

Improving Childhood Immunization Rates in a Saskatchewan First Nations Community – A Quality Improvement Initiative

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ABSTRACT

Background

First Nations children in Canada continue to face disparities in routine immunization coverage compared to non-Indigenous populations. To address these inequities, we aimed to improve childhood vaccine uptake in a northern Saskatchewan First Nations community through a systems-based quality improvement (QI) initiative.

Methods

We implemented a multifaceted QI project from April 2018 to March 2021. Our team applied continuous improvement tools—including Plan-Do-Study-Act (PDSA) cycles, root cause analysis, and key driver diagrams—to identify and address barriers to timely immunization. We prioritized interventions that strengthened data accuracy, expanded clinic accessibility, supported caregiver engagement, and facilitated outreach. We enhanced the utilization of the existing public health immunization registry (Panorama) and implemented a structured reminder-recall system. We evaluated changes in immunization coverage using monthly statistical process control (SPC) charts and Joinpoint regression analysis.

Results

Our findings revealed substantial and sustained improvements in vaccine coverage among young children. Immunization rates for one-year-olds increased from 87.4% to 97.1%, and coverage among two-year-olds rose from 60.7% to 91.7% over the course of the intervention. Improvements in data integrity, consistent follow-up, and systems-based quality improvement strategies appeared to support these gains. Community leadership and the use of trusted communication channels likely contributed to overcoming long-standing systemic and historical barriers.

Conclusion

Our results demonstrate that community-led, systems-based QI approaches can significantly enhance childhood immunization rates in First Nations settings. This model offers a replicable framework for advancing vaccine equity in other Indigenous communities across Canada and beyond.

Keywords: Childhood immunization, Quality improvement, First Nations, Community-led intervention

Introduction

Immunization has consistently served as one of the most effective public health strategies for preserving life and promoting population health (1–3). According to the Public Health Agency of Canada (PHAC), routine childhood vaccinations protect against 14 serious infectious diseases, offering more than 90% protection (4). In addition to health benefits, immunization significantly reduces the economic burden associated with disease and contributes substantial social value to communities (5). Specifically, it mitigates the financial strain of medical expenses and prevents income loss due to caregiving responsibilities (6–8).

Recognizing these benefits, both the federal and Saskatchewan provincial governments offer free, mandatory childhood vaccination programs, targeting a 95% completion rate, with particular emphasis on northern Saskatchewan First Nations communities (9). Despite these efforts, childhood immunization coverage remains suboptimal across several Canadian provinces, including Saskatchewan, and is consistently lower among First Nations children (10,11). Childhood immunization coverage is especially inadequate among one- and two-year-olds residing in northern Saskatchewan First Nations communities (12).

Low immunization rates in these communities elevate the risk of outbreaks of vaccine-preventable diseases. To address this, it is essential to identify and address local, context-specific barriers to optimal vaccine uptake, as reported in previous studies (13,14). A detailed understanding of these barriers supports the development of community-led, evidence-informed strategies, delivered through interdisciplinary collaboration, to enhance immunization efforts and reduce the risk of infection (15–17).

Given the persistent challenges in pediatric immunization coverage and the limited evidence on multicomponent, team-based interventions within northern Saskatchewan First Nations populations, we applied a team-based quality improvement framework to identify key drivers of suboptimal immunization. We assessed the effectiveness of this structured intervention in improving routine immunization coverage among First Nations children under two years of age in northern Saskatchewan over a 36-month implementation period. The aim of our study was to increase childhood immunization coverage rates to 90% for 1-year-olds and 90% for 2-year-olds by March 31, 2019, up from 82% and 80%, respectively.

Methods

Study Design

We implemented a group-based quality improvement initiative to boost immunization rates in children under two.

Setting

Our study took place in a northern Saskatchewan First Nations community which is served by the Northern Inter-Tribal Health Authority (NITHA). Established in 1998, NITHA supports 33 northern Saskatchewan communities with culturally appropriate public health services, including immunization monitoring, communicable disease control, and workforce training(12).

Participants

We focused on children who turned one or two years old between April 1, 2018, and March 31, 2021, and were eligible for immunizations according to the Saskatchewan Immunization Manual (9).

Interventions

Our cross-disciplinary QI team, comprising physicians, nurses, public health practitioners, and administrators, was trained in QI tools and principles, including those outlined in the literature (18–20). We began with a comprehensive audit of immunization records from both electronic (Panorama) and paper-based (Red Book) systems. We corrected inconsistencies such as data entry errors, missing or duplicated records, and cross-jurisdictional mismatches. Public health nurses validated all corrections to ensure data accuracy.

We used fishbone diagrams to systematically identify and organize root causes into six domains: personnel, process, environment, materials, equipment, and

management. Based on these findings, we constructed a Key Driver Diagram to align specific interventions with identified root causes and broader project goals. This framework guided the development of PDSA cycles which were used to test and refine each intervention. PDSA is a structured quality improvement method that is used for testing changes and improving processes. It involves identifying a specific problem, developing a plan to address it, and identifying how to measure the results.

In the second phase, we developed a registry of under- and unimmunized children nearing or past their vaccine due dates. We initiated reminder and recall efforts via phone calls and text messages encouraging caregivers to book follow-up appointments. To boost community engagement, we offered educational materials and incentives. For sustainability, we integrated immunization into routine care, provided transportation support, conducted monthly audits, and offered continuous staff training on Panorama use and immunization protocols to ensure accurate data and ongoing improvement.

Measurements

We calculated monthly immunization coverage for both 1-year-old and 2-year-old cohorts by dividing the number of children who received the recommended number of vaccine doses for their age by the total number of eligible children in the community at each time point.

Analysis

We applied statistical process control (SPC) charts to track and interpret immunization trends, utilizing upper and lower control limits with a central mean line to differentiate normal variation from significant changes. We created these charts in Microsoft® Excel® LTSC MSO (16.0.14332.21031). Additionally, we used Joinpoint regression analysis (version 4.9.1.0) to detect significant shifts over time, calculating monthly and average monthly per cent changes (MPC and AMPC). Statistical significance was assessed through Monte Carlo permutation testing, with a threshold of $p < 0.05$.

Ethical Considerations

We carried out this initiative as a quality improvement project to strengthen immunization delivery in a First Nations community. For this reason, we did not seek ethics approval. Per Article 2.5 of the Tri-Council Policy Statement 2 (2022), quality improvement studies do not require formal REB review (21). We followed applicable

provincial privacy laws and adhered to OCAP® principles—Ownership, Control, Access, and Possession in collaboration with community leaders, the community health director and health staff.

Results

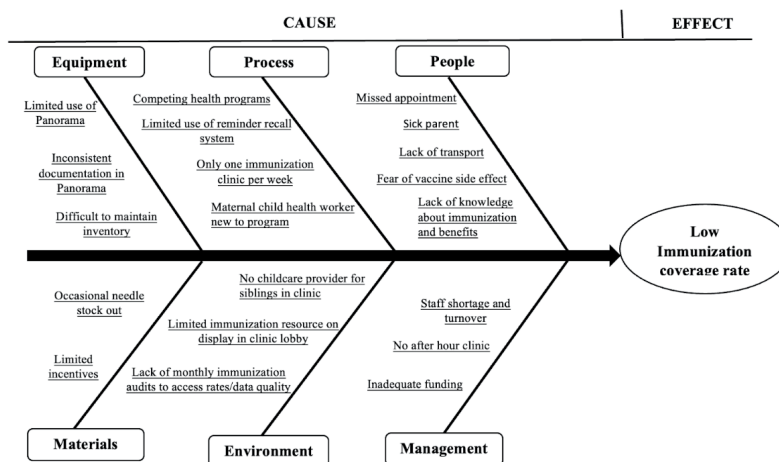
Our analysis uncovered interconnected barriers to low immunization rates among children under two years old. Using root cause analysis, control charts, and Joinpoint regression, we identified intervention points and tracked progress over a 36 month period.

Root Cause Analysis of Low Immunization Coverage

We used a fishbone diagram (Figure 1) to classify barriers into six categories: equipment, process, people, materials, environment, and management. In the

equipment domain, inconsistent use of the Panorama system, poor record-keeping, and challenges in vaccine inventory management emerged as major issues. Process barriers included limited clinic hours, competing health priorities, underuse of reminder systems, and the inexperience of a new maternal-child health worker. People-related obstacles involved missed appointments due to caregiver illness, transportation difficulties, vaccine safety concerns, and limited awareness of immunization benefits. Material shortages, such as needles and syringes, and lack of caregiver incentives were also noted. Environmentally, the absence of educational resources, lack of sibling childcare during visits, and irregular data audits affected service quality. Lastly, management challenges, such as staff turnover, limited after-hours availability, and budget restrictions, further hindered immunization efforts.

Figure 1. Fishbone diagram for root cause analysis of low immunization coverage in children 2 years old and younger.



Key Drivers of Immunization Improvement

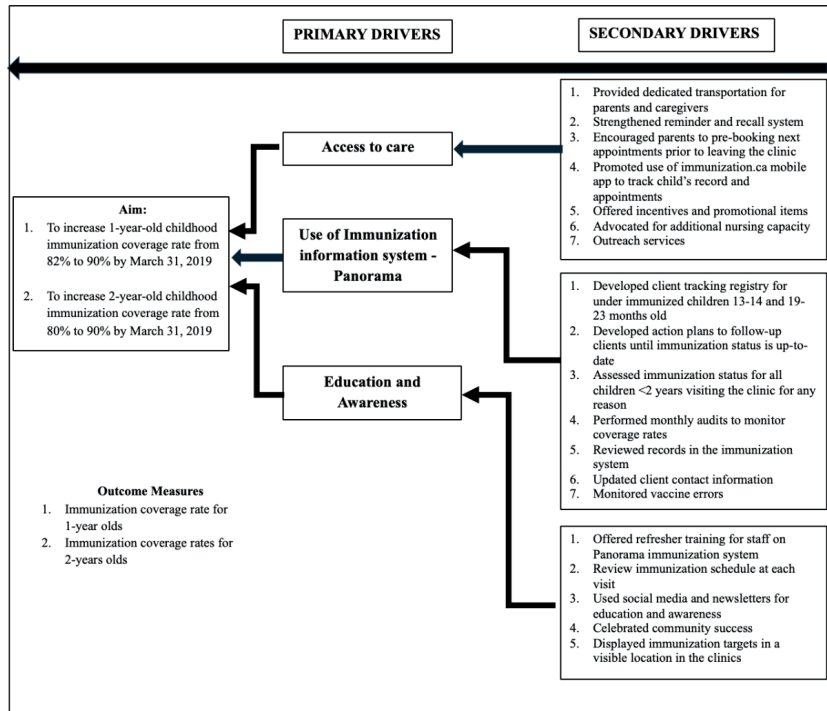
Our study created a Key Driver Diagram (Figure 2) to guide our quality improvement (QI) efforts. We focused on three main drivers to boost routine childhood immunization rates: enhancing access to care, optimizing the Panorama system, and increasing education and awareness among caregivers and staff.

staff to meet growing demand. For the Panorama system, we developed a registry of under-immunized children, performed monthly data audits, and maintained up-to-date client records. Immunization status checks became a routine part of all child health visits, supported by a structured follow-up protocol to address missed vaccinations.

To improve access, we facilitated transportation assistance for caregivers, strengthened reminder and recall processes, and implemented pre-scheduled immunization appointments. We also organized outreach clinics and advocated for additional nursing

Our education strategy involved refresher training for clinical staff on immunization guidelines and Panorama use, regular communication of vaccine information through newsletters and social media, and public display of immunization goals and community progress within clinics.

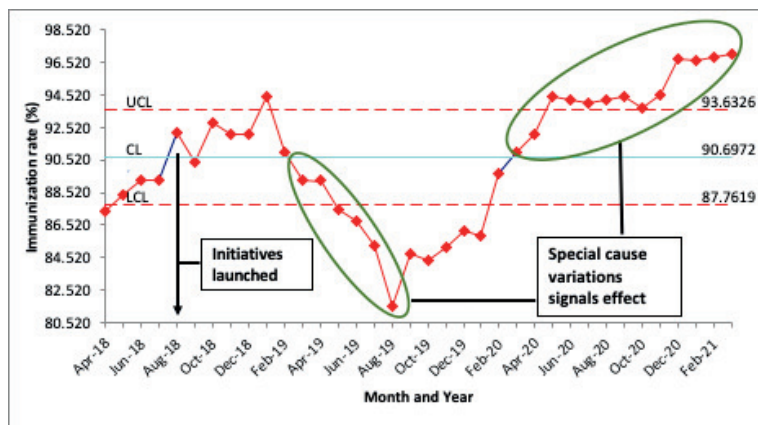
Figure 2. Immunization improvement Key Driver diagram



Immunization Trends of 1-Year Age Cohort

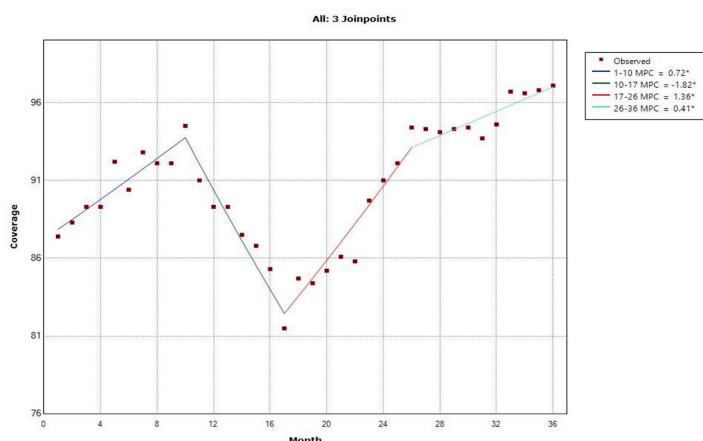
Figure 3 shows immunization coverage trends among 1-year-olds from April 2018 to March 2021. Starting at 87.4% in April 2018, coverage rose steadily after quality improvement (QI) interventions, peaking at 97.1% by March 2021—a 9.7 percentage point increase. Early improvements occurred between May and August 2018, followed by a dip from February to August 2019 (months 11–17). A consistent upward trend resumed in September 2019 (month 18). Coverage stayed above the mean for 13 straight months, from March 2020 to March 2021 (months 24–36), indicating sustained progress.

Figure 3. Control chart for overall immunization rate for the 1-year old cohort, with upper and lower control limits, April 2018 to March 2021, showing special cause variations (Green).



Joinpoint regression (Figure 4) revealed three significant inflection points at months 10, 17, and 26. We identified four statistically significant segments: months 1–10 (MPC = 0.72, $p < 0.001$), 10–17 (MPC = -1.82, $p < 0.001$), 17–26 (MPC = 1.36, $p < 0.001$), and 26–36 (MPC = 0.41, $p = 0.001$). Overall, the Average Monthly Percent Change (AMPC) was 0.3% (95% CI: 0.1–0.4; $p < 0.001$), indicating a meaningful and sustained upward trend in immunization coverage among 1-year-olds.

Figure 4. Joinpoint analysis of the trend in 1-year-old vaccination rates from the 1st month (April 2018) to the 36th month (March 2021)

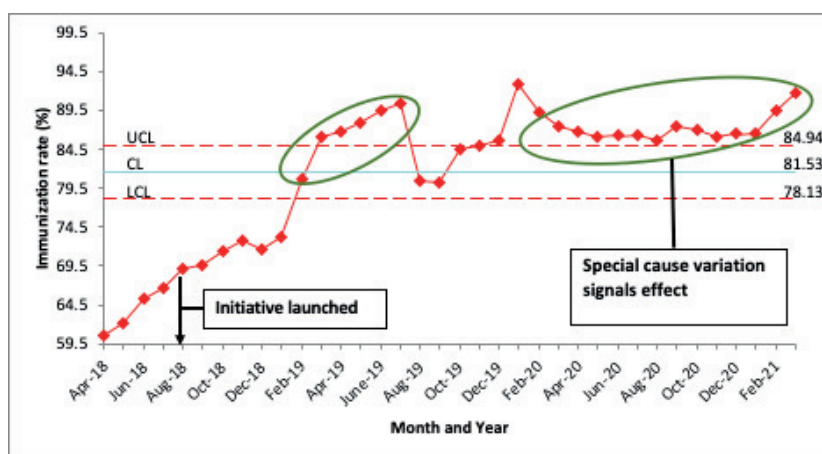


Immunization Trends of 2-Year Age Cohort

As illustrated in Figure 5, the mean immunization coverage for the 2-year-old cohort was 81.5%, with coverage ranging between 78.1% and 84.9%. At baseline in April 2018, only 60.7% of children had completed their immunization schedule by their second birthday. By March 2021, this figure had risen to 91.7%, reflecting a 31-percentage point improvement.

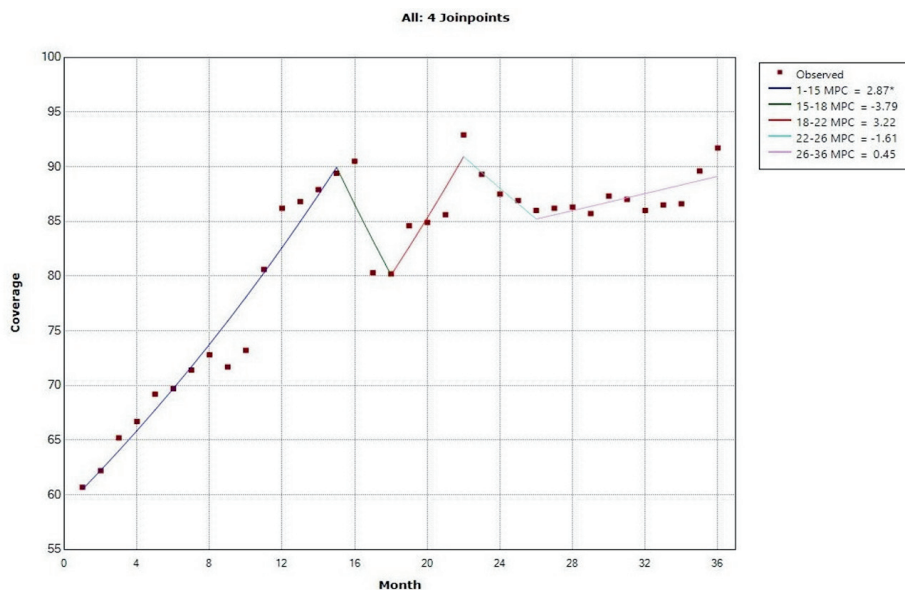
We observed rapid gains between months 2 and 16 (May 2018–July 2019), followed by a short dip during months 16–18. A rebound occurred from months 19 to 22, after which the coverage plateaued but remained stable through month 34. Notably, during this phase, 26 consecutive data points stayed at or above the mean coverage rate.

Figure 5. Control chart for overall immunization coverage rate for 2-year-old cohort, with upper and lower control limits, April 2018 to March 2021, showing special cause variations (Green).



Joinpoint analysis (Figure 6) identified four breakpoints at months 5, 18, 22, and 26, producing five intervals. A statistically significant rise was seen in the first interval (months 1–15) with an MPC of 2.9% ($p < 0.001$). While the subsequent segments showed no significant trends, the overall AMPC for the whole study period was 1.1% (95% CI: 0.3–1.9; $p = 0.007$), confirming a positive and sustained trajectory in immunization uptake for the 2-year-old group.

Figure 6. Joinpoint analysis of the trend in 2-year-old vaccination rates from the 1st month (April 2018) to the 36th month (March 2021)



Discussion

In this study, we set out to improve routine childhood immunization coverage in a northern First Nations community using a systems-based QI approach. Our findings indicate the effectiveness of community-driven interventions in achieving sustained improvements in immunization rates.

The upward trend in immunization coverage observed, particularly among 1- and 2-year-olds, aligns with findings from similar studies that have demonstrated the efficacy of QI initiatives in pediatric populations (22–24). By employing structured QI tools such as Plan-Do-Study-Act (PDSA) cycles, root cause analysis, and key driver diagrams, our team was able to identify and address service bottlenecks promptly. This approach corroborates earlier research suggesting that QI frameworks can effectively pinpoint system-level constraints and facilitate timely adjustments (23–25).

A pivotal component of our intervention was the utilization of the Panorama immunization information

system. Prior to our initiative, the system was underutilized. Through staff retraining and integrating immunization checks into all child health encounters, we enhanced data quality and leveraged it for proactive client outreach. This strategy supports findings from studies indicating that digital immunization registries, when actively maintained and integrated into routine workflows, can improve vaccine uptake (26–28).

Beyond structural changes, our intervention emphasized the importance of trust, communication, and education, consistent with a previous study (29). Vaccine hesitancy and misinformation are global concerns, and Indigenous communities often face additional layers of mistrust rooted in historical and systemic inequities (27,30–32). By prioritizing culturally safe communication, developing targeted educational materials, and ensuring that health messages were delivered through trusted local channels, we aimed to address these challenges. Our approach aligns with recommendations that advocate for Indigenous-led health solutions that acknowledge colonial legacies and support community empowerment (33).

We recognize that Indigenous populations in Canada, including First Nations Peoples, have long experienced lower childhood immunization rates than non-Indigenous groups (10,11). Research consistently attributes this disparity to systemic challenges such as chronic underfunding of health services, geographic remoteness, and a misalignment between culturally safe care and existing health delivery models (11,32,34). During our intervention, we observed that enabling First Nations communities to lead their own health initiatives—when equipped with proper resources and authority—transformed many systemic challenges into strengths. This shift often reinforced local health systems. Our findings align with those of Kyoon et al. (2022), who emphasized that self-determined, community-led healthcare can drive sustainable transformation in primary care for First Nations communities (35).

The incorporation of outreach clinics and flexible scheduling also proved effective in our context. Similar interventions in other underserved populations have emphasized the importance of bringing services closer to families and reducing logistical burdens (28,36). By extending clinic hours, offering transportation support, and conducting home visits, we increased both access and convenience. These findings parallel those of other studies highlighting the success of community-based immunization programs that integrate logistical support and minimize appointment-related challenges (35,37).

We also saw the value of visual and public-facing data displays in promoting staff motivation and community engagement. Sharing progress on immunization goals, such as posting clinic performance in visible spaces, created a culture of accountability and pride. This strategy draws on principles of behavioral economics and nudge theory, both of which suggest that timely feedback can shape professional behavior and promote quality care (38,39). In our experience, such visual cues served as both a reminder and an incentive for teams to sustain their efforts.

Public Health Implications

The implications of our findings are both local and national in scope. Locally, our work suggests that First Nations-led public health teams, when supported with the right tools, resources, and data access, can close immunization gaps that have persisted for decades. At the national level, our results provide actionable pathways for fulfilling the Truth and Reconciliation Commission of Canada's (TRC) Call to Action #19, which urges federal, provincial, and territorial

governments to close health outcome gaps, including immunization, between Indigenous and non-Indigenous populations (33). Our model supports the development of community-directed public health programs that are data-driven, culturally anchored, and grounded in relationships.

Strengths and Limitations

Our study's strengths include a systems-based approach, real-world application, and strong community engagement. By addressing immunization gaps as interconnected challenges, we created adaptable, context-specific solutions. Embedding the initiative within a community-led public health system enhanced its relevance and ecological validity. Using control charts and Joinpoint regression enabled rigorous monitoring of trends and significant changes. We respected Indigenous data sovereignty by following OCAP® principles, thereby fostering trust and community leadership. Engaging local health staff throughout ensured sustainability and capacity building.

However, the study's limitations include its focus on a single community, which may affect generalizability. We lacked qualitative insights from caregivers to deepen our understanding of vaccine hesitancy. The multifaceted intervention design prevented the isolation of the effects of individual components. Lastly, we did not perform a cost-effectiveness analysis, which limited scalability assessment. Future research should address these gaps.

Conclusion

Our findings contribute to the growing evidence that First Nations communities when supported with systems-based quality improvement and evidence-informed strategies, can lead to transformative public health improvements. We demonstrated that sustained improvements in routine childhood immunization coverage are achievable through QI initiatives. By addressing logistical, informational, and operational barriers in a coordinated manner, we significantly enhanced vaccine uptake in a historically underserved First Nations community in northern Saskatchewan. Our approach offers an adaptable model for similar efforts in other Indigenous communities across Canada and globally.

References

1. Bbaale E. Factors influencing childhood immunization in Uganda. *J Health Popul Nutr.* 2013;31(1):118.
2. Ehreth J. The value of vaccination: a global perspective. *Vaccine.* 2003;21(27-30):4105-17.
3. WHO. Immunization [Internet]. 2019 [cited 2025 May 5]. Available from: <https://www.who.int/news-room/facts-in-pictures/detail/immunization>
4. PHAC. Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. [Internet]. Ottawa; 2017 [cited 2025 Apr 7]. Available from: <https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html>
5. Bloom DE, Canning D, Weston M. The value of vaccination. *Fighting the diseases of poverty.* Routledge; 2017. 214-238 p.
6. Ozawa S, Clark S, Portnoy A, Grewal S, Brenzel L, Walker DG. Return on investment from childhood immunization in low-and middle-income countries, 2011-20. *Health Aff.* 2016;35(2):199-207.
7. Ozawa S, Zhou M, Wonodi C, Chen HH, Bridges JFP. Parents' preferences for interventions to improve childhood immunization uptake in northern Nigeria. *Vaccine.* 2018;36(20):2833-41.
8. Ozawa S, Yemeke TT, Thompson KM. Systematic review of the incremental costs of interventions that increase immunization coverage. *Vaccine.* 2018;36(25):3641-9.
9. MOH-SK. Saskatchewan Ministry of Health. Saskatchewan Immunization Manual Chapter 5 - Immunization Schedules [Internet]. 2021 [cited 2025 Mar 15]. Available from: <https://www.ehealthsask.ca/services/Manuals/Documents/sim-chapter5.pdf>
10. Halseth R, Greenwood M. Indigenous early childhood development in Canada: Current state of knowledge and future directions. National Collaborating Centre for Aboriginal Health Prince George, BC; 2019.
11. Lemstra M, Neudorf C, Opondo J, Toye J, Kurji A, Kunst A, et al. Disparity in childhood immunizations. *Paediatr Child Health.* 2007;12(10):847-52.
12. Northern Inter-Tribal Health Authority. 2022/2023 Annual Report: Pandemic Recovery [Internet]. Prince Albert; 2023 [cited 2024 Jan 18]. Available from: https://www.nitha.com/wp-content/uploads/2023/10/NITHA-Annual-Report-2023_web.pdf
13. Gagnon D, Dubé È. Literature review on effective strategies to improve vaccine acceptance and uptake. Ottawa: Canadian Public Health Association CAN-Vax. 2019;
14. Tarrant M, Gregory D. Exploring childhood immunization uptake with First Nations mothers in north-western Ontario, Canada. *J Adv Nurs.* 2003;41(1):63-72.
15. Bottino CJ, Cox JE, Kahlon PS, Samuels RC. Improving immunization rates in a hospital-based primary care practice. *Pediatrics.* 2014;133(4):e1047-54.
16. Fu LY, Weissman M, McLaren R, Thomas C, Campbell J, Mbafor J, et al. Improving the quality of immunization delivery to an at-risk population: a comprehensive approach. *Pediatrics.* 2012;129(2):e496-503.
17. Gannon M, Qaseem A, Snooks Q, Snow V. Improving adult immunization practices using a team approach in the primary care setting. *Am J Public Health.* 2012;102(7):e46-52.
18. Elizabeth Esan A, Williams SJ, Gakhali S, Caley L, Cooke MW. Healthcare quality improvement-policy implications and practicalities. *Int J Health Care Qual Assur.* 2012;25(7):565-81.
19. Nguyen GT, Klusaritz HA, Cronholm PF. Achieving sustainable increases in childhood immunization rates. *Fam Pract Manag.* 2014;21(4):13-7.
20. Schriefer J, Leonard MS. Patient safety and quality improvement: an overview of QI. *Pediatr Rev.* 2012;33(8):353-60.

