

Uptake of pneumococcal vaccines in the Nordic region of Nunavik, province of Quebec, Canada

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ABSTRACT

OBJECTIVES: Pneumococcal infections constitute an important public health problem in Nordic regions of Canada. Nordic populations are not included in national and provincial immunization surveys and there is no centralized immunization registry in these regions. The objective of this study was to estimate pneumococcal vaccination coverage and delays in immunization of children in Nunavik, Quebec.

METHODS: Immunization records of children born in 1994-2005 were collected in all villages. Children were classified into three groups: born in the period January 1, 1994 to April 30, 1997 and targeted by the 2002 mass campaign with the 23-valent polysaccharide vaccine (PPSV23); born in the period May 1, 1997 to March 31, 2002 and targeted by the 7-valent conjugate vaccine (PCV7) catch-up campaign; born in the period April 1, 2002 to December 31, 2005 and targeted by the PCV7 routine infant program.

RESULTS: In the first group ($n=896$), 86.8% (95% CI: 84.4%-89.0%) were vaccinated with PPSV23. In the second group ($n=1,252$), 84.3% (95% CI: 82.1%-86.2%) received ≥ 1 PCV7 dose. In the third group, 90.4% (95% CI: 88.5%-92.1%) received 4 PCV7 doses. Delays >4 weeks in vaccine administration were observed for 26.3% of doses. There were substantial variations between villages for all indicators.

CONCLUSIONS: In the challenging setting of a Nordic and remote region, uptake rates of pneumococcal vaccines in Nunavik were found to be similar to those measured in population surveys in Quebec.

KEY WORDS: Streptococcus pneumoniae; pneumococcal vaccines; immunization; infectious diseases; Aboriginal health

La traduction du résumé se trouve à la fin de l'article.

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Respiratory infections constitute a major public health problem in Nordic communities of Canada and *Streptococcus pneumoniae* (*Sp*) is an important causal pathogen.^{1,2} In 2000, an outbreak of severe pneumonia caused by serotype 1 *Sp* was identified in the Inuit population of Nunavut and Nunavik.^{3,4} Nunavik is the most northerly region of the province of Quebec. Approximately 90% of its population ($n \approx 12,000$) are Inuit, living in 14 villages located along the Hudson and Ungava bays. In order to control this outbreak, a mass immunization campaign was carried out during the spring of 2002, targeting persons ≥ 5 years of age and using the 23-valent pneumococcal polysaccharide vaccine (PPSV23).⁵ At the same time, the 7-valent pneumococcal conjugate vaccine (PCV7) was introduced for the routine immunization of infants (4 doses, offered respectively at 2, 4, 6 and 18 months of age) with a catch-up for children less than 5 years of age.⁶ The 10-valent pneumococcal conjugate vaccine (PCV10) replaced PCV7 in the summer of 2009, and the 13-valent vaccine (PCV13) replaced PCV10 in January 2011.⁷ In order to assess the impact of pneumococcal vaccines on the epidemiology of invasive pneumococcal diseases, lower tract respiratory infections and otitis media, knowledge of pneumococcal vaccine uptake in different segments of the population is essential.

As part of the International Polar Year Initiative,⁸ a retrospective study was performed, targeting children residing in Nunavik and born during the period 1994 to 2005. We report

results pertaining to pneumococcal vaccine uptake and delays in vaccine administration in different cohorts of births in the 14 villages of Nunavik.

METHODS

The study population included all children born in the period January 1, 1994 to December 31, 2005 and registered by the public health services of the region of Nunavik. There is a primary care health centre in each village where immunization cards are kept. There is no centralized computerized system for immunization in the region. In 2008, copies of immunization

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Conflict of Interest: During the last year, Philippe De Wals received research grants and reimbursements of travel expenses from vaccine manufacturers, including Glaxo-Smith-Kline, Novartis, Sanofi Pasteur, Merck and Pfizer, as well as from governmental agencies, including the Quebec Ministry of Health and Social Services and the Public Health Agency of Canada. None of the other authors have conflicts to declare.

Table 1. Uptake rate of PCV7 according to the number of doses among 1,075 children born in the period April 1, 2002 to December 31, 2005, who were targeted by the routine immunization program implemented in the spring of 2002, Nunavik, province of Quebec, Canada

Number of doses administered	Village and number of children														
	1 N=56	2 N=171	3 N=133	4 N=74	5 N=198	6 N=41	7 N=52	8 N=24	9 N=132	10 N=57	11 N=44	12 N=55	13 N=28	14 N=10	All N=1075
0 dose	10.7%	2.3%	–	1.4%	9.6%	2.4%	1.9%	–	5.3%	–	2.3%	1.8%	14.3%	–	4.2%
≥1 dose	89.3%	97.7%	100%	98.6%	90.4%	97.6%	98.1%	100%	95.7%	100%	97.7%	98.2%	85.7%	100%	95.8%
≥2 doses	89.3%	97.7%	100%	97.3%	89.9%	95.1%	98.1%	100%	91.7%	100%	97.7%	98.2%	85.7%	100%	95.0%
≥3 doses	89.3%	97.7%	99.2%	97.3%	86.9%	92.7%	98.1%	95.8%	87.9%	100%	97.7%	98.2%	85.7%	100%	93.9%
4 doses	87.5%	94.2%	97.7%	97.3%	83.3%	90.2%	92.3%	95.8%	80.3%	100%	97.7%	98.2%	85.7%	90.0%	91.0%
Total doses administered	199	662	528	289	692	154	201	94	468	228	172	216	96	39	4038
Proportion with delay ≥4 weeks	32.7%	18.3%	35.4%	14.9%	29.5%	17.5%	23.4%	24.5%	40.2%	21.1%	30.2%	10.2%	31.3%	17.3%	26.3%

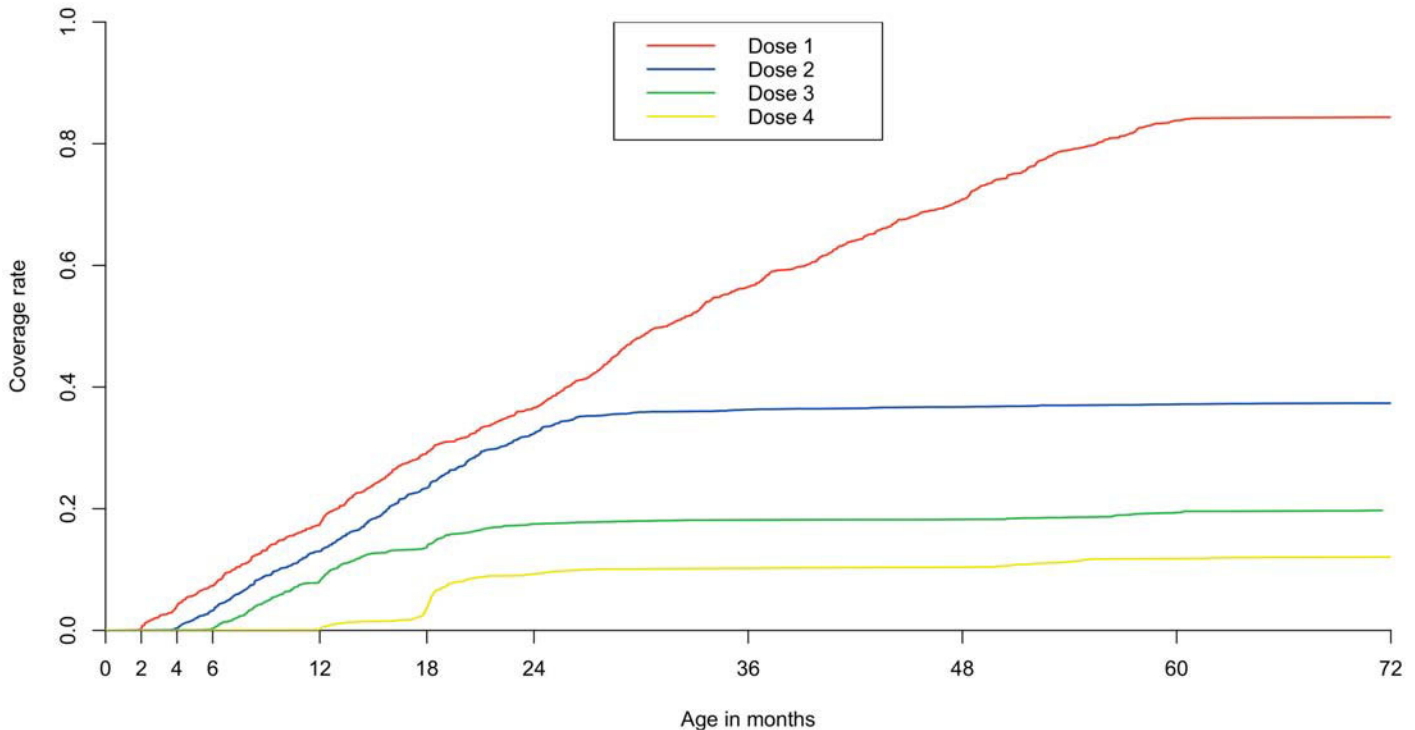


Figure 1. Cumulative frequency by age at 1st, 2nd, 3rd and 4th PCV7 dose among 1,252 children born in the period May 1, 1997 to March 31, 2002, who were targeted by the catch-up program implemented in the spring and summer of 2002, Nunavik, province of Quebec, Canada

cards were obtained; in 2011, all 14 primary care health centres were visited and immunization cards reviewed. The information collected included names, village of residence, date of birth, sex, type of pneumococcal vaccine received and date of administration up to the 5th birthday anniversary. Children were classified into in 3 groups: i) those born in the period January 1, 1994 to April 30, 1997 and targeted by the 2002 mass campaign with PPSV23; ii) those born in the period May 1, 1997 to March 31, 2002 and targeted by the PCV7 catch-up campaign initiated in the spring of 2002; and iii) those born in the period April 1, 2002 to December 31, 2005 and targeted by the PCV7 routine infant program. Immunization rates according to the number of doses received were calculated by village and cohort of birth.

Vaccine uptake rate by vaccine dose and exact 95% confidence intervals were computed with R statistical software 2.12.1 (R Foundation for Statistical Computing, Vienna, Austria). Cumulative vaccine coverage curves by age (in days and converted into months) were also calculated. According to

the recommendation of the Canadian Immunization Registry Network,^{9,10} a delay in vaccine administration was defined as a dose given more than 4 weeks after the recommended age. The study protocol was approved by the Quebec University Hospital Research Ethics Committee and by the Directors of the two regional health centres of Nunavik (Inuulitsivik Health Centre, Puvirnituk, and Ungava Tulattavik Health Centre, Kuujuaq).

RESULTS

A total of 3,505 children born in the period January 1, 1994 to December 31, 2005 and who had resided in Nunavik during the first five years of their life were identified. Of these, 280 children (8.0% of the total) were excluded because their medical file or immunization card was not found or was grossly incomplete, signaling an early death, an early departure or a transitory stay in the region. Thus, the statistical analysis included 3,223 children; 48.9% were female (1,576/3,211 whose sex was indicated).

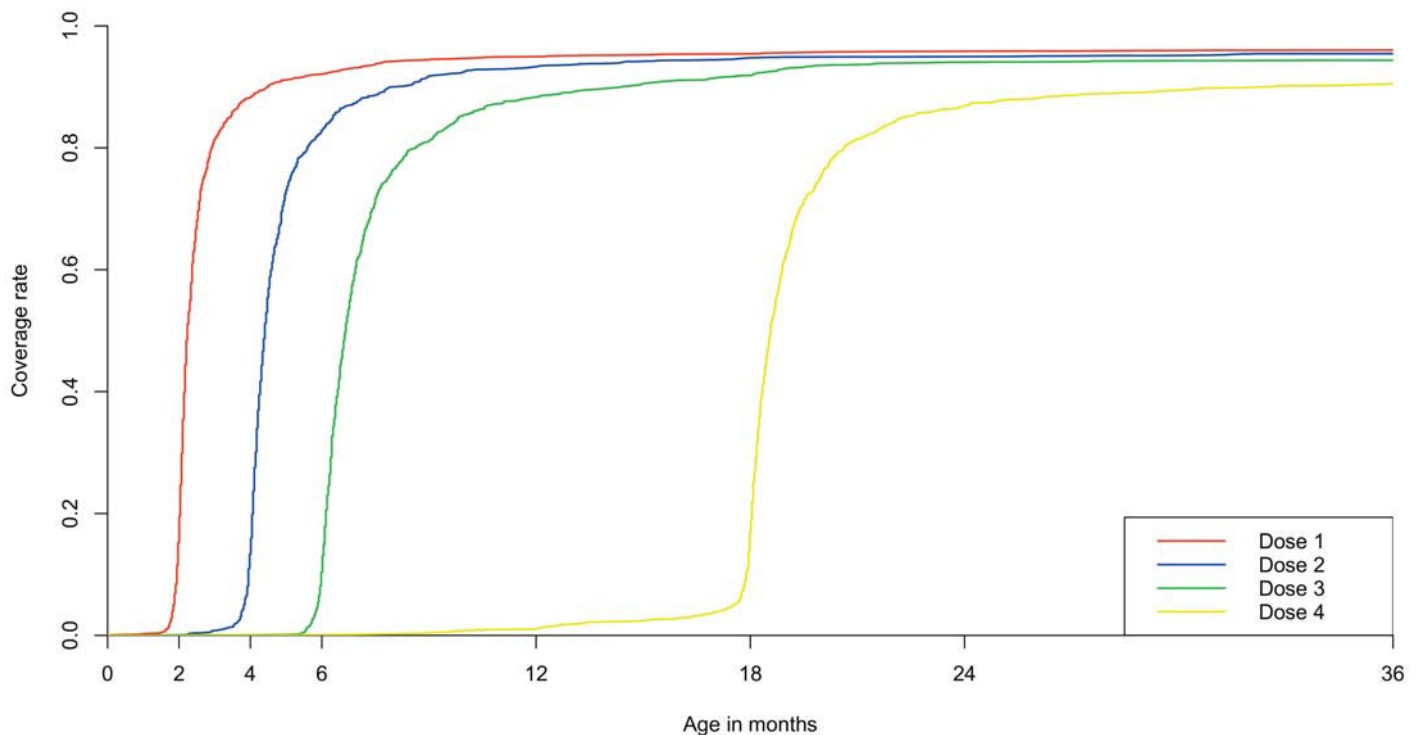


Figure 2. Cumulative frequency by age (in days) at 1st, 2nd, 3rd and 4th PCV7 dose among 1,075 children born in the period April 1, 2002 to December 31, 2005, who were targeted by the routine immunization program implemented in the spring of 2002, Nunavik, province of Quebec, Canada

Group I

Of 896 children born in the period January 1, 1994 to April 30, 1997, 86.8% (95% CI: 84.4%-89.0%) were vaccinated with PPSV23 during the 2002 mass immunization campaign and 9 received a second dose later (probably because of the existence of a high-risk condition). None of these children received PCV7 before their 5th year anniversary.

Group II

There were 1,252 children born in the period May 1, 1997 to March 31, 2002, who were targeted by the PCV7 catch-up program. The cumulative frequency by age of 1st, 2nd, 3rd and 4th PCV7 dose is shown in Figure 1. All of these children should have received at least one PCV7 dose and the overall ≥1 dose coverage was 84.3% (95% CI: 82.1%-86.2%). The recommended number of PCV7 doses varied according to the age of each child when seen at a vaccination clinic. Only 11.7% (95% CI: 10%-13.7%) had received four doses before their 5th birthday anniversary.

Group III

There were 1,075 children born in the period April 1, 2002 to December 31, 2005, who were targeted by the routine 4-dose PCV7 program implemented in the spring of 2002. The distribution of children according to the number of doses received in each of the 14 villages is shown in Table 1. Overall, 87.0% (95% CI: 84.8%-88.9%) of children received the recommended number of doses by age 2 years and 91.3% (95% CI: 89.5%-93.0%) by age 5 years. There was no statistically significant difference between girls and boys (87.6% vs. 85.6% by age 2 years, *p*=0.37; 91.7% vs. 90.2% by age 5 years, *p*=0.43). In 6 of 14 villages (43%), the 95% coverage target was achieved. In

3 villages, rates were lower than 90%, with a minimum of 80.3% in one village. Overall, the proportion of children who did not receive at least one PCV7 dose was 4.2%, ranging from a minimum of 0% to a maximum of 14% according to villages.

The cumulative frequency by age at 1st, 2nd, 3rd and 4th PCV7 dose is shown in Figure 2. The overall one-dose coverage was 95.8% (95% CI: 94.4%-96.9%) at 2 years and 96.3% (95% CI: 95.0%-97.3%) at 5 years. 94.9% received at least 2 doses before 2 years of age (95% CI: 93.4%-96.1%) and 95.4% before 5 years (95% CI: 94.0%-96.6%). 94.0% received at least 3 doses before 2 years of age (95% CI: 92.5%-95.4%) and 94.4% before 5 years (95% CI: 92.9%-95.7%). 87.0% (95% CI: 84.8%-88.9%) received the recommended 4 doses before 2 years of age and 91.3% (95% CI: 89.5%-93.0%) before 5 years.

Overall, 17.1% of vaccinated children received their 1st PCV7 dose more than four weeks after the age of 60 days. Delays tended to increase for the following doses: 26.2% for the 2nd dose, 27.4% for the 3rd dose, and 33.3% for the 4th dose. Overall, 26.3% of doses were administered with a delay of more than 4 weeks, the proportion ranging from a minimum of 10.2% to a maximum of 40.2% according to villages (Table 1).

DISCUSSION

The implementation of the pneumococcal conjugate vaccine program in December 2004 in the province of Quebec (16 out of 18 health regions) was highly successful in terms of coverage rates, both in infants targeted by the routine 3-dose program and older children targeted by the catch-up campaign.¹¹ Results of the 2012 Quebec provincial immunization survey showed that 93.1% of children are receiving the recommended 3 doses by age 2 years.¹² Results of the current study confirm that the

performance was as good in the mostly Inuit population of Nunavik: more than 80% of children targeted by the catch-up campaign received at least one PCV7 dose, more than 90% of infants are routinely receiving the recommended four doses (because they are considered to be at high risk), and the majority of doses were administered in the desired age-window. Vaccine uptake rates in Nunavik were much higher than those observed (approximately 43%) in low-income communities of Saskatoon (SK) with a high proportion of Aboriginal children,¹³ and comparable with those observed in Alaska.^{14,15} Although the overall performance of primary health care services in Nunavik is satisfactory, efforts should be made to better understand obstacles to immunization in the region, especially in villages with uptake lower than 90%.

Obtaining information on vaccine uptake in Aboriginal populations of Canada is particularly challenging. National immunization surveys have been periodically conducted since 1994, first by Health Canada and thereafter by the Public Health Agency of Canada.¹⁶ In the 2004 survey, computer-assisted telephone interviews were performed with approximately 1,500 parents of children aged between 20 and 40 months, aged 7 years and aged 17 years, in seven regions: British Columbia, Alberta, Manitoba and Saskatchewan, Ontario, Quebec, the Atlantic Provinces, and the territories.¹⁶ The most recent survey was conducted in 2011, in a sample of approximately 2,800 children aged 2, 7, 10 to 14 (girls) and 17 years, living in the 10 provinces and 3 territories, not residing in institutions or reserves.¹⁷ Results have not been published yet. The sampling process, sample size and data collection methods of these national surveys are not suitable to provide precise and valid estimates of vaccination coverage in aboriginal populations. In the province of Quebec, the two northern regions of Nunavik and Terres-Cries-de-la-Baie-James are excluded from childhood immunization surveys conducted every two years.¹² Population-based centralized immunization registries are a solution to overcoming linguistic and cultural barriers to health surveys in high-risk population groups. Moreover, computerized records could facilitate the work of health professionals in assessing the immunization status of patients and calling those eligible for vaccine administration at a given age. In Quebec, the implementation of an integrated information system on immunization is planned but it will take years to be fully operational in the two Nordic regions. Investment will be needed for this, not so much in equipment, but in the training of personnel. In the meantime, time-consuming and expensive surveys involving travel and stays in each village are requested for collecting data at the individual level.

There are several limitations to our study. First, no reliable information could be collected for approximately 8% of children in the study population. Uptake rates in this group could be different than in the group included in statistical analyses. However, even a large difference would not affect overall estimates greatly. In small villages, estimates of vaccine coverage are not statistically precise and this is why confidence intervals and statistical tests were not performed at this level. Finally, a positive history of vaccination is confirmed by a written document while a negative history is always presumptive. Uptake rates measured in our study can thus be considered as the lowest possible values.

CONCLUSIONS

Uptake rates of pneumococcal vaccines in Nunavik are meeting expectations and are similar to those measured in population surveys in Quebec. Computerized immunization registries are urgently needed to facilitate the work of health care professionals and to avoid time-consuming and costly on-site surveys in northern regions of Canada.

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RÉSUMÉ

OBJECTIFS : Les infections pneumococciques représentent un important problème de santé publique dans les régions nordiques du Canada. Les populations nordiques ne sont pas incluses dans les enquêtes de couverture vaccinale nationales et provinciales. Un registre centralisé de couverture vaccinale n'existe pas dans ces régions. L'objectif de cette étude était d'obtenir des estimés de couverture vaccinale pneumococcique et des retards vaccinaux chez les enfants du Nunavik, Québec.

MÉTHODOLOGIE : Les données de couverture vaccinale des enfants nés entre 1994 et 2005 ont été collectées dans tous les villages. Les enfants ont été regroupés en trois cohortes : ceux nés dans la période du 1^{er} janvier 1994 au 30 avril 1997 et visés par la campagne d'immunisation de masse au VPP-23v de 2002; ceux nés dans la période du 1^{er} mai 1997 au 31 mars 2002 et éligibles au programme de rattrapage au VPC-7; ceux nés dans la période du 1^{er} avril 2002 au 31 décembre 2005 et éligibles au programme d'immunisation de routine au VPC-7.

RÉSULTATS : Dans la 1^{ère} cohorte ($n=896$), 86,8 % (95% IC : 84,4 %-89,0 %) ont été vaccinés au VPP-23v. Dans la 2^e cohorte ($n=1252$), 84,3 % (95% IC : 82,1 %-86,2 %) ont reçu une dose de VPC-7 ou plus. Dans la 3^e cohorte, 90,4% (95% CI : 88,5 %-92,1 %) ont reçu 4 doses de VPC-7. Un retard de plus de 4 semaines dans l'administration du VPC-7 a été observé pour 26,3 % de l'ensemble des doses administrées. Des variations substantielles ont été observées entre les villages pour tous les indicateurs.

CONCLUSION : Dans la configuration complexe d'une région nordique et isolée, les taux de couverture au VPC-7 au Nunavik sont similaires à ceux retrouvés dans les enquêtes populationnelles du Québec.

MOTS CLÉS : streptococcus pneumoniae; vaccins pneumococciques; immunisation; maladies infectieuses; santé des populations autochtones