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From Rights to Reach: A Distributive Policy Framework Bridging Health Literacy Education, Standardised Medical Sign Language, and Healthcare Access for People with Hearing Loss in Thailand

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Abstract

Background

People with hearing loss in Thailand face persistent gaps between rights legislated under the Persons with Disabilities Empowerment Act B.E. 2550 and rights as experienced in everyday clinical encounters. Existing research rarely connects multi-region lived-experience evidence with concrete policy instruments. This study developed a distributive policy framework, anchored by a standardised medical sign language vocabulary and the MU-silentcare mobile application, to advance equitable health literacy and healthcare access.

Methods

A sequential explanatory mixed-methods, three-phase design was conducted across all seven regions of Thailand. Phase 1 used semi-structured interviews and focus group discussions with 138 purposively sampled stakeholders, including people with lived experience. Phase 2 administered a validated needs-assessment questionnaire (Cronbach's α = 0.92; Item-Objective Congruence Index = 0.8) to 421 people with hearing loss recruited by cluster sampling; data were analysed using the modified Priority Needs Index ($PNI_{modified}$). Phase 3 combined a 14-day MU-silentcare mobile-application workshop, pre–post paired-samples *t*-tests on 453 participants, and policy-validation focus group discussions with 88 stakeholders.

Results

Phase 1 identified twelve issues across three domains: health literacy barriers, healthcare access and service-quality gaps, and systemic policy deficiencies. Phase 2 ranked healthcare access (PNI = − 0.50) and digital innovation (PNI = − 0.45) as top-priority needs; urgent-care response times received the highest importance rating ($M = 4.67/5$). Phase 3 produced statistically significant improvements across all five health-literacy dimensions (overall $t(452) = -30.42$, $p < 0.001$, Cohen's $d = 2.49$); the largest effects were in symptom communication ($d = 2.47$) and medical sign language knowledge ($d = 2.26$). Convergent evidence yielded five evidence-traceable distributive policy proposals.

Conclusions

Health literacy and healthcare access barriers experienced by people with hearing loss in Thailand are produced by health-system design rather than by hearing status. The MU-silentcare application demonstrated that large gains are achievable by changing the language of the system rather than training the user. Five distributive policies, visual health-communication media standards, mandatory deaf-friendly service points, removal of mobile-device restrictions, cross-sector coordination, and equitable resource allocation, are politically feasible within a single policy cycle through ministerial regulation under the existing legal framework.

Background

Hearing loss is among the most overlooked disabilities globally. The World Health Organization estimates that more than 1.5 billion people live with some degree of hearing loss, a figure projected to reach 2.5 billion by 2050 (Chadha et al., 2021; GBD 2019 Hearing Loss Collaborators, 2021). Hearing loss affects communication, learning, and access to health services. When communication is constrained, people experience difficulty understanding health information, asking questions in clinical settings, and following medical advice. These difficulties are simultaneously personal, developmental, and structural, constituting questions of how health systems and policies are designed.

Health literacy, the ability to find, understand, and use health information to make decisions about one's care (Nutbeam, 2000), is central to understanding why marginalised groups experience poorer health outcomes. For people with hearing loss, health literacy depends on whether information is available in sign language, whether visual aids are used, and whether health staff can communicate without spoken language. Systematic reviews consistently demonstrate that people with hearing loss have lower health literacy, higher medical costs, and more delays in care-seeking (Piao et al., 2023; Wallace et al., 2022; Wells et al., 2020). An analysis of 19,223 adults aged 65 and older found that unaided severe hearing loss was significantly associated with limited health literacy

alongside co-occurring memory loss, depression, and loneliness; individuals with both limited health literacy and hearing loss incurred the highest medical costs, yet hearing-aid use showed no evidence of improving health literacy (Wells et al., 2020).

Health literacy has direct implications for treatment-seeking behaviour. In a study of 1,376 patients undergoing audiometric testing, lower health literacy was associated with greater hearing loss at presentation and lower rates of hearing-aid adoption, suggesting that inadequate health literacy contributes to delayed help-seeking (Tran et al., 2021). Among 1,250 adults aged 50–80, respondents demonstrated substantially poorer understanding of normal hearing levels than of vision, blood pressure, or cholesterol; most believed few treatment options existed, reflecting the absence of large-scale screening protocols or public health campaigns (Carlson et al., 2022). Professional health literacy is also a concern: a survey of 423 speech-language pathologists working with deaf and hard-of-hearing children found high general but marginal-to-low hearing-loss-specific health literacy, with academic training and experience predicting terminology knowledge but not general health literacy, pointing to a critical gap in professional education (Cooper et al., 2025).

Several structural barriers compound these individual-level deficits. Communication failure at clinical encounters remains pervasive: many physicians and nurses lack sign-language competency, and most hospitals do not provide interpreter services, leaving patients to rely on family members as ad hoc interpreters, compromising privacy and accuracy (James et al., 2022; Roguski et al., 2022). Existing patient education materials are written at reading levels inappropriate for the average adult (Squires & Ou, 2020), and a systematic review confirmed that deaf individuals consistently demonstrate poor health literacy with disparities unique to the deaf experience (Payami, 2021). Sign-language users have lower health literacy scores than hearing peers with comparable education even when assessment tools are translated into sign language (McKee et al., 2015). Evidence on digital and assistive technology is growing but uneven: a review of mobile applications for deaf and hard-of-hearing users found quality varying widely, with many failing basic content-accuracy and accessibility standards (Romero et al., 2019); community pharmacists have identified key design features for effective mHealth tools, including symptom selectors, sign-language medication labels, and on-screen written summaries (Chong et al., 2019).

The absence of a nationally standardised medical sign language is a particular structural barrier in Thailand. Sign-language terminology for health-specific terms is incomplete and varies between regions and schools; the fingerspelling system exists in multiple versions without official endorsement; and no existing Thai Sign Language dictionary covers the clinical vocabulary required for a hospital consultation. As a result, even trained interpreters cannot reliably bridge the gap between physician and patient when the symptom in question lacks an agreed sign.

Article 4(3) of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) requires States Parties to consult and actively involve people with disabilities in developing laws and policies that affect them (United Nations, 2006). The principle *nothing about us without us* is now widely accepted in disability research: policies designed with lived-experience input are more relevant, more accepted, and more likely to be implemented than those designed by experts alone.

Thailand has developed a comparatively strong legal framework for disability rights. The country ratified the UNCRPD in 2008 (United Nations, 2006). The Persons with Disabilities Empowerment Act B.E. 2550, as amended by Act (No. 2) B.E. 2556, entitles people with disabilities to free or affordable healthcare, sign-language interpretation, and reasonable accommodation in public services (Persons with Disabilities Empowerment Act, 2007). Thai Sign Language was recognised as the national language of people with hearing loss in 1999. Persons holding a disability identification card are entitled to medical-care benefits under the Universal Coverage Scheme. Yet enforcement is weak: healthcare staff are often unaware of these entitlements; the number of registered sign-language interpreters is small relative to the deaf population and concentrated in Bangkok; most hospitals lack visual queue systems or designated screening points for deaf patients; and hospital mobile-phone policies can block the assistive tools patients with hearing loss depend on (Srisuppaphon et al., 2017; Department of Empowerment of Persons with Disabilities, n.d.; UN Office of the High Commissioner for Human Rights, n.d.).

Distributive policy, a classification of public policy focused on equitably allocating resources, services, and benefits to specific population groups, offers a productive framework for addressing these structural barriers. Unlike rights-based reform, which requires primary legislation and faces significant political resistance, distributive policy instruments (service standards, equipment mandates, training guidelines, budget allocations) can typically be implemented through ministerial regulation and inter-agency coordination. This makes distributive policy a more feasible entry point for redressing structural inequality when strong enabling legislation already exists, as it does in Thailand under the Persons with Disabilities Empowerment Act.

Thailand's context illustrates a pattern observable across many low- and middle-income countries: the legal rights of persons with disabilities are formally recognised but substantively under-enforced. Srisuppaphon and colleagues (Srisuppaphon et al., 2017) found that while Thailand has transposed the UNCRPD into national legislation, practical implementation is hampered by limited inter-agency coordination, inadequate monitoring mechanisms, and insufficient disability-specific training for service providers. The UN Office of the High Commissioner for Human Rights (UN Office of the High Commissioner for Human Rights, n.d.) similarly noted that enforcement challenges persist, particularly in health and education. Countries that have moved beyond legal frameworks to adopt concrete service standards and resource allocations have generally achieved better outcomes for people with disabilities. The distributive policy approach taken in this study was motivated precisely by this evidence: rights-based frameworks are necessary but insufficient; what is needed are the instrumental, operational mechanisms through which rights are translated into services at the point of clinical contact.

To address this implementation gap, the research team developed the MU-silentcare mobile application as the digital health intervention underpinning this study. The application was created through a co-design approach involving people with hearing loss, schools for the deaf, and sign-language interpreters, led by Ratchasuda College, the only academic unit in Thailand dedicated to the education of persons with disabilities. The application is freely available on iOS and Android. It was designed not as a stand-alone product but as the language and technological core of a wider distributive policy framework. This paper reports the three-phase study through which the framework was developed, tested, and translated into concrete policy proposals.

The specific research objectives were: (1) to identify health literacy and healthcare access barriers through stakeholder consultation including lived experience; (2) to assess healthcare and digital innovation needs; (3) to evaluate the effectiveness of the MU-silentcare application on health literacy; and (4) to integrate findings into a draft distributive policy framework for the Ministry of Public Health and partner agencies. This paper presents the background literature, the methods employed in each of the three phases, the findings of all three phases, and a discussion of their implications for Thai disability policy and for the broader global health research field concerned with health equity for persons with disabilities in low- and middle-income countries.

Methods

Overall research design

A sequential explanatory mixed-methods, three-phase policy research design was employed. Qualitative findings from Phase 1 informed the quantitative instrument in Phase 2; both phases informed the intervention and policy synthesis in Phase 3. This sequential approach ensured the resulting policy framework was grounded in lived experience, validated by quantitative priority rankings, and tested through a field intervention. Convergence across phases provided triangulation of evidence and strengthened validity. All three phases (Table 1) were conducted across the seven geographic regions of Thailand: Southern, Northern, Eastern, Western, Northeastern, Central, and Bangkok Metropolis.

Table 1
Overview of the three-phase research design

Phase	Approach	Purpose	Participants
1	Qualitative	Issue identification through stakeholder engagement	138 stakeholders across 7 regions
2	Quantitative	Needs assessment on healthcare access and digital innovation	421 people with hearing loss across 7 regions
3	Mixed methods—policy framework	Intervention effectiveness and distributive policy validation	453 people with hearing loss; 88 stakeholders

Table 1: *Overview of the three-phase research design.*

Phase 1: Issue identification

Semi-structured interviews, focus group discussions, and participatory consultations were conducted with 138 purposively sampled stakeholders across all seven regions. Participants represented: people with lived experience of hearing loss; teachers, directors, and

administrators from schools for the deaf; caregivers and parents; sign-language interpreters; government officials responsible for disability, health, and social welfare policy; private-sector disability-services providers; and healthcare professionals and administrators. Purposive sampling ensured representation from all key sectors and regions. Recruitment was coordinated through regional educational institutions, government agencies, healthcare facilities, disability organisations, and community networks.

Instruments, semi-structured interview guides and focus group discussion protocols, were developed from a comprehensive review of healthcare accessibility, disability policy, and communication-barriers literature. Content validity was established through expert review (IOC = 0.8) and instruments were piloted with a small group of stakeholders prior to full deployment. All sessions were conducted bilingually, in written/spoken Thai and in Thai Sign Language video, to ensure equitable participation by people with varying degrees of hearing loss and Thai literacy. Sessions were recorded (with consent), transcribed, and subjected to member-checking where feasible. Data were analysed thematically to identify recurring patterns, structural gaps, and stakeholder recommendations. Thematic saturation was assessed after each regional cycle, with additional consultations conducted in regions where saturation had not been reached.

The issue identification process employed a structured three-step analytical procedure. In the first step, raw qualitative data from each regional consultation were coded inductively to identify themes; in the second step, themes were clustered across regions to identify issues that recurred consistently; in the third step, issues were mapped against three pre-defined analytical domains (health literacy, healthcare access and quality, and systemic policy deficiency) derived from the theoretical framework. This structured procedure ensured that the resulting issue identification framework, which informed the Phase 2 questionnaire domains and Phase 3 application design, reflected the full range of regional stakeholder perspectives rather than any single constituency's priorities. Issues that were reported in five or more of the seven regions were classified as nationally prevalent; issues reported in two to four regions were classified as contextually specific but policy-relevant.

Phase 2: Needs assessment

A cross-sectional survey design with cluster sampling was used. Clusters were defined by the seven geographic regions; within each cluster, participants were recruited through deaf associations, healthcare facilities, educational institutions, and disability organisations, ensuring diverse representation by age, gender, education, and degree of hearing loss. The sample size of 421 was determined by power analysis to achieve sufficient statistical power for the planned analyses.

The structured needs-assessment questionnaire covered six domains: demographic characteristics; healthcare access and utilisation patterns (convenience, communication barriers, satisfaction); perceived needs for healthcare-centre improvements and digital innovation; digital technology access and usage (smartphone ownership, internet access, application familiarity, willingness to adopt digital health tools); urgent-care response times; and hospital care effectiveness (clinical outcomes, patient safety, patient experience). The questionnaire was developed from Phase 1 findings and an extensive review of existing needs-assessment tools. Content validity was established by specialist review in audiology, public health, special education, and disability policy (IOC = 0.8); internal consistency was acceptable (Cronbach's $\alpha = 0.92$). The questionnaire was administered in both written Thai and Thai Sign Language video format, supported throughout by trained research assistants and sign-language interpreters.

Data were analysed using the modified Priority Needs Index ($PNI_{modified}$) (Benge et al., 2019), computed as: $PNI_{modified} = (I - D) / D$, where I is the importance/expectation score (desired state) and D is the degree of success/actual score (current state). Negative PNI values indicate that the current state falls below the desired state; larger negative values denote higher-priority needs.

Phase 3: Policy research framework

Phase 3 adopted a distributive public policy research framework and comprised three components: a 14-day mobile-application intervention, policy-validation focus group discussions, and a reporting and advocacy process.

For the intervention component, 453 people with hearing loss recruited across all seven regions participated in a 14-day workshop during which they used the MU-silentcare application in their daily healthcare interactions. The workshop included structured orientation sessions, daily usage logs, and periodic check-ins. Participants received training on application features and standardised medical sign language; research assistants and sign-language interpreters provided support throughout. Health literacy was

assessed before and after the workshop across five dimensions: (1) understanding health information; (2) ability to communicate symptoms; (3) medical sign language knowledge; (4) awareness of health entitlements and rights; and (5) confidence in navigating healthcare services. The instrument was administered in Thai Sign Language video alongside written Thai. Pre–post differences were tested by paired-samples *t*-tests at $\alpha = 0.05$; Cohen's *d* was computed as the measure of effect size.

Following the workshop, 88 stakeholders, including persons with lived experience and professionals from educational, government, private, and healthcare sectors, participated in focus group discussions to evaluate intervention outcomes, identify barriers to scale-up, and generate consensus on priority policy actions. Qualitative data from these sessions were analysed by thematic coding. Quantitative and qualitative findings were then integrated through a convergent synthesis process to identify evidence-traceable distributive policy proposals.

To ensure methodological transparency, all phases were conducted in accordance with relevant reporting standards: Phase 1 qualitative data collection and analysis followed the Consolidated Criteria for Reporting Qualitative Research (COREQ); Phase 2 quantitative survey procedures followed the STROBE guidelines for cross-sectional studies; and Phase 3 intervention reporting followed the TREND guidelines for non-randomised behavioural and public health interventions. The integration of findings across phases followed a convergent synthesis approach in which quantitative priority rankings from Phase 2 and qualitative structural gap analysis from Phase 1 were mapped against the Phase 3 intervention outcomes to produce evidence-traceable policy proposals. All authors had full access to all data and take responsibility for the integrity of the data and the accuracy of the data analysis.

Ethical considerations

All protocols were approved by the Committee for Research Ethics (Social Sciences), Faculty of Social Sciences and Humanities, Mahidol University, Thailand. All participants provided informed consent before participation, delivered in Thai Sign Language video and written Thai to ensure accessibility. For participants under 18, written informed consent was obtained from a parent or legal guardian with assent from the minor. Participants could withdraw at any time without consequence.

Results

Phase 1: Stakeholder consultation findings

Healthcare ecosystem and key actors

Thematic analysis revealed a complex, fragmented healthcare ecosystem for people with hearing loss in Thailand comprising nine interconnected but insufficiently coordinated actor groups (Table 2). People with hearing loss are the primary service users, relying on sign language, mobile applications, or companions to navigate hospitals, pharmacies, and health information. Sign-language interpreters serve as the critical communication bridge but are severely limited in availability, particularly during emergencies, at night, and in rural areas. Healthcare providers deliver clinical services but often lack sign-language competency and disability-specific training, tending to assess symptoms from external observation rather than patient-reported information. Schools for the deaf function as de facto health-literacy hubs, coordinating student health access, vaccinations, and rights awareness. Parents, especially in rural areas, often lack awareness of their children's health entitlements and disability rights. Government agencies set policy and allocate resources but coordination with frontline units is inconsistent. Community health centres are key potential nodes for digital screening tools but often lack disability-awareness training. Digital health innovators and trusted deaf-community influencers on social media represent emerging but under-utilised channels for accessible health promotion.

Table 2
Key actors in the healthcare ecosystem for people with hearing loss in Thailand

Actor	Role in healthcare ecosystem
People with hearing loss	Primary service users; rely on sign language, mobile applications, or companions to navigate hospitals, pharmacies, and health information
Sign-language interpreters	Critical communication bridge; availability severely limited—especially during emergencies, at night, and in rural areas
Healthcare providers	Deliver clinical services but often lack sign-language competency; tend to assess symptoms from external observation rather than patient-reported information
Schools for the deaf	De facto health-literacy hubs; coordinate student health access, vaccinations, and rights awareness; intermediaries between families and hospitals
Parents and caregivers	Accompany patients; those in rural areas often lack awareness of children's health entitlements and disability rights
Government agencies	Set policy and allocate resources (vaccines, disability benefits); coordination with frontline units inconsistent
Community health centres	Provide primary care; key potential nodes for digital screening tools but often lack disability-awareness training
Digital health innovators	Develop applications to bridge communication gaps; facilitate symptom reporting, queue notification, and sign-language health content
Deaf community influencers	Trusted information channels on social media; effective vehicles for health promotion and application adoption campaigns

Table 2: *Key actors in the healthcare ecosystem for people with hearing loss in Thailand.*

Issue identification framework

Twelve issues were identified and organised into three interconnected domains (Table 3).

Table 3
Issue identification framework: health literacy, healthcare access, and systemic gaps

Domain	Key issues	Evidence from stakeholder data
Health literacy barriers	Limited medical vocabulary in sign language; low Thai reading proficiency; inadequate health education in sign language; poor awareness of health entitlements	Teachers reported incomplete sign-language health glossary; users unable to read app text; parents unaware of Tor.74 benefit; copyright barriers to educational media
Healthcare access and quality gaps	Communication failure at point of care; interpreter scarcity; inaccessible queue systems; pharmacy access difficulties	Patients received wrong medication; no interpreters at night or in emergencies; voice-only queue calls; patients purchase OTC medication at convenience stores to avoid pharmacy communication
Systemic and policy deficiencies	No mandatory accessibility standards; fragmented cross-sector coordination; no standardised medical sign language; hospital mobile-device restrictions	No regulation for visual communication tools; schools and hospitals not linked; fingerspelling versions unresolved; applications prohibited in clinical areas

Table 3: *Issue identification framework. Twelve specific issues were identified across three domains.*

Five concrete problem areas were identified from the structural gap analysis, corroborated across all regional consultations.

Communication failure at the point of care. Physicians lacking sign-language skills assess symptoms from external observation rather than patient-reported information, producing misdiagnoses and incorrect prescriptions. School administrators reported that even when students can identify their pain location, the inability to articulate it in Thai written language or to find appropriate medical terminology in sign language results in misdiagnosis and incorrect medication. Field notes documented cases where patients received medication that did not correspond to their actual symptoms because of miscommunication at the screening point.

Interpreter scarcity and reliance on informal support. Sign-language interpreters are unavailable in most healthcare settings, particularly in rural hospitals and during emergency situations. Participants described needing urgent medical care at night and being unable to communicate with staff who had no sign-language knowledge. The current system relies on family members, teachers, or companions as ad hoc interpreters, introducing communication errors and limiting patient autonomy. Participants noted that even with a mobile application, the interpreter remains essential in complex consultations, reflecting the depth of the structural dependency.

Inaccessible queue and navigation systems. Most hospitals, especially in rural provinces, use voice-based queue calls without visual displays. Patients with hearing loss frequently miss their turn, resulting in delayed treatment. Several participants reported purchasing medication at convenience stores rather than pharmacies to avoid the communication challenge of interacting with pharmacists, a strategy that introduces risks of incorrect self-medication and foregoes professional pharmaceutical counselling.

Inequitable resource distribution. School administrators reported that while basic health entitlements exist on paper, resource allocation, particularly for vaccinations, does not adequately reach schools for the deaf when supplies are limited. Parents, especially those in rural provinces whose children board at Bangkok schools, often lack awareness of their children's health entitlements, including the Tor.74 disability benefit for free medical treatment. This information gap perpetuates chronic under-utilisation of available services.

Hospital policies restricting mobile-device use. Policies prohibiting mobile phones, video recording, and video calls in clinical areas directly conflict with the communication needs of deaf patients, preventing use of assistive applications, video relay interpreting services, and pre-prepared symptom descriptions. No exception policies exist for patients with communication disabilities, a barrier that is entirely policy-constructed rather than resource-constrained.

Cross-sector collaboration needs

A consistent theme across all discussion sessions was the urgent need for coordinated multi-sector collaboration. Stakeholders envisioned an integrated network linking schools for the deaf, hospitals, community health centres, pharmacies, and government agencies through a standardised communication framework and shared digital tools. Specific proposals included: a designated screening point at all hospitals for patients with hearing loss; basic sign-language training for frontline healthcare staff; a standardised medical sign language vocabulary endorsed by a national authority; a disability status card or digital profile that patients can present to expedite service; and a referral network through which schools can share baseline student health data with hospitals prior to consultations. Without such a network, service delivery remains fragmented, each facility operates independently, producing inconsistent outcomes largely dependent on whether an interpreter or a supportive staff member happens to be available on any given day.

Phase 2: Needs assessment findings

Participant characteristics

Of the 421 participants, 62.0% were female, 35.3% male, and 2.7% identified as a gender minority. The largest age group was 20–29 years (38.0%), followed by 30–39 years (22.0%) and 10–19 years (18.0%); adults aged 40–49 and 50–59 each accounted for 5.5%, and those aged 60 and above for 11.0%. Students comprised the largest occupational group (31.0%), followed by the self-employed (19.0%) and general hired labour (15.0%). The most common hospital-visit frequency was once per month, confirming regular interaction with healthcare facilities.

Priority needs index results

The issue identification framework (Table 3) synthesises the twelve issues into three domains that are structurally interlinked. Health literacy barriers are upstream constraints that prevent people with hearing loss from effectively navigating the healthcare system even when they have physical access. Healthcare access and quality gaps describe how the health system itself is constructed in ways that exclude people with hearing loss, not through explicit discrimination, but through design choices that default to spoken or written Thai communication. Systemic policy deficiencies describe the absence of mandates, standards, and coordination mechanisms that would otherwise compel the health system to accommodate different communication needs. The twelve issues are not independent problems requiring twelve separate solutions; they form a system that must be addressed through an integrated policy framework.

Across the three health literacy barrier issues, a common thread emerged: the health system produces health information exclusively in formats that are inaccessible to sign-language users. Medical terminology in Thai Sign Language is incomplete and unstandardised; written Thai information assumes a reading proficiency that many people with hearing loss do not have; health education in schools for the deaf is constrained by copyright restrictions and the absence of professionally produced sign-language health content; and health entitlements are unknown even to the staff who are supposed to deliver them. These are not limitations of the individuals; they are limitations of the information systems in which those individuals operate.

Across the four healthcare access and quality gap issues, the central mechanism is communication failure, which produces cascading consequences: misdiagnosis, incorrect prescriptions, missed appointments, and avoidance of formal healthcare services. The severity of these consequences varies by setting—rural hospitals with no interpreters and voice-only queues pose greater risks than urban hospitals with some digital infrastructure, but the root cause is the same: the health system does not guarantee an accessible communication channel at any point of contact. The three systemic policy deficiency issues describe the structural absence of the mandates and mechanisms that would compel the system to provide such channels: no accessibility standard for hospitals, no coordination between sectors, no standardised vocabulary, and no exception for persons with disabilities from technology bans.

All five domains produced negative $PNI_{modified}$ values, confirming that the current state falls below the desired state across every dimension assessed (Table 4).

Table 4
Descriptive statistics and $PNI_{modified}$ by domain (n = 421)

Domain	Mean I	Mean D	SD I	SD D	PNI mod.	Rank
1. Healthcare access and utilisation	4.19	2.11	0.73	0.86	−0.50	1 (Highest)
2. Healthcare-centre improvements and digital innovation	4.29	2.37	0.32	0.50	−0.45	2
3. Digital technology access and usage	4.18	2.54	0.99	0.71	−0.39	3 (tied)
4. Urgent care response times	4.67	2.86	0.57	0.99	−0.39	3 (tied)
5. Hospital care effectiveness	4.11	2.53	0.87	0.64	−0.38	5

Table 4: *I = importance/expectation; D = degree of success/actual. Scale: 1–5.* $PNI_{modified}$ *= (I − D) / D. All values are negative, indicating the current state falls below the desired state across all domains.*

Domain-by-domain analysis revealed three key patterns. Healthcare access and utilisation (Domain 1, PNI = − 0.50) emerged as the highest-priority need; participants rated the importance of accessible healthcare at 4.19 out of 5 while the current reality was rated at only 2.11, a gap of 2.08 points. Communication barriers, lack of sign-language interpretation, and difficulty navigating hospital systems were identified as the primary contributors, directly corroborating Phase 1 findings. Healthcare-centre improvements and digital innovation (Domain 2, PNI = − 0.45) ranked second; this domain had the smallest standard deviations for both the desired state (SD = 0.32) and the current state (SD = 0.50), indicating exceptionally strong consensus that digital health innovation is both highly desired and consistently absent.

Urgent care response times (Domain 4) received the highest importance rating of all five domains (I = 4.67), reflecting the critical nature of timely emergency response for patients who cannot communicate verbally. The current-state score (D = 2.86) was the highest of all domains, suggesting urgent care is somewhat more functional than other aspects, but the high standard deviation (SD D = 0.99) indicates considerable urban–rural variability in emergency service availability. Digital technology access and usage (Domain 3, PNI = − 0.39) had the second-highest current-state score (D = 2.54), indicating that some level of digital access exists; the gap is therefore produced not by device absence but by policy barriers and infrastructure limitations that prevent meaningful use. Hospital care effectiveness (Domain 5, PNI = − 0.38) ranked lowest in terms of priority gap, suggesting that while clinical treatment is perceived as somewhat adequate once communication occurs, upstream access barriers reduce the quality of clinical encounters before treatment begins.

Phase 3: Intervention effectiveness and policy synthesis

Pre–post health literacy outcomes

Paired-samples *t*-tests revealed statistically significant improvements from pre-test to post-test across all five health-literacy dimensions ($p < 0.001$ for all comparisons; Table 5). Overall health literacy increased from $M = 2.00$ (SD = 0.79) to $M = 3.79$ (SD = 0.64), $t(452) = -30.42$, $p < 0.001$, $d = 2.49$, a very large effect. The mean improvement of 1.79 points on a 5-point scale represents a substantial shift from below-average to above-average health literacy after a 14-day intervention. All Cohen's *d* values exceeded the conventional large-effect threshold of 0.80.

Table 5
Paired-samples *t*-test results: pre- and post-test health literacy scores (N = 453)

Dimension	Pre-test M (SD)	Post-test M (SD)	t	p	Cohen's d
1. Understanding health information	2.18 (0.84)	3.87 (0.71)	−24.61	< 0.001	2.17
2. Communicating symptoms	1.94 (0.91)	3.92 (0.68)	−28.35	< 0.001	2.47
3. Medical sign language knowledge	1.76 (0.89)	3.64 (0.77)	−26.78	< 0.001	2.26
4. Health entitlements awareness	2.03 (0.96)	3.71 (0.74)	−22.87	< 0.001	1.96
5. Navigating health services	2.11 (0.87)	3.79 (0.69)	−25.14	< 0.001	2.14
Overall health literacy	**2.00 (0.79)**	**3.79 (0.64)**	**−30.42**	**< 0.001**	**2.49**

Table 5: *Scale: 1–5. df = 452 for all comparisons. All p values < 0.001.*

The largest gain was in symptom communication (Dimension 2, $d = 2.47$), where pre-test scores ($M = 1.94$) were the second lowest of all dimensions and post-test scores rose to the highest post-test mean ($M = 3.92$). The visual body-map and pain-scale tools enabled participants to communicate symptoms effectively without reliance on written Thai or interpreters, directly addressing the highest-priority Phase 2 domain (healthcare access, PNI = − 0.50). Medical sign language knowledge (Dimension 3, $d = 2.26$) began at the lowest pre-test mean of all dimensions ($M = 1.76$), reflecting the Phase 1 finding that standardised medical sign language is largely absent in Thailand, and increased substantially after the 14-day vocabulary-embedded intervention. Understanding health information (Dimension 1, $d = 2.17$) and navigating health services (Dimension 5, $d = 2.14$) both showed very large effects, indicating that participants became substantially more confident in accessing and interpreting health information and in independently navigating hospital registration, queue management, and wayfinding. Health entitlements awareness (Dimension 4, $d = 1.96$) produced the smallest effect, still very large, suggesting that sustained educational support beyond a 14-day intervention may be needed to fully close the entitlements awareness gap, consistent with the Phase 1 finding that even healthcare staff are unaware of these rights.

The pattern of gains across the five dimensions is theoretically coherent. Dimensions 2 and 3, symptom communication and medical sign language knowledge, showed the largest effects because the MU-silentcare application was specifically designed to address these deficits: the body-map tool bypassed the need for written Thai symptom description, and the sign language glossary directly taught the vocabulary that was absent. These two dimensions also correspond precisely to the highest-priority needs identified in Phase 2 (healthcare access, PNI = − 0.50) and the most significant structural gap identified in Phase 1 (absence of standardised medical sign language). The convergence of the three phases on these two dimensions provides unusually strong, multi-method evidence that symptom communication and medical sign language knowledge are the most tractable entry points for improving health literacy among people with hearing loss in Thailand.

Dimensions 1 (understanding health information, $d = 2.17$) and 5 (navigating health services, $d = 2.14$) produced large effects primarily through the application's health-information content in Thai Sign Language, its appointment-management features, and its QR-code wayfinding tools, features that address the broader information-literacy and navigation deficits identified in the Phase 1 health literacy barriers domain. The fact that Dimension 4 (health entitlements awareness) showed the smallest effect ($d = 1.96$)—still very large—but did not reach the same magnitude as the other dimensions is interpretable: the Tor.74 entitlement and related disability-rights information require sustained educational engagement, institutional coordination, and staff-level awareness that a 14-day mobile application intervention can begin to address but cannot fully resolve. This finding is directly informative for policy design: Policy 4 (cross-sector cooperation network) and Policy 5 (equitable resource allocation) are not substitutable by technology and must be pursued through institutional mechanisms.

The pattern of gains across the five dimensions is theoretically coherent and directly connected to the evidence gathered in Phases 1 and 2. Dimensions 2 (symptom communication) and 3 (medical sign language knowledge) showed the largest effects because the MU-silentcare application was specifically designed to address these two deficits: the body-map tool bypassed the need for written Thai symptom description, and the sign language glossary directly taught the vocabulary that was absent. These two dimensions also correspond precisely to the highest-priority need identified in Phase 2 (healthcare access, PNI = − 0.50) and the most significant structural gap identified in Phase 1 (absence of standardised medical sign language). The convergence of three independent phases on the same two dimensions provides unusually strong, multi-method evidence that symptom communication and medical sign language knowledge are the most tractable and impactful entry points for improving health literacy among people with hearing loss in Thailand.

Dimensions 1 (understanding health information, d = 2.17) and 5 (navigating health services, d = 2.14) produced large effects primarily through the application's health-information content in Thai Sign Language, its appointment-management features, and its QR-code wayfinding tools, features that address the broader information-literacy and navigation deficits identified in the Phase 1 health literacy barriers domain. Dimension 4 (health entitlements awareness, d = 1.96) showed the smallest effect, still very large by conventional standards. This result is interpretable: the Tor.74 entitlement and related disability-rights content require sustained educational engagement, institutional coordination, and staff-level awareness that a 14-day mobile application intervention can begin to address but cannot fully resolve. This finding is directly informative for policy design: Policies 4 and 5 (cross-sector network and equitable resource allocation) address the institutional mechanisms that a technology intervention alone cannot supply, and must therefore be pursued in parallel through institutional channels.

Distributive policy proposals

Convergent evidence from all three phases yielded five distributive policy proposals, each traceable to specific qualitative and quantitative findings (Table 6).

Table 6
Five distributive policy proposals with evidence traceability

Policy	Core components	Evidence trace
1. Visual health-communication media standards	Zoned body map with Thai Sign Language and simple Thai labels; 0–10 colour-graded pain scale with level descriptions; medical sign language glossary with video; pain-level video sets; symptom-description guide for children and adolescents	Phase 1: incomplete sign-language health vocabulary; no national standard. Phase 2: smallest SDs in Domain 2 (strong consensus for innovation). Phase 3: largest gains in symptom communication (d = 2.47) and sign language knowledge (d = 2.26)
2. Mandatory deaf-friendly service points in health facilities	Touch-screen/app interfaces for symptom input at screening; flashing-light and vibration queue devices; basic medical vocabulary set and introductory sign language training for screening-point staff; disability-service information sheets; dedicated disability reimbursement channel; QR-code wayfinding	Phase 1: queue inaccessibility; Tor.74 unknown to staff. Phase 2: top-priority domain—Healthcare Access (PNI = − 0.50); highest importance rating for urgent care (I = 4.67)
3. Removal of restrictions on communication technology for persons with disabilities	Define scope of permitted use (communication applications, not photography of other patients); standardised permission procedures; officially recognise MU-silentcare or compliant applications as sanctioned screening-support tools; develop offline alternatives for no-internet settings	Phase 1: hospital bans on phones, recording, and video calls; no disability exception. Phase 2: digital technology (PNI = − 0.39)—devices are owned (D = 2.54, highest current-state score) but policy barriers prevent meaningful use
4. Cross-sector cooperation network for a unified standard	Joint working group: Ministry of Public Health, MSDHS, schools for the deaf, hospitals, pharmacies; unified service and documentation standard; rights guide via schools and application; sign-language video series on entitlements; provincial hospital–school vaccine coordination; school–hospital student information channels	Phase 1: fragmented coordination; rural parents unaware of entitlements; ecosystem analysis identified need for integrated network. Cross-cutting—underpins all five PNI domains
5. Equitable resource allocation for special-education institutions	Minimum allocation quotas for schools for the deaf when vaccines or resources are constrained; national registry of special-education institutions; direct school–hospital coordination for vaccines and urgent services; application channel for tracking entitlement use and resource allocation for students	Phase 1: schools for the deaf deprioritised in vaccine allocation; Tor.74 under-utilised. Phase 2: access inequity as highest-ranked gap (PNI = − 0.50)

Table 6: *Five distributive policy proposals with evidence traceability. MSDHS = Ministry of Social Development and Human Security.*

Each proposal can be enacted through ministerial regulation, inter-agency coordination, and budget reallocation under the existing Persons with Disabilities Empowerment Act, without requiring primary legislation. The five proposals are mutually reinforcing: visual media standards (Policy 1) create the content that mandatory service points (Policy 2) deploy; removing technology restrictions (Policy 3) enables the application that embeds those standards to be used clinically; the cross-sector network (Policy 4) ensures content and application reach patients, schools, and pharmacies; and equitable resource allocation (Policy 5) addresses the inequity in who receives health resources in the first place. The MU-silentcare application functions as the language and technological core across all five: its body-map and pain-scale tools establish a common symptom-communication language; its medical sign language glossary provides standardised vocabulary; its empirical effectiveness provides the evidence base for technology-use guidelines; and its central platform connects patients, physicians, pharmacists, and schools.

Discussion

This three-phase mixed-methods study produced three principal findings. Qualitative consultation with 138 stakeholders across all seven regions of Thailand identified twelve issues across health literacy barriers, healthcare access and service-quality gaps, and systemic policy deficiencies. Quantitative needs assessment with 421 people with hearing loss confirmed healthcare access (PNI = − 0.50) as the highest-priority need, followed by digital innovation (PNI = − 0.45). A 14-day field trial of the MU-silentcare application with 453 participants produced statistically significant improvements in health literacy across all five assessed dimensions, with the largest effects in symptom communication and medical sign language knowledge. These findings converged into five distributive policy proposals, each traceable to specific evidence from at least two phases.

The pre–post pattern is consistent with the view that health literacy among people with hearing loss is constrained more by the absence of standardised health vocabulary than by individual cognitive capacity. Participants did not lack the capacity to learn medical concepts; they lacked access to an accurate set of signs. This aligns with prior evidence that people with hearing loss make large gains in health-communication interventions when content is delivered in their first language (McKee et al., 2015; Piao et al., 2023), and supports the view that health literacy among sign-language users should be understood as a multilingual phenomenon shaped by system design rather than user deficit. Changing the language of the system produces gains that training the user alone cannot achieve.

Standard health literacy instruments validated in hearing populations are not designed to capture the multilingual nature of deaf health literacy. When a sign-language user cannot describe a symptom because the sign does not exist, the problem is invisible to a reading-level assessment tool. Future research and monitoring should include system-level indicators alongside individual-level measures: availability of sign-language content in patient-facing materials, presence of visual queue systems, trained staff at screening points, and policies permitting communication technology. The five-dimension health literacy instrument used in Phase 3 offers a starting point for this expanded assessment framework.

The integration of lived experience strengthened the legitimacy of every policy proposal. Each was defensible not only by quantitative priority indices but also by the testimony of those most affected, consistent with Article 4(3) of the UNCRPD (United Nations, 2006) and the growing evidence that participatory disability research produces more relevant policies. Several issues emerged in qualitative data that expert consultation alone would likely have missed: buying medication at convenience stores to avoid pharmacy communication, the impact of mobile-phone bans on deaf patients, and regional variation in fingerspelling. These findings reinforce the case for treating lived experience as standard methodology in disability-policy research, not as optional consultation.

The pattern of findings across all three phases has implications for how health literacy is measured and monitored in populations that use sign language. Standard health literacy instruments validated in hearing populations are not designed to capture the multilingual nature of deaf health literacy. When a sign-language user cannot describe a symptom because the sign does not exist, the problem is invisible to a reading-level assessment tool. Future policy-relevant research and routine monitoring should include system-level indicators alongside individual-level measures: availability of sign-language content in patient-facing materials, presence of visual queue systems, trained staff at screening points, and policies permitting communication technology. The five-dimension instrument used in Phase 3, administered in Thai Sign Language video, offers a starting point for an expanded assessment framework that is sensitive to the unique health literacy needs of this population.

The five policy proposals are mutually reinforcing and are most effective when implemented as a coordinated set rather than as isolated interventions. Visual media standards (Policy 1) create the content that mandatory service points (Policy 2) deploy; removing technology restrictions (Policy 3) enables the application that embeds those standards to be used clinically; the cross-sector network (Policy 4) ensures that standardised content and the application reach patients, schools, and pharmacies equitably; and equitable resource allocation (Policy 5) addresses who receives health resources in the first place. A single-policy intervention is likely insufficient; pilot hospitals that implement all five simultaneously will generate more informative evidence for national scale-up than those implementing any one policy in isolation. The sequencing proposed in the study—beginning with Policies 1 and 2, which have the strongest evidence base and can be implemented immediately at the hospital level, before moving to the more institutionally complex Policies 4 and 5, offers a practical roadmap for the Ministry of Public Health.

This study contributes three methodological advances to the global literature on disability and health policy research. First, it demonstrates a viable three-phase sequential design for translating qualitative issue identification and quantitative needs assessment into a tested policy framework within a single study, offering a replicable model for researchers in other low- and middle-income country contexts. Second, it provides a validated mixed-methods research instrument, combining the $PNI_{modified}$ formula with qualitative ecosystem mapping, that can prioritise intervention targets in populations with heterogeneous communication needs. Third, it operationalises Article 4(3) of the UNCRPD at the research level: people with lived experience did not merely validate findings but contributed to instrument development, ecosystem mapping, application design, focus group content, and policy proposal formulation. This degree of participatory integration is rare in clinical health literacy research, and its value is demonstrated by the policy-relevant issues that emerged exclusively from lived-experience consultations and would not have appeared in a standard epidemiological or health-services study.

The central inequality in Thai disability policy is the gap between rights as written and rights as experienced. The Persons with Disabilities Empowerment Act provides a strong rights-based legal foundation (Persons with Disabilities Empowerment Act, 2007), yet stakeholders reported that healthcare staff are commonly unaware of the rights disabled patients hold, that most hospitals lack visual queue systems or dedicated screening points, and that disability benefits are chronically under-utilised. This is not a minor administrative failure; it is a structural source of inequality that aspirational legal norms alone cannot close. The distributive policy framework proposed here is designed to close that gap by directing concrete resources, services, and standards to specific points of clinical contact.

The five policies are politically less contested than rights-based reforms and can be implemented through ministerial regulation, budget reallocation, and inter-agency coordination without primary legislation, making them feasible within a single policy cycle. Pilot implementation in two or three hospitals with structured outcome measurement would generate the evidence required for national scale-up. Practical first steps for the Ministry of Public Health include: issuing a guideline that adopts the standardised visual health-communication media as a national reference; establishing dedicated screening points for patients with hearing loss supported by basic sign-language training and visual queue systems; and authorising the use of mobile phones and communication applications by persons with hearing loss in clinical areas with clear privacy procedures.

This study extends the structural rethinking of health literacy by demonstrating that very large improvements can be achieved by redesigning the language of the system. It provides empirical evidence from a low- and middle-income country context and demonstrates how a distributive policy approach can be operationalised within a rights-based legal framework, offering a transferable model for other countries with comparable legal foundations.

Several limitations should be noted. The 14-day intervention duration was sufficient to detect very large effects but does not establish long-term retention; longitudinal follow-up is required. The over-representation of younger, digitally active participants may limit generalisability to older or less digitally literate subgroups. Policy proposals were derived from a single national context; transferability to other low- and middle-income country settings with different sign-language landscapes warrants further study. Real-world deployment will require infrastructure for ongoing technical support and content updates not present during the research-supported trial. Self-reported health-literacy scores, even when administered in Thai Sign Language video, may be susceptible to social-desirability bias in post-test conditions.

Conclusions

Looking ahead, the most important single action within the Thai health system is the issuance of a Ministry of Public Health guideline that: (1) adopts the standardised visual health-communication media (body map, pain scale, and medical sign language glossary embedded in the MU-silentcare application) as a national reference for deaf-friendly hospital screening points; (2) authorises the use of communication applications and mobile devices by persons with hearing loss in clinical areas, with clear privacy safeguards; and (3) establishes a national working group comprising the Ministry of Public Health, the Ministry of Social Development and Human Security, and the National Association of the Deaf to develop the cross-sector coordination framework within 18 months. These three actions fall entirely within existing ministerial authority and collectively lay the institutional foundation for the remaining policy proposals. Research priorities for the next phase include a longitudinal cohort study tracking health-literacy retention and healthcare-outcome changes among MU-silentcare users, a cost-effectiveness analysis of the five policy proposals for presentation to policymakers, and adaptation studies in other Southeast Asian countries that have sign-language legislation but incomplete medical sign-language standards.

People with hearing loss in Thailand face health literacy and healthcare access barriers produced by health-system design rather than by hearing status. A mixed-methods, multi-region study showed that these barriers can be identified through stakeholder consultation with lived experience, quantified through a national needs assessment, and substantially reduced through the MU-silentcare mobile application, which embeds a standardised medical sign language vocabulary. Five distributive policy proposals, visual health-communication media standards, mandatory deaf-friendly service points, removal of mobile-device restrictions, a cross-sector coordination network, and equitable resource allocation—are evidence-traceable, politically feasible, and implementable through ministerial regulation within the existing Persons with Disabilities Empowerment Act framework. The findings support a structural rethinking of health literacy as a multilingual phenomenon shaped by system design and offer a transferable model for translating disability-rights legislation into measurable distributive policy instruments in low- and middle-income settings.

The overarching lesson of this study is that the gap between rights as legislated and rights as experienced is not inevitable. It is produced by specific, identifiable system failures—the absence of a standardised sign-language medical vocabulary, the absence of visual queue systems, the absence of permitted communication technology, and the absence of coordinated information flows between the institutions that serve people with hearing loss. Each of these failures has a corresponding distributive policy solution. The solutions are evidence-based, costed through existing budget mechanisms, and feasible within a single policy cycle. What is now required is the political will to implement them and the institutional infrastructure to monitor their effects. The MU-silentcare application provides both the language tool and the data infrastructure for that monitoring. The path from rights to reach is clear.

Abbreviations

DEP
Department of Empowerment of Persons with Disabilities
FGD
focus group discussion
IOC
Item-Objective Congruence Index
LMIC
low- and middle-income country
mHealth
mobile health
MoPH
Ministry of Public Health
MSDHS
Ministry of Social Development and Human Security
MU-silentcare
Mahidol University SilentCare mobile application
OHCHR
Office of the United Nations High Commissioner for Human Rights
PNI
Priority Needs Index

$PNI_{modified}$
modified Priority Needs Index
PWHL
people with hearing loss
SD
standard deviation
UNCRPD
United Nations Convention on the Rights of Persons with Disabilities
WHO
World Health Organization.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. Ethics approval was obtained from the Committee for Research Ethics (Social Sciences), Faculty of Social Sciences and Humanities, Mahidol University, Thailand (Certificate of Approval No. 2025/070.0508.). Informed consent was obtained from all participants prior to their participation in the study.

Consent for publication

Not applicable. The manuscript does not contain individual identifying images, videos, or personal details requiring consent for publication.

Competing interests

The author declares no competing interests.

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Author Contribution

S.C. conceived and designed the study, supervised data collection across all three phases, conducted the analysis, drafted the manuscript, and approved the final version for submission.J.L drafted the manuscript and research fieldsM.K. and P.K. research fields and sign language interpreters

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Data Availability

The author confirms that all data generated or analysed during this study are included in this published article and can be shared on request.

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