

Equity and Actionability in Bilingual Digital Pneumonia Communication in a Lower-Middle-Income Setting: A Qualitative Analysis from Pakistan

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ABSTRACT

Pneumonia, a leading cause of child morbidity and mortality in Pakistan needs to be studied beyond biomedical interventions to address structural inequities, language barriers, and the role of inclusive e-health communication in improving outcomes. Caregivers often access online health information for prevention and treatment of pneumonia, yet the translation of pneumonia related information ENG-UR received little attention. In this study, seven publicly available bilingual English-Urdu materials (three pamphlets and four web pages) published after 2015 by recognised health organisations were analysed and compared against content coverage, meaning consistency, terminology used, and actionability. Although core themes were maintained across languages, systematic differences were observed: English texts were generally more explanatory, whereas Urdu versions were more directive and condensed. Guidance on urgency and care-seeking was inconsistently presented, particularly in digital formats. Findings suggest that strengthening quality assurance of bilingual health communication may enhance clarity and support more timely care-seeking and equitable access to information.

KEYWORDS:

uneven access, comprehensibility, health literacy, health equity, poor translations, action-oriented information, e-health material. lower-middle-income countries (LMICs)

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INTRODUCTION

The United Nations' Sustainable Development Goal 3 (Good Health and Well-Being) pledges to reduce child morbidity and mortality from pneumonia among children under five worldwide, with particular emphasis on low- and middle-income countries (LMICs) such as Pakistan (World Health Organization, 2026). Even though the preventive and treatment interventions are available, the disease continues to exert a disproportionate burden in low- and middle-income countries. It is owing to the delayed care seeking, limited awareness of the disease, and uneven access to accurate health information that children lose their lives to preventable deaths (Wilson Fell et al., 2024; World Health Organization, 2026). The awareness raising becomes problematic when institutional health communication is primarily produced in dominant language to be translated into a local lingua franca. Therefore, access to comprehensible and actionable health information becomes critical to bridging health inequities and ensuring inclusive communication. As digital health dissemination expands across LMICs, the quality and functional adequacy of bilingual online health communication may directly influence timely recognition, decision-making and access to treatment. In Pakistan health system is shaped by a myriad linguistic, geographic, and socio-economic factors, therefore the accessibility and comprehensibility of pneumonia-related health information are critical determinants of timely care and appropriate health-seeking behaviour.

Accessing health information and services imply the ability of caregivers to understand, interpret, and respond to the health messages to reach the health facility in due time (World Health Organization, n.d.-c). In multilingual Pakistan, English functions as a dominant language of



policy and institutional communication, whereas Urdu serves as the primary lingua franca for information and action in the society (Rahman, 2006). In this context, translation plays a central role in mediating access to health information and knowledge (World Health Organization, 2022). Pneumonia-related literacy material for caregivers mapped across symptoms, diagnosis, complication, treatment, management and prevention, home care, and referral pathways are often adopted from English (produced by WHO or UNICEF) to be translated in Urdu for wider audience. Hence, the quality, clarity, and functional advocacy of these translations directly influence the comprehension and action upon these health messages at the point of need (World Health Organization, n.d.-a).

The role of translation in public health literacy and communication is increasingly recognized in relation to health literacy and health equity (World Health Organization and United Nations Children's Fund, 2013). Poor translations of health information materials often result in omission or diagnostic distortion of key information, overuse of the technical terminology/foreign terms, and ambiguity in action-oriented guidance (World Health Organization, n.d.-d). These translation problems may become consequential for pneumonia, as prompt care-seeking is essential for survival (Narasimhan et al., n.d.). In Pakistan, the importance of language and translation in disease prevention and treatment is often undermined, while greater attention is given to programmatic interventions (Minhas, 2025). Policymakers overlook the fact that the success of disease eradication programs also depends on effective communication, accurate translation, and culturally sensitive dissemination of health information (Ittefaq, Kamboh, Zelaya, and Arif, 2024; Tam and Peh, 2025).

With the notable shift in health information dissemination, i.e. from conventional to digital means of communication in Pakistan, the role of effective and reliable translation has also gained heightened importance in ensuring accessibility, accuracy, and cultural relevance of health messages (World Health Organization, 2021). The digitization in healthcare context accelerated by the expansion and accessibility of mobile phones and internet, and the reliance on digital platforms during Covid 19 for health promotion, awareness, and vaccination advocacy (ITU/GSMA, n.d.). Government health departments, national and international agencies, and NGOs increasingly rely on websites, e-pamphlets, and telephonic messages in Urdu to communicate health messages to public. E-health materials produced at the institution level are often reused across programmes, shared on social media, and accessed repeatedly over time, thereby amplifying reach and impact (Jafar et al., 2023). However, the digital access to health information also reduces opportunities for real-time clarification by health workers, placing greater responsibility on the clarity and completeness of the written or visual messages (Kazi et al., 2020; World Health Organization, 2021).

Despite the growing reliance on digital health communication, limited empirical attention has been paid to how pneumonia-related information is translated across languages in official online materials in Pakistan. Existing research has largely focused on clinical effectiveness, service delivery, or caregiver knowledge and practices (ITU/GSMA, n.d.; World Health Organization, 2021), with comparatively little examination of the linguistic and communicative pathways through which pneumonia information reaches caregivers. Studies that do address health communication frequently treat translated materials as neutral or equivalent representations of the source text, without examining whether meaning, emphasis, and actionability are preserved across languages (Jafar et al., 2023). As a result, potential gaps between English-language institutional messaging and Urdu-language public communication remain underexplored.

This gap is particularly salient given the centrality of bilingual communication in Pakistan's

health system. Many official websites use English as a main mode of communication (Mairaj and El-Hadi, 2012; *More Than Half of All Websites Are Unreadable to Most of the World*, 2024), whereas parallel pamphlets and translated pages or major information within the webpages are intended for public consumption. These bilingual materials are rarely examined as paired texts. Systematic analysis of key health information on pneumonia about signs and symptoms, complications, diagnosis, and treatment, management and prevention across languages would help assess the effectiveness of translated materials in health literacy and behavior change.

The present study examines pneumonia e-health information material across English and Urdu in Pakistan. Focusing exclusively on already translated and publicly available digital content published after 2015, three bilingual (English and Urdu) pamphlets and four bilingual web pages produced by authentic health organizations have been analyzed, with particular attention to completeness, clarity, and action-oriented guidance (House, 2015). The findings of this study are of relevance to national and provincial health authorities and development partners. The study inform recommendations for the standardization and quality assurance of health communication to enhance public understanding of pneumonia prevention and management. Hence, the study contributes to the broader agenda of equitable access to health information, emphasized by the WHO's framework for effective health communication and health literacy (*CMAM Guidelines*, 2021; World Health Organization, n.d.-b). Consequently, the study supports Pakistan's ongoing efforts to reduce childhood mortality and strengthen community-level responses to pneumonia.

KEY QUESTIONS

What is already known on this topic?

- Pneumonia remains a leading cause of child morbidity and mortality in low- and middle-income countries.
- Timely recognition of symptoms and appropriate care-seeking are critical for reducing pneumonia-related deaths.
- Digital health platforms are increasingly used to disseminate public health information in multilingual settings.

What are the new findings?

- Bilingual English–Urdu online pneumonia materials demonstrate thematic alignment but systematic differences in explanatory depth, terminology and urgency cues.
- English versions are generally more explanatory, whereas Urdu versions are more directive.
- Actionability, particularly clarity regarding danger signs and referral guidance, is inconsistently presented across formats.

What do the new findings imply?

- Translation quality is a health systems issue that can influence equitable access to comprehensible and actionable pneumonia information.
- Establishing minimum content standards and bilingual quality assurance mechanisms may strengthen digital health communication in multilingual low-resource settings.

METHODS

Figure 1 presents the step-by-step methodological framework employed in this study, from systematic search to cross-language comparison. This framework was designed to ensure transparency, replicability, and rigor in the qualitative analysis of bilingual health communication materials. Each step in the framework builds upon the previous one, creating a coherent pathway from data identification to final synthesis.

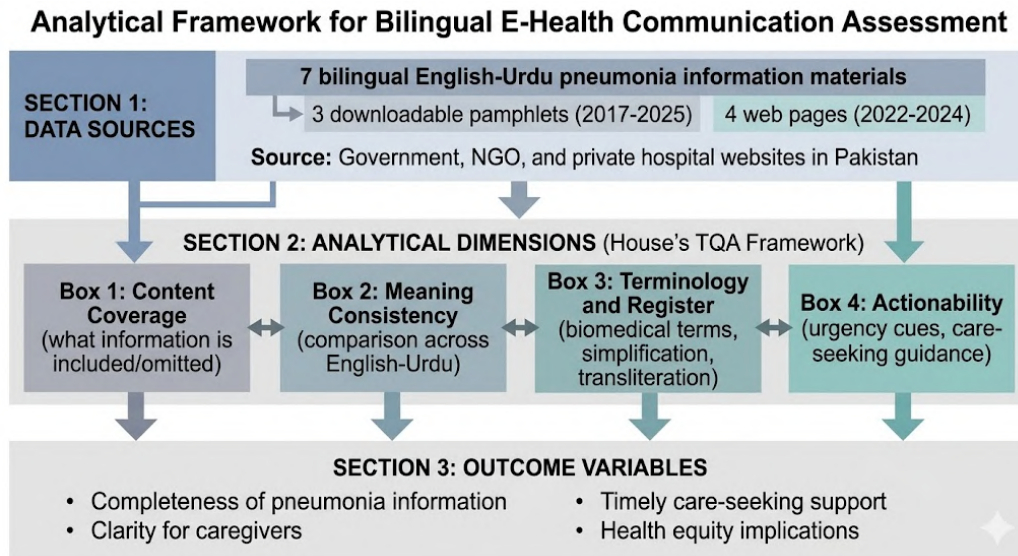


Figure 1: Methodological framework for bilingual document analysis

The translation and communication of pneumonia-related digital information material across bilingual English-Urdu material were analysed employing qualitative document analysis (Crespo-Gonzalez, Benrimoj, Frommer, and Dineen-Griffin, 2024). This methodological approach is particularly well-suited for examining how meaning is constructed, preserved, or transformed across language versions of institutional health content. Qualitative document analysis allows researchers to systematically compare texts, identify patterns, and interpret the implications of linguistic choices for public health outcomes. The analysis compared parallel language version of already translated, publicly available information material about pneumonia, focusing specifically on how English source texts were rendered into Urdu for public audiences in Pakistan's digital health landscape.

The data comprised seven bilingual information artefacts, including three online downloadable pamphlets, and four web pages providing information in both English and Urdu (Sandars and Brown, 2024). This diverse dataset was intentionally selected to capture variation across digital formats, as pamphlets and web pages differ in their design, length, accessibility features, and intended use contexts. Pamphlets are typically concise, printed or downloadable documents designed for quick reference, whereas web pages offer more extensive content but may present navigation challenges for users with limited digital literacy. By including both formats, the study aims to provide a comprehensive assessment of how pneumonia information is communicated across the digital health ecosystem in Pakistan.

The information materials were identified through systematic searches of official government, international agencies, and private health organization websites using pneumonia-related key-

words in both languages (e.g. "pneumonia", "Childhood pneumonia", "pneumonia vaccine", "ايومن"). The search strategy was deliberately comprehensive, covering multiple institutional sources to capture the range of materials that caregivers might encounter when seeking online pneumonia information. Searches were conducted in both English and Urdu to ensure that materials primarily targeting Urdu-speaking audiences were not overlooked. Each website was navigated systematically, examining both explicit pneumonia-dedicated pages and related content on vaccination, child health, and respiratory infections. The search process was documented in detail, including search dates, keywords used, and the number of results reviewed at each stage.

Inclusion Criteria

Materials were included if they met all of the following criteria, which were designed to ensure the relevance, quality, and comparability of the analyzed content:

1. Availability of parallel English and Urdu versions addressing the same topic, as this is essential for direct cross-linguistic comparison of meaning, emphasis, and actionability;
2. Publication or endorsement by authentic and credible health organizations, including government bodies (such as EPI Pakistan), international agencies (such as WHO or UNICEF affiliates), or recognized private health institutions (such as Aga Khan University Hospital or Shfia4you);
3. Explicit focus on pneumonia, including information on symptoms, danger signs, prevention, vaccination, diagnosis, treatment, management, home care, or care-seeking guidance;
4. Publication after 2015, ensuring alignment with contemporary pneumonia policies, digital communication practices, and updated clinical guidelines;
5. Orientation towards public or caregiver audiences, rather than clinicians alone, as the study focuses on health literacy and equitable access for non-specialist users; and
6. Substantial content equivalence between language versions, allowing meaningful comparison of how the same health information is presented across English and Urdu.

Materials that were monolingual, clinician-only, or thematically divergent across languages were excluded from the analysis. Additionally, materials that did not provide sufficient textual content for meaningful comparison, such as image-only posters or video content without accompanying text, were not included. The exclusion criteria were applied consistently to maintain the analytical focus on bilingual textual communication.

Data Collection and Archiving

The pamphlets were downloaded in their original formats (PDF or image files) directly from the source websites, preserving the exact layout, typography, and visual elements as intended by the publishers. This preservation of original formatting is important because visual features such as bullet points, headings, and font emphasis can influence readability and actionability. Webpages were archived using PDF captures and screenshots to preserve content as accessed at the time of data collection, recognizing that online health content may be updated, modified, or removed over time. Each captured webpage included the full text, headings, images, and any embedded links or interactive elements.

Each item was assigned a unique identifier (P1-P3 for pamphlets and W1-W4 for web pages) and documented using a metadata template capturing source organization, year of publication, format (pamphlet or web page), language pair (English-Urdu), and intended audience (Table 1). This systematic

metadata documentation ensured transparency and replicability of the dataset, allowing other researchers to locate and verify the materials if needed. The metadata template also included fields for notes on content structure, such as whether the English and Urdu versions appeared on the same page or separate pages, and whether the Urdu content was a full translation or a summary.

Table 1: Characteristics of bilingual English–Urdu online pamphlets and web pages on pneumonia included in the analysis, Pakistan, 2017–2025

ID	Source organization	Year	Format	English version	Urdu version	Intended audience
PAMPHLETS						
P1	Aga Khan University Hospital (AKUH)	2017	Pamphlet (poster, PDF/image)	World Pneumonia Day poster (English)	World Pneumonia Day poster (Urdu)	General public, caregivers
P2	Immunization Action Coalition / CDC (distributed internationally)	2025	Pamphlet (PDF)	Pneumococcal Conjugate Vaccine (PCV) information statement	Pneumococcal Conjugate Vaccine (PCV) Urdu information statement	Parents, caregivers
P3	Immunization Action Coalition / CDC (distributed internationally)	2019	Pamphlet (PDF)	Pneumococcal Polysaccharide Vaccine (PPSV23) information statement	Pneumococcal Polysaccharide Vaccine (PPSV23) Urdu information statement	Adults, caregivers
WEBSITE						
W1	I.M.C Hospital (Pakistan)	2023	Web Page	imchospital.com.pk/...	Urdu version available on site	General public
W2	Memon Medical Institute (MMI), Pakistan	2023	Web Page	mmi.edu.pk/blog/...	Urdu version available on site	General public
W3	Shifa4you (Pakistan health platform)	2024	Web Page	shifa4u.com/blog/...	Urdu explanation integrated	Patients, caregivers
W4	Federal Directorate of Immunization (EPI Pakistan)	2022	Web Page	epi.gov.pk/...	Urdu explanations embedded	Caregivers, general public

Table 1 provides a comprehensive overview of the seven bilingual artifacts analyzed in this study. As shown in the table, the materials span a publication period from 2017 to 2025, capturing both pre-COVID and post-COVID digital health communication practices. The sources represent a mix of international agencies (Immunization Action Coalition/CDC), national government bodies (EPI Pakistan), private hospital systems (AKUH, I.M.C Hospital, MMI), and commercial health information platforms (Shifa4you). This diversity of sources reflects the fragmented nature of online health information in Pakistan, where caregivers may encounter content from multiple institutional origins with varying quality standards.

Analytical Framework

Drawing on House's conceptualization of translation quality as functional adequacy, the e-pamphlets and websites content were analysed for meaning preservation, content clarity and completeness, terminology, information salience, and actionability (House, 2015) to gauge effective information delivery. House's framework was selected because it moves beyond simple notions of accuracy or fidelity to examine how translations function in their intended communicative contexts. Unlike purely linguistic approaches to translation assessment, House's model considers the pragmatic and sociocultural dimensions of cross-language communication, making it particularly relevant for public health materials designed to influence behavior.

Consistent with the public health concerns of this study, House's framework was pragmatically applied to assess communicative functions of English and Urdu versions in conveying pneumonia-related information to public. The framework was operationalized through four analytical dimensions: (a) content coverage, examining what information is included, omitted, or added across language versions;

(b) consistency of meaning, comparing how key concepts and risk messages are preserved or shifted; (c) terminology and register, analyzing the use of biomedical terms, simplification strategies, and transliteration; and (d) actionability, evaluating the clarity and specificity of guidance for care-seeking behavior, including urgency cues and referral instructions.

To maintain analytical rigor, consistent coding categories were applied across materials, and comparisons were drawn on cross-text patterning. Each bilingual pair was analyzed side-by-side, with the English version treated as the source text and the Urdu version as the target text. For web pages where English content was substantially longer than Urdu content, the analysis focused on the overlapping content areas to ensure comparable units of analysis. Coding was conducted by the lead author, with regular debriefing sessions to review interpretations and resolve any ambiguities. Patterns identified across multiple artifacts were grouped into thematic categories, which form the basis of the results section. The analytical process was iterative, with initial codes refined and reorganized as analysis progressed to capture emergent themes not anticipated in the initial framework.

RESULTS

The analysis identified recurring patterns across bilingual pamphlets and web pages. These patterns are classified into four main analytical dimensions: content coverage, consistency of meaning, terminology use, and actionability of the pneumonia-related information. Each dimension revealed systematic differences between English and Urdu versions, as well as between pamphlet and web page formats. These patterns are summarized in Table 2 below.

Table 2: Summary of key findings across bilingual English-Urdu pneumonia e-health materials

Analytical Dimension	English Versions	Urdu Versions
Content Coverage	Comprehensive, explanatory, covers causes, risk factors, symptoms, prevention	Condensed, limited space on web pages, primarily symptoms and treatment
Meaning Consistency	Source text for translation	Directive tone, reformulated, brevity prioritized over explanation
Terminology & Register	Institutional register, biomedical terms with explanations	Simplified register, transliteration (e.g.,), omission of technical terms
Actionability	Explanatory but less immediate, informational depth	Directive (e.g., "consult doctor immediately"), but lacks specific urgency cues

As shown in Table 2, the differences between English and Urdu versions are not merely linguistic but functional, affecting how caregivers might interpret and act upon pneumonia information. Each analytical dimension is examined in detail below.

Coverage of core pneumonia information across bilingual materials

All English versions described pneumonia as a lung infection and listed common symptoms such as fever, cough, chest pain, and breathing difficulty. These descriptions typically included contextual information about disease mechanisms, transmission routes, and populations at highest risk. However, the completeness of information in Urdu versions varied considerably across pamphlets and web pages, creating an uneven information landscape for Urdu-speaking caregivers. The content on pamphlets held consistent coverage in both languages, suggesting that printed or downloadable materials undergo more rigorous bilingual quality assurance than web-based content. For example, the bilingual posters on pneumonia day and pneumonia-related vaccines presented parallel information about pneumonia

symptoms, with both language versions containing equivalent detail about fever duration, breathing patterns, and when to seek help.

In contrast, web contents showed marked variations that could have real-world consequences for information access. The web pages were predominantly in English, with English sections typically covering causes, risk factors, prevention strategies, diagnostic procedures, treatment options, and recovery guidance. Urdu occupied a limited space on these pages, often relegated to a small section at the bottom of the page or accessible only through a separate dropdown menu. Consequently, Urdu meagerly provided symptoms and treatment-related information, with minimal explanation of underlying disease mechanisms or preventive measures. This disparity means that Urdu-speaking caregivers accessing the same web page as English-speaking caregivers receive substantially less information, potentially affecting their ability to recognize early symptoms or understand prevention strategies.

Referral guidance was found to be inconsistent across both e-formats, creating potential confusion about when and where to seek care. Pamphlets frequently encouraged consulting a physician through clear imperative statements such as "See a doctor immediately" or "Contact your healthcare provider." However, web pages (Urdu versions specifically) lacked emphasis on the danger signs that require urgent care over routine symptoms. Danger signs such as fast breathing, chest indrawing, inability to drink, or lethargy were often mentioned in English versions but omitted or generalized in Urdu versions. Thereby, the materials though addressed pneumonia at a general level, bilingual artefacts individually fail to cover all care components such as signs and symptoms, diagnosis, complications, prevention, management, and treatment of pneumonia in both English and Urdu. This fragmented coverage means that no single material provides a complete picture of pneumonia care, requiring caregivers to consult multiple sources or rely on memory and inference.

Consistency of meaning between English and Urdu versions

These coverage patterns helped in comparing parallel English and Urdu versions for consistency of meaning across the seven bilingual artefacts. The analysis revealed partial and uneven consistency shaped by systematic shifts in emphasis, depth, and pragmatic tone. These shifts were not random but followed predictable patterns based on format and translation approach. Pamphlets tended to maintain message equivalency across languages, likely because their concise, bullet-point format limits the scope for substantial reformulation. For instance, the pneumonia day poster stated: "Pneumonia kills more than 100 children every hour" which was translated directly as "ہدایز سے س 100 یم ے ٹھگ رہ ے س اینومن" "یہ ے تاج وہ کالہ ے چب" preserving both the numerical claim and the emotional urgency of the original message.

Conversely, web-based content showed greater divergence between language versions, raising questions about whether Urdu readers receive equivalent information to English readers. English versions included extended explanations of disease pathophysiology, risk factors associated with environmental conditions (such as indoor air pollution and overcrowding), and detailed prevention strategies including vaccination schedules and nutritional support. Urdu versions were condensed through systematic omission of information, often removing explanatory clauses, examples, and contextual details. For example, English used probabilistic and advisory language such as "symptoms may require medical attention depending on their severity and duration," which guides caregivers to exercise judgment. The corresponding Urdu version adopted a directive tone: "یروف ے س رٹکاڈ یم تروص یک یگدیشک یم تامالع" [in case of complications, it is of utmost importance to visit a doctor]. This enhanced immediacy changes the communicative tone and intent from explanatory to instructional, shifting from "consider seeking care" to "you must visit a doctor."

These shifts in meaning did not constitute mistranslation in the technical sense, as the Urdu versions did not contain factually incorrect statements. Rather, they were a reflection of reformulation driven by space constraints, assumptions about Urdu reader preferences, or translation guidelines prioritizing brevity over elaboration. Web contents in Urdu chose brevity and practicality over explanation and description of symptoms and actions at the caregiver's end. This choice likely makes the text faster to read and easier to remember for basic actions but may deprive caregivers of the contextual understanding needed to recognize atypical presentations or understand why certain actions are recommended. This choice further informed subsequent differences in the register use and actionability of information available on e-platforms about pneumonia, as discussed in the following sections.

Terminology and register in public communication

Register and terminological choices also determined the meaning construction across languages in e-health materials, influencing how accessible and understandable the content would be for audiences with varying educational backgrounds and health literacy levels. Contents available in English adopted a more institutional and explanatory register, using common biomedical terms such as "respiratory infections," "bacterial infections," "viral," and "antibiotics." In English web pages, these terms were often accompanied by explanatory clauses or parentheses defining the terms, thereby increasing informational density while supporting comprehension. For example, an English page might state "antibiotics (medicines that kill bacteria)" ensuring that even readers unfamiliar with the term could understand its meaning and relevance to pneumonia treatment.

Comparatively, Urdu content on websites and pamphlets displayed diverse translation approaches that were not applied consistently across materials. On websites, the translated limited content in Urdu favored a simplified and instructional register that prioritized action over explanation. Pneumonia was described as a lung infection or a breathing difficulty using everyday Urdu vocabulary, whereas the biomedical terminology was either omitted entirely or transliterated if retained in the content. For example, "antibiotic" became "کٹریاب یتیا" and "infection" became "نشکینا" as commonly used in everyday discourse in Pakistan. This transliteration strategy likely supported word recognition for readers already familiar with these terms through media exposure but assumed a pre-existing familiarity with biomedical concepts that may not hold for all caregivers, particularly those with limited formal education or limited exposure to English-medium health information.

However, pamphlets on pneumonia vaccinations used a specialized academic register distinct from common communication practices, creating a different set of accessibility challenges. For instance, "Meningitis (infection of the tissue covering the brain and spinal cord)" was equivalently translated as "نشکینا یم تهاب یلاو ے نکھڈ وک یدہ یک ہڑیر روا غامد سٹاجنیم" preserving the technical term "meningitis" as a transliteration followed by a descriptive explanation. Similarly, "health care provider" was equivalently translated as "هدنک مهارف تحص شادھگن" a formal, almost bureaucratic phrase rarely used in everyday Urdu conversation. While these translations are accurate and complete, their register may be too formal or technical for caregivers under stress who need rapid, clear guidance.

Register shifts were particularly evident in treatment-related content, where the functional purpose of the text (to inform versus to instruct) shaped linguistic choices. English content used neutral, descriptive tones to explain treatment options, presenting information about antibiotic courses, supportive care, and hospitalization criteria as factual statements. Urdu content focused on action (i.e., consult a doctor) rather than explanation, often omitting details about what treatment entails or why specific interventions are needed. Pamphlets and websites both tended to explain the disease in a specialized academic register that diverges from everyday discourse, making the comprehensibility of information difficult for a heterogeneous audience that includes caregivers with wide-ranging literacy levels, educa-

tional backgrounds, and prior exposure to biomedical concepts.

Actionability of pneumonia-related guidance

The registers used and terminology-specific translations directly shaped the actionability of pneumonia-related information and guidelines available on e-health materials. Actionability refers to the extent to which a reader can understand what specific actions to take, when to take them, and how to prioritize different actions based on urgency. Unlike websites, pamphlets demonstrated higher actionability across both languages. For instance, both English and Urdu versions of pamphlets directed caregivers to consult a physician through imperative phrasing such as "See a doctor" or "یرک عوگر ےس رٹکاڈ" without conditional clauses or qualifying statements. This directness leaves no ambiguity about the recommended action.

Besides this positive feature, explicit indicators of urgency such as specifying when symptoms warrant immediate care were inadequately provided in both languages across both versions of e-material. The content mentioned "complications" as a general common term but did not provide specific details about which complications require urgent hospice admission versus which can be managed through outpatient care or home observation. For example, neither version consistently distinguished between "fast breathing" (which requires medical evaluation) and "chest indrawing" (which indicates severe pneumonia requiring emergency care). Therefore, guidance about appropriate point of care, timely and informed care-seeking is scant in English and Urdu on both versions. A caregiver reading these materials might understand that pneumonia is serious but remain uncertain about whether their child's specific symptoms warrant an immediate emergency room visit, a same-day clinic appointment, or monitoring at home.

Across all analytical dimensions, format emerged as a key differentiating factor with implications for health communication strategy. Since pamphlets relied on bullet points, short statements, visual emphasis (such as bolded text and warning icons), and direct imperative tone, the information provided was concise and actionable in both languages. A caregiver reading a pamphlet can quickly scan for key action points without wading through explanatory text. In contrast, English web-based content used long explanatory paragraphs that provided informational depth at the cost of immediacy, requiring readers to extract action points from dense prose. Urdu web content, owing to its meager presence on the websites, provided simplified content using transliterated biomedical terminology but often omitted specific action guidance altogether. Overall, pamphlets functioned as rapid awareness tools suitable for distribution in clinical waiting rooms or community health events, while web pages served a more informational role substantially in English, potentially leaving Urdu-speaking web users with less actionable guidance than English-speaking users.

DISCUSSION

Bilingual English-Urdu pneumonia information e-health material available to the general public and caregivers were examined to assess the effectiveness of these literacy materials in framing pneumonia, providing guidelines, and supporting caregivers to recognize and act upon symptoms with appropriate care and timely referrals. The analysis revealed that bilingual communication is not merely converting text from source language (English) to target language (Urdu) through direct translation equivalents. Rather, it involves a systematic shift in what information is communicated, how risk is framed and emphasized, and how actions are prompted or discouraged through linguistic choices. These shifts are important because child mortality from pneumonia remains one of the major concerns across the globe, with Pakistan bearing a disproportionate burden of preventable deaths (Rudan, Boschi-Pinto, Biloglav, Mulholland, and Campbell, 2008). Effective public health interventions depend not only on

the availability of clinical services and vaccination programs but also on timely recognition of symptoms by caregivers and appropriate care-seeking behavior, both of which are supported by clear, publicly available online guidance that is accessible in the languages caregivers understand best.

English versions of web pages tended to be more explanatory, providing contextual information about disease mechanisms, risk factors, and treatment rationales. In contrast, Urdu versions (already scarce on the web pages in terms of both word count and content breadth) were more directive and compressed, focusing on immediate actions without supporting explanation. From a public health perspective, this variation may increase readability for low-literacy audiences by reducing cognitive load, but it can also affect contextual understanding of why certain actions are necessary or what to do in atypical situations (Monlezun et al., 2025). Compressed information on pneumonia that provides inadequate risk explanation and generalized advice such as "seek care when needed" rather than specific guidance on "when to take urgent care" may result in partial comprehension among caregivers. As a consequence, caregivers may correctly recognize that pneumonia symptoms are serious but could remain uncertain about the specific urgency threshold, the distinction between danger signs and routine symptoms, and the appropriate point of entry into the health system (pharmacy, clinic, emergency room, or home care). This is particularly important in Pakistan, where care-seeking involves multiple sources of information and care, including home remedies, pharmacy advice, traditional healers, spiritual healers, general practitioners, and tertiary hospitals. Delays in reaching appropriate care can be clinically consequential, with each hour of delay increasing the risk of severe complications or death (Ahmad, Ahmad, Huber, and Weckerle, 2021; Oyeboode, Kandala, Chilton, and Liflord, 2016).

Terminological and register differences used in both languages across online formats shaped how the public interprets health messages and their perception of disease severity. English texts frequently used elaborate explanations that built conceptual understanding but also kept biomedical terms intact in the content without consistent simplification. This strategy supports information completeness and professional accuracy at the cost of general comprehension of the disease among lay audiences. By comparison, Urdu texts more often used omission (removing technical terms entirely) and transliteration (rendering English terms in Urdu script without translation). These translation choices often obscure a complete understanding of the disease because caregivers may recognize words like "کنٹویاب یتیا" without understanding what antibiotics do, why they are needed for bacterial pneumonia, or why completing the full course matters. Pneumonia information dissemination would be more successful if implemented as a coherent system that guides caregivers through the full care pathway: recognition of symptoms, classification of severity (mild versus severe pneumonia), appropriate treatment referral, and follow-up care, rather than providing isolated technical information fragments (Rudan et al., 2008; Verguet et al., 2025).

Actionability emerged as a policy-relevant gap with direct implications for health outcomes. Pamphlets as compared to websites were more actionable due to design features such as bullet points that break information into discrete steps, short statements that are easy to remember and repeat, visual emphasis (bold text, warning symbols, color coding) that directs attention to critical information, and a direct imperative tone that leaves no ambiguity about required actions. Web pages provided a format that allowed space for paragraph-length explanations and extensive background information, which may be appropriate for readers seeking deep understanding but less suitable for caregivers under time pressure or emotional stress who need rapid action guidance. Urdu texts on websites emphasized general consultation ("see a doctor") over the specific triggers for urgency (such as "if the child is breathing faster than normal" or "if the child is unable to drink"). Ekyaruhanga and colleagues highlighted that pneumonia management depends substantially on rapid and appropriate response along the care pathways, with delays at any point (recognition, decision to seek care, travel to facility, triage, treatment)

compounding to increase mortality risk (Ekyaruhanga et al., 2023). Hence, inconsistent actionability across bilingual materials is not a minor editorial issue or a matter of stylistic preference. It is rather a potential bottleneck in translating policy into behavior, particularly as online materials are increasingly reused and circulated across platforms, social media, and messaging applications, amplifying any existing weaknesses or omissions (Abouzahr and Boerma, 2005; Shah, Nazeer, Ali, Qasim, and Khan, 2025).

Since digital platforms have revolutionized the health sector and are now an integral part of health communication strategies in both high-income and low-middle-income countries, digital approaches must be human-centered, equitable, and aligned with local needs to avoid creating or widening knowledge and communication gaps (Monlezun et al., 2025). Simply providing information online is insufficient if that information is not accessible, comprehensible, and actionable for all linguistic groups. In Pakistan, bilingual online materials need to be governed through systematic translation quality assessments to enhance public health literacy about pneumonia by ensuring adequate, inclusive, and accessible language that is widely understood by the public with diverse educational backgrounds, literacy levels, and prior health knowledge. This governance should include pre-publication review by language specialists and community representatives, as well as post-publication monitoring of how materials are used and understood.

These findings should be interpreted in light of two limitations that suggest directions for future research. First, the dataset was intentionally small and focused exclusively on English-Urdu language pairs, reflecting the dominant bilingual configuration in Pakistani institutional communication but excluding the many other languages spoken in Pakistan (such as Punjabi, Pashto, Sindhi, Balochi, and Saraiki). Therefore, the analysis identifies patterns and mechanisms rather than prevalence rates of translation problems for biomedical content designed for public health literacy in the Pakistani digital health context. Second, this study did not measure caregiver comprehension or behavioral response directly, relying instead on textual analysis to identify potential barriers to understanding and action. Without direct user testing, we cannot definitively state how caregivers actually interpret these materials or whether the observed differences lead to differential health outcomes. Nevertheless, paired bilingual analysis of authentic institutional materials provides a useful window into how official pneumonia information is currently translated and packaged for public audiences, and it offers practical, actionable targets for quality improvement that can be tested in future research.

CONCLUSION

Bilingual e-health material on pneumonia published in Pakistan displayed broad thematic alignment with public health literacy guidelines and international recommendations for pneumonia communication. However, the materials varied systematically in explanatory depth, terminology choices, and actionability across languages and formats (World Health Organization, 2021). Urdu versions prioritized an academic-specific register and directive tone that emphasizes immediate action, while English versions provided longer explanations that build conceptual understanding but may be harder to scan for action points. These systematic differences suggest that merely providing "Urdu versions" of English materials is not sufficient to ensure equitable access to accurate, comprehensible, and usable pneumonia information for Urdu-speaking caregivers. Without deliberate attention to translation quality, content completeness, and actionability, Urdu versions may create an illusion of accessibility while delivering substantively different information than English versions.

Bilingual e-health communication should be considered a program component that requires active governance and quality assurance at the level of national and provincial health authorities, rather than being treated as a minor translation task delegated to junior staff or automated systems without oversight. Practical steps for improving bilingual health communication include involving multiple stakeholders

(clinicians, community health workers, caregivers, language specialists, and health communication experts) to systematically identify and address translation challenges. These stakeholders should review and revise existing translations to ensure they fit the purpose of supporting comprehension, appropriate care-seeking, and timely response. The process should include forward translation (English to Urdu), back translation (Urdu to English) to check meaning preservation, and field testing with target audiences.

Additionally, AI tools for translation can be leveraged to meet the needs of public health literacy needed to alleviate pneumonia burden, particularly given the scale of content that requires translation and the limited human resources available for this work in many LMICs. AI-generated translations could be modified by human post-editing to address cultural nuances, incorporate local idioms and examples, and ensure broader understanding of the disease across diverse educational backgrounds. In multilingual settings such as Pakistan, translation is not merely a linguistic exercise or a technical task. It is a fundamental mechanism through which access to life-saving information is either enabled or constrained for large segments of the population. Integrating quality assurance protocols and AI-assisted translation workflows for bilingual materials into pneumonia control programmes and digital health strategies may contribute to more equitable access to prevention information and timely care, thereby supporting both national child health targets in Pakistan and global Sustainable Development Goal 3 commitments to reduce under-five mortality from preventable causes.

CREDIT AUTHOR STATEMENT

Mehwish Arfi: Conceptualization, Methodology, Data curation, Formal analysis, Writing - Original draft preparation, Supervision, Project administration. **Dr Sajida Zaki:** Methodology, Investigation, Validation, Writing - Reviewing and Editing, Resources, Visualization.

ETHICS APPROVAL

Ethical approval was not required as all materials analysed were publicly available and no human participants were involved.

PATIENT AND PUBLIC INVOLVEMENT STATEMENT

Patients and the public were not involved in the design, conduct, reporting or dissemination plans of this research.

DATA AVAILABILITY STATEMENT

All materials analysed in this study are publicly available online.

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The authors declare no competing interests.

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