


Access to ultrasound imaging: A qualitative study in two northern, remote, Indigenous communities in Canada

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ABSTRACT

Ultrasound imaging is an essential component of healthcare services. This study sought to explore perceptions of access, and factors which shape access, to ultrasound imaging in two northern, remote, Indigenous communities in Canada. Using interpretive description as a methodological approach and a multi-dimensional conceptualisation of access to care as a theoretical framework, 15 semi-structured interviews were conducted in the northern Canadian communities of Stony Rapids and Black Lake, Saskatchewan. All participants had an obstetrical or non-obstetrical ultrasound exam performed in the past 10 years. Interviews were audio recorded and interview transcripts were analysed using constant comparative analysis. Geographic isolation from imaging facilities was a central barrier to participants accessing ultrasound imaging. Other barriers became apparent when participants had to travel for ultrasound, including fear of air travel, isolation from family, financial means, and unfamiliarity with larger cities. Barriers such as family and work responsibilities were exacerbated by the barrier of geography. Participants overcame these barriers as they were motivated by potential diagnostic benefits of ultrasound imaging. This study highlights disparities in access to ultrasound for northern, remote, Indigenous populations. Future efforts to improve access to imaging should consider barriers of distance to imaging facilities and strategies to bridge these barriers.

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Introduction

Medical imaging is an essential component of healthcare services. Together with radiography, ultrasound imaging is considered a basic imaging modality, and approximately 75–80% of imaging needs in developed countries are met with radiography and ultrasound imaging alone [1,2]. Ultrasound offers several benefits for patient assessment as it is non-invasive and not associated with ionising radiation. Ultrasound imaging is commonly used to assist in the diagnosis of a wide variety of diseases and is also an established part of routine prenatal care [3,4].

However, access to ultrasound imaging remains limited for many people across the world. Access has been defined as “the opportunity to reach and obtain appropriate health care services in situations of perceived need for care” [5] or “the degree of ‘fit’ between the clients and the system” [6]. Accessibility is viewed as “the nature of the services that provide this opportunity [to access care]” [5] or the “degree of adjustment between the characteristics of health resources and the corresponding characteristics of the population in the process of seeking and obtaining services” [7]. Significant in each of these definitions is the

dynamic interrelationship between health system characteristics and patient factors, which together determine access to care. Access to care is not simply dependent on the existence of healthcare services to meet health needs from a biomedical perspective; it also considers the degree to which care is available at facilities which individuals can reach and compatible with personal and cultural values. This interrelationship between individuals and the health system is also reflected in Levesque et al.’s framework of access to care [5]. In this framework, five dimensions of accessibility are conceptualised as *approachability*, *acceptability*, *availability* and *accommodation*, *affordability*, and *appropriateness*. Five corresponding abilities of individuals and populations interact with the dimensions of accessibility to generate access, namely the *ability to perceive*, *ability to seek*, *ability to reach*, *ability to pay*, and *ability to engage* [5]. This framework may have important implications when exploring access to imaging.

Access to healthcare is recognised as an important determinant of health [8]. Suboptimal access to healthcare can result in delays in diagnosis and treatment, development of more advanced disease, and increased

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rates of complications [9]. In northern Canada, the large geographic dispersion of communities result in ultrasound services being not locally available, and patients in many northern, remote communities must travel long distances to the closest ultrasound facility [10]. A large proportion of the population in northern Canada is Indigenous; in the Canadian province of Saskatchewan, over 85% of northern residents identify as Indigenous, and this proportion is as high as 96% in the northernmost part of Saskatchewan based on health authority boundaries [11]. Significant disparities in health status exist between Indigenous and non-Indigenous peoples in Canada [8,12]. This may be due to a multitude of interrelated factors related to colonial legacies, income, employment, housing, and education, as well as access to healthcare services [13,14].

There is a paucity of data regarding access to medical imaging and limited understanding of how access to imaging is conceptualised, particularly in northern, remote, Indigenous communities in Canada. Thus, we sought to answer the question: what are the perceptions of access, and factors which shape access, to ultrasound imaging among northern, remote, Indigenous community members in Saskatchewan, Canada? We specifically focused on ultrasound imaging due to the foundational importance of this imaging modality and the operator-dependent nature of this imaging modality resulting in it not being locally available in many northern, remote communities [15]. We employed a qualitative research methodology to obtain a greater richness and depth of understanding surrounding access to imaging as shared through the narratives of interview participants. Improved understanding of the barriers which patients face by hearing directly from patients is critical to reduce health disparities; support culturally safe, patient- and family-centred care; and inform the development of solutions to better meet the imaging needs of populations.

Methods

Methodological approach and theoretical framework

Interpretive description, a qualitative research methodology which focuses on developing new understanding to inform clinical practice, was chosen as the methodological approach for this study due to its grounding in the health professions and its potential to generate evidence-based knowledge which is relevant to radiology practices and health systems [16–19]. This methodology aims to capture the perceptions and experiences of groups of interest using a transparent

research process [18], which is ideally suited to addressing the research question posed. In this study, we drew upon rich narratives of individuals' experiences accessing ultrasound imaging as shared in semi-structured interviews. Similar to other qualitative research methodologies, interpretive description privileges depth of understanding and actionable improvements over broad generalisability. This methodological approach also values participant voices, an important feature of Indigenous methodologies [20,21].

Within this methodological approach, Levesque et al.'s conceptualisation of access to care [5] was used as a theoretical framework for this study. This framework, along with clinical expertise brought by the researchers and lived experience by community partners, informed development of the study design and interview guide and provided a lens through which to interpret findings. While this theoretical framework was used to help interpret findings, an inductive approach was employed in analysis of participants' narratives, allowing ideas which did not fit within the established framework to be incorporated into the analysis [16,18]. Postcolonial, decolonising, and Indigenous perspectives were also applied to provide additional context regarding perceptions of access, and factors which shape access, to ultrasound imaging among northern, remote, Indigenous community members [22–26].

Setting

Black Lake and Stony Rapids – two northern Indigenous communities in the province of Saskatchewan, Canada – were chosen as the setting for this study (Figure 1). These two communities share characteristics of having a high proportion of people of Indigenous ancestry. In winter a seasonal road (ice road) connects the communities to the Saskatchewan rural road system; however, during the remainder of the year the communities are only accessible via air transportation [27].

The community of Black Lake is part of the Black Lake Denesuline First Nation. Based on 2016 Census data, the population of Black Lake (Chicken 224 Indian Reserve) is 1,379. The average age of the population is 26.8 years and 96% of the population is younger than 65 years. Dene is the mother tongue of 93% of the population, and 98% of community members report English as their first official language spoken. Approximately 98% of community members are Registered or Treaty Indians (persons registered under the *Indian Act* of Canada or persons who are members of a First Nation or Indian band that signed a treaty with the Crown) [28].

ensure participant confidentiality, no medical records or other health information were accessed to identify potential participants. The local advisor did not have a healthcare background, which helped assure participants that their choice of whether or not to participate would not impact their future care. Consistent with interpretive description methodology, a purposive sampling method was used, with consideration given to participant age (to gather a broad spectrum of participant ages), community of residence (residing in either Black Lake or Stony Rapids), and self-identified gender (aiming for representation from all genders and taking into account gender diversity [30]).

All participants provided written, informed consent to participate in the study. Care was taken that the advisor and interviewer – who obtained written, informed consent – were not in positions of authority with any of the participants and did not have any relationships with participants which could result in undue influence regarding their choice of whether to participate or not. The study was submitted to the University of Saskatchewan Research Ethics Board (application identification number Beh 17–376) and was determined to be exempt from ethics review. Additionally, the project received support from the Black Lake Denesuline First Nation Band Council as part of a project on improving access to ultrasound imaging using novel technologies.

Data collection

Development of the interview guide was informed through conversations with local healthcare providers. The interview guide was developed by a radiology resident physician (S.A.) in collaboration with a qualitative research specialist (R.T.) and local community advisor (M.B.). Interviews were conducted by a specialist in qualitative research (R.T.) in collaboration with a local community advisor (M.B.). Interviews were audio recorded if participants consented to audio recording; otherwise, detailed notes were taken during interviews. Participants were also asked to complete a short form requesting demographic information, including information about dates and locations of previous ultrasound exams and previous pregnancies. Interview audio recordings were transcribed and transcripts were reviewed for accuracy. Data analysis was conducted after approximately every five interviews, and participant recruitment continued until data saturation – the point at which no additional thematic categories emerged from recruiting additional participants [31] – was achieved. In total, 15 semi-structured interviews were conducted in-person in Stony Rapids and Black Lake.

Data analysis

Transcripts were imported into a software package to store, organise, and analyse data for qualitative and mixed-methods research (NVivo 11, QSR International, Melbourne, Australia). Constant comparative analysis – an analytic method initially developed by Glaser [32] which has subsequently been applied within interpretive description methodology [18] – was used to analyse text data. This analytic method comprises a set of systematic procedures relating to coding data and subsequently identifying themes or patterns [18,33]. Consistent with established procedures, interview transcripts were initially read in their entirety for the researchers to immerse themselves in the data. On subsequent readings of the transcripts, initial codes reflective of key concepts in the transcripts were developed. Relationships between the codes were identified, and codes with common elements were combined into categories [33]. A preliminary coding scheme was developed based on the initial five transcripts. As data collection and analysis continued, data was compared and contrasted between and across individuals, and codes and categories were refined to more accurately represent the data [33]. The analysis was a collaborative effort among a radiology resident physician (S.A.), qualitative research specialist (R.T.), research assistant with training in qualitative research (R.E.), and local community advisor (M.B.). Strategies to ensure analytic rigour included having multiple members of the research team review the initial coding and categorisation at multiple time points during the analysis and using an audit trail to trace how codes and categories evolved in subsequent stages of analysis [18,34,35].

Researcher characteristics and reflexivity

Acknowledging the characteristics of the study's researchers and the perspectives which each bring is a critical aspect of qualitative research methodologies [36]. The research team was diverse and was comprised of two radiologists with health system leadership expertise (P. B. and B.B.), a radiology resident physician (S.A.), a surgeon and expert in virtual care (I.M.), a qualitative research specialist (R.T.), a local Indigenous community advisor (M.B.), and a research assistant with training in qualitative research (R.E.). Researchers' prior experiences – including experience in the provision of healthcare and serving in health system leadership roles in Saskatchewan – were viewed as sources of insight, consistent with interpretive description methodology [18]. All researchers except the local community advisor were external to the community; this allowed them to interpret findings with objectivity, but it is acknowledged that they did not bring lived experience in accessing care in the

communities included in the study. All members of the research team – including Indigenous and non-Indigenous members – ensured that culturally safe research methods were employed and findings were interpreted from postcolonial, decolonising, and Indigenous perspectives. The researchers carefully reflected on their own worldviews and lived experiences, the participants' voices as gathered through interviews, and postcolonial, decolonising, and Indigenous perspectives which are documented in the literature. The local community advisor helped the research team navigate carrying out the project in a *good way*, bringing lived experience to the diverse range of perspectives which other team members brought to the project.

Results

Participant demographics

Six participants were included on the basis of being pregnant in the past 10 years, and 10 participants were included on the basis of having required a non-obstetrical ultrasound exam in the past 10 years, including one participant who met criteria for both groups. Fourteen females and one male were included. Among those being pregnant in the past 10 years, the mean age (\pm standard deviation [SD]) of participants was 29.7 (± 6.2) years, the mean gravidity (\pm SD) was 3.7 (± 1.9), and the mean parity (\pm SD) was 3.2 (± 1.3). Among those meeting criteria for having a non-obstetrical ultrasound in the past 10 years, the mean age (\pm SD) was 37.7 (± 12.1) years. Indications for non-obstetrical ultrasound studies were right upper quadrant pain/assess for gallbladder pathology ($n = 4$), pelvic pain ($n = 3$), assess for the presence of renal calculi ($n = 1$), assess hernia ($n = 1$), and vaginal bleeding ($n = 1$).

Themes

Five themes were identified from semi-structured interviews: geographic isolation from imaging facilities, (not) adapting in the face of remoteness from ultrasound imaging facilities, competing responsibilities of family and work, ultrasound as a tool towards understanding disease and securing optimal health outcomes, and the importance placed on imaging services near one's community.

Geographic isolation from ultrasound imaging facilities

Geographic isolation was seen as an ever-present factor which most participants were accustomed to, but which directly impacted their way of life, including

when accessing imaging. Participants were acutely aware of the geographic isolation of their communities; as one participant noted, "It's so isolated up here, up north". Another participant commented on the degree of remoteness of her community in comparison to communities classified as rural: "Those small farm towns, they can go to Regina [a major city in the province]. Well, here you got to go all the way to La Ronge, P.A. [smaller centres 664 km and 903 km away]". Some participants connected geographic isolation to the lack of availability of imaging and other healthcare technologies; for example, a participant noted, "we all are isolated to all the modern technologies that a hospital and facilities down south can be equipped with". For some, this resulted in a sense of vulnerability: "I think because we have less services like the people do in the cities, you know, you never know what kind of a medical situation we are in".

(Not) adapting in the face of remoteness from ultrasound imaging facilities

Participants commonly had to either wait for an itinerant sonographer to come to their community generally once each month or travel to a larger community for ultrasound imaging (provided that travel costs were approved for federal funding). Challenges associated with travelling to another community for imaging included fear of travel, isolation from family and unfamiliarity with the city, financial challenges, inadequacy of accommodations, and feelings of guilt. These sub-themes are discussed below.

Wait times. Wait times for ultrasound exams was one of the most salient features about their ultrasound exam experience which participants recalled, including wait times for the day of the ultrasound exam and wait times at the clinic on the day of the exam. Wait times for an ultrasound exam ranged from a few days to a year. One participant noted that even though she was scheduled for an ultrasound exam on a specific date, because of the volume of exams to be performed the day the itinerant sonographer was at the facility, the exam had to be rescheduled for the following month. While waiting for the exam, some residents described feeling anxious, while others felt it was "okay". The long wait times also led to a sense of unfairness by some residents: "Like why do we have to be on a waiting list? Wait until we die or what? You know? ... It's like we're left behind. What do you call that again? We're just like ignored or whatnot".

Fear of travel. A fear of air travel was shared by many participants and deterred some participants from travelling for an ultrasound examination. A plane crash

resulting in a fatality in the six months preceding the interviews remained on participants' minds, and there was a general desire for residents to have their health-care needs met locally. Sometimes the fear of flying led participants to find other means of travelling to their appointments such as driving, even if the trip took 12 or 14 hours.

Participants often missed their ultrasound appointments due to weather impeding flights to southern communities. In some cases the challenges associated with rescheduling the appointment led residents to forego the ultrasound exam altogether. One participant noted, "So I thought they were automatically going to reset [reschedule the exam]. But I had to go through the whole process again for them to remake an appointment. I didn't even bother".

Isolation from family and unfamiliarity with the city. Some obstetrical participants wanted to share the experience of having an ultrasound exam with their partner, but because of the need to travel and travel costs not being covered for their partner, found this was not possible:

And I was always alone going – I was told that I couldn't bring my partner with me at the time to see the ultrasound. I don't know why because it was some transportation thing they had to pay for. I don't know. . . . all those three ultrasounds I went to I was there alone. [I felt] pretty upset because it was my first time pregnancy and it'd be nice for my partner to be there and actually hear the heart beat the first time and all that, yeah. I was pretty upset about that.

A larger city was an unfamiliar or strange place for many participants who had lived in a northern community their entire life. For obstetrical patients especially at a younger age, going alone to a larger city was sometimes a frightening experience: "[The ultrasound exam] was in Saskatoon and I was just 18 so I never really travelled out alone that far so I was kind of scared. And my mom was so concerned about me when I went . . . And then after my ultrasound they didn't tell me anything of what was going on with me; they just made me go back here".

However, for others, the opportunity to travel to the city for an ultrasound exam meant that other tasks such as shopping could be done at the same time: "And there's some people that want to go down south because they get to go shopping. I'll be honest with you. Like when I went, I said, "Oh great! I'll get some things done. I got to go to this, I got to go get this".

Financial challenges and inadequacy of accommodations. While the cost of ultrasound exams and travel costs were generally covered by federal funding, participants found difficulty managing additional costs, for

example related to snacks and some meals, when they were travelling. One participant reflected, "With people with medical conditions such as diabetic or gestational, if they don't have any money and they'll be sent out on a medical and some they might faint or something like that. And they won't have any money for – like right after the appointment they don't have nothing to eat right away like if they don't have money".

Depending on the time of their appointment, some patients stayed overnight in a hotel room provided through federal funding. However, these accommodations were often substandard: "But the accommodations were just gross, awful places to stay waiting for appointments and whatnot. . . . You know. . . . Who wants to stay in a dingy hotel like that, you know? When you live up here in a comfortable home where you feel at home, it's just awful".

Feelings of guilt. One participant described having felt guilty about having to expend government resources on travel for health services, resulting in delaying care: "For years of living here I felt guilty letting somebody else pay my way to P.A. [a city which has regular ultrasound services]. But that's my treaty right. For years I'd just wait until I get to Regina to take care of my physical health needs. Because I felt guilty saying I need to go and have them pay".

Competing responsibilities of family and work

Having children who needed their care was a barrier for many participants to attend an ultrasound appointment. Participants noted that it was common to miss appointments if childcare was not available: "It [local ultrasound exams] would be better than travelling down south . . . cause you have to stay away from your family while going for appointments and some people don't have babysitters . . . Cause a lot of people miss their appointments down south". In contrast, travelling south for an ultrasound exam was a different experience for participants who did not have children. For example, one participant noted, "I didn't mind. Cause me, I don't have kids".

Work responsibilities were also identified as barriers to accessing ultrasound exams, as travelling to a larger city often meant missing multiple days of work. One participant shared, "If it's here in Stony it's reasonable. Cause I work throughout Stony and I could just go over there and then I could see my supervisor. If I'm telling her that I'm going down south there will be like, stuff I can't go. Like missing days, and if it's like emergency and it's too last minute, I have to tell her two weeks ahead of time".

Ultrasound as a tool towards understanding disease and securing optimal health outcomes

Medical obligation. Residents considered going for an ultrasound exam as an obligation and a priority despite the many challenges associated with access. For example, one participant noted, "Well it takes long but still I have to be there for my health". Another participant commented, "But no choice, eh? You've got to go for your medical appointments, so I had to go because I got really sick from my last gallstones". One participant equated ultrasound imaging to a lifesaving technology: "Ultrasound is really good. It's saved lots of people. It saves lots of babies too. ... You know, like that [ultrasound exam] saved her, you know? Ultrasound saved [name de-identified]".

Diagnostic information to inform and empower patients. Participants placed high importance on the need for ultrasound exams, especially obstetrical examinations to monitor foetal development. Ultrasound was also seen as a tool for reassurance: "[The ultrasound exam] was pretty important. I wanted to actually follow-up and do a [follow-up exam] – see if my son was in a healthy – you know?"

Diagnostic information provided by ultrasound imaging was valued by patients and seen as a tool to help them understand their health and disease: "I think ... ultrasound is good because it helps them [patients] to understand. It helps them where they are, you know, if something – they want to know something is wrong with them, hey? That's what they're there for. ... We deserve to know what's going on in our bodies I guess, right?"

Need for patient education. Despite the general acceptance and importance placed on imaging, some participants expressed concerns regarding radiation risks that they associated with ultrasound imaging, suggesting that further education about the safety and risks associated with medical imaging may be helpful: "But people are concerned about that radioactive kind of thing If you get more and more and more ultrasound of different in I don't know how many years or months, they pick that up and it builds in the body and people they get cancer or get sick".

Importance placed on ultrasound services near one's community

Participants indicated that having ultrasound services near one's community was important, and commented that locally available ultrasound services may mitigate some of the challenges previously identified such as childcare, fear of travel, the time associated with travel

to a southern community, and costs to the healthcare system. One participant reflected, "Because probably there's other patients that would actually [go for a local ultrasound exam] – [they] don't want to go [south] and they have no babysitters and so whatever and they don't have time to actually go south for it. They could just always go to Stony Hospital and just get it done there". Participants also stressed the importance of imaging from someone who "knows" – the ability to receive care from a specialist in one of the larger cities.

Discussion

This study provides a richer understanding of perceptions of access, and factors which shape access, to ultrasound imaging among northern, remote, Indigenous community members in Canada, demonstrating significant disparities in access to ultrasound imaging services. Geographic isolation from centrally situated ultrasound imaging facilities was a central barrier for northern residents to access prenatal and general diagnostic ultrasound. Large geographic separation from ultrasound imaging facilities and the increased time required for travel exacerbated other barriers, including fear of air travel, isolation from family, financial means, and unfamiliarity with larger cities. Additional barriers, such as family and work responsibilities, were exacerbated by the barrier of geographic isolation. Compared to urban areas in which childcare may be required for only two hours during an appointment, an ultrasound appointment for a northern resident resulted in the need for childcare for a full day or multiple days. Residents overcame these barriers as they were motivated by potential diagnostic benefits of ultrasound imaging, and ultrasound imaging provided reassurance about the health of their baby.

In addition to Levesque et al.'s framework of access to care which provides a theoretical grounding for this study, a number of other frameworks of access have been described in the literature. Among the dominant theories of healthcare access is one described by Penchansky and Thomas in 1981; in their framework, access consists of the five dimensions of availability, accessibility, accommodation, affordability, and acceptability [6]. Other researchers have conceptualised access in a similar manner. Peters et al. describe dimensions of access as quality, geographic accessibility, availability, financial accessibility, and acceptability of services [37], and Shengelia et al. describe physical access, resource availability, cultural acceptability, financial affordability, adherence, and quality of care as concepts representing effective health coverage and the health service provision function [38]. More recently, drawing upon the

work of Penchansky and Thomas and others, Levesque et al.'s framework [5] uniquely describes five dimensions of accessibility which interact with five corresponding abilities of populations. This results in an attractive theoretical framework to understand and conceptualise access from both health system and patient perspectives. Postcolonial, decolonising, and Indigenising perspectives on health system access – which emphasise the social, historical, and political contexts of healthcare, access as a social responsibility and a social relationship, and a holistic approach to health and well-being – are also critical in understanding the challenge of access to ultrasound in northern, remote, Indigenous communities [22–26].

Drawing upon Levesque et al.'s conceptualisation of access to care, disparities in specific dimensions of accessibility – including availability, appropriateness, acceptability, approachability, and affordability – contributed to limited access to ultrasound imaging for patients in the two northern, remote, Indigenous communities studied. As the itinerant sonographer model provided ultrasound services only one day each month, availability of ultrasound imaging was significantly limited, and patients often had to travel long distances for ultrasound imaging for urgent exams or if wait times were too long. Participants described a myriad of concerns regarding appropriateness of services, which is thought of as the “fit between services and clients need” [5]. These concerns ranged from long wait times, unfavourable policies regarding funding for family members or partners to travel with them for an appointment, and inadequate hotel accommodations when travelling for an appointment, which together worked to limit access to ultrasound imaging.

The acceptability of ultrasound services, another dimension of accessibility related to cultural and social factors of the population [5], is particularly important to consider in this largely Indigenous population. Many Indigenous cultures consider pregnancy to be a natural process maintained by nature and requiring no interference [39]. While ultrasound is a Western concept outside of traditional Indigenous medicine, in this study it was observed that ultrasound had become integrated into the norms of prenatal care for Indigenous mothers. This is a significant finding, as perceptions that healthcare is inadequate or not culturally appropriate are barriers for many Indigenous persons in seeking care [13]. Ultrasound – both obstetrical ultrasound and general diagnostic non-obstetrical ultrasound – could be considered as contributing to a pursuit towards holistic health in terms of understanding one's health, providing reassurance about the health of one's baby (thereby promoting mental well-being), and ensuring

one's physical health is maintained or repaired (thereby promoting physical well-being).

Holistic health and well-being, including the interaction between mental, emotional, and spiritual stress and physical health, are important when considering the acceptability of ultrasound services for Indigenous peoples [26]. Although an ultrasound exam may be considered a tool to help patients achieve mental and physical well-being as described above, the process of obtaining an ultrasound exam has the potential to diminish holistic health and well-being, as exemplified in our study by the emotional hardships of a young patient travelling alone for an ultrasound exam without her family. Indigenous peoples' negative experiences in the healthcare system may lead some to not proceed with care, as one participant explained in our study. A sense of unfairness about wait times for an ultrasound exam expressed by participants may reflect historical legacies associated with healthcare services for Indigenous peoples. Health disparities secondary to colonial legacies have been documented in Canada as well as other countries such as Australia, New Zealand, and the USA, with colonisation adversely affecting physical, social, emotional, and mental health and well-being of Indigenous peoples [40]. It is critical for health systems to ensure cultural safety throughout the planning, delivery, and evaluation of medical imaging services in a way which supports Indigenous peoples' needs and fosters ethical and respectful relationships between patients and providers [41,42].

Affordability and approachability – the final two dimensions of accessibility in Levesque et al.'s framework – featured less prominently in the narratives of study participants. The universal health system in Canada which allows all Canadians to receive publicly funded ultrasound services without patient payment, as well as funding for travel and accommodations for medical appointments for Registered Indians, worked together to contribute to achieving accessibility for Indigenous patients. However, patient-related costs such as loss of employment income and cost of meals during travel should be acknowledged. Approachability, which relates to services “mak[ing] themselves more or less known among various social or geographical population groups” [5], was slightly diminished as exemplified by participants' cancelled appointments not automatically being rebooked. However, relative to other dimensions of accessibility, approachability featured less prominently in participants' narratives, possibly because all the interview participants had previous personal experience with having an ultrasound exam.

Despite many factors which limited *accessibility* to ultrasound services, the five corresponding abilities of

populations which interact with the dimensions of accessibility in Levesque et al.'s framework, including the ability to perceive, ability to seek, ability to engage, ability to reach, and ability to pay, helped generate some degree of *access* to ultrasound services. Participants had a strong understanding of the benefits of ultrasound imaging and perceived a clear need for ultrasound exams. Participants sought ultrasound exams as they were consistent with their personal and cultural values. This contributed to participants' abilities to seek and engage in ultrasound imaging, requirements for creating access according to Levesque et al.'s framework [5]. Borrowing terminology proposed by Frenk, despite the many obstacles to accessing imaging ("resistance" imposed by systemic and social barriers), many participants overcame these obstacles ("utilization power") [7]. However, exceptions should be noted, and it must be recognised that some participants chose not to proceed with their ultrasound exam due to personal or administrative barriers (e.g. work concerns, childcare needs, or appointments cancelled due to weather). These barriers compromised individuals' ability to reach ultrasound imaging and resulted in missed opportunities to provide imaging, with uncertain consequences on health status. The final corresponding ability in Levesque's model, the ability to pay, was less prominent in participants' narratives as a barrier to accessing ultrasound imaging due to the universal coverage of medically necessary ultrasound exams in Canada's healthcare system, though was highlighted as a challenge when patients travelled for an ultrasound exam.

This study identified geographic isolation as a central barrier to accessing ultrasound imaging. The importance of geography in promoting or hindering access to imaging is a finding that is a key theme in the literature, particularly among marginalised or underserved populations. In a systematic review of the literature regarding healthcare access and utilisation among Indigenous peoples in North America, Australia and New Zealand, rural location – along with communication and socioeconomic status – was a barrier to healthcare services that disproportionately affected Indigenous communities [43]. In a study exploring travel time to mammography, breast ultrasound, and breast magnetic resonance imaging (MRI), Native American women in the USA had median travel times 2–3 times longer than women of other racial/ethnic groups [44]. Additionally, in the context of lung cancer screening in the USA, census tracts which had relatively greater distances to computed tomography (CT) facilities had higher proportions of uninsured patients, Medicaid patients, and undereducated patients (less than a high school degree) [45].

This study points towards the need for increased availability of local ultrasound services and new solutions which overcome challenges associated with geographic dispersion of a population in small communities over a large territory. One of those solutions may be telerobotic ultrasound, a technology which allows sonographers or radiologists to remotely manipulate an ultrasound probe from a central site (such as an urban ultrasound clinic or hospital) [46–48]. Using this technology, patients can stay in their home community while receiving imaging care from sonographers and radiologists. This technology was recently used by our group to provide critical ultrasound services during the COVID-19 pandemic in a northern Canadian community [49]. Benefits of providing ultrasound services using this technology included eliminating the need to travel, increased availability of ultrasound services (including availability for emergencies and decreased wait times for exams), increased convenience, and increased safety – particularly prominent during the COVID-19 pandemic [49]. These benefits closely align with the dimensions of availability and acceptability in Levesque et al.'s framework.

Other potential solutions to address some of the barriers identified in this study include proactively reaching out to patients to re-book cancelled or missed exams, providing solutions to facilitate childcare during appointments, and providing extended hours for patients with family and work responsibilities. Policies should consider the personal and bonding benefits of obstetrical ultrasound imaging and ensure patients' partners are welcome to participate in the experience of an ultrasound exam. Reaching out to patients who missed their appointments to identify and help resolve any barriers which stand in the way of undertaking their imaging exam may also help improve access to ultrasound services. These solutions may be broadly applicable across radiology practices to increase access to imaging. In addition, Brooks-Cleator et al. identified six key elements of culturally safe health initiatives: collaboration and partnerships with members of Indigenous communities; acknowledging power dynamics and empowering patients; addressing the broader context of patients' lives; creating safe environments which are non-judgemental, free from racism and stereotyping, and supportive of Indigenous cultures; organisational and individual level self-reflection on personal biases and those of the health system; and cultural safety and cultural competency training for healthcare providers [42]. These may be important strategies for radiology practices and health systems to consider to ensure cultural safety and increase access to imaging for Indigenous peoples.

There are a few limitations to this study. All participants were from only two northern, remote, Indigenous communities. While this approach provided rich and focused data to describe access to ultrasound services in its many

dimensions in these two communities, findings may not be generalisable to other northern communities in Canada or beyond. Although the interviewer was external to the local health authority, social desirability bias and perceived power differentials may have manifested in some participants being reluctant to speak negatively about current services or provide detailed responses about their experiences [50]. As the interviewer was not from either of the northern, remote communities, participants may have expressed their thoughts in a way which they felt would best be accepted by the interviewer. Additionally, while there have been few policy changes related to ultrasound imaging in the two northern communities over the study period, the relatively long period of time since some participants may have had previous ultrasound exams may distort participants' recollections of past experiences of ultrasound imaging [51]. This study explores the concept of access to ultrasound imaging as "the opportunity to reach and obtain appropriate health care services in situations of perceived need for care" [5]. It does not, however, explore the concept of utilisation, and does not explore whether access to imaging affects utilisation, defined as "the quantity of health care services and procedures used" [38]. Further, while the perspectives of patients and community members are presented in this study, the study does not include the potentially different perspectives of healthcare administrators, physicians, or other healthcare providers in describing access to ultrasound imaging. The design of this study emphasises the importance of patients' voices in defining access to ultrasound imaging, and is consistent with principles of patient- and family-centred care and Indigenous health research in that the perspective of patients and the community is of primary importance.

In conclusion, this study highlights disparities in access to ultrasound imaging – a core imaging modality – for northern, remote, Indigenous populations. As shared through the narratives of interview participants, this study emphasises the importance of regularly available local ultrasound services to meet patients' needs, and suggests that future efforts to improve access to imaging should consider barriers of distance to imaging facilities and strategies to bridge these barriers. As healthcare leaders focus on patient- and family-centred care, cultural safety, and improving patient experience, it will be increasingly important to focus on access to imaging and its multi-dimensional conceptualisation.

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