Original Article

Does proximity to a fertility centre increase the chance of achieving pregnancy in Northeastern Ontario?

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Abstract

Introduction: Northern Ontario has a population of approximately 800,000 people distributed over 806,707 km^2. Before 2018, the only fertility treatment centre in Northern Ontario was located in Thunder Bay; many patients travelled south for care. In 2018, the Northeastern Ontario Women's Health Network (NEOWHN) opened in Sudbury, providing fertility treatments to people living in Northeastern Ontario. The goal of this study was to determine if proximity to this new fertility centre increases one's chance of achieving pregnancy when undergoing fertility treatment. Secondary outcomes included the quantity and types of fertility investigations and treatments completed by patients.

Materials and Methods: A retrospective chart review was performed for all patients seeking fertility treatment at NEOWHN between January 2019 and December 2020. Traveling >100 km to access healthcare was considered to be a clinically significant determinant of health.

Results: Seven hundred and 5 patients were seen in consultation for fertility services at NEOWHN during the study period. One hundred eighty-one of 478 (37.9%) patients living <100 km from NEOWHN achieved pregnancy compared to 39 of 227 (17.2%) patients living >100 km from NEOWHN ($P < 0.01$).

Conclusion: Living in proximity (<100 km) to NEOWHN increased the likelihood that individuals in Northeastern Ontario would seek fertility services and would achieve pregnancy. Financial constraints and inaccessibility likely play a role in this, but further studies are needed to explain this difference.

Keywords: Health equity, *in vitro* fertilization, infertility, insemination, Northern Ontario, remote, rural

Résumé

Introduction: Le Nord de l'Ontario compte une population d'environ 800,000 personnes réparties sur 806,707 km^2. Avant 2018, le seul centre de traitement de la fertilité du Nord de l'Ontario était situé à Thunder Bay; de nombreux patients SE rendaient dans le sud pour recevoir des soins. En 2018, le Northeastern Ontario Women's Health Network (NEOWHN-le Réseau de santé des femmes du Nord-Est de l'Ontario) a ouvert ses portes à Sudbury, offrant des traitements de fertilité aux personnes vivant dans le Nord-Est de l'Ontario. L'objectif de cette étude était de déterminer si la proximité de ce nouveau centre de fertilité augmente les chances d'obtenir une grossesse lors d'un traitement de fertilité. Les résultats secondaires comprenaient la quantité et les types

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d'examens et de traitements de fertilité effectués par les patients.
Méthodes: Une étude rétrospective des dossiers a été réalisée pour tous les patients cherchant un traitement de fertilité au NEOWHN entre janvier 2019 et décembre 2020. Le fait de voyager >100 km pour accéder aux soins de santé a été considéré comme un déterminant de la santé cliniquement significatif.
Résultats: Seven hundred and 5 patients ont été vus en consultation pour des services de fertilité au NEOWHN pendant la période d'étude. One hundred eighty-one des 478 (37.9%) patientes vivant à moins de 100 km du NEOWHN ont obtenu une grossesse, contre 39 des 227 (17.2%) patientes vivant à plus de 100 km du NEOWHN ($P < 0.01$).
Conclusion: Le fait de vivre à proximité (<100 km) du NEOWHN augmente la probabilité que les habitants du Nord-Est de l'Ontario aient recours à des services de fertilité et obtiennent une grossesse. Les contraintes financières et l'inaccessibilité jouent probablement un rôle à cet égard, mais d'autres études sont nécessaires pour expliquer cette différence.

Mots-clés: Éloigné, équité en matière de santé, fécondation *in-vitro,* infertilité, insémination, Nord de l'Ontario, rural

INTRODUCTION

Approximately 1 in 6 Canadian couples experience infertility.[1] Infertility is defined as an inability to achieve conception after 1 year of regular intercourse without contraception.[2,3] Individuals struggling with infertility may seek assistance to achieve pregnancy through a variety of treatments including medical therapy, intrauterine insemination (IUI) and *in vitro* fertilization (IVF).[4]

Northern Ontario covers a vast land mass over 800,000 km^2 and has a population of almost 800,000 people.[5] Before 2018, this entire region was home to 1 fertility centre located in Thunder Bay, Northwestern Ontario. All patients living in Northern Ontario interested in infertility treatments and/or investigations were required to travel to Northwestern, Eastern and/or Southern Ontario. During this time, patients reported barriers to accessing these services, including the distance required to travel and financial constraints.[6]

On 25 October 2018, Northeastern Ontario Women's Health Network (NEOWHN) opened in Sudbury becoming the first fertility clinic to serve the patients of Northeastern Ontario. Since its inception, the clinic has offered a variety of services including diagnostic investigations, cycle monitoring, blood work and IUI.[7] IVF is not available at this site, but a partnership exists with a Toronto fertility clinic which offers IVF, allowing many of the associated tests and monitoring to be completed at NEOWHN.[7] Residents of Ontario are currently eligible for government-funded fertility services through the Ontario fertility programme. The programme allows patients access to unlimited IUIs and 1 funded IVF cycle. However, since the demand for IVF cycles exceeds the current funding, patients can wait 6 months up to 2 years for a funded IVF cycle. Many couples will choose to pay privately for quick access to IVF, spending up to $25,000 for embryo retrieval and genetic testing. Medication costs can range from a few hundred dollars to over $5000 for both IUI and IVF, further adding to the financial burden of accessing fertility treatments.

In Northern Ontario, patients who travel more than 100 km one-way to access medical care are eligible to receive a Ministry of Health Northern Health Travel Grant to help offset the transportation and accommodation costs incurred. One hundred kilometre is recognised as a significant distance to travel for specialist care.[8] The travel grant does not cover all costs of travel, including hours missed from work, leaving patients to pay out of pocket for many expenses associated with infertility investigations and/or treatments.[6,8]

The primary objective of this study was to determine if individuals seeking fertility treatment are more likely to achieve pregnancy if they live within 100 km of NEOWHN. It was hypothesised that patients living >100 km from NEOWHN are less likely to achieve pregnancy in comparison to patients who live <100 km. Secondary objectives included identifying if there are any differences in the quantity and types of fertility investigations and treatments pursued by patients based on their distance from the clinic.

MATERIALS AND METHODS

Design

This was a retrospective chart review of patients seeking infertility investigations and/or treatment at NEOWHN in Sudbury, Ontario. All new patient consultations at NEOWHN between January 2019 and December 2020 were considered for the study and were followed until August 2021. This 2-year window was chosen based on the opening of the clinic in October 2018, and a desire to ensure that at least 6 months had passed from the consultation to assess for investigations, treatments and potential pregnancy. The study received ethics approval from the Health Sciences North Research Ethics Board.

Study participants

Patients had to express a desire to achieve pregnancy at the time of the consultation to be included. Exclusion criteria included patients seeking oocyte cryopreservation, sperm banking and other (non-fertility) gynaecological issues. Patients were included in the retrospective review based on exclusion and inclusion criteria. Stratified sampling was used to divide the sample of patients into 2 groups based on how far they lived from the clinic. The local group was identified as having a permanent address <100 km from NEOWHN, and the travel group was identified as having a permanent address equal to or >100 km from NEOWHN. One hundred kilometre was chosen as the cut-off based on the government-recognised criteria for the Northern Health Travel Grant. For patients who did not live in fly-in communities, the driving distance to the clinic was calculated using the patient's postal code and the clinic address via Google Maps. For patients living in fly-in communities, the distance to the clinic was calculated by using the distance of road access plus the distance flown.

Data collection

Data were collected using the HIPPA-compliant software Accrue through Citrix Gateway. Sociodemographic and clinical variables were extracted from each patient record that met the inclusion criteria. Age, gender, body mass index (BMI), smoking status, nulliparity and relationship status were identified as the most important sociodemographic variables. If there was a same-sex couple both undergoing investigations, each patient was logged as a separate entry. Once all required data were extracted for statistical analysis, all identifying features were removed, and the patient was assigned a study ID number. If fertility investigations were completed at another facility within 12 months of the consult date at NEOWHN, fertility investigations were identified as 'complete.' Pregnancy was defined as any positive hCG [human chorionic gonadotropin] (home urine or serum hCG test) or ultrasound suggesting pregnancy.

The types of infertility were grouped into five categories: uterus/tubal, male factor, ovulatory, other and unexplained. The ovulatory category included polycystic ovary syndrome, advanced maternal age (>35 years of age), decreased ovarian reserve, poor follicle growth, anovulation during diagnostic testing defined as progesterone <10 nmol/L, antral follicle count <10 and anti-Mullerian hormone <1.5 pmol/L. Male factor was diagnosed as a total sperm count of <10 million or motility <40%. The 'other' category included endometriosis, subclinical thyroid, hypothyroidism, therapeutic donor insemination, same-sex couples and single patients. Patients that did not complete the recommended diagnostic investigations were included in the analysis and categorised as 'unexplained.'

The population of the area within a radius of 100 km of NEOWHN was based on data collected by Statistics Canada in the 2021 census and an online radius calculator.[9] The population was calculated by manually adding the census population of the Greater Sudbury area and its surrounding areas within 100 km. It was estimated to be approximately 200,000 people. The population of the rest of Northeastern Ontario (>100 km from NEOWHN) was determined by subtracting 200,000 from 557,000 (population of Northeastern Ontario according to census), resulting in 357,000 people.[5]

Data analysis

All data analyses were completed in IBM SPSS Statistics v 28 (IBM Corporation, Armonk, New York, USA). Demographic data were

reported using descriptive statistics. Continuous variables were compared using the Student's *t*-test. Categorical variables were compared using the Chi-squared test or Fisher's exact test. Statistical significance was defined as $P < 0.05$ for the primary outcome and secondary outcomes.

RESULTS

Of the 705 charts studied, all patients identified as female. There were no significant differences in mean age, smoking status, BMI, nulliparity or relationship status between the 2 groups [Table 1].

Patients living within 100 km of the NEOWHN were 4 times more likely to seek fertility treatment compared to patients living ≥100 km of NEOWHN [Table 2]. Diagnostic investigations to help identify the cause of infertility were more likely to be completed by the local group [Table 2]. This group was also more likely to complete all fertility investigations at NEOWHN compared to those in the travel group [Table 2].

The most common cause of infertility diagnosed in both groups was unexplained, followed by ovulatory issues [Figure 1]. Overall, there were no significant differences in the prevalence of infertility diagnoses between the 2 groups ($P > 0.05$).

The proportion of patients pursuing medicated cycles, IUI and IVF was similar between the local and travel groups [Table 3]. Rates of pregnancy achieved between both groups were also comparable, with no statistically significant differences.

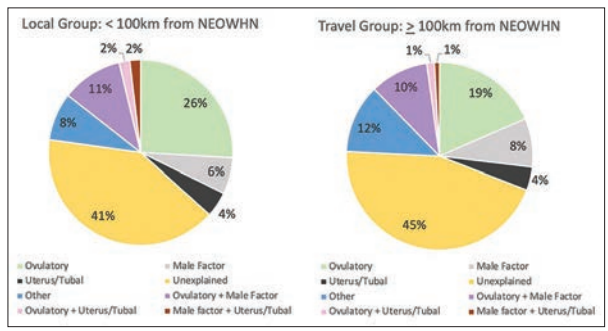


Figure 1: Infertility diagnoses.

	Local group: <100 km from NEOWHN (*n*=478), *n* (%)	Travel group: ≥100 km from NEOWHN (*n*=227), *n* (%)	*P*
Ovulatory	124 (25.9)	42 (18.5)	0.030
Male factor	30 (6.3)	19 (8.4)	0.307
Uterus/tubal	21 (4.4)	9 (4.0)	0.792
Unexplained	194 (40.6)	102 (44.9)	0.274
Other	40 (8.4)	27 (11.9)	0.136
Ovulatory + male factor	51 (10.7)	23 (10.1)	0.828
Ovulatory + uterus/tubal	9 (1.9)	3 (1.3)	0.590
Male factor + uterus/tubal	9 (1.9)	2 (0.9)	0.316

NEOWHN: Northeastern Ontario Women's Health Network

Table 1: Demographics

Variable	Local group: <100 km from NEOWHN (*n*=478)	Travel group: ≥100 km from NEOWHN (*n*=227)	*P*
Sex (*n*)			
Female	478	227	-
Male	0	0	-
Other	0	0	-
Age at consult, mean (SD)	32.0 (5.3)	31.7 (5.2)	0.477
Smoking status, *n* (%)			
Yes	80 (16.7)	32 (14.1)	0.370
No	398 (83.3)	195 (85.9)	0.370
BMI, mean (SD)	30.4 (8.3)*	31.3 (7.5)†	0.194
Nulliparous, *n* (%)			
Yes	223 (46.7)	120 (52.9)	0.123
No	255 (53.3)	107 (47.1)	0.123
Relationship status, *n* (%)			
Female/female	32 (6.7)	14 (6.2)	0.791
Female/male	425 (88.9)	197 (86.8)	0.413
Female/other	20 (4.1)	16 (7.0)	0.106
Unknown	1 (0.2)	0	-

*Based on 422 patients, †Based on 178 patients. NEOWHN: Northeastern Ontario Women's Health Network, SD: Standard deviation, BMI: Body mass index

Overall, after the initial consultation at NEOWHN, patients living within 100 km of the clinic were more likely to achieve pregnancy than patients who lived ≥100 km from the clinic [37.9% vs. 18.1%, $P < 0.01$, Table 4]. NEOWHN was able to treat patients with medicated cycles (at home or with monitoring at the clinic), IUI or partial monitoring for IVF. These treatments were defined as pregnancy 'with assistance'. Of all the pregnancies recorded in the data set, patients living within 100 km of the clinic were more likely to achieve pregnancy without assistance from NEOWHN, whereas those who lived farther from the clinic were more likely to achieve pregnancy with assistance from NEOWHN [$P < 0.01$, Table 4].

DISCUSSION

Within a 100 km radius of NEOWHN, there are approximately 200,000 people and approximately 357,000 people in the remainder of Northeastern Ontario.[5] Despite its smaller population size, patients living within 100 km of NEOWHN (Local Group) accounted for more than two-thirds of the total fertility consultations completed at the clinic between 2019 and 2020. Patients in the local group were 4 times more likely to seek fertility consultation than those living ≥100 km of NEOWHN (travel group). It is unknown how far individuals would be willing to travel to access fertility services offered by

Table 2: Infertility diagnostic investigations

	Local group: <100 km from NEOWHN	Travel group: ≥100 km from NEOWHN	*P*
Number of patients seeking fertility consultation (*n*)	478	227	-
Prevalence of patients seeking fertility consultation by location (%)	0.24*	0.06†	<0.01
Previously underwent fertility investigations, *n* (%)	138 (28.9)	93 (43.2)	<0.01
US and BW complete, *n* (%)	313 (65.5)	114 (50.2)	<0.01
SIS/HSG complete, *n* (%)	306 (64.0)	122 (53.7)	<0.01
Semen analysis, *n* (%)	241 (50.4)	94 (41.4)	0.025
All investigations completed, *n* (%)	231 (48.3)	85 (37.4)	<0.01
All investigations completed at NEOWHN, *n* (%)	187 (39.1)	17 (7.5)	<0.01

*Based on population of 200,000 people, †Based on population of 357,000 people. NEOWHN: Northeastern Ontario Women's Health Network, US: Ultrasound, BW: Blood work, SIS: Saline infusion sonohysterogram, HSG: Hysterosalpingography

Table 3: Fertility treatments and pregnancy outcomes

	Local group: <100 km from NEOWHN, *n* (%)	Travel group: ≥100 km from NEOWHN, *n* (%)	*P*
Medicated cycles			
Proceeded with treatment	122/478 (25.5)	57/227 (25.1)	0.906
Pregnancy	33/122 (27.0)	19/57 (33.3)	0.486
IUI			
Proceeded with treatment	98/478 (20.5)	38/227 (16.8)	0.237
Pregnancy	21/98 (22.4)	8/38 (21.1)	0.962
IVF			
IVF consult	55/478 (11.5)	21/227 (9.3)	0.367
Proceeded with treatment	31/55 (56.4)	12/21 (57.1)	0.951
Pregnancy	13/31 (41.9)	3/12 (25.0)	0.302

NEOWHN: Northeastern Ontario Women's Health Network, IUI: Intrauterine insemination, IVF: *In-vitro* fertilization

Table 4: Overall pregnancy rates

	Local group: <100 km from NEOWHN (*n*=478), *n* (%)	Travel group: ≥100 km from NEOWHN (*n*=227), *n* (%)	*P*
Achieved pregnancy after consult	181/478 (37.9)	41/227 (18.1)	<0.01
Achieved pregnancy with assistance from NEOWHN	67/181 (37.0)	31/41 (75.6)	<0.01

NEOWHN: Northeastern Ontario Women's Health Network

NEOWHN; however, this finding aligns with international studies that highlight how living near a treatment centre dramatically increases the accessibility rates to fertility services.[10]

NEOWHN offers virtual consultations and so travel to the clinic for the initial visit was not anticipated to be a major barrier to seeking a consultation. However, patients with infertility may be aware that fertility investigations and treatments are an onerous time commitment influencing their decision to proceed with a consultation to begin with.[11] Diagnostic testing alone can require at least 6 clinic visits, including the consultation and follow-up. Treatment cycles for IUI require 2–3 visits per month, IVF cycles require 5–7 visits per month and cycle monitoring for both medicated and unmedicated cycles can require up to 3–4 visits per month. Clinic appointments at NEOWHN are scheduled during regular business hours, requiring most patients to take time off during work, which is further compounded by distance from the clinic. The Northern Health Travel Grant does not provide reimbursement for missed work or cover fuel costs for the first 100 km of mileage.[8] Subsequently, investigations and treatments become time-consuming and costly for patients when they have multiple appointments. Travel is also complicated by the difficult geography Northern Ontarians must traverse to reach NEOWHN. Poor weather, fatal collisions, wildlife, and non-linear single-lane highways come with the territory of driving in Northern Ontario. It is unknown if the significant difference in the proportion of patients pursuing initial consultations was related to travel, finances, geography or other unidentified factors that may impact fertility.

Completion of all fertility diagnostics was more likely to be carried out by the local group and completed at NEOWHN. Diagnostics need to be updated every 1–2 years, so although many patients in the travel group had already completed fertility investigations in the past, most required updated diagnostics to counsel for treatment options. There was minimal variation between the rate of patients in both groups who proceeded with medicated cycles, IUI and IVF after their initial consultation with NEOWHN. Medicated cycles can be done from home, allowing the patient to stimulate egg production and induce ovulation without having to visit the clinic frequently. NEOWHN has always offered Ontario Telemedicine Network (OTN) virtual consults and follow-up appointments for patients outside of Sudbury. Twenty-five per cent of patients, regardless of proximity to the clinic, proceeded with medicated cycling with timed intercourse. Pregnancy rates were similar. We believe treatment at home was chosen in the same proportions by the 2 groups because the distance to the clinic is not relevant. Patients can safely take medications without regular monitoring and can receive their prescriptions through fax to their pharmacy after an OTN visit.

IUI is a funded fertility treatment that typically involves oral medications and 3 visits to NEOWHN per cycle (1 month period).[12] Most patients start treatment with IUI before proceeding to IVF; however, there are cases where patients proceed directly to IVF, such as low sperm counts and blocked fallopian tubes.[13] Unexpectedly, there was a non-significant decrease in the proportion of patients from the travel group who chose to proceed with at least 1 IUI cycle at NEOWHN. Half of the patients in the travel group proceeding with IUI had previously undergone infertility treatments in the past compared to 30% of patients in the local group. We theorize that this prior exposure increased this group's understanding of how onerous investigations and treatments are, and subsequently, their commitment to fertility treatments such as IUI before the initial consultation at NEOWHN.[11] As well, this group may have been motivated to try IUI again, before proceeding to IVF, which would require even more travel and likely substantially more financial burden. Pregnancy rates amongst both groups were similar. This was expected as patient diagnoses and demographics were similar between both groups.

Forty-three of 705 patients proceeded to IVF treatment. IVF is commonly pursued by patients who are unsuccessful with IUI and medicated cycles.[11] In Ontario, only 1 IVF cycle is funded, and this does not include all costs, most notably medications.[12] We do not know the difference in personal finances from our study population since household income and third-party insurance coverage for medications are not recorded in our patient charts. NEOWHN does provide patients with local monitoring of follicular growth and

endometrial lining assessment for IVF, reducing the number of trips outside of Sudbury. However, IVF treatment requires the patient to travel to Toronto for egg retrieval and embryo transfer. Our results demonstrated similar rates of patients choosing to proceed with an IVF referral and to follow through with IVF as a treatment option. With similar pregnancy rates amongst the patients who proceeded with medicated cycles and IUI, and similar rates of infertility diagnoses between the groups, the aforementioned is not surprising. There was a non-significant difference in positive pregnancy rates after IVF treatment. The study is underpowered due to the small sample size for this secondary objective, and many patients were still in the process of IVF treatment at the study cut-off date.

Overall, patients <100 km from NEOWHN had statistically higher rates of pregnancy after their initial consultation. Pregnancy rates for patients undergoing fertility treatment of any kind (medicated, IUI and IVF) were similar between the groups. Interestingly, almost 25% of all patients in the local group were able to achieve pregnancy without treatment, compared to 4% of patients in the travel group. We believe the explanation of this may be multifactorial: Underreporting of pregnancies for patients out of town who likely contacted their local health team for pregnancy tests/ultrasounds; over half of the local group had unknown diagnoses and may have been referred to NEOWHN prematurely due to proximity of the clinic; and increased rates of tubal patency testing completed by patients in the local group which can assist with conception.

Limitations

There are limitations to our study. The total populations used in Table 2 to determine the point prevalence of fertility consultations were based on estimated values. In our data set, the proportion of patients seeking consultation at NEOWHN from within 100 km of the clinic was 4 times higher. We do not know the reasons why fewer couples outside of the 100 km radius of the clinic did not seek consultations at NEOWHN or if they sought consultations at other clinics. This underrepresentation of patients from outside of the 100 km radius of the clinic could affect pregnancy rates reported in Table 4. Pregnancy rates are based on diagnostic tests performed at NEOWHN, local health centres and patient self-reporting. All patients who achieve pregnancy after consultation at NEOWHN are asked to inform the clinic of their pregnancy, regardless of the method of conception. Contacting the clinic is not a requirement, therefore it is probable that the number of patients identified as having achieved pregnancy after consultation is higher than documented. New patient consults from 2019 to 2020 were followed until the end of August 2021. It is likely that there were patients who were able to achieve pregnancy beyond August 2021. Finally, Sudbury was often identified as a COVID-19 hotspot for Northeastern Ontario throughout the pandemic, so it is possible that patients chose to have their investigations completed elsewhere or proceed with their fertility journey at a later date.[14,15]

CONCLUSION

Living in rural and remote areas is a barrier to accessing healthcare services. Individuals living <100 km from NEOWHN were 4 times as likely to seek out fertility services in comparison to those living ≥100 km from NEOWHN. After the initial consultation, rates of pregnancy for patients were significantly higher for those living within 100 km of NEOWHN. We observed similar rates of pregnancy for patients during medicated, IUI, and IVF cycles, regardless of distance from the clinic. While the reason is likely multifactorial, we suspect geography and financial constraints pose an uncorrected barrier to seeking medical care. Our study demonstrates that within this northern community, increased distance from a major northern hub further affects access to fertility services. Further studies are needed to fully understand why the discrepancy in untreated pregnancy rates occurs.

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Conflicts of interest: There are no conflicts of interest.

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