

“It wasn’t just a robot”: Women’s and providers’ experiences with telerobotic ultrasound in rural prenatal care

Women's Health

Volume 22: 1–17

© The Author(s) 2026

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/17455057261494262

journals.sagepub.com/home/whe

Amal Khan, MD, MSc (CPHS), PhD^{1,2} , Reanna Prychak, MD cand^{2,3} ,
Brent Burbridge, MD, FRCPC², and Ivar Mendez, MD, PhD, FRCSC^{2,4}

Abstract

Background: Women living in rural and remote communities face longstanding barriers to accessing prenatal diagnostic care, including long travel distances, limited appointment availability, and delayed diagnostic evaluation. Telerobotic ultrasound may improve prenatal care by expanding access through imaging in local communities. However, little is known about women’s lived experiences with this technology and providers’ perspectives on cultural safety within prenatal care. **Objectives:** To explore women’s and providers’ experiences and perceptions of telerobotic ultrasound in prenatal care. **Design:** Qualitatively driven mixed-methods study. **Methods:** Postpartum women with experience using or declining telerobotic ultrasound, along with providers involved in service delivery in Gravelbourg and Saskatoon, participated in semi-structured remote interviews and were offered nine-point Likert-scale surveys. Discussion topics included decision-making, cultural and linguistic considerations, and integration of telerobotic imaging into rural care. Interviews were transcribed and analyzed using inductive coding, constant comparison, and framework-informed interpretation in NVivo 15. **Results:** A total of 40 participants took part in the study, including 19 patient participants and 21 provider participants, all of whom completed interviews. Survey findings, based on 7 sufficiently complete patient surveys and 10 provider surveys returned within the data-collection period, supplemented the qualitative findings. Participants reported improved access to prenatal care, particularly through reduced travel and local service availability. However, limited awareness, inconsistent communication, and gaps in knowledge were identified as key barriers to uptake. Participants also highlighted challenges related to cultural and linguistic accommodation and reliance on technological infrastructure. Cultural and linguistic aspects were often characterized by uncertainty, with many patients reporting neutral views on cultural sensitivity and language accessibility. Patients expressed mixed levels of trust and information sufficiency, while providers reported confidence in image quality and workflow integration but identified gaps in language accessibility and patient preparedness. **Conclusion:** Telerobotic ultrasound in prenatal diagnostic care was perceived as acceptable and potentially beneficial for improving access, but attention to cultural safety, communication, workflow alignment, and reliable technical support will be important when expanding service delivery.

¹Department of Community Health & Epidemiology, College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada

²Virtual Health Hub, Saskatoon, SK, Canada

³College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada

⁴Department of Surgery, College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada

Corresponding author:

Amal Khan, Department of Community Health & Epidemiology, College of Medicine, University of Saskatchewan, Box 7, Health Science Building, 107 Wiggins Road, Saskatoon S7N 5E5, SK, Canada.

Email: amal.khan@usask.ca



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Plain Language Summary

Access to prenatal ultrasound is important for monitoring a baby's growth and development, identifying possible health concerns, and supporting clinical decisions during pregnancy. However, women living in rural and remote communities across Canada continue to face challenges accessing prenatal ultrasound. Long travel distances, shortages of healthcare professionals, limited local diagnostic services, and difficult weather conditions can delay access to care. Travelling to larger centres can also create financial, logistical, and emotional burdens for women and their families. Telerobotic ultrasound offers an approach to improving access to prenatal imaging closer to home. With this technology, an ultrasound professional located elsewhere remotely guides an ultrasound probe operated by a trained local provider. This allows pregnant women to receive ultrasound imaging within their own communities rather than travelling long distances. Research has shown that telerobotic ultrasound can provide clinically useful images and support diagnostic assessment in communities with limited on-site expertise. Despite growing interest in this technology, less is known about how women experience telerobotic prenatal ultrasound and how trust, culture, language, and personal preferences influence its acceptability. Most previous research has focused on whether the technology works and whether it produces suitable images. However, women's experiences of prenatal care are also shaped by emotional, cultural, and relational factors. Understanding healthcare providers' experiences is similarly important, including how the technology fits into clinical workflows, training needs, and local care. This study examined patients' experiences and decision-making about telerobotic prenatal ultrasound, with particular attention to trust in technology, cultural considerations, language preferences, and emotional safety. It also examined healthcare providers' perspectives on feasibility, workflow, and culturally safe care. Together, these perspectives provide important information for developing prenatal telemedicine services that improve access while remaining practical, respectful, culturally safe, and responsive to the needs of women and families living in rural and remote communities across Canada.

Keywords

Women's health, Maternal health, Cultural safety, Telerobotic prenatal ultrasound, Remote ultrasound, Rural health, Patient experience, Access to care

Received: 17 May 2026; Revised: 9 September 2026; Accepted: 17 September 2026

Introduction

Timely access to prenatal ultrasound is essential for monitoring fetal development, identifying anomalies, and guiding clinical decision-making during pregnancy.¹ However, women living in rural and remote regions across Canada continue to face significant barriers to obtaining prenatal imaging due to geographic dispersion, healthcare human resource shortages, and limited diagnostic infrastructure.² These challenges disproportionately affect women living in rural and remote areas, where geographic isolation, limited availability of specialist services, and fragmented referral pathways can further delay access to prenatal diagnostic care.^{2,3} For many families, accessing prenatal ultrasound may require travel over long distances to regional centres, creating financial, logistical, and emotional burdens, particularly in rural areas where transportation options are limited, and weather conditions can affect travel safety.^{2,4}

Telerobotic ultrasound has emerged as a potential solution to improve access by allowing an urban sonographer to remotely guide an ultrasound probe operated by a trained local provider, enabling women to receive high-quality imaging in their own communities^{5,6} during pregnancy. Telerobotic ultrasound can provide clinically usable imaging and support diagnostic assessment in settings with limited on-site expertise.^{7,8} During the COVID-19 pandemic, telehealth use in prenatal care expanded rapidly, and studies reported generally favorable provider attitudes and moderate to high patient satisfaction, although preferences for in-person care often remained.^{9,10}

Despite growing interest, little is known about how women experience telerobotic prenatal ultrasound and how cultural values, language preferences, and trust influence its acceptability in rural and Indigenous contexts. Most existing research has focused on feasibility and diagnostic performance,^{11,12} while lived experience research remains scarce. Understanding these factors is essential, as women's prenatal care decisions are shaped not only by clinical needs but also by emotional, cultural, and relational dimensions.¹⁴ Providers' perspectives on workflow integration, training, and technical support have also been studied.⁶ However, the emotional and cultural safety of pregnant women offered this technology is equally critical for its sustainable implementation^{13,14} and remains underexplored.

This study aims to address the identified gaps by examining patients' decision-making, cultural and linguistic considerations, and trust in technology, alongside provider perspectives on feasibility and workflow in relation to cultural safety, to inform the development of culturally safe telemedicine prenatal care models.

Methods

Study design and setting

This qualitatively driven mixed-methods study was conducted at St. Joseph's Hospital/Foyer d'Youville in Gravelbourg, Saskatchewan,^{15,16} where telerobotic ultrasound was implemented to address limited local prenatal imaging capacity. The study was conducted between September 2025 and April 2026, inclusive. Formal participant recruitment, survey administration, and interviews were undertaken from September through December 2025. The timely conduct of the study was facilitated by our research team's ongoing community engagement and established partnerships with local healthcare providers through related telerobotic ultrasound projects in the same region. The telerobotic ultrasound service was delivered at St. Joseph's Hospital/Foyer d'Youville, Gravelbourg, in collaboration with remote specialists at the Telerobotic Ultrasound Centre of Excellence, Virtual Health Hub,¹⁹ Saskatoon. Both sites serve rural communities that experience substantial travel distances, limited diagnostic infrastructure, and longstanding barriers to accessing prenatal care. Gravelbourg is a rural community located approximately 300 km southwest of Saskatoon with a mixed anglophone and francophone population. St. Joseph's Hospital/Foyer d'Youville serves a number of small surrounding communities, some with Indigenous populations.

Eligible patient participants included postpartum women or pregnant individuals living in the Gravelbourg and surrounding area who had either used or declined telerobotic ultrasound for prenatal care within the preceding 36 months (2023–2025). Eligibility was defined to capture experiences from the period during which the telerobotic ultrasound service was available in the region. Purposive sampling was used to ensure variation across age, parity, cultural identity, proximity to care, and familiarity with technology. Provider participants included clinicians and telemedicine technical staff involved in the delivery, operation, or technical support of prenatal telerobotic ultrasound services during the same period (2023–2025).

The study followed Morse's dominant–less dominant mixed-methods model, in which qualitative inquiry guided the research direction and survey data provided only supplementary context.²⁰ The survey sample size was determined pragmatically by the number of eligible patients and providers available during the study period, reflecting the supplementary descriptive role of the quantitative component within the qualitatively driven mixed-methods design; therefore, no formal sample size calculation was undertaken. The study was grounded in pragmatism, emphasizing the production of useful, contextually relevant knowledge to inform real-world prenatal care delivery.²¹ This approach was selected to capture the complexity of women's experiences during pregnancy, including cultural and linguistic needs, as well as provider workflow considerations, as it relates to cultural safety and sustainable implementation of telerobotic ultrasound technology.

Ethics approval for this study was granted by the University of Saskatchewan Research Ethics Board (Behavioural Research Ethics Board; Protocol No. Beh-REB-5806) on 25 August 2025. All participants provided either written or verbal informed consent prior to participation. For participants providing verbal consent, consent was audio-recorded as part of the interview recording. Cultural safety principles, including respectful engagement, attention to linguistic preferences, and consideration of data confidentiality, were embedded throughout the research process. The reporting of this study conforms to the Consolidated Criteria for Reporting Qualitative Research (COREQ) statement.²²

Data collection

Participants were invited via email to complete a short survey followed by a one-to-one semi-structured interview conducted remotely by Zoom or a phone call. All 19 patient and 21 provider participants completed interviews and were offered the survey. Seven patient surveys contained sufficient completed responses for inclusion in the descriptive analysis; surveys with substantial item non-response were excluded because the extent of missing data precluded meaningful interpretation of response distributions. Among providers, competing clinical and operational responsibilities affected survey completion within the designated data-collection period, resulting in 10 completed surveys available for analysis. Interviews were conducted from September 2025 through December 2025 at the University of Saskatchewan's and Virtual Health Hub's offices. Surveys and interviews were conducted by undergraduate research assistants (R.P. and C.R.) under the supervision of the lead author (A.K.), a physician-scientist. The interviewers received training in qualitative interviewing and conducted the interviews using a semi-structured guide. The lead author has a research interest in rural health, virtual care, and implementation science, and remained mindful of the potential influence of the research team's professional backgrounds and perspectives throughout the study. This was addressed through reflexive practice, analytic memoing, and regular team discussions during data collection and interpretation.

Patient participants were recruited through clinic posters, word-of-mouth by local health teams, and community-based outreach. Provider participants were recruited through organizational emails and professional networks. Patient surveys and interviews explored: a) communication and information availability; b) decision-making factors and perceived changes in

access; c) perceptions, emotional comfort, and cultural accommodation. Provider surveys and interviews explored: a) adequacy of the technology, training, and access; b) workflow integration and communication between urban and rural sites; c) cultural and linguistic accommodation. Surveys used nine-point Likert-scale items adapted from previously validated telehealth evaluation and patient satisfaction measuring instruments.^{17,18} Interview guides were informed by Interpretive Description²⁵ to guide qualitative inquiry, while the He Pikinga Waiora²⁶ and the Consolidated Framework for Implementation Research (CFIR)¹⁵ frameworks helped structure questions related to cultural safety, implementation processes, and provider workflow.

Qualitative and thematic analysis

Interviews lasted 30–60 minutes, were audio-recorded, transcribed verbatim using the University of Saskatchewan-supported Zoom transcription and manually cleaned by a research team member (R.P). Field notes documenting contextual observations and initial reflections were recorded during and immediately after interviews to support subsequent data analysis. Formal data analysis followed a thematic analysis approach, using a hybrid deductive and inductive coding strategy. Deductive coding was informed by the He Pikinga Waiora Framework (cultural-centeredness, systems-thinking, community engagement) and CFIR (innovation characteristics, inner setting, outer setting, implementation processes).

Transcripts were read in full in several rounds. Initial codes were developed inductively from recurring patterns within participants' accounts and deductively from the He Pikinga Waiora and CFIR constructs. Emerging quotations and codes were mapped to framework components and organized into tables to facilitate comparison across transcripts, grouping into preliminary categories, and iterative refinement into themes through team discussion. The coding structure evolved iteratively from initial codes to preliminary categories and ultimately to the final themes through ongoing comparison, discussion, and refinement by the research team (R.P, C.R and A.K).

Braun and Clarke's Reflexive Thematic Analysis²⁷ guided the iterative development and refinement of themes. NVivo V15 (Lumivero, 2023)²⁸ was used for data management, coding, and theme refinement. Coding was undertaken collaboratively by two members of the research team, who jointly reviewed and coded the transcripts, discussed coding decisions throughout the analytic process, and reached consensus during theme development through regular team discussions. Themes were illustrated with verbatim quotations and reviewed and refined through researcher triangulation involving comparison of interpretations, analytic memoing, and team debriefings. Survey findings were summarized descriptively and integrated with the qualitative findings by comparing survey response patterns with the corresponding interview themes. The research team examined whether the interview findings supported or provided additional context for patterns observed in the survey responses, and the qualitative findings were then used to help explain and interpret the descriptive survey results.

Credibility was strengthened through comparison of interview and survey findings and ongoing researcher triangulation. Dependability was supported through detailed documentation of coding procedures. Reflexivity was maintained through analytic memoing and regular team discussions to acknowledge how researchers' perspectives and professional backgrounds could influence data interpretation, particularly in the context of rural maternal care. Consistent with Braun and Clarke's Reflexive Thematic Analysis, the analysis prioritized depth and richness of interpretation rather than formal assessment of thematic saturation. Accordingly, no predefined saturation criterion was applied; instead, data collection and analysis focused on generating rich, information-rich accounts that adequately addressed the study objectives.

Statistical analysis

Survey data available for analysis were analyzed descriptively using frequencies and percentages for each 9-point Likert-scale item. Given the supplementary role of the survey within this qualitatively driven mixed-methods study, no inferential statistical analyses were performed. Descriptive findings were presented graphically to complement the qualitative findings.

Results

Participant characteristics

19 patient participants took part in the interview sessions (Table 1). All were women residing in southern Saskatchewan, including Gravelbourg and surrounding communities, and had recently completed a pregnancy. All women had prior experience with conventional ultrasound and reflected on their prenatal imaging experiences either through the telerobotic program at St. Joseph's Hospital (Gravelbourg) or through conventional care. Ages ranged from 20 to 40 years. All participants reported fluency in English, with one identifying French as their first language. One participant identified South

Table 1. Patient Participants' characteristics.

Participant ID	Age (years) ^a	Home Community	Ultrasound Type
P1	35-40	Palmer	Telerobotic ^b
P2	29-34	Gravelbourg	Conventional
P3	25-35	Gravelbourg	Conventional
P4	29-34	Gravelbourg	Conventional
P5	28-35	Gravelbourg	Telerobotic
P6	20-25	Gravelbourg	Conventional
P7	25-30	Gravelbourg	Conventional
P8	25-30	Gravelbourg	Telerobotic
P9	20-25	Lafleche	Telerobotic
P10	28-35	Gravelbourg	Telerobotic
P11	28-35	Gravelbourg	Telerobotic
P12	25-30	Assiniboia	Telerobotic
P13	35-40	Lafleche	Telerobotic
P14	25-30	Gravelbourg	Telerobotic
P15	28-35	Gravelbourg	Telerobotic
P16	35-40	Assiniboia	Telerobotic
P17	29-34	Lafleche	Telerobotic
P18	35-40	Palmer	Telerobotic
P19	35-40	Gravelbourg	Telerobotic

^aEstimate.^bFirst Trimester only.

Africa as their country of origin; no other cultural identity details were collected or provided. Additional demographic information, including education, detailed ethnicity, Indigenous identity, socioeconomic characteristics, and previous telehealth experience, was not reported.

21 providers participated in the interview sessions (Table 2). Provider participants represented a range of clinical and non-clinical roles, including sonographers, family physicians, radiologists, public health and outpatient nurses, information technology personnel, support staff, and facility leadership based in Gravelbourg, Saskatoon, and Assiniboia. Clinical staff described their roles in recommending, ordering, or performing prenatal ultrasounds, while non-clinical staff discussed

Table 2. Provider participant characteristics.

Participant ID	Category	Role	Location
P1	Clinical	Family Physician	Assiniboia
P2	Technical	IT support	Saskatoon
P3	Technical	Administrative support	Gravelbourg
P4	Clinical	Outpatient Nurse	Gravelbourg
P5	Clinical	Public Health Nurse	Gravelbourg
P6	Clinical	Radiologist	Saskatoon
P7	Technical	Program manager	Saskatoon
P8	Technical	Operations manager	Saskatoon
P9	Clinical	Telerobotic sonographer	Saskatoon
P10	Clinical	Radiologist	Saskatoon
P11	Technical	Robotic technician	Saskatoon
P12	Clinical	Patient site assistant	Gravelbourg
P13	Clinical	Telerobotic sonographer	Saskatoon
P14	Clinical	Family Physician	Gravelbourg
P15	Non-technical	Remote Support staff	Saskatoon
P16	Non-technical	Onsite Support staff	Gravelbourg
P17	Clinical	Director of Client Services	Gravelbourg
P18	Technical	Operations Director	Gravelbourg
P19	Technical	Facility Director	Gravelbourg
P20	Clinical	Family Physician	Gravelbourg
P21	Non-technical	Remote Support staff	Saskatoon

workflow coordination, operational processes and considerations related to cultural and linguistic accommodation. Additional provider characteristics, including years of experience, previous telemedicine exposure, urban or rural practice setting, and clinical workload, were not collected or reported. A purposive sampling approach was used to ensure representation across diverse professional roles and levels of experience.

Patient Survey Findings

Survey responses from the 7 patient surveys with sufficient completed responses for descriptive analysis are summarized in Figure 1, with frequencies reported across a 9-point Likert scale. Overall, patients expressed the strongest agreement with questions related to improved access, more variable responses to questions concerning information availability and trust, and lower agreement for cultural and linguistic accessibility.

Perceived improvements in access received the strongest endorsement. All patient survey respondents agreed that conventional ultrasound required greater travel than telerobotic ultrasound, and many recognized the potential of telerobotic ultrasound to reduce barriers to prenatal care. In contrast, responses regarding the influence of transportation, appointment availability, and wait times on decision-making were more variable. Overall, these findings suggest that while the access benefits of telerobotic ultrasound were widely recognized, logistical factors did not consistently influence participants' decisions.

Responses related to information availability, awareness, and trust demonstrated greater variability. Patients differed in how well informed they felt when choosing between ultrasound services, whether sufficient information was available to support informed decision-making, and their awareness of the availability of telerobotic ultrasound. Similarly, responses related to trust showed no consistent pattern regarding the influence of trust on decision-making or preference for conventional over telerobotic ultrasound. Overall, these findings suggest variable awareness of the service and differing levels of confidence in the technology.

Lower agreement was observed for items related to cultural and linguistic accessibility. Most responses regarding the influence of cultural values, the cultural sensitivity of telerobotic ultrasound, and the likelihood of receiving care in a preferred language were neutral or indicated uncertainty. Overall, these findings suggest that while telerobotic ultrasound was perceived as improving logistical access, its cultural and linguistic dimensions remained less clearly defined from the patients' perspective.

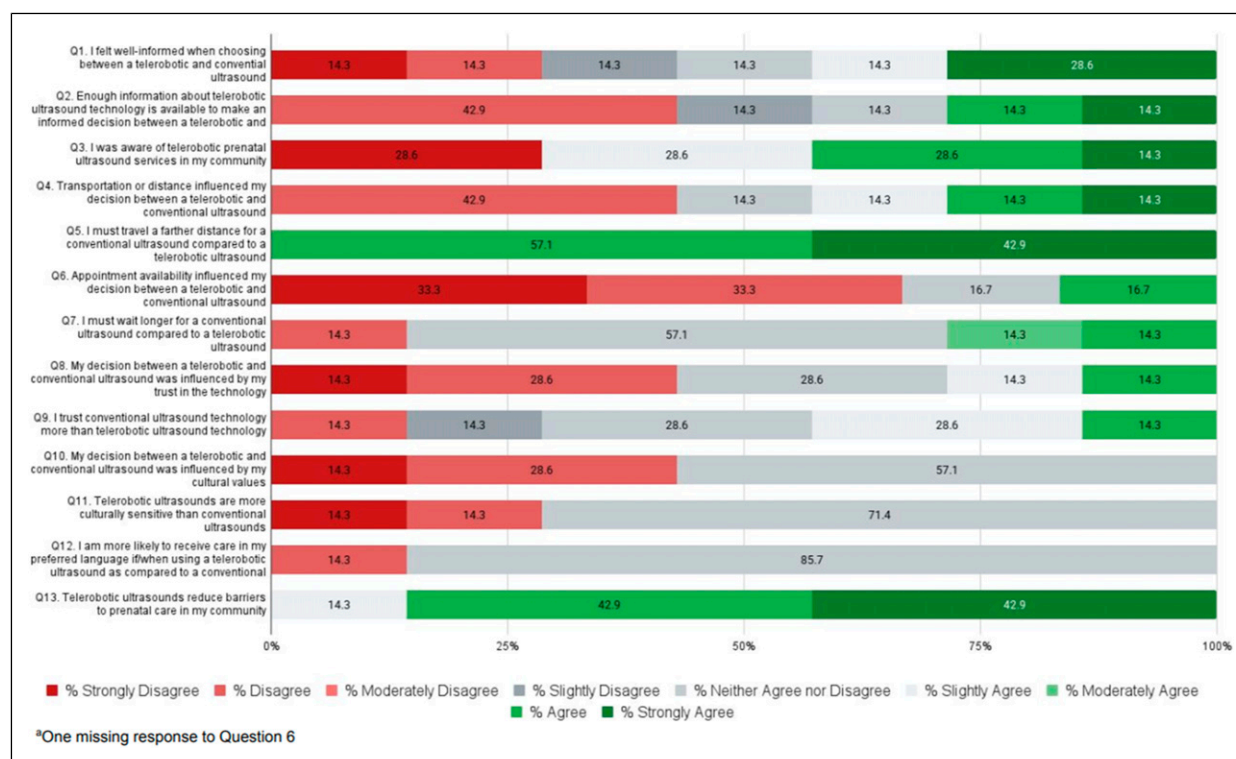


Figure 1. Patient survey results.

Patient Interview Themes

Full excerpts are provided in [Appendix A](#). Findings from the patient interviews provided additional context and depth to the survey results, illustrating how participants experienced prenatal imaging decisions in their daily lives. Overall, the themes that emerged from patient interviews largely reflected patterns observed in the patient survey, while also offering richer insight into how access, information, and trust shaped decision-making. Across the themes, interview findings helped explain the survey responses by illustrating how participants experienced the reported benefits of improved access alongside uncertainties related to information, trust, and cultural and linguistic accessibility.

Navigating Access and Travel Burden

Women described the substantial impact of travel on their prenatal care, emphasizing how distance, weather, childcare, and work-demands shaped their ability to attend appointments. These experiences complemented the survey findings, in which participants consistently identified improved access and reduced travel as the strongest perceived benefits of telerobotic ultrasound. Many participants felt that telerobotic services reduced logistical strain and offered a safer, more feasible alternative to long-distance travel, particularly during winter months or urgent clinical situations. These experiences underscored how travel demands shaped not only convenience, but also emotional stress and clinical decision-making as well. Patients frequently emphasized the convenience of local access:

Not having to travel, having two other small children and working, it was nicer to just be able to book into my local hospital. (P1)

Patients contrasted this with the burden of conventional care:

I had to travel, I had to drive a lot, many hours. Sometimes I was just travelling from Gravelbourg to Moose Jaw, and twice I had to do Gravelbourg to Regina. (P3)

I canceled a lot of times because of the weather... I wouldn't have had to do that had I chosen here in town, or had known about it, or got the option (P2)

One patient described how local access could have reduced anxiety during emergencies:

Twice I had emergencies... so I had to rush and go to Regina and Moose Jaw. If we had that option here, I think I would have used it, especially if it would have saved me time... I'm driving here and I'm worried. (P3)

Overall, patients viewed local access as a major facilitator of timely, consistent prenatal care. These reflections reinforce how telerobotic ultrasound may help address structural inequities in rural prenatal health access.

Limited Awareness and Barriers to Informed Decision-Making

A dominant theme was limited awareness of the telerobotic service, with many patients describing learning about it late, informally, or not at all during their prenatal care. This theme helped explain the variability observed in survey responses related to information availability, awareness, and trust. Patients consistently expressed a desire for clearer, earlier, and more proactive communication from trusted clinical sources to support informed decision-making. Their reflections suggested that limited awareness constrained uptake, even among those who would have preferred local care.

Several patient participants described learning about the service only through informal channels:

I heard through the grapevine about the telerobotic ultrasound... and then nothing really came of it for me. (P7)

I actually was never given the option to have any sort of telerobotic ultrasound. I only knew about it because of it being in the community and I heard about it from a friend. (P4)

Some participants also perceived that their providers had limited information about the service:

I just feel like the doctors didn't really mention it... they didn't really tell me. (P2)

I feel like there's not quite enough information... I think it's a really great idea—it's really nice to have it here in town. But I just don't know much about it, and I think the doctors don't know much. (P2)

Participants emphasized that information should be communicated through trusted clinical sources or accessible patient education materials:

People need to know about this... if you have your doctor telling you a little bit more about that, or their nurse practitioner. (P3)

Like, a pamphlet or something... on how it works, and what exactly it's doing. (P6)

These reflections underscore the importance of strengthening communication pathways and improving patient awareness to support informed decision-making.

Trust, Reassurance, and Emotional Safety

Patients described nuanced experiences related to trust, reassurance, and emotional comfort, with some participants expressing confidence in telerobotic ultrasound once they understood how it worked; others associated conventional scans with emotional connection, intimacy, and opportunities for in-person dialogue. These reflections illustrate how emotional safety and familiarity influenced patient preferences, even among participants who remained open to technological alternatives.

Some patients expressed greater familiarity with conventional scans:

That's what I've used for my other two kids... I just trust it a little more. (P2)

Others described the emotional significance of traditional ultrasound environments:

For me, it was a little more intimate with being pregnant and... you see the baby right close on the screen when you are in the office. They dimmed the lights and it was almost like it was romanticized. (P1)

You have so many questions, so... you could talk to somebody. (P3)

A common source of disappointment was the lack of printed photos during telerobotic scans:

With the conventional one, they give a little picture afterwards... with the telerobotic one, you don't get a little picture. (P5)

Despite these concerns, many patients expressed openness to using telerobotic care if offered the choice:

If I was given the option, I think I would have opted to at least try it, especially because of the distance (P6)

I definitely would have used it... if my doctor would have brought it up to me for sure. (P7)

These reflections highlight the importance of maintaining emotional connection, reassurance, and patient-centred communication when introducing new technologies. The findings also suggest that implementation strategies should consider relational aspects of care alongside technical functionality.

Linguistic and Cultural Resonance

While most participants did not identify cultural values or linguistic factors as primary drivers of decision-making, language accessibility emerged as meaningful for some. Direct discussion of cultural safety was limited within the interviews; therefore, the findings presented in this theme should be interpreted as exploratory observations rather than definitive conclusions. A Francophone patient described significant challenges accessing care in their preferred language, even when travelling to larger centres. They also suggested that the experience could be strengthened by offering language-inclusive interfaces or staff support:

I was not able to get any services in French, even if I had to do the travelling (P3)

They suggested that language-inclusive features could strengthen the experience:

Sometimes you have questions... and it's like, okay, I have to try to translate this, otherwise you don't understand. So, I think if we have the option of having a French person or the option of French on the machine, I think that would be a very good thing. (P3)

Patients also emphasized the comfort of receiving care in familiar settings:

I think it's just more comfortable being in your own community, potentially knowing the doctor, or you're more comfortable with the hospital care. (P6)

One participant described discomfort with visibility in small communities:

You're walking into the hospital, people see you, and they're wondering why are you there? So I think if it was in its own building... that would have made me more comfortable. (P2)

Collectively, these experiences emphasize the importance of culturally and linguistically responsive implementation strategies that honour community norms and reduce barriers to comfort, privacy, and understanding.

Community Suitability and Integration into Local Care

Patients viewed telerobotic ultrasound as a valuable addition to rural healthcare. Many participants felt the service addressed a clear community need, particularly in areas with growing young families or limited prenatal resources. Their reflections emphasized the importance of integrating telerobotic ultrasound within existing local care systems to strengthen continuity and reduce reliance on distant services.

Participants described how the service aligned with community demographics:

There is a higher population of elderly people, but there's also a good population of young families, and there's been a lot of pregnant women, so I think it would have been a great thing. (P4)

They also noted gaps in other local prenatal services:

Having more physiotherapists and things like that to help with things when you're pregnant would have been helpful as well. I just didn't do it because I couldn't spare going to the city any more than I already was. (P7)

Other than picking up my prescriptions at the pharmacy, I didn't really have any access to prenatal care in my community. (P7)

Several participants expressed hope that the service would return or expand:

I hope it comes back so I can use it for next time. (P7)

Overall, patients viewed telerobotic ultrasound as a promising, community-aligned innovation that could strengthen rural prenatal care delivery. These reflections reinforce the importance of community-informed implementation approaches and highlight the potential for telerobotic models to enhance local access, continuity of care, and system integration in rural settings.

Provider Survey Findings

Survey responses for the ten providers who completed the survey within the data-collection period are summarized in [Figure 2](#), with frequencies reported across a 9-point Likert scale. Overall, providers expressed moderate to strong agreement across most survey items, particularly those related to patient comfort, communication quality, and perceived improvement in access.

Items related to patient comfort, communication, and access received the strongest endorsement. Most providers perceived patients as comfortable during the procedure, expressed confidence in communication between patients and remote sonographers, and unanimously agreed that telerobotic ultrasound improves prenatal care accessibility for rural and remote communities.

Provider training and communication were also viewed positively. Most respondents felt staff received adequate training to support telerobotic ultrasound delivery and reported generally positive communication between technical and non-technical team members.

Items related to technical performance, including image quality, integration with existing information systems, ease of system use, and technical support, were generally rated favourably, although responses were more variable. While most providers expressed confidence in image quality and system integration, perceptions of technical support and ease of use were

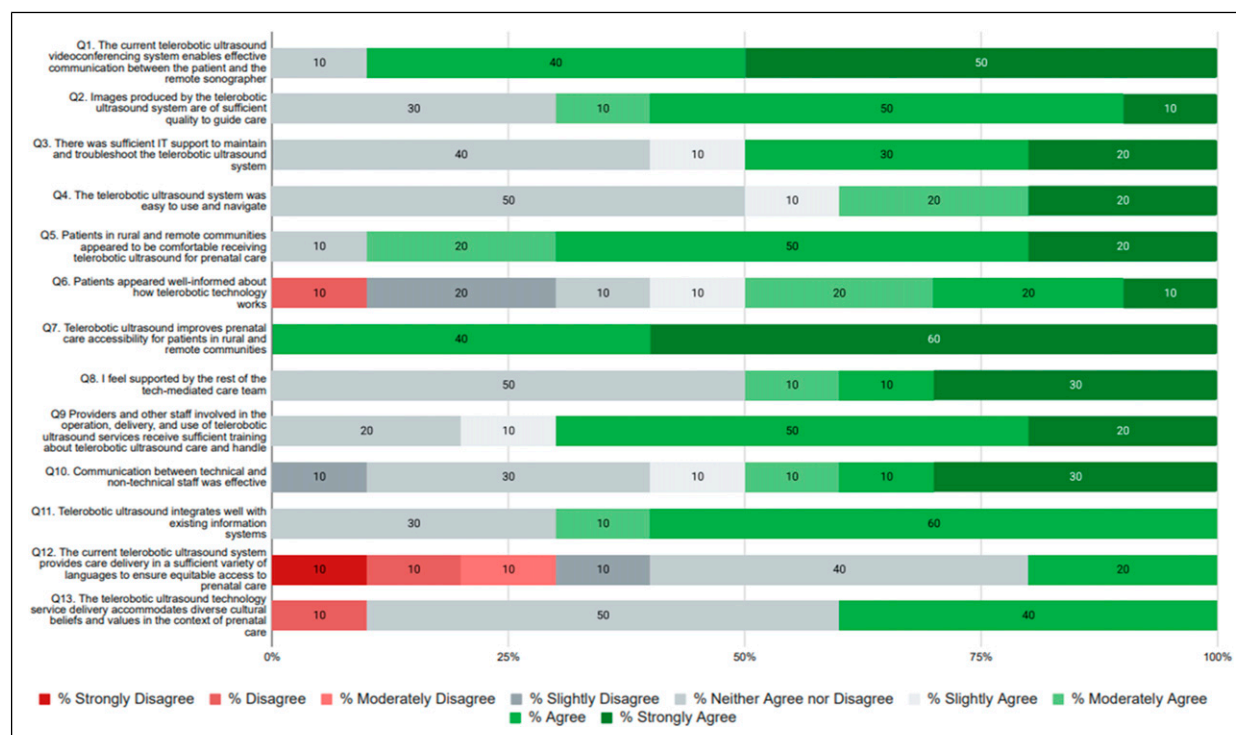


Figure 2. Provider survey results.

mixed, with several respondents selecting neutral responses, likely reflecting differences in direct involvement with the technology or IT support.

Lower agreement was observed for language accessibility, cultural responsiveness, and patient preparedness. Providers generally perceived language support as insufficient, whereas views regarding the technology's ability to accommodate diverse cultural beliefs and patients' understanding of the service were more variable. Overall, these findings suggest that although providers expressed strong confidence in the technology and its ability to improve access, opportunities remain to strengthen communication, language accessibility, and patient awareness.

Provider Interview Themes

Full excerpts are provided in [Appendix B](#). Themes emerging from provider interviews generally converged with the provider survey findings and provided additional context regarding workflow integration, communication, training, technological infrastructure, and implementation challenges.

Operational Coordination and System Efficacy

Providers described a wide range of experiences with operational coordination, noting that the telerobotic system ultimately aligned well with rural clinical workflows but required considerable effort to establish reliable routines. While providers felt the model fit their clinical environment, early implementation involved navigating scheduling constraints, limited clinic days, and unpredictable rural conditions such as power outages and severe weather, all of which influenced how the system functioned in practice.

Providers frequently emphasized how intuitive the system became once routines were established:

It was a very smooth and easy process... very easy to operate. (P1)

They also noted that the physical setup supported workflow integration:

The room was right next to public health, which is an area that prenatal moms are encouraged to access, so it was just a good fit. (P3)

At the same time, providers described challenges related to time-sensitive prenatal care and the need for clearer scheduling processes:

Time is important when you're dealing with ultrasound in prenatal... I need a clear schedule and confirmation that they will book my patient exactly when I want it to be done. (P10)

Early misunderstandings about service availability led to confusion:

It wasn't that we were on standby and ready to scan, 7 days a week. I don't know if all of the site staff was in the understanding that it was scheduled and designed to be an outpatient clinic where they couldn't just walk down the hall from the emergency department and bring us patients. (P1)

We couldn't offer a second trimester at our site during the research period, but I think that might have caused... some of the physicians not to be sending us all of their third trimester exams. (P1)

As workflows stabilized, providers reported strong appointment adherence and few missed visits. Overall, these experiences highlight the importance of clear communication, structured processes, and ongoing refinement to support long-term operational sustainability.

Provider Awareness and Professional Development

Providers identified varying levels of awareness among referring clinicians, particularly urban obstetricians, which influenced how frequently the service was utilized. Many providers felt that clearer communication about the system's capabilities, combined with more proactive outreach, would strengthen referral pathways and ensure that rural patients could fully benefit from local access to prenatal imaging.

Some providers felt that urban specialists were not fully aware of the service's potential or existence:

Some obstetricians "need to be a bit more aware of the quality of service that can be provided [because] at the end of the day, it's their decisions on where the requisitions get sent to. (P1)

A lot of ultrasound orders are done by obstetricians in Moose Jaw or Regina, and they're not realizing we have this capability here that could save this patient another trip. I asked if we could advertise it, even so patients locally know this is a possibility... but there were limitations on the advertising that is allowed. (P3)

Providers widely viewed telerobotic ultrasound as an important resource for supporting rural healthcare capacity and sustainability:

We could be running full time... the need is in the area... The doctors here... want to use it for acute measures and [outpatient department], but they can't... We would like to use it more. (P6)

Some providers also emphasized the importance of experience and role clarity within the clinical team:

My one reservation is bringing in a fresh, excited graduate... I don't feel they have the proper experience of doing ultrasound. (P5)

Some assistants "thought they could understand the ultrasound and would move the camera to where they thought it should be without our guidance." (P4)

Together, these reflections underscore the need for structured, competency-based training and sustained communication strategies as the model expands.

Community Engagement and Cultural Safety

Providers described a broad range of experiences related to community engagement and cultural safety, emphasizing how local staffing, familiarity, and cultural responsiveness shaped patient comfort. Providers felt the telerobotic model fit well with community expectations for care, while also identifying areas where language, communication, and cultural norms required additional support.

Providers frequently highlighted the value of local staffing in building trust:

In small town healthcare centres like ourselves, just having that familiarity with the people that are doing the care, is very, very accepted and very, very welcomed by those undergoing prenatal care. (P6)

One provider noted that the telerobotic model could enhance cultural safety by reducing physical contact:

In some cultures, people don't like to be touched... With the telerobotic ultrasound, I don't touch the patients at all. It's only the bracket and the probe. I think sometimes that could be a concept for cultural respect—appreciating somebody's personal space. (P1)

Language barriers were described as common, particularly among Francophone, newcomer, and Mennonite patients:

We have a French community, so we have a lot of people that only speak French. There is that cultural or language barrier here. Generally, we have to use apps, or Sask Health has a translator. But usually there's someone working in the facility that does speak the language. (P8)

A remote sonographer described assistants as “very, very good” at supporting communication, though some patients still struggled to understand instructions. Despite these challenges, providers consistently emphasized that receiving care in familiar settings supported dignity, comfort, and culturally safe care. These experiences reinforce the importance of culturally grounded, community-embedded implementation strategies.

Observed Patient Access, Convenience, and Care Experience

Providers consistently observed that the telerobotic service improved access to prenatal ultrasound for rural patients, particularly those facing transportation, weather, or financial barriers. These observations paralleled the provider survey findings, in which improving access to prenatal care received the strongest level of agreement. Providers felt that local availability reduced patient stress, supported more consistent prenatal care, and allowed patients to remain connected to their communities during pregnancy. These observations highlighted how the model addressed longstanding structural barriers to rural prenatal imaging.

Providers often described the relief patients felt when care was available locally:

It's such a relief to have this opportunity in a small town... This technology is very welcomed and I can't sing its praises high enough. (P6)

They also emphasized the clinical team's ability to help patients feel comfortable during the procedure:

The sonographer was always very polite [and] introduced themselves and explained what we were about to do before we started. (P1)

If somebody wasn't sure about the concept of the telerobotic ultrasound, I always offered to talk them through what it was beforehand and I always made an offer to them that if they wanted to come in the day before the clinic, I could show them the equipment, show them the space, to give them that opportunity to feel comfortable. (P1)

One provider explained how patients initially perceived the technology and its broader implications for rural healthcare:

A lot people, when they first heard it, they said 'Oh, that's kind of neat—It's kind of a gimmick.' But no, how it can be used and integrated into rural healthcare is probably one of the small, shining lights in our healthcare system. We live by a wing of prayer every day here, and I'm sure I'm not speaking just for our facility. (P6)

Providers noted that patients appreciated not having to arrange childcare, take a full day off work, or drive long distances:

The moms I know that we did have come through were quite happy with the exam. They were happy that it was close to home, they were happy that it was quick, and that it was painless. (P1)

A few patients were disappointed about non-clinical aspects of the experience, such as the inability to receive printed baby pictures, which providers felt could be addressed through clearer communication and expectation-setting. Providers observed meaningful improvements in comfort, dignity, and access, reinforcing the importance of patient-centred implementation as the model continues to evolve.

Technological Infrastructure and Program Sustainability

Providers described a mix of positive and challenging experiences with the technological infrastructure supporting telerobotic ultrasound. Providers felt the system was reliable under normal conditions but noted that even minor disruptions could significantly affect service continuity.

Providers consistently praised the responsiveness of IT support:

Fantastic. I wish that we had this kind of support everywhere. (P5)

One sonographer felt that device quality limited image resolution and requested improved hardware:

The ultrasound machine itself is... not top quality, like what I'm used to. The ultrasound machine itself is not as user-friendly... I would like to see a better ultrasound machine, in general, to work with, to get the diagnostic images that we need. (P5)

Weather-related outages and equipment malfunctions occasionally forced clinic cancellations:

If there is a storm, maybe the tower of the internet service will be damaged... so that's one problem that unfortunately, we cannot control. (P2)

Technical staff described the complexity of establishing and maintaining connectivity in remote communities:

I have to deal with three different groups... and program everything so that when [the vendor is] here, eHealth will be able to do their job. (P2)

But if we're talking about La Loche... they don't have an electrician there. If they need to install a simple Ethernet jack, it can take months. (P2)

Across sites, providers emphasized that long-term sustainability requires stable connectivity, ongoing technical investment, and improved on-site technical literacy. Despite these challenges, providers expressed strong optimism about the future of telerobotic care:

It is in its infancy... but it can grow, and it should grow, and it must grow... this is the way to go for healthcare, hands down. I have no doubts about that whatsoever. And that's across the board, and probably across the world, honestly. (P6)

Discussion

This qualitatively driven mixed-methods study sought to understand women's and providers' experiences with telerobotic prenatal ultrasound in rural and remote regions of Saskatchewan. We found that women clearly recognized the access benefits of telerobotic imaging, particularly reduced travel—yet their experiences revealed a more complex reality shaped by uncertainty around information, trust, and cultural and linguistic relevance. Providers similarly identified that while the model improves access, its sustainability depends on coordinated workflows, adequate training, and reliable technological support. Together, these findings suggest that telerobotic prenatal ultrasound is beneficial and feasible in rural communities, but also highlight important implementation challenges, including communication gaps, referral processes, technological limitations, and patient preferences for conventional ultrasound, that should be addressed to support broader implementation.

Women consistently described the burden of long-distance travel and weather-related cancellations associated with conventional ultrasound—a burden that extended beyond inconvenience to shape stress, safety, and continuity of care. Survey findings reinforced these experiences, as all patient survey respondents agreed that conventional ultrasound required more travel, and most agreed that telerobotic imaging reduced barriers to care significantly. Provider survey respondents uniformly endorsed the access benefits. However, not all patients felt fully informed about the technology or confident in its availability. Gaps in clinician awareness and communication emerged as barriers to appropriate and timely referrals and uptake, highlighting the importance of improving referral pathways, clinician awareness, and patient education to facilitate informed decision-making and equitable access.

Beyond these practical implementation considerations, the combined use of He Pikinga Waiora and CFIR provided a valuable interpretive lens, demonstrating that successful implementation depended not only on technological effectiveness but also on relational, cultural, and system-level factors. These findings further highlight that successful implementation requires healthcare innovations to be responsive to the social, cultural, and relational contexts in which care is delivered. The

study moves beyond existing literature by centring cultural and linguistic safety—dimensions largely underexplored in earlier evaluations that focused primarily on technical feasibility and diagnostic performance.^{6,11} Although many women did not describe cultural values as central to their decision-making, qualitative findings showed that receiving imaging within one's home community contributed to emotional safety, familiarity, and reduced stress. These subtle findings suggest that cultural safety may not always be articulated directly by participants but may instead be reflected through experiences of familiarity, local care, and emotional comfort. Given the limited direct discussion of cultural safety within the interviews, these observations should be interpreted cautiously. These findings align with broader evidence that patient-centred and accessible models of prenatal care can improve maternal satisfaction and reduce pregnancy-related stress.^{17,19}

Language emerged as an important consideration, with Francophone participants describing subtle but meaningful language barriers that reduced confidence in the modality, revealing how even small gaps in communication can shape feelings of inclusion, understanding, and trust. This finding highlights that linguistic accessibility remains a critical, yet often underestimated, determinant of equitable maternal care, even when basic translation supports are available. Language barriers can negatively affect patient understanding, safety, and trust in healthcare interactions, underscoring the importance of multilingual communication supports and culturally responsive care delivery.^{20,21}

Existing literature further documents the historical experiences of Indigenous women with disrespectful, culturally unsafe, and fragmented maternal healthcare systems.^{22,23} In this context, delivering imaging services within one's home community may contribute to greater familiarity and perceived comfort while potentially supporting trust in care; however, these broader implications warrant further investigation. Participants also expressed preferences for aspects of conventional ultrasound, including familiarity, opportunities for in-person interaction, and receiving printed ultrasound images, highlighting considerations that should inform future implementation. Overall, community-based and culturally safe care approaches have been associated with improved trust and engagement among Indigenous patients and may mitigate fear and mistrust linked to mainstream healthcare institutions.³⁴

Beyond access and cultural considerations, trust and emotional safety were central to the acceptability of prenatal care delivered through telerobotic ultrasound. Some women preferred conventional ultrasound due to familiarity and the perceived intimacy of in-person scans, while others were open to telerobotic care but lacked sufficient information to feel confident in the modality. These findings highlight that technological innovation alone does not determine acceptability; the emotional and relational dimensions of care play a central role in shaping whether new models are embraced or resisted. Similar barriers related to awareness and provider engagement have been documented in the implementation of telehealth programs, where clinician engagement, clear referral pathways, and dedicated resources significantly influence adoption and integration into routine practice.^{1,24} Proactive communication strategies, including clinician-facing materials that clearly outline capabilities, limitations, and referral processes, may therefore help address these gaps and support integration into routine prenatal care.

Provider perspectives further highlighted the operational complexity of implementing remote imaging services. Workflow redesign, reliable broadband connectivity, structured communication pathways, and competency-based training were viewed as essential enablers, consistent with telehealth implementation research.^{1,13} Even infrequent technical disruptions were reported to affect clinic flow, while limitations in scheduling processes and referral coordination also influenced implementation, emphasizing the importance of stable digital infrastructure, responsive technical support and well-defined operational pathways. Despite these challenges, providers expressed strong optimism about the role of telerobotic ultrasound in sustaining access to prenatal imaging in rural regions facing persistent workforce shortages. This optimism reflects confidence in the technology and its potential to support the delivery of prenatal imaging in underserved settings, although further evaluation is needed to understand its longer-term impact on models of care. Telemedicine research suggests that remote technologies can play an important role in maintaining service delivery in underserved and rural communities where specialist availability is limited.¹

Strengths of this study include the qualitatively driven mixed-methods design, which provided rich insight into both patient and provider experiences and extended prior technical feasibility research. Using the Consolidated Framework for Implementation Research (CFIR) alongside He Pikinga Waiora strengthened the analysis by integrating implementation science with principles of cultural safety, community engagement and Indigenous self-determination.^{13,25} The inclusion of both users and non-users of the service, along with a diverse provider group, enabled triangulation across data sources and helped identify barriers that may not have been captured through a single perspective. Conducting the study within a rural and Indigenous-serving community also generated context-specific insights that are deeply grounded in place and relevant to future adaptation and scale-up in similar settings. Although the findings are context-specific, they may be transferable to other rural and remote healthcare settings facing similar challenges related to specialist access, workforce shortages, and geographic barriers. Their applicability should be considered in light of local cultural, organizational, and health system contexts.

Limitations

Several limitations should be considered. The relatively small sample size and focus on a single geographic region limit generalizability to other rural or Indigenous communities with different cultural, linguistic, or infrastructural contexts. Survey findings were descriptive and may be subject to recall bias, particularly among postpartum participants. In addition, no formal sample size or power calculation was undertaken because the survey was designed to provide supplementary descriptive information within this qualitatively driven mixed-methods study rather than support inferential statistical analyses. Although all 40 participants completed interviews, the supplementary descriptive survey analyses were based on 7 patient and 10 provider surveys. The smaller survey samples limit the representativeness of the quantitative findings but do not affect the full interview sample underlying the primary qualitative analysis.

Member checking was not undertaken; therefore, participants did not have the opportunity to review or validate the researchers' interpretations of their interview data. Although limited information on parity, education, ethnicity, and Indigenous identity was initially collected, these data were not reported because responses were sparse or uncertain and, given the small rural community setting, could increase the risk of participant identification. Similarly, detailed provider characteristics (e.g., years of experience, previous telemedicine exposure, and practice characteristics) were not collected to maintain comparable demographic reporting across participant groups and to help preserve participant confidentiality. This risk was particularly relevant for participants who had used the telerobotic ultrasound service or were involved with its service delivery, as reporting combinations of demographic characteristics within this small subgroup could increase the likelihood of identification.

Consequently, the absence of these characteristics limits assessment of the transferability of the findings and deeper exploration of structural inequities. Data were also collected during the early phase of implementation; therefore, some barriers, such as limited awareness or scheduling confusion, may reflect start-up challenges rather than persistent system-level limitations. However, these early experiences provide valuable preliminary insights into implementation barriers and facilitators that may help inform future refinement and evaluation of the service.

Conclusion

Telerobotic prenatal ultrasound has the potential to signal a meaningful shift in how diagnostic maternity services can be delivered in rural health systems. Its perceived acceptability and implementation experiences suggest that bringing imaging closer to communities shifts the focus of access beyond geography to include trust, information, and considerations of cultural and emotional safety. Realizing this potential requires effective communication, well-defined referral pathways, intentionally planned workflows, appropriate training, reliable technological infrastructure, and ongoing engagement with patients, providers, and communities. Moving beyond pilot initiatives will require more than scale: it will require thoughtful integration within existing care pathways and genuine partnership with the communities these services are intended to serve. Future research should include larger, multi-site studies and Indigenous-led, community-partnered approaches to better understand emotional and cultural safety, community priorities, and long-term acceptability. Future research should also examine how these models reshape relationships between patients, providers, and health systems over time. Ultimately, the perceived potential of telerobotic prenatal ultrasound lies in combining technical capability with a more human-centred, locally grounded approach to care, with the potential to support clinical care while bringing essential services closer to where women live, and where their experiences of care truly matter. Realizing this potential will require thoughtful implementation, ongoing evaluation, and continued partnership with the communities it is intended to serve.

ORCID iDs

Amal Khan  <https://orcid.org/0000-0001-8615-4024>

Reanna Prychak  <https://orcid.org/0009-0004-1889-0408>

Ivar Mendez  <https://orcid.org/0000-0002-2877-7570>

Ethical considerations

Ethics approval for this study was granted by the University of Saskatchewan Research Ethics Board (Behavioural Research Ethics Board; Protocol No. Beh-REB-5806) on 25 August 2025.

Consent to participate

All participants provided either written or verbal informed consent prior to participation. For participants providing verbal consent, consent was audio-recorded as part of the interview recording.

Consent for publication

The manuscript does not contain any identifiable participant data or information requiring separate consent for publication. Publication of de-identified, aggregate findings and anonymized quotations was covered under the approved participant consent process.

Author contributions

A.K. contributed to the conceptualization and methodology of the study, data curation and formal analysis, investigation, funding acquisition, project administration, resources, software, supervision, validation, and visualization. A.K. also prepared the original draft and contributed to reviewing and editing the manuscript. R.P. contributed to data curation, formal analysis, project administration, resources, software, validation, and visualization, and reviewed and edited the manuscript. B.B. contributed to the conceptualization and methodology of the study, funding acquisition, investigation, resources, validation, and visualization, and reviewed and edited the manuscript. I.M. contributed to the conceptualization and methodology of the study, funding acquisition, investigation, resources, supervision, validation, and visualization, and reviewed and edited the manuscript. All authors contributed substantially to the study's conception and design, data acquisition, analysis, and interpretation. All authors were involved in drafting or revising the manuscript critically for important intellectual content and have approved the final version for publication.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the 2024 College of Medicine Research Award; 429449.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are not publicly available due to participant confidentiality but are available from the corresponding author on request.

Generative AI disclosure

ChatGPT (OpenAI) was used during manuscript preparation for language and style refinement and grammatical correction. The manuscript's content was prepared, reviewed and verified by the authors, who take full responsibility for the accuracy, originality, and integrity of the final manuscript.

Guarantor

Dr. Ivar Mendez accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Supplemental material

Supplemental material for this article is available online.

References

1. DeNicola N, Grossman D, Marko K, et al. Telehealth interventions to improve obstetric and gynecologic health outcomes: A systematic review: A systematic review. *Obstet Gynecol* 2020; 135: 371–382. <https://doi.org/10.1097/AOG.0000000000003646>
2. Grzybowski S, Stoll K and Kornelsen J. Distance matters: a population based study examining access to maternity services for rural women. *BMC Health Serv Res* 2011; 11: 147. <https://doi.org/10.1186/1472-6963-11-147>
3. Sutherns R and Bourgeault IL. Accessing maternity care in rural Canada: there's more to the story than distance to a doctor. *Health Care Women Int* 2008; 29: 863–883. <https://doi.org/10.1080/07399330802269568>
4. *Returning birth to aboriginal, rural, and remote communities*. Society of Obstetricians and Gynaecologists of Canada, 2010.
5. Khan A, Adams SJ, Burbridge B, et al. Enhancing ultrasound access in rural Saskatchewan: A mixed-methods study of telerobotic technology. *J Diagn Med Sonogr* 2025; 41: 464–472. <https://doi.org/10.1177/87564793251326870>
6. Arbeille P, Capri A, Ayoub J, et al. Use of a robotic arm to perform remote abdominal telesonography. *AJR Am J Roentgenol* 2007; 188: W317–W322. <https://doi.org/10.2214/AJR.05.0469>
7. Le Vance J, Vaughan M, Bhatia T, et al. Teleultrasound in obstetrics: A systematic review and meta-analysis. *PLoS Med* 2026; 23: e1004922. <https://doi.org/10.1371/journal.pmed.1004922>

8. Adams SJ, Burbridge B, Chatterson L, et al. Telerobotic ultrasound to provide obstetrical ultrasound services remotely during the COVID-19 pandemic. *J Telemed Telecare* 2022; 28: 568–576.
9. Madden N, Emeruwa UN, Friedman AM, et al. Telehealth uptake into prenatal care and provider attitudes during the COVID-19 pandemic in New York City: A quantitative and qualitative analysis. *Am J Perinatol* 2020; 37: 1005–1014. <https://doi.org/10.1055/s-0040-1712939>
10. Liu CH, Goyal D, Mittal L, et al. Patient satisfaction with virtual-based prenatal care: Implications after the COVID-19 pandemic. *Matern Child Health J* 2021; 25: 1735–1743. <https://doi.org/10.1007/s10995-021-03211-6>
11. Adams SJ, Burbridge B, Obaid H, et al. Telerobotic sonography for remote diagnostic imaging: narrative review of current developments and clinical applications. *J Ultrasound Med* 2021; 40: 1287–1306.
12. Mendez I, Hill R and Clarke M. Telerobotic ultrasound to provide diagnostic imaging in remote communities. *Can J Rural Med* 2021; 26: 60–66.
13. Damschroder LJ, Aron DC, Keith RE, et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci* 2009; 4: 50. <https://doi.org/10.1186/1748-5908-4-50>
14. Curtis E, Jones R, Tipene-Leach D, et al. Why cultural safety rather than cultural competency is required to achieve health equity: a literature review and recommended definition. *Int J Equity Health* 2019; 18: 174. <https://doi.org/10.1186/s12939-019-1082-3>
15. St. Joseph's Hospital/Foyer d'Youville. SaskHealthAuthority. <https://www.saskhealthauthority.ca/facilities-locations/st-josephs-hospitalfoyer-dyouville> (accessed 6 March 2026).
16. St. Joseph's Hospital/Foyer D'Youville – Gravelbourg. <https://emmanuelhealth.ca/facilities/stjosephs-gravelbourg/> (accessed 6 March 2026).
17. Pflugeisen BM and Mou J. Patient satisfaction with virtual obstetric care. *Matern Child Health J* 2017; 21: 1544–1551. <https://doi.org/10.1007/s10995-017-2284-1>
18. Kruse CS, Krowski N, Rodriguez B, et al. Telehealth and patient satisfaction: a systematic review and narrative analysis. *BMJ Open* 2017; 7: e016242. <https://doi.org/10.1136/bmjopen-2017-016242>
19. Shmerling A, Hoss M, Malam N, et al. Prenatal care via telehealth. *Prim Care* 2022; 49: 609–619. <https://doi.org/10.1016/j.pop.2022.05.002>
20. Bowen S. The impact of language barriers on patient safety and quality of care. *Société Santé en français* 2015.
21. de Moissac D and Bowen S. Impact of language barriers on quality of care and patient safety for official language minority Francophones in Canada. *J Patient Exp* 2019; 6: 24–32. <https://doi.org/10.1177/2374373518769008>
22. Smylie J. Indigenous birth outcomes in Canada: a systematic review and meta-analysis. *Journal of Obstetrics and Gynaecology Canada*.
23. Varcoe C, Browne AJ and Ford-Gilboe M. Reclaiming our spirits: development and pilot testing of a health promotion intervention for Indigenous women who have experienced intimate partner violence. *Res Nurs Health*, 40: 237–254.
24. Gagnon M-P, Duplantie J, Fortin J-P, et al. Implementing telehealth to support medical practice in rural/remote regions: what are the conditions for success?. *Implement Sci* 2006; 1: 18. <https://doi.org/10.1186/1748-5908-1-18>
25. Oetzel J, Scott N, Hudson M, et al. Implementation framework for chronic disease intervention effectiveness in Māori and other indigenous communities. *Global Health* 2017; 13: 69. <https://doi.org/10.1186/s12992-017-0295-8>