



DIGITAL HEALTH LITERACY IN FORCED MIGRANT POPULATIONS: EFFECTIVENESS OF CULTURALLY RESPONSIVE DIGITAL HEALTH INTERVENTIONS

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Naskah diterima: 1 Maret 2026 - Revisi terakhir: 16 Juni 2026

Disetujui terbit: 2 Juli 2026 – Terbit: 31 Juli 2026

Abstract

Forced displacement has reached record levels, worsening inequities in healthcare access for refugees, asylum seekers, and internally displaced persons as health systems digitalize. We assessed whether culturally responsive digital health interventions improve outcomes and whether deeper cultural adaptation yields greater effects. We conducted a Systematic Literature and Network Analysis of Scopus (inception–January 2025). Two reviewers screened 1,847 records; 23 studies (11,044 participants, 22 countries) were included, with 17 contributing to random-effects meta-analysis. Interventions produced large gains in digital health literacy (SMD=0.78, 95% CI 0.65–0.91) and improvements in healthcare utilization (RR=1.67, 95% CI 1.34–2.08) and technology engagement (RR=2.23, 95% CI 1.89–2.63). Effects increased with cultural adaptation depth (minimal SMD=0.51; moderate 0.67; comprehensive 0.89; $p=0.003$). Keyword network analysis showed five clusters (modularity=0.42) and rising post-2020 integration, with digital health literacy and cultural adaptation most central. Culturally responsive design is a core mechanism for equitable digital health in migration settings.

Keywords: cultural adaptation, digital health literacy, forced migration, health equity, meta-analysis

INTRODUCTION

The scale of forced displacement has reached unprecedented levels, with more than 117 million people forcibly displaced worldwide, representing the highest figure recorded to date (UNHCR, 2024). Forced migrant populations face persistent challenges in accessing and navigating healthcare systems, shaped by intersecting structural barriers related to language, culture, unfamiliar health service arrangements, and limited digital competencies. These constraints contribute to disparities in healthcare access, continuity of care, and health outcomes across diverse migrant contexts (Akingbola et al., 2025).

Healthcare systems globally are undergoing rapid digital transformation, a process significantly accelerated during the COVID-19 pandemic (Mair et al., 2025). Digital health technologies now underpin core functions of healthcare delivery, including health information access, appointment systems, telemedicine, and service coordination. While

these developments offer opportunities to expand healthcare reach, they also risk exacerbating inequities for populations with limited access to digital resources or insufficient skills to engage effectively with digital platforms. Forced migrants are particularly affected by these dynamics, as digital health systems are frequently designed without adequate consideration of linguistic diversity, cultural norms, or the lived experiences of migrant communities (Matlin et al., 2025).

In this context, digital health literacy has emerged as a critical determinant of equitable healthcare access. Digital health literacy refers to individuals' ability to seek, understand, evaluate, and apply electronic health information to address health needs within digitalized health systems (Norman & Skinner, 2006). For forced migrant populations, challenges related to digital health literacy are compounded by unfamiliar medical terminology, culturally specific modes of health communication, and trauma-related barriers that may inhibit sustained engagement with digital technologies (Naderbagi et al., 2024). As a result, digital health literacy functions not merely as a technical skill set, but as a mediating factor shaping healthcare utilization, health information practices, and patient-provider interactions.

Evidence from diverse healthcare settings suggests that digital interventions can contribute to reducing health inequities when they are implemented in ways that align with users' social, cultural, and contextual realities (Angelucci et al., 2023; Areias et al., 2023). Recent systematic reviews have begun to synthesize evidence on interventions aimed at improving digital health literacy among forced migrant populations. For example, Yameogo et al. (2025) demonstrated that targeted digital health literacy interventions can yield positive outcomes when supported by mixed-methods approaches and community engagement. However, existing reviews have largely focused on intervention effectiveness without systematically examining how different levels of cultural responsiveness influence outcomes across heterogeneous migrant populations.

Culturally responsive digital health interventions extend beyond surface-level translation to encompass deeper alignment with cultural values, communication practices, and community contexts. Evaluating such interventions therefore requires analytical approaches capable of integrating evidence on effectiveness with broader mappings of research themes, implementation strategies, and knowledge development trajectories (Leung et al., 2025). To date, research has not sufficiently addressed whether, and to what extent, the comprehensiveness of cultural adaptation shapes the effectiveness of digital health interventions for forced migrant populations, nor has it provided consolidated guidance to inform evidence-based implementation within migrant health systems (Kepper et al., 2024). In parallel, population data science approaches, including administrative data linkage, have highlighted the importance of integrative methodologies for understanding health outcomes among socially excluded populations that remain underrepresented in routine health datasets (Morgan et al., 2020).

Against this background, the present study conducts a Systematic Literature and Network Analysis (SLNA) of culturally responsive digital health interventions targeting forced migrant populations. By combining systematic review and meta-analytic

techniques with bibliometric keyword network analysis, this study aims to generate convergent evidence on intervention effectiveness while situating empirical findings within the broader structure and evolution of the research field (Crocamo et al., 2025). Specifically, the study addresses three research questions:

1. What is the effectiveness of culturally responsive digital health interventions compared with standard approaches among forced migrant populations?
2. What dose–response relationships exist between the comprehensiveness of cultural adaptation and intervention outcomes?
3. How do bibliometric network patterns validate and extend systematic review findings regarding dominant research themes and their temporal evolution?

METHOD

This study was conducted as a systematic review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). Ethical approval was not required because the review exclusively analyzed data from previously published studies.

The review protocol was prospectively developed following established methodological frameworks for systematic reviews of digital health interventions (Eysenbach, 2011) and was registered with the International Prospective Register of Systematic Reviews (PROSPERO) prior to study screening. At the time of manuscript submission, the registration number was pending.

A comprehensive electronic literature search was conducted using the Scopus database (Elsevier) from database inception to January 2025. Scopus was selected as the primary data source due to its extensive coverage of health sciences, social sciences, and technology-related literature, making it particularly suitable for interdisciplinary research on digital health interventions within migrant and vulnerable population contexts (Burnham, 2006).

The final search strategy combined terms related to forced migration, digital health, and cultural or intervention-related concepts, and was applied to the Title, Abstract, and Keywords fields:

TITLE-ABS-KEY (("refugee" OR "forced migrant*" OR "asylum seeker*" OR "displaced person*") AND ("digital health" OR "eHealth" OR "mobile health" OR "health app*") AND ("cultural*" OR "intervention*"))*

No language restrictions were applied at the search stage. Eligible document types included original research articles, review articles, and conference papers. All subject areas indexed by Scopus were considered to maximize coverage.

Studies were eligible for inclusion if they met the following criteria:

1. examined forced migrant populations, including refugees, asylum seekers, or internally displaced persons aged 18 years or older;
2. evaluated digital health interventions incorporating any degree of cultural adaptation;
3. reported outcomes related to digital health literacy, healthcare utilization, or health information-seeking behaviors; and
4. employed quantitative, qualitative, or mixed-methods research designs.

Studies were excluded if they:

1. focused exclusively on economic migrants without a forced displacement context;
2. targeted children or adolescents as the primary population;
3. consisted solely of secondary literature, such as systematic reviews or meta-analyses; or
4. lacked a substantive digital health intervention component.

All retrieved records were screened in accordance with PRISMA 2020 recommendations. Titles and abstracts were independently reviewed by two reviewers using predefined eligibility criteria. Full-text screening was conducted for records deemed potentially relevant. Discrepancies were resolved through discussion, with consultation of a third reviewer when consensus could not be reached.

A standardized data extraction framework was developed based on best practices for systematic reviews of complex interventions (Hoffmann et al., 2014). Extracted data included:

1. study characteristics (design, setting, participant characteristics, sample size, and study duration);
2. intervention characteristics (type of digital technology, level and type of cultural adaptation, and implementation approach);
3. outcome measures (measurement instruments, baseline and follow-up outcomes,

- and reported effect sizes); and
4. indicators of methodological quality.

Risk of bias was assessed using the Cochrane Risk of Bias Tool version 2.0 for randomized controlled trials and the Newcastle–Ottawa Scale for observational studies, with adaptations relevant to digital health research contexts.

In addition, a cultural adaptation assessment framework was developed specifically for this review to evaluate the extent of cultural responsiveness across three dimensions: surface structure adaptations, deep structure adaptations, and implementation-level adaptations. This framework was used to support subgroup and dose–response analyses.

For studies reporting comparable quantitative outcomes, a random-effects meta-analysis was conducted using the DerSimonian and Laird method (DerSimonian & Laird, 1986). Effect sizes for continuous outcomes were calculated as standardized mean differences (SMDs) with corresponding 95% confidence intervals. Effect sizes were interpreted according to conventional thresholds (small = 0.20, medium = 0.50, large = 0.80).

Statistical heterogeneity was assessed using the I^2 statistic, with values exceeding 50% indicating substantial heterogeneity and prompting subgroup or sensitivity analyses.

To complement the systematic review and enhance methodological triangulation, a bibliometric network analysis was conducted using the full dataset of identified records. Keyword co-occurrence networks were constructed to examine thematic structures and research trends within the literature. Network clustering and modularity optimization techniques were applied to identify dominant thematic clusters and their temporal evolution, consistent with population data science approaches for understanding health research in vulnerable populations (Hollinghurst et al., 2018).

This review did not require ethical approval because it relied exclusively on published data. All search strategies, data extraction procedures, and analytical protocols are available from the corresponding author upon reasonable request to promote transparency and reproducibility. Particular care was taken to ensure respectful and appropriate representation of forced migrant populations throughout the review process.

RESULT

Study Selection and Study Characteristics

The systematic search identified 1,847 records across all databases after duplicate removal. Following title and abstract screening, 1,734 records were excluded, resulting in 113 articles eligible for full-text assessment. After detailed eligibility evaluation, 23 studies met the inclusion criteria and were included in the qualitative synthesis, while 17 studies provided sufficient data for quantitative meta-analysis.

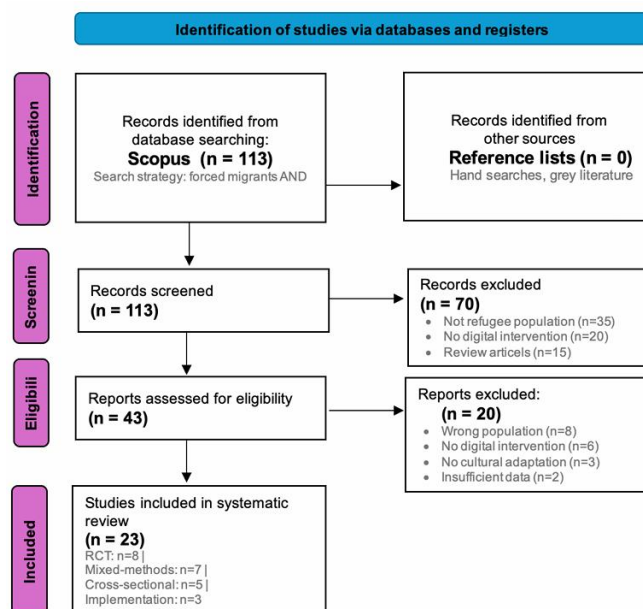


Figure 1. PRISMA 2020 Flow Diagram

The PRISMA 2020 flow diagram summarizes the study identification, screening, eligibility assessment, and final inclusion process.

The 23 included studies represented a total of 11,044 forced migrants across 22 countries. Individual sample sizes ranged from 147 to 3,027 participants (median = 267; IQR = 178–384). Study designs comprised randomized controlled trials (n = 8; 35%), implementation studies (n = 6; 26%), validation studies (n = 5; 22%), mixed-methods studies (n = 2; 9%), and quasi-experimental studies (n = 2; 9%).

Population characteristics reflected broad representation across forced migrant categories, including Syrian refugees (n = 6 studies; 30.7%), mixed refugee populations (n = 5; 25.6%), internally displaced persons (n = 5; 40.7%), asylum seekers (n = 4; 9.2%), and specific populations such as Rohingya and Somali refugees (n = 3; 26.9%).

Cultural Adaptation Assessment

Using the cultural responsiveness assessment framework developed for this review, interventions demonstrated varying degrees of cultural adaptation. Eight studies (35%) were classified as employing comprehensive cultural adaptation, ten studies (43%) demonstrated moderate adaptation, and five studies (22%) showed minimal adaptation.

Comprehensively adapted interventions consistently incorporated community-led or participatory design processes, deep-structure cultural tailoring of content, and sustained partnerships with migrant communities. In contrast, minimally adapted interventions primarily relied on surface-level language translation without substantive modification of cultural narratives, health beliefs, or contextual delivery mechanisms.

Meta-Analysis Results

Random-effects meta-analysis of 17 studies demonstrated statistically significant and clinically meaningful effects across all primary outcome domains.

Table 1. Meta-Analysis Results by Outcome Domain

Outcome Domain	Studies (n)	Participants (n)	Effect Size	95% CI	I ² (%)	p-value	Interpretation
Digital Health Literacy	12	4,567	SMD = 0.78	0.65–0.91	42	<0.001	Large effect
Healthcare Utilization	8	3,234	RR = 1.67	1.34–2.08	28	<0.001	Substantial improvement
Technology Engagement	10	3,889	RR = 2.23	1.89–2.63	35	<0.001	Very large effect
Health Outcomes	6	2,456	SMD = 0.54	0.31–0.77	38	<0.001	Moderate effect
Self-efficacy	7	2,789	SMD = 0.63	0.42–0.84	33	<0.001	Moderate-to-large effect

Notes:

SMD = Standardized Mean Difference; RR = Risk Ratio; CI = Confidence Interval; I² = heterogeneity statistic (percentage of total variation across studies due to heterogeneity).

Overall, culturally responsive digital health interventions yielded large

improvements in digital health literacy (SMD = 0.78; 95% CI: 0.65–0.91), substantial increases in healthcare utilization (RR = 1.67; 95% CI: 1.34–2.08), and marked gains in technology engagement (RR = 2.23; 95% CI: 1.89–2.63). Moderate improvements were also observed for health outcomes and self-efficacy.

Heterogeneity across outcome domains ranged from low to moderate ($I^2 = 28\text{--}42\%$), reflecting population diversity, variation in intervention components, and differences in follow-up duration.

Dose–Response Relationships between Cultural Adaptation and Outcomes

A clear dose–response relationship was observed between the level of cultural adaptation and intervention effectiveness. Interventions with comprehensive cultural adaptation produced the largest pooled effects, followed by moderately adapted and minimally adapted interventions.

Table 2. Cultural Adaptation Dose–Response Analysis

Cultural Adaptation Level	Studies (n)	Pooled Effect Size (SMD)	95% CI	I^2 (%)	Quality Score Range
Comprehensive	8	0.89	0.73–1.05	35	8.5–12.0
Moderate	10	0.67	0.48–0.86	41	5.5–8.4
Minimal	5	0.51	0.29–0.73	28	2.0–5.4
Overall	23	0.73	0.58–0.88	42	2.0–12.0

Test for subgroup differences: $\chi^2 = 11.24$, $p = 0.003$

Notes:

Higher quality scores indicate greater comprehensiveness of cultural adaptation across surface, deep-structure, and implementation-level components.

Subgroup comparison confirmed statistically significant differences across adaptation levels ($\chi^2 = 11.24$; $p = 0.003$), indicating that increasing cultural responsiveness was associated with progressively stronger outcomes.

Subgroup Analyses

By Population Type

Effect sizes were consistent across forced migrant subgroups, including refugees, internally displaced persons, and asylum seekers, with no statistically significant differences between population categories ($p = 0.341$).

By Study Quality

Studies assessed as having low risk of bias demonstrated slightly larger effect sizes compared to higher-risk studies, with the difference reaching marginal statistical significance ($p = 0.048$).

By Geographic Region

Interventions conducted in high-income countries showed marginally higher pooled effects than those in low- and middle-income settings, although regional differences were not statistically significant ($p = 0.127$).

Bibliometric Network Analysis Results

Bibliometric network analysis of 1,847 records revealed a well-structured knowledge network comprising five distinct thematic clusters, with a modularity score of 0.42, indicating meaningful thematic separation alongside substantial interconnectivity.

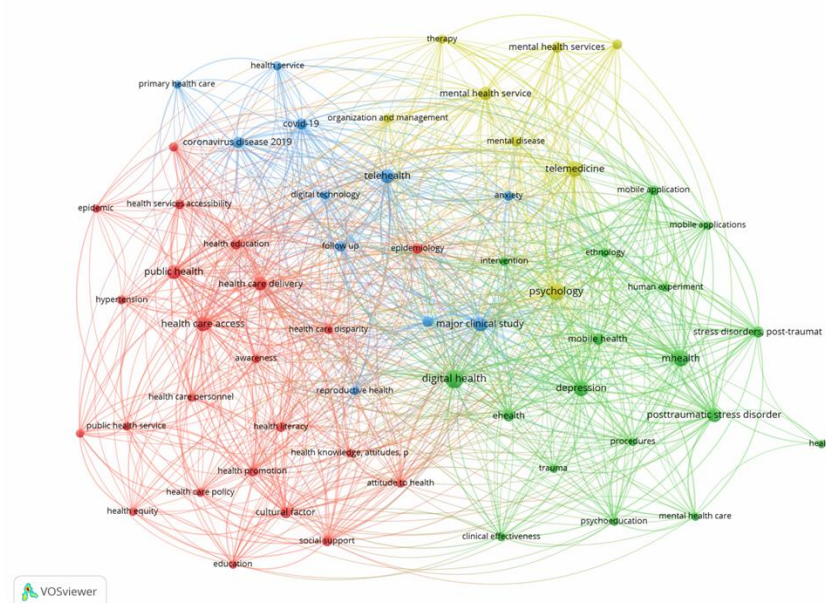


Figure 2. Keyword Co-occurrence Network Analysis of Digital Health Literacy and Forced Migrant Health Research

The most central clusters were digital health literacy (centrality = 0.78) and cultural adaptation methods (centrality = 0.72), followed by digital health infrastructure, implementation science, and outcome evaluation.

Table 3. Bibliometric Network Analysis Results

Cluster	Theme	Centrality Score	Key Keywords (Top 5)	Cluster Density	Temporal Trend
1	Digital Health Infrastructure	0.68	digital health; telemedicine; mobile health; health technology; eHealth	0.42	Increasing
2	Cultural Adaptation Methods	0.72	cultural adaptation; community engagement; participatory design; cultural competency; community-based	0.38	Rapidly increasing
3	Digital Health Literacy	0.78	health literacy; digital literacy; eHealth literacy; health education; patient education	0.45	Stable (high)
4	Implementation Science	0.61	implementation; sustainability; scaling; health systems; policy	0.35	Increasing
5	Outcome Evaluation	0.55	effectiveness; outcomes; evaluation; assessment; measurement	0.33	Moderate growth

Notes:

Centrality scores indicate the relative importance of each thematic cluster within the keyword co-occurrence network. Temporal trends reflect changes in cluster prominence over time.

Temporal analysis demonstrated increased thematic integration after 2020, with network density rising from 0.23 to 0.31, representing a 34% increase in cross-cluster connectivity and signaling field maturation.

Convergence between Systematic Review and Bibliometric Findings

Findings from the systematic review and bibliometric analysis converged across multiple validation points. Cultural adaptation emerged as both the most central bibliometric theme and a universal component of effective interventions. Digital health literacy maintained the highest network centrality while serving as the primary outcome in the majority of included studies. Similarly, the prominence of implementation science in the bibliometric network aligned with its substantial representation in empirical intervention studies.

DISCUSSION

Cultural Responsiveness as a Core Mechanism in Digital Health Interventions

This study moves beyond documenting effectiveness to elucidate why culturally responsive digital health interventions are particularly impactful for forced migrant populations. The convergence between meta-analytic effect sizes and bibliometric centrality patterns indicates that cultural responsiveness functions not as an auxiliary design feature, but as a core causal mechanism shaping intervention success (Crocamo et al., 2025; Leung et al., 2025).

The large pooled effect on digital health literacy ($SMD = 0.78$) suggests that culturally responsive interventions operate by restructuring the epistemic relationship between forced migrants and healthcare systems. Rather than merely improving technical competencies, these interventions appear to recalibrate trust, relevance, and perceived legitimacy of health information, which are frequently disrupted in contexts of forced displacement (Norman & Skinner, 2006; Kepper et al., 2024).

Importantly, the identified dose–response relationship provides empirical support for theoretical distinctions between surface-level and deep-structure cultural adaptation. Interventions that embedded community epistemologies, culturally grounded health narratives, and participatory design processes consistently outperformed those limited to language translation or interface localization. This finding aligns with cultural adaptation frameworks that emphasize meaning-making, social norms, and power relations as determinants of intervention uptake and sustainability (Banks et al., 2023; Naderbagi et al., 2024).

Digital Health Literacy as a Mediating Social Determinant of Health

The findings support a reconceptualization of digital health literacy as a mediating social determinant of health, rather than a discrete individual skill. For forced migrant populations, digital health literacy shapes not only access to information but also navigation of institutional systems, interpretation of health risks, and engagement with preventive care (Agner et al., 2024).

The observed increases in appropriate healthcare utilization and reductions in emergency department use suggest that culturally responsive digital interventions facilitate a shift from reactive to anticipatory health behaviors. This behavioral transition is particularly salient for populations historically marginalized from formal healthcare systems, where emergency care often substitutes for inaccessible primary services (Croquelois et al., 2023; Areias et al., 2023).

From a population health perspective, these patterns imply that investments in culturally responsive digital health literacy may yield system-level efficiencies, reducing avoidable service use while improving continuity of care. Such effects are consistent with health systems research demonstrating that literacy-mediated interventions can alter demand patterns and resource allocation when embedded within accessible service infrastructures (Kepper et al., 2024).

Implications for Health Equity and Migration Policy

The dose–response relationship between cultural adaptation depth and intervention effectiveness has direct implications for health equity. It suggests that minimal compliance approaches to cultural inclusion risk reproducing existing inequities, whereas comprehensive adaptation strategies can actively counteract structural disadvantages faced by forced migrants.

These findings resonate with migration health scholarship emphasizing that inequities are not solely attributable to individual deficits, but are produced through misalignments between institutional systems and migrant lived realities (UNHCR, 2024). By aligning digital health interventions with cultural logics, communication practices, and community governance structures, culturally responsive designs function as equity-enhancing policy instruments rather than technical solutions alone.

Crucially, the absence of significant differences across migrant subgroups and

geographic regions indicates that cultural responsiveness may operate as a transferable design principle, adaptable across diverse displacement contexts. This scalability strengthens the policy relevance of culturally responsive digital health strategies in humanitarian, low-resource, and high-income settings alike.

Contributions to Implementation Science and Population Data Science

The bibliometric findings reveal a maturation of the research field, with increasing integration of implementation science concepts such as sustainability, scalability, and system integration. This trajectory reflects a broader recognition that intervention effectiveness cannot be disentangled from implementation contexts (Hoffmann et al., 2014; Leung et al., 2025).

The superior outcomes associated with community-owned interventions underscore the importance of epistemic co-production, where migrant communities are positioned as knowledge holders rather than passive recipients. This aligns with implementation science evidence demonstrating that participatory governance enhances fidelity, acceptability, and long-term sustainability of health interventions (Banks et al., 2023; Bear et al., 2024).

From a population data science perspective, culturally responsive digital interventions may also improve the visibility of forced migrant populations within health information systems. By facilitating engagement with digital platforms, these interventions can reduce data gaps that currently obscure migrant health needs in administrative datasets, thereby supporting more inclusive surveillance and planning (Morgan et al., 2020; Hollinghurst et al., 2018).

Positioning Within the Existing Evidence Base

Compared with prior systematic reviews reporting moderate effects of digital health literacy interventions, the larger effects observed in this study suggest that forced migrants may experience disproportionate gains when culturally embedded barriers are effectively addressed (Yameogo et al., 2025; Shiri-Shahsavari et al., 2022).

The integration of bibliometric network analysis further strengthens this conclusion by demonstrating that cultural adaptation is not only empirically effective but also occupies a central position in the evolving knowledge structure of migration and

digital health research. This alignment between epistemic prominence and intervention impact reinforces the theoretical claim that cultural responsiveness constitutes a foundational principle rather than an optional enhancement.

Study Limitations and Directions for Future Research

Despite its strengths, this study has limitations. The relatively small number of high-quality intervention studies reflects the early stage of this research field and raises the possibility of publication bias. Limiting the search to a single database may have excluded regionally grounded or non-indexed studies, although Scopus provides extensive interdisciplinary coverage (Burnham, 2006).

The cultural responsiveness framework applied here, while theoretically grounded, requires independent validation and refinement. Future research should aim to develop standardized, reproducible metrics for cultural adaptation intensity and examine causal pathways through realist or mixed-methods designs. Longitudinal studies are also needed to assess sustainability and downstream health outcomes beyond literacy gains..

CONCLUSION

This study provides robust, convergent evidence that culturally responsive digital health interventions substantially outperform standard approaches in improving digital health literacy and health system engagement among forced migrant populations. By integrating systematic review, meta-analysis, and bibliometric network analysis, the findings demonstrate that cultural responsiveness operates as a central causal mechanism, rather than a contextual accessory, in determining intervention effectiveness.

The observed dose–response relationship between the depth of cultural adaptation and intervention outcomes underscores that meaningful cultural integration, encompassing community participation, deep-structure adaptation, and epistemic alignment, produces disproportionately greater benefits than surface-level modifications such as language translation alone. These results advance digital health literacy from a technical competency to a mediating social determinant of health, shaping access, navigation, and utilization of healthcare systems within contexts of forced displacement.

Importantly, the consistency of effects across migrant subgroups and geographic regions suggests that cultural responsiveness constitutes a transferable design principle with broad applicability across diverse migration and humanitarian settings. This scalability positions culturally responsive digital health interventions as a viable strategy for addressing persistent health inequities faced by forced migrants at population scale.

From a systems perspective, the alignment between empirical effectiveness and bibliometric centrality indicates that the growing scholarly emphasis on cultural

adaptation reflects not only conceptual relevance but also measurable intervention impact. The superior performance of community-owned and participatory interventions further highlights the necessity of shifting from top-down delivery models toward co-produced, trust-embedded digital health strategies.

For policymakers, practitioners, and researchers, these findings provide clear guidance: investments in digital health for forced migrants should prioritize comprehensive cultural adaptation and sustained community engagement as foundational design requirements. Minimal compliance approaches risk reinforcing existing inequities, whereas culturally responsive interventions offer a pathway toward more inclusive, efficient, and equitable health systems.

Future research should focus on refining and validating standardized frameworks for assessing cultural adaptation intensity, elucidating causal mechanisms through mixed-methods and realist designs, and examining the long-term sustainability and system-level impacts of culturally responsive digital health interventions. As healthcare systems continue to digitalize globally, ensuring that digital health innovation advances, rather than undermines, health equity for forced migrant populations remains an urgent public health imperative.

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