementary and alternative medicines: two vignette studies. *Br J Health Psychol* 29:333–350. <https://doi.org/10.1111/bjhp.12702>
- García R (2019) Medicina tradicional o complementaria: Pacientes que lo usan al mismo tiempo que su tratamiento farmacológico. *Cienc Desarro* 22(1):25–30. <https://doi.org/10.21503/cyd.v22i1.1735>
- Holford D, Lopez-Lopez E, Fasce A, Karlsson LC, Lewandowsky S (2024) Identifying the underlying psychological constructs from self-expressed anti-vaccination argumentation. *Humanit Soc Sci Commun* 11:926. <https://doi.org/10.1057/s41599-024-03416-4>
- Hurst A, Lerer A, Goucher AP, Perelman A, Ramesh A, Clark A, ... Kivlichan I (2024). Gpt-4o system card. Preprint at <https://doi.org/10.48550/arXiv.2410.21276>
- León Montoya GB, Acosta Román M, Saavedra Chinchayán ME, Almonacid Quispe S (2023) Medicina tradicional como tratamiento de la COVID-19 en estudiantes y familiares en una universidad de la sierra del Perú. *Aten Primaria* 55(1):102526. <https://doi.org/10.1016/j.aprim.2022.102526>
- Lopez-Lopez E, Herzog SM (2025) Surfacing citizens' policy perspectives at scale in the age of large language models. *Behav Sci Policy* 11(1):10–21. <https://doi.org/10.1177/23794607251346311>
- Luján-Carpio E, Lizarraga-Castañeda Z, Mayor-Vega A, Medrano-Canchari K, Medina-Salazar H, Goicochea-Lugo S (2014) El servicio de Medicina complementaria de EsSalud, una alternativa en el sistema de salud peruano. *Rev Méd Hered* 25(2):105–106. <https://doi.org/10.20453/rmh.v25i2.255>
- Malzer C, Baum M (2020) A hybrid approach to hierarchical density-based cluster selection. In: 2020 IEEE international conference on multisensor fusion and integration for intelligent systems (MFI). IEEE. <https://doi.org/10.1109/MFI49285.2020.9235263>
- Mejía Gálvez JA, Carrasco E, Miguel JL, Flores SA (2017) Conocimiento, aceptación y uso de medicina tradicional peruana y de medicina alternativa/complementaria en usuarios de consulta externa en Lima Metropolitana. *Rev Peru Med Integr* 2(1). <https://doi.org/10.26722/rpmi.2017.21.44>
- Mostacero León J, López Medina SE, Yabar H, De La Cruz Castillo J (2017) Preserving traditional botanical knowledge: the importance of phytogeographic and ethnobotanical inventory of Peruvian dye plants. *Plants* 6(4):63. <https://doi.org/10.3390/plants6040063>
- Mukerji N, Ernst E (2022) Why homeopathy is pseudoscience. *Synthese* 200(5):1–29. <https://doi.org/10.1007/s11229-022-03882-w>
- Niggemann B, Grüber C (2003) Side-effects of complementary and alternative medicine. *Allergy* 58(8):707–716. <https://doi.org/10.1034/j.1398-9995.2003.00219.x>
- Rathje S, Mirea D, Sucholutsky I, Marjeh R, Robertson CE, Van Bavel JJ (2024) GPT is an effective tool for multilingual psychological text analysis. *Proc Natl Acad Sci USA* 121(34):e2308950121. <https://doi.org/10.1073/pnas.2308950121>
- Recuero R, Soares F, Zago G (2021) Polarization, hyperpartisanship and echo chambers: how the disinformation about COVID-19 circulates on Twitter. *Contracampo* 40(1). <https://doi.org/10.22409/contracampo.v40i1.45611>
- Sanh V, Debut L, Chaumond J, Wolf T (2019) DistilBERT, a distilled version of BERT: smaller, faster, cheaper and lighter. Preprint at <https://doi.org/10.48550/arXiv.1910.01108>
- Santa María LA (2017) Intercultural health: the life cycle stages in the Andes. *Rev Peru Med Exp Salud Publica* 34(2):293–298. <https://doi.org/10.17843/rpmesp.2017.342.2732>
- Santiváñez-Acosta R, Valenzuela-Oré F, Angulo-Bazán Y (2020) Use of complementary and alternative medicine therapies in the Coronel Portillo province, Ucayali, Peru. *Peruv J Exp Med Public Health* 37(3):510–515. <https://rpmesp.ins.gob.pe/index.php/rpmesp/article/view/4939>
- Schulz VM, Ücker A, Scherr C, Tournier A, Jäger T, Baumgartner S (2023) Systematic review of conceptual criticisms of homeopathy. *Heliyon* 9(11):e21287. <https://doi.org/10.1016/j.heliyon.2023.e21287>
- Siew CS, Guru A (2023) Investigating the network structure of domain-specific knowledge using the semantic fluency task. *Mem Cogn* 51(3):623–646. <https://doi.org/10.3758/s13421-022-01314-1>
- Singhal A (2001) Modern information retrieval: a brief overview. *IEEE Data Eng Bull* 24(4):35–43
- Stussman BJ, Nahin RL, Barnes PM, Scott R, Feinberg T, Ward BW (2022) Reasons office-based physicians in the United States recommend common complementary health approaches to patients: an exploratory study using a national survey. *J Integr Complement Med* 28(8):651–663. <https://doi.org/10.1089/jicm.2022.0493>
- Tangkiatkumjai M, Boardman H, Walker DM (2020) Potential factors that influence usage of complementary and alternative medicine worldwide: a systematic review. *BMC Complement Med Ther* 20:363. <https://doi.org/10.1186/s12906-020-03157-2>
- Topaloğlu Ören ED, Dorukoğlu S, Ertem G (2024) The use of complementary and alternative medicine and approaches to coping with stress in women with breast cancer: a cross-sectional study. *Enferm Clin (Engl Ed)* 34(5):386–401. <https://doi.org/10.1016/j.enfcl.2024.04.007>
- Villena-Tejada M, Vera-Ferchau I, Cardona-Rivero A, Zamalloa-Cornejo R, Quispe-Florez M, Frisnacho-Triveño Z, Abarca-Meléndez S, Alvarez-Sucari S, Mejía C, Yañez J (2021) Use of medicinal plants for COVID-19 prevention and respiratory symptom treatment during the pandemic in Cusco, Peru: a cross-sectional survey. *PLoS ONE* 16(9):e0257165. <https://doi.org/10.1371/journal.pone.0257165>
- Wang Z, Pang Y, Lin Y (2023) Large language models are zero-shot text classifiers. Preprint at <https://doi.org/10.48550/arXiv.2312.01044>
- Wardle JL, Adams J (2014) Indirect and non-health risks associated with complementary and alternative medicine use: an integrative review. *Eur J Integr Med* 6(4):409–422. <https://doi.org/10.1016/j.eujim.2014.01.001>
- World Health Organization (2019) WHO Global Report on Traditional and Complementary Medicine 2019. Retrieved from <https://apps.who.int/iris/handle/10665/312342>
- Zhu J, Li J, Yang L, Liu S (2021) Acupuncture, from the ancient to the current. *Anat Rec* 304(11):2365–2371. <https://doi.org/10.1002/ar.24625>

Acknowledgements

Angelo Fasce received funding from the Alexander von Humboldt-Stiftung and the University of Lima by means of research fellowships for experienced researchers. Ezequiel Lopez-Lopez is funded by the Deutsche Forschungsgemeinschaft (DFG), project number 458366841 (POLTOOLS - Assisting behavioral science and evidence-based policy making using online machine tools). Ezequiel Lopez-Lopez was also funded by the Federal Ministry of Research, Technology and Space (BMFT) and the Free State of Saxony as part of the Excellence Strategy of the Federal and State Government.

Author contributions

AF: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, supervision, validation, visualization,

writing of the original draft, review and editing of the paper; JRT: Conceptualization, funding acquisition, investigation, methodology, project administration, resources, supervision, writing of the original draft, review and editing of the paper; JRF: conceptualization, data curation, formal analysis, investigation, methodology, validation, review and editing of the paper; IB: conceptualization, data curation, formal analysis, investigation, methodology, validation, review and editing of the paper; EPY: funding acquisition, review and editing of the paper; JMEN: Funding acquisition, review and editing of the paper; WMOT: funding acquisition, review and editing of the paper; CDPM: funding acquisition, review and editing of the paper; MRB: funding acquisition, review and editing of the paper; CCL: funding acquisition, review and editing of the paper; ELL: conceptualization, data curation, formal analysis, investigation, methodology, resources, supervision, validation, visualization, writing of the original draft, review and editing of the paper.

Funding

Open Access funding enabled and organized by Projekt DEAL.

Competing interests

The authors declare no competing interests.

Ethical approval

This study was conducted in accordance with the Declaration of Helsinki and received approval from the ethics committee of the Faculty of Health Sciences of the Peruvian University of Applied Sciences (PI 290-24).

Informed consent

Informed consent was obtained from all participants.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-026-08902-5>.

Correspondence and requests for materials should be addressed to Angelo Fasce.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2026