

BMJ Open Living lab approaches in rural healthcare: a scoping review

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ABSTRACT

Objective Living labs represent a user-centric approach to solving real-world challenges by encouraging active participation of external stakeholders in co-designing the research and innovation process. Highlighted by contextual research and user co-creation, living labs are ideal for addressing the challenges of providing optimal healthcare to patients living in rural and remote regions. Our objective was to synthesise the existing research on the living lab approach in co-designing, developing or implementing a rural healthcare service, clinical intervention or health-related technology.

Design Scoping review.

Data sources A search was conducted on 10 May 2025, to identify articles from three electronic databases (MEDLINE, EMBASE and CINAHL).

Eligibility criteria We included published literature that presented a living lab approach to improve the provision of healthcare services in a rural environment. We excluded articles examining social determinants of health (eg, physical activity and general health promotion) without a direct link to clinical service innovation or healthcare delivery.

Data extraction and synthesis We collected data on study methodologies, settings, stakeholders and innovation types. Data extraction was performed by two independent reviewers using a standardised form. We used frequencies and a narrative synthesis to map characteristics, methods and contexts of living lab applications in rural healthcare.

Results The search identified a total of 1080 articles and ultimately included 11 articles. Studies were published between 2016 and 2025 and conducted in Canada (n=3), the USA (n=3), Australia (n=2), Guatemala (n=1), Uganda (n=1) and France/Portugal (n=1). Study settings included rural hospitals, regional health networks, Indigenous communities, farming and fishing communities and underserved rural regions. Health issues targeted included cardiovascular disease, diabetes, musculoskeletal conditions, perinatal care, palliative care and infectious disease management. Study methodologies included formalised, theory-driven frameworks (n=4), community-based participatory research (n=4), user- or human-centred design (n=3) and co-design workshops and interviews (n=3). Only one study explicitly used the term 'living lab' to describe their innovation.

Conclusions Relatively few living lab approaches have been meaningfully applied in rural health. There is a need for greater global diversification, expanded domains of focus and more robust evaluation to fully understand the potential and impact of living labs in rural healthcare.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study's strengths include adhering to the Joanna Briggs Institute methodology for scoping reviews and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews reporting guidelines, enhancing methodological transparency and reproducibility.
- ⇒ Another strength is that a broad, database-specific search was conducted across MEDLINE, EMBASE and CINAHL using tailored rural health and co-creation terms, ensuring wide coverage of relevant literature without date restrictions.
- ⇒ Inclusion criteria were refined to focus specifically on co-created innovations within healthcare service delivery, allowing for a more clinically relevant synthesis of living lab applications in rural settings.
- ⇒ A weakness of this study is that we did not include grey literature sources, which may have excluded relevant but unpublished living lab initiatives.

INTRODUCTION

Rural populations experience persistent health inequities stemming from geographical isolation, socioeconomic constraints and inadequate healthcare infrastructure.¹ These disparities manifest through multiple interconnected factors that compound healthcare delivery challenges in non-metropolitan areas. A fundamental barrier to rural health equity is healthcare workforce distribution. In the USA, less than 10% of physicians practise in rural areas despite rural populations comprising 20% of the nation.² Furthermore, rural public health agencies receive less funding per capita compared with their urban counterparts, constraining both technological capacity and human resource development.² Traditional healthcare delivery models developed for urban settings often prove inadequate when applied to rural contexts, highlighting the need for innovative approaches that account for the unique characteristics of rural healthcare environments by considering geographic constraints, resource limitations and community-specific health needs.



Living labs represent a methodological approach that has been conceptualised variably across scientific literature, yet the core definitional elements remain consistent.³ The European Network of Living Labs provides the most widely recognised definition, characterising living labs as ‘user-centred open innovation ecosystems’ that integrate research and innovation through co-creation processes within real-world environments.⁴ Operationally, living labs function as organisational frameworks or experimental spaces (virtual or physical) that convene diverse stakeholders, including researchers, industry partners, government entities and citizens to collaboratively design, test and implement solutions within authentic implementation contexts. This multistakeholder approach enables iterative development and refinement of innovations while ensuring relevance to end-user needs and environmental constraints.

Living labs have emerged as critical platforms for addressing rural health disparities by focusing on community-identified priorities.^{5 6} A living lab at the Baie Saint-Paul Hospital in Québec (Living Lab Charlevoix) exemplifies this approach by engaging rural stakeholders, including patients, providers and policymakers to co-design emergency care innovations such as telemedicine and workforce retention strategies.⁷ Similarly, the Digital Health Living Lab in Brighton, UK, partnered with older adults to co-create digital health services, demonstrating how rural populations can directly shape solutions targeting accessibility gaps.⁸ Contemporary healthcare literature demonstrates a paradigmatic shift towards person-centred care, co-design methodologies and community engagement frameworks, with particular relevance for rural healthcare delivery.⁹

Person-centred care, distinguished from traditional patient-centred models, prioritises collaborative care planning, enhanced health outcomes and improved patient satisfaction through active involvement of individuals, families and communities in healthcare decisions. This approach has gained recognition as essential for rural healthcare systems, particularly for workforce recruitment and retention, and for developing interventions that align with local community needs and resources.¹⁰ Evidence demonstrates that meaningful engagement of rural residents, caregivers and community stakeholders in healthcare design and delivery processes is fundamental to addressing distinctive rural health challenges and ensuring intervention relevance and sustainability.¹¹ Previous reviews have examined the living lab literature,¹² the use of living labs in healthcare^{5 6} and the role of community participation in rural health.¹³

Objective

The objective of this scoping review was to examine how living lab approaches have been used to co-design, develop or implement healthcare services, clinical interventions and health-related technologies in rural

and remote settings. Specifically, the review aimed to (1) describe how living lab methodologies have been applied in rural and remote healthcare settings, (2) identify the key actors, processes and types of innovations involved and (3) summarise reported outcomes, benefits and challenges associated with these initiatives.

METHODS

This scoping review was conducted in accordance with the methodological framework outlined by the Joanna Briggs Institute (JBI) for scoping reviews.¹⁴ The review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist to ensure methodological rigour and transparency.¹⁵

Information sources and search strategy

A comprehensive search strategy was developed in collaboration with an experienced health sciences librarian (online supplemental material 1). Searches were conducted in three databases: MEDLINE (Ovid), EMBASE (Elsevier) and CINAHL (EBSCO). No restrictions were placed on the language or date of publication when searching these three electronic databases. Search terms targeted two main concepts: (1) living labs and related methodologies (eg, co-creation and participatory design) and (2) rural or remote health contexts. In MEDLINE, we used search terms such as living lab* OR co-creat* OR cocreat* OR co-design* OR codesign* OR co-research* OR co-conception, combined with rural-specific terms (eg, rural* OR remote OR nonmetropolitan* adj3 health OR healthcare) and MeSH terms such as ‘Rural Health Services/’, ‘Rural Health/’ and ‘Hospitals, Rural/’. Similar strategies were applied in EMBASE and CINAHL, including text word searching and controlled vocabulary (eg, ‘rural health’ subject headings). Search results were uploaded into Covidence for deduplication and screening.

Study selection

All titles and abstracts retrieved from the search were screened independently and in duplicate by two reviewers using predefined eligibility criteria. Before commencing full screening, the reviewers conducted pilot exercises on a random sample of 50 citations to ensure consistent interpretation of inclusion and exclusion criteria. Agreement was assessed qualitatively during these calibration exercises, and discrepancies were discussed until a common understanding was reached.

Following calibration, each record was screened by two reviewers at both the title/abstract and full-text stages. Any disagreements regarding inclusion were resolved through discussion, and when consensus could not be reached, a third reviewer was consulted. The full texts of all potentially relevant articles were obtained and assessed using the same duplicate process.

Eligibility criteria

Included studies met all the following criteria:

- ▶ Involved active engagement of patients, providers or community members in the co-design, development or implementation of a healthcare service, clinical intervention or health-related technology. Engagement approaches may include co-creation, participatory design, co-design, real-world innovation testing or collaborative research.
- ▶ Described or implemented a structured, real-world environment (eg, Living Lab) intended to support inclusive innovation in a healthcare delivery or clinical setting, characterised by multistakeholder collaboration.
- ▶ Aimed to improve or redesign clinical care pathways, healthcare access, service integration, patient-provider interactions or health system delivery mechanisms.
- ▶ Conducted in a rural or remote health context.

We excluded articles with any of the criteria listed below:

- ▶ Focused primarily on social determinants of health (eg, physical activity and general health promotion) without a direct link to clinical service innovation or healthcare delivery.
- ▶ Involved only consultation or feedback after implementation, without engaging stakeholders in design or development stages.
- ▶ Described standard clinical care or interventions without applying any co-creation, participatory or innovation approaches.
- ▶ Not conducted in a rural health context or lacked relevance to rural healthcare systems.
- ▶ Did not pertain to human health.

Data extraction

A standardised data extraction form was developed collaboratively and piloted on a subset of included studies to ensure clarity, completeness and consistent interpretation among reviewers. The following data were extracted from included studies: title, date of publication and country; types of stakeholders involved; methods or approaches used (eg, co-design and participatory research); real-life setting or context (eg, hospital, clinic and community); and innovation type (eg, design, product, prototype, solution, concept, knowledge and service). Data extraction was performed by one reviewer and independently verified by a second reviewer for accuracy and completeness. Any discrepancies in extracted information were discussed and resolved by consensus. If disagreement persisted, a third reviewer adjudicated.

Synthesis

Extracted data were imported into Covidence to facilitate collaborative review, version control and transparent documentation of coding decisions. Within Covidence, frequency counts were generated to describe study characteristics, stakeholder types, methodological approaches

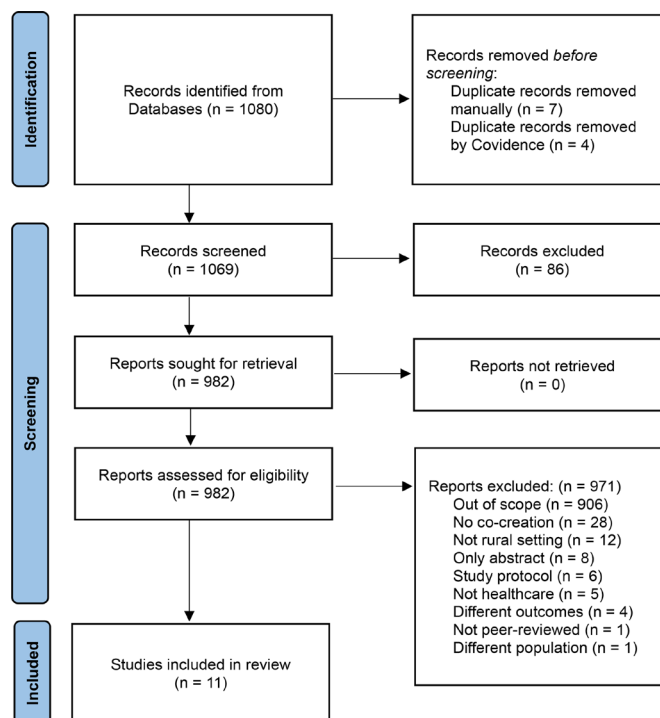


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart of included studies.

and innovation contexts. Data were then summarised descriptively and synthesised narratively to map the characteristics, methods and contexts of living lab applications in rural health. Themes were developed iteratively through team discussion to identify recurrent patterns across studies related to stakeholder involvement, innovation types and rural implementation contexts.

Patient and public involvement

Patients and members of the public were not involved in the design, conduct, reporting, or dissemination plans of this scoping review, which is based exclusively on previously published and publicly available literature.

RESULTS

Study characteristics and settings

A total of 11 studies were included in this review (figure 1). The characteristics of these studies are described in table 1. Studies were published between 2016 and 2025, and conducted across diverse rural and remote settings spanning 7 countries: Canada,^{7 16 17} the USA,^{18–20} Australia,^{21 22} Guatemala,²³ Uganda²⁴ and a cross-national collaboration between Portugal and France.²⁵ Study settings included rural hospitals, regional health networks, Indigenous communities, farming and fishing communities and underserved rural regions.

Most studies were situated within real-world healthcare or community health environments, reflecting the emphasis on contextually embedded innovation. Several studies were situated within rural hospitals or health networks, leveraging institutional infrastructure to

**Table 1** Characteristics of included studies (n=11)

Study (year), country	Health issue	Stakeholders involved	Methods	Real-life environment	Innovation
Dent <i>et al</i> ²¹ (2016), Australia	Musculoskeletal conditions	Academic and community stakeholders	Co-creating KT framework	Rural community of Port Lincoln, South Australia	Design; Solution; Service
Beleigoli <i>et al</i> ²² (2021), Australia	Cardiac rehabilitation	Patients, clinicians and health service managers	Co-design of health services and model for large-scale KT	Six local health networks in regional, rural and remote South Australia	Design; Solution; Service
Fleet ⁷ (2020), Canada	Healthcare provider quality of work life, local CT scanner, telemedicine	Academic and community stakeholders	Survey and mixed methods	Baie-Saint-Paul Hospital	Design; Solution; Concept; Service
Bernier <i>et al</i> ¹⁶ (2024), Canada	Cardiac rehabilitation	Healthcare professionals (nutritionists, nurses and kinesiologists), managers and patients	User-centred design	Rural Quebec	Design; Prototype; Solution
Silver <i>et al</i> ¹⁷ (2025), Canada	Indigenous-led perinatal cultural safety training programme	Perinatal nurses and physicians and community members	Fuzzy cognitive mapping and Joyce's Principle framework	Inuit and Cree Nation of Eeyou-Istchee communities	Design; Knowledge; Service
Hall-Clifford <i>et al</i> ²³ (2017), Guatemala	Childhood diarrhoeal treatment: oral rehydration therapy and zinc supplementation	Community health promoters	Co-design, community-based surveys, interviews and focus group discussions	Rural Mayan community	Design; Solution; Knowledge
Kern <i>et al</i> ²⁵ (2019), Portugal, France	Ageing well at home	Academic, technological, research network, associative and industrial sectors	Co-design	Rural communities	Design; Product; Solution
Wali <i>et al</i> ²⁴ (2023), Uganda	Heart failure	Community, patients, clinicians and village health teams	User-centred design and CBPR	Gulu Regional Referral Hospital and Lira Regional Referral Hospital	Design; Solution; Knowledge
Elk <i>et al</i> ¹⁸ (2020), USA	Palliative care	Community members, council members, church leaders and healthcare workers	CBPR	Beaufort Memorial Hospital (BMH) in Beaufort, SC	Design; Solution; Knowledge; Service
Oser <i>et al</i> ¹⁹ (2022), USA	Diabetes	Community Advisory Council and researchers	Boot camp translation approach to CBPR	Rural Colorado	Design; Product; Knowledge
Kim <i>et al</i> ²⁰ (2023), USA	Monitoring and care of diabetes and hypertension	Researchers, community co-designers (advisory group) including staff and providers, adult patients and community members	Co-design	California's Central Valley	Design; Product; Solution; Service

CBPR, community-based participatory research; KT, knowledge translation.;

co-design services with both providers and patients. For example, Fleet (2020) conducted their living lab initiative within Baie-Saint-Paul Hospital in rural Quebec, focusing on improving work life, diagnostic capacity and telemedicine use.⁷ Elk *et al* (2020) worked within Beaufort Memorial Hospital in South Carolina to co-develop a

culturally sensitive palliative care intervention in partnership with community leaders and providers.¹⁸ Similarly, Wali *et al* (2023) developed a heart failure management programme in two Ugandan regional referral hospitals through a process that blended user-centred design and community-based participatory research (CBPR).²⁴

Bernier *et al* (2024) and Beleigoli *et al* (2021) focused on regional and rural health networks for cardiac rehabilitation, engaging clinicians and patients across decentralised service delivery environments in Canada and Australia.^{16 22} These settings facilitated innovation in care pathways that spanned multiple rural sites.

Other studies were anchored in community settings, reflecting a more decentralised or grassroots model of living lab activity. Silver *et al* (2025) implemented their project within Inuit and Cree Nation communities in Canada's Eeyou Istchee region, situating cultural safety training in the lived realities of Indigenous perinatal care.¹⁷ Hall-Clifford *et al* (2017) engaged a rural Mayan community in Guatemala to co-design a childhood diarrhoea intervention, rooted in local knowledge and delivered through community health promoters.²³ Oser *et al* (2022) worked with a Community Advisory Council in rural Colorado to co-create diabetes education tools, using the *Boot Camp Translation (BCT)* model as a participatory mechanism.¹⁹ Kim *et al* (2023) engaged researchers, patients and clinic staff in California's Central Valley to design a digital monitoring solution for chronic disease management.²⁰ These community-based studies emphasised cultural grounding, accessibility and relevance, demonstrating the feasibility of co-creation even in settings with limited formal infrastructure.

Healthcare issues addressed

Across studies, there was significant variation in the health issues targeted, including cardiovascular disease,^{16 20 22 24} diabetes,^{19 20} musculoskeletal conditions,²¹ perinatal care,¹⁷ palliative care¹⁸ and infectious disease management.²³ While some studies focused on improving access to or delivery of specific clinical services (eg, cardiac rehabilitation and diabetes management), others explored the development of new models of care or technological supports to improve patient autonomy and provider experiences in rural contexts. Several studies focused on the development or adaptation of healthcare services to support the management of cardiovascular disease (CVD). For example, Beleigoli *et al* (2021) and Bernier *et al* (2024) co-designed cardiac rehabilitation programmes tailored to rural patients in Australia and Canada, respectively, aiming to improve access and adherence in settings where traditional rehabilitation services were underutilised or unavailable.^{16 22} Wali *et al* (2023) extended this focus by applying a user-centred design approach to improve heart failure management in rural Uganda, integrating both patient and provider perspectives into a context-specific care model.²⁴ Fleet (2020) examined system-level issues by applying a living lab approach within a rural Canadian hospital to improve healthcare provider well-being, telemedicine use and access to diagnostic imaging (CT scanner).⁷ This study was notable for linking workforce quality of life and rural infrastructure to innovation priorities.

Chronic disease management, particularly of diabetes and hypertension, was a focus in studies such as Kim *et al*

(2023) and Oser *et al* (2022).^{19 20} These studies emphasised the development of community-driven solutions to improve disease monitoring, education and culturally appropriate communication, using participatory methods to ensure alignment with rural patient needs and preferences. Maternal and perinatal health was the focus of Silver *et al* (2025), which described the co-design of a culturally safe perinatal training programme led by Indigenous communities in Canada.¹⁷ This initiative aimed to improve perinatal outcomes and address historical mistrust by embedding Indigenous values and priorities into care delivery models. Elk *et al* (2020) explored rural palliative care by applying a CBPR model to co-develop a palliative care intervention within a rural hospital in South Carolina.¹⁸ The study addressed a recognised service gap in rural end-of-life care, engaging local stakeholders, including church leaders and council members, in its development. Dent *et al* (2016) addressed musculoskeletal conditions using a co-creation framework to redesign service delivery for patients in a rural Australian community, emphasising better integration of primary care and self-management supports.²¹ Other studies addressed unique and underrepresented areas of rural health. Hall-Clifford *et al* (2017) focused on the treatment of childhood diarrhoeal disease in rural Guatemala, developing a community-informed intervention to improve uptake of oral rehydration therapy and zinc supplementation.²³ Finally, Kern *et al* (2019) addressed the challenge of ageing in place by co-designing a smart personal assistant device aimed at supporting autonomy and social connection among elderly individuals in rural European settings.²⁵

Stakeholder engagement

Stakeholder engagement was central to all included studies. Participants typically included patients, community members, healthcare providers, researchers and, in several cases, technology developers or health system managers. These groups were actively involved in co-designing interventions or services, consistent with the principles of living labs, though the terminology and structures varied across projects. Community members and patients were the most consistently engaged stakeholders across studies. Their roles ranged from advisory or consultative (eg, participating in focus groups or mapping exercises) to co-leadership in intervention design. For example, in Oser *et al* (2022) and Kim *et al* (2023), community advisory councils and local residents worked alongside researchers to shape the content and delivery of chronic disease interventions.^{19 20} In Hall-Clifford *et al* (2017) and Wali *et al* (2023), community health workers and village health teams played a central role not only in informing intervention design but also in supporting implementation within resource-constrained rural contexts.^{23 24}

Healthcare providers, including physicians, nurses, kinesiologists and other frontline workers, were key participants in studies focusing on health system redesign. In Fleet (2020), healthcare providers were both the focus



and active participants in the co-creation of workplace solutions to improve rural hospital work life.⁷ Beleigoli *et al* (2021) and Bernier *et al* (2024) similarly engaged clinical professionals in the co-design of cardiac rehabilitation services, ensuring clinical feasibility and alignment with rural service realities.^{16 22} Several studies emphasised Indigenous and cultural leadership. Silver *et al* (2025) engaged perinatal care providers and community members from Inuit and Cree Nation communities in the co-design of a cultural safety training programme.¹⁷ The project was grounded in Joyce's Principle and reflected an Indigenous-led approach to healthcare redesign. Similarly, Elk *et al* (2020) involved church leaders and local community members in co-developing a rural palliative care programme, reinforcing the importance of culturally grounded engagement strategies in underserved populations.¹⁸

Academic researchers were central actors in most studies, often serving as facilitators of the co-design process. Their role was typically to structure participatory processes, collect and synthesise data from stakeholder input and support the iterative refinement of solutions. In several cases, researchers worked in collaboration with technology developers or industrial partners, as seen in Kern *et al* (2019), where an interdisciplinary consortium supported the development of a smart personal assistant for elderly residents in rural communities.²⁵

Co-creation methodologies

The included studies employed a range of co-creation methodologies, reflecting both the flexibility of the living lab concept and the need to adapt participatory approaches to diverse rural contexts. These methods varied in terms of structure, theoretical grounding and level of stakeholder involvement, but all shared a commitment to iterative, user-informed development of health services or technologies. Four studies applied formalised, theory-driven frameworks to guide their co-creation processes. Dent *et al* (2016) used the *Co-Knowledge Translation (Co-KT) Framework* to translate evidence into practice for managing musculoskeletal conditions in a rural Australian community.²¹ Silver *et al* (2025) grounded their culturally safe perinatal training programme in *Joyce's Principle*, ensuring the intervention was led by and reflective of Indigenous values and priorities.¹⁷ Beleigoli *et al* (2021) used a *Model for Large Scale Knowledge Translation* to guide the redesign of cardiac rehabilitation services across six rural health networks in Australia.²² Finally, Oser *et al* (2022) employed BCT, a structured method of CBPR that supports communities in developing and adapting health messages.¹⁹ Other studies also used a CBPR approach: Elk *et al* (2020) engaged a broad spectrum of community stakeholders, including church leaders, council members and healthcare workers, in the development of a rural palliative care model¹⁸; Hall-Clifford *et al* (2017) used CBPR alongside qualitative methods to design a diarrhoeal disease intervention for children in rural Guatemala,²³ and Wali *et al* (2023) combined CBPR with

user-centred design principles to develop a heart failure management programme in Uganda.²⁴

Three studies explicitly described the use of user- or human-centred design to develop tailored health interventions. Wali *et al* (2023) integrated user-centred design methods with CBPR to co-develop a heart failure intervention in rural Ugandan hospitals.²⁴ Bernier *et al* (2024) applied user-centred design in a Canadian context to prototype a rural cardiac rehabilitation service in collaboration with patients and providers.¹⁶ Kern *et al* (2019) used human-centred design to co-develop a smart personal assistant device that would support ageing in place in rural European communities, integrating feedback from older adults, care providers and industrial partners.²⁵ Several studies used workshops, interviews and community engagement sessions as core co-design activities. Fleet (2020) engaged healthcare providers and local stakeholders through surveys and interviews to co-design workplace innovations in a rural Canadian hospital.⁷ Kim *et al* (2023) facilitated workshops and collaborative sessions with patients, providers and researchers in California's Central Valley to co-develop a digital intervention for diabetes and hypertension monitoring.²⁰ Silver *et al* (2025) employed collaborative mapping exercises (fuzzy cognitive mapping) alongside interviews to elicit community priorities and co-create culturally safe perinatal training content.¹⁷

Innovation types

The included studies co-created a diverse array of innovations tailored to rural health system needs, spanning service redesigns, digital tools, knowledge products and physical prototypes. These innovations reflect the multidimensional nature of living lab approaches, which emphasise user-driven development in real-world contexts. Most studies focused on the design or adaptation of healthcare services to better fit the realities of rural healthcare delivery. For example, Beleigoli *et al* (2021) and Bernier *et al* (2024) co-developed cardiac rehabilitation models that were feasible within regional and rural care structures in Australia and Canada, respectively.^{16 22} Fleet (2020) generated service-level changes within a rural Canadian hospital to improve healthcare provider work life, access to diagnostic imaging and telemedicine capacity.⁷ Kim *et al* (2023) and Oser *et al* (2022) developed interventions for diabetes and hypertension management that were embedded in local service environments and tailored to community priorities.^{19 20}

A subset of studies resulted in tangible products or digital health tools. Kern *et al* (2019) developed a smart personal assistant device, a voice-activated tool intended to support older adults in ageing well at home in rural European settings.²⁵ Kim *et al* (2023) co-designed a digital health monitoring tool with features responsive to patients' needs for managing chronic illness in a low-resource US setting,²⁰ while Oser *et al* (2022) adapted health messaging tools using BCT to ensure cultural relevance and usability in rural Colorado.¹⁹ These product

innovations were typically accompanied by implementation plans or evaluation strategies suited to their respective contexts. Only one study explicitly described the development of a prototype. Bernier *et al* (2024) produced a service prototype for a redesigned rural cardiac rehabilitation pathway, co-developed with patients and multidisciplinary providers.¹⁶

Knowledge products and conceptual frameworks

Several studies produced knowledge-based outputs or theoretical frameworks to guide future service design. Dent *et al* (2016) described the application of a Co-KT framework, which structured the translation of evidence into action in rural musculoskeletal care.²¹ Silver *et al* (2025) incorporated *Joyce's Principle* to embed Indigenous knowledge systems into perinatal care training.¹⁷ Elk *et al* (2020) and Hall-Clifford *et al* (2017) emphasised the development of culturally relevant communication and education materials co-produced with local stakeholders.^{18 23} These knowledge outputs were designed not only as end products but also as iterative tools to guide service delivery and future adaptations.

DISCUSSION

Principal findings

In all 11 included studies, co-creation methods were adapted to the capacities and preferences of rural communities and health systems. Several studies combined methods such as structured frameworks with CBPR, highlighting the flexibility and hybrid nature of living lab-informed design. Many studies produced hybrid innovations (eg, pairing knowledge development with service redesign), emphasising the value of co-creation in developing adaptable, context-specific health solutions. Another recurring feature was the blending of methodological approaches. Several studies combined structured frameworks (eg, Co-KT, *Joyce's Principle* and BCT) with participatory or user-centred design techniques. This hybridisation reflects a pragmatic orientation—adapting methods to suit the needs of rural settings while preserving methodological rigour and community leadership. Stakeholder engagement was characterised by iterative consultation, although the intensity and depth of engagement varied. Some projects used structured advisory councils, while others adopted more fluid, embedded engagement through workshops, mapping exercises or community governance structures. Importantly, most studies demonstrated efforts to move beyond tokenistic consultation towards sustained and contextually meaningful collaboration with rural residents and health actors. Taken together, the included studies reveal a wide spectrum of rural health challenges being addressed through co-creation.

Strengths and weaknesses of the study

The strengths of this study include its scoping review design using tailored rural health and co-creation terms

to identify published literature regarding the use of the living lab approach in the context of rural healthcare. Other strengths include adherence to the JBI methodology for scoping reviews and the PRISMA-ScR reporting guidelines, enhancing methodological transparency and reproducibility. In addition, our inclusion criteria focused specifically on co-created innovations within healthcare service delivery, allowing for a more clinically relevant synthesis of living lab applications in rural settings.

While this scoping review followed the JBI methodological framework and adhered to PRISMA reporting standards, several limitations should be acknowledged. The search was limited to three major databases (MEDLINE, EMBASE and CINAHL). Although these provide extensive coverage of biomedical and health services literature, the exclusion of databases such as Scopus and Web of Science, as well as grey literature sources, may have led to the omission of relevant unpublished studies. The current review did not assess methodological quality or risk of bias within included studies, consistent with JBI guidance for scoping reviews, which limits the ability to comment on the robustness of primary evidence. Given the small number of eligible studies (n=11) and their concentration in high-income countries, the transferability of findings to low- and middle-income rural contexts remains uncertain. Finally, narrative synthesis relies on qualitative interpretation of diverse study designs and contexts, which may introduce interpretive bias despite the use of consensus-based coding.

Important comparisons across included studies

Despite considerable variation in setting, health focus and stakeholder composition, several key patterns emerged across the included studies. Most notably, all studies demonstrated a strong commitment to co-creation in real-world rural contexts, aligning with living lab principles of stakeholder-driven, iterative innovation. Another pattern was the emphasis on adapting healthcare services to local realities, with co-created innovations focusing heavily on improving access, acceptability and quality of care in underserved settings. This was especially evident with service delivery innovations for chronic disease (eg, diabetes and cardiac rehabilitation) and culturally specific care (eg, Indigenous perinatal and palliative services). Most studies focused on collaborative knowledge production as a core innovation output. Even where digital tools or prototypes were developed, these were accompanied by conceptual models, training programmes or service frameworks that emphasised sustainability and contextual appropriateness. In contrast, the Living Lab Charlevoix described in Fleet (2020) represents, to our knowledge, the first rural hospital-embedded living lab model designed to address systemic service delivery challenges rather than focusing on a singular clinical pathology or technological innovation. Specifically, the Living Lab Charlevoix addresses the provision of care in environments with persistent human resource shortages, limited technological infrastructure and centralised governance



decisions that often result in service reductions or emergency department closures. This model operationalises an open innovation framework within a rural hospital setting, facilitating the co-creation of context-sensitive solutions by engaging citizens, healthcare professionals and policymakers in a continuous, participatory process of problem identification, ideation and implementation.

The meaning of the study

Overall, the findings of this scoping review suggest that while living lab approaches are being meaningfully applied in rural health, there is a need for greater global diversification, expanded domains of focus and more robust evaluation to fully understand their potential and impact. Addressing these gaps will strengthen the evidence base and support more widespread adoption of living lab methodologies to generate strategies and solutions for improving access to and provision of rural healthcare services.

Possible explanations and implications for clinicians and policymakers

Collectively, the studies in this review illustrate the flexibility of living lab and co-creation approaches to rural health innovation. Whether embedded in hospitals, community centres or multisectoral networks, all projects maintained a strong emphasis on real-life applicability, contextual tailoring and end-user involvement, consistent with the goals of sustainable and inclusive rural health system innovation. While chronic and cardiovascular conditions were most commonly targeted, the presence of maternal, paediatric, ageing and palliative care interventions suggests a broad and adaptable application of living lab principles across clinical domains.

Unanswered questions and future research

While the included studies highlight the potential of living lab approaches to advance rural health innovation, several important gaps were identified. Despite broad international interest in living labs, most included studies were concentrated in high-income countries, particularly Canada, the USA and Australia. Only one study was conducted in sub-Saharan Africa (Uganda),²⁴ and only one in Central America (Guatemala),²³ pointing to an underrepresentation of low- and middle-income rural contexts. Although several studies involved digital tools or smart devices, many co-created innovations were service-oriented or knowledge-based. There were relatively few examples of living labs being used to develop or scale technology-enabled solutions (eg, telehealth platforms and mobile health apps) tailored for rural use. Most studies focused on the design and initial implementation phases, with limited reporting on long-term outcomes, scalability or sustainability of the innovations. Further research is needed to assess whether these co-created solutions are sustained and integrated into rural health systems over time. While all studies aligned with living lab principles (eg, multistakeholder collaboration,

real-world testing and user-centred design), only Fleet (2020) explicitly used the term 'living lab' in their study. This suggests potential conceptual ambiguity and an opportunity to clarify what constitutes a living lab in rural health contexts.

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