

Coverage for the Entire Population: Tackling Immunization Rates and Disparities in Saskatoon Health Region

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ABSTRACT

Objective: Our objective was to determine the effectiveness of an intervention, the Immunization Reminders Project, in terms of a) improving vaccination coverage rates for measles, mumps and rubella (MMR) among 2-year-olds and b) ameliorating geographical disparities in early childhood immunization coverage.

Target Population: All 14-month-old and 20-month-old children in Saskatoon Health Region who were overdue for their immunizations.

Setting: Saskatoon Health Region (SHR).

Intervention: The intervention involved calling the parents/caregivers of the children in the target population with a reminder about immunizations. After five telephone calls and if the parent/caregiver could not be reached, a letter was mailed to the last known address. If there was no response to the letter, a reminder home visit was attempted for families residing in the low-income neighbourhoods in Saskatoon. Since January 2009, all reminders for families not residing in the low-income neighbourhoods in Saskatoon are made through mailed letters.

Outcomes: After the introduction of the Immunization Reminders Project, coverage rates among 2-year-olds for MMR increased significantly overall and in most geographical areas examined. Disparities between geographical subgroups appeared to be declining, but not significantly.

Conclusion: A universal approach to early childhood immunization can likely contribute to increases in coverage rates, but there is still room for improvement in SHR. These findings have prompted additional practice and policy changes.

Key words: Immunization; child; intervention studies

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

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Immunization is considered one of the most successful public health interventions in history, often providing the opportunity for disease prevention at a population level.¹ Therefore, it was quite troubling when Saskatoon Health Region (SHR) discovered statistically significant geographical disparities in immunization coverage rates among young children in Saskatoon, Saskatchewan. For instance, the average complete measles, mumps and rubella (MMR) immunization coverage rate, defined in Saskatchewan as two doses of MMR by 2 years of age, was 43.7% in the city's low-income neighbourhoods (commonly termed the "core neighbourhoods") as compared with 90.6% in the affluent neighbourhoods and 69.1% in the rest of the city for the period 2001-2005 (Figure 1).²

Although disparities in immunization coverage rates in Saskatoon were of great concern in and of themselves, overall coverage rates also garnered concern since in most areas of the city coverage rates were not high enough to offer herd immunity. Herd immunity affords disease resistance among unvaccinated individuals as a result of the protective immunity that exists if the majority of individuals in a population are vaccinated. Coverage rates for herd immunity vary by disease; for example, measles is highly contagious, so it is estimated that measles vaccination rates must be in the range of 94% for herd immunity to occur.³ If immunization coverage rates drop to too low a level in a population, outbreaks can occur and/or previously eliminated diseases can re-emerge.⁴ Lower-than-expected coverage rates and geographical disparities in Saskatoon prompted further study and the implementation of a

universal intervention, the Immunization Reminders Project. The effectiveness of the project is the focus of this article.

We sought to understand why coverage rates were lagging in a number of neighbourhoods and also why disparities existed. Previous studies have consistently identified low income, at both an area and/or an individual level, as a predictor of incomplete immunization.⁵⁻⁷ For example, a 2011 comprehensive review of immunization in Manitoba found low income at an area level had the strongest association with incomplete coverage for measles vaccination among children.⁸ It should be noted that low income is not necessarily the cause of incomplete coverage, since most routine childhood immunizations are provided at no expense to families in Canada, but it is likely a confounder for other factors that inhibit access to immunization services.⁹ For instance, access to transportation can often be a barrier to immunization.¹⁰ Previous stud-

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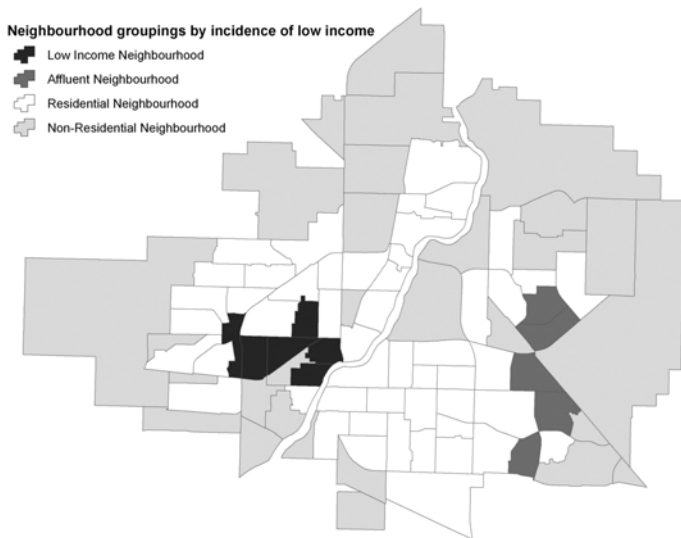
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Conflict of Interest: None to declare.

Figure 1. Neighbourhood groupings* in Saskatoon, Saskatchewan



* Neighbourhood groupings were determined using low-income cut-off data from the 2001 Canadian Census.²

ies have also uncovered other associations with incomplete immunization coverage at an area and/or an individual level, including residence in a city, low education levels, single parent status, mobility, vehicle registrations per neighbourhood and minority cultural status.^{2,11,12}

To determine whether the aforementioned associations also existed in Saskatoon and whether these factors were contributing to disparities, we conducted a telephone survey with 689 parents in 2006. We surveyed two groups of parents with a child who had turned 2 in 2004 or 2005: 1) those parents with a child who was at least 6 months overdue for immunizations (n=271) and 2) those parents with a child who was up to date for immunizations (n=418). In multivariate logistic regression analysis, our telephone survey revealed that at an individual level, low income, single parent status and other cultural status (i.e., not Caucasian or Aboriginal) were significantly associated with incomplete coverage.²

When we conducted the telephone survey, we also asked parents about their preferred options for keeping their child up to date with immunizations. We found the two most popular options among all parents surveyed were a reminder telephone call and/or letter. It is interesting that in the survey, 63.9% of parents with a child whose coverage was incomplete actually thought their child was up to date.² This is not too surprising, given that immunization schedules for children are increasingly complex.⁸

Immunization reminder systems are a proven means of increasing immunization coverage rates among children.¹³⁻¹⁶ The United States Task Force on Community Preventive Services has strongly recommended the use of reminder systems on the basis of robust evidence that they improve vaccination coverage in children and adults in a range of settings/populations, both when applied in a targeted or universal fashion and when used alone or as part of multi-component interventions.¹⁷ Additionally, a Cochrane review found that for childhood vaccinations, reminder systems significantly increased the likelihood of being vaccinated (odds ratio=1.47, 95% confidence interval [CI]=1.28-1.68).¹⁸

Given the results of the telephone survey, along with the best practices detailed in the literature, designing and implementing a

Figure 2. Study population flow chart

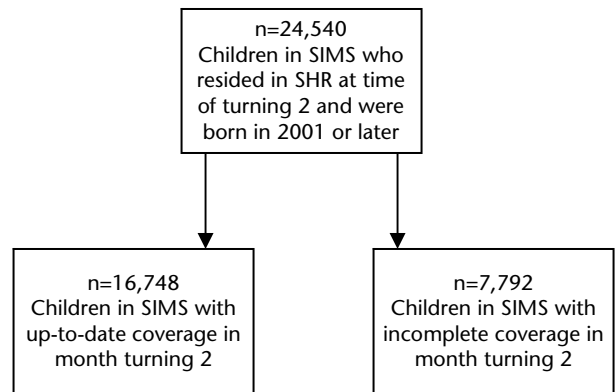
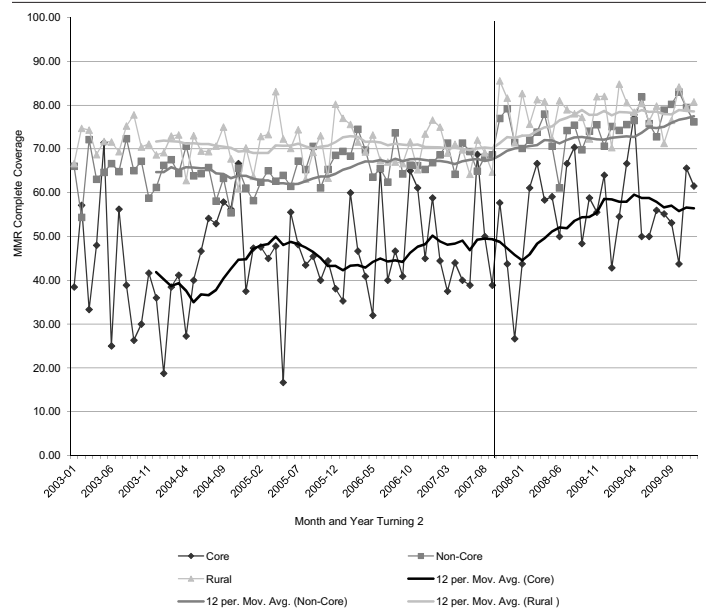


Figure 3. MMR complete coverage rates (%) for 2-year-olds in Saskatoon Health Region, 2003-2009 (the black vertical line indicates when the universal intervention began)



reminder intervention, termed the Immunization Reminders Project, was the logical next step for SHR.

OBJECTIVE

The objective of our study was to determine the effectiveness of the Immunization Reminders Project in terms of a) improving early childhood complete coverage rates for MMR and b) ameliorating geographical disparities related to MMR.

PARTICIPANTS, SETTING AND INTERVENTION

The intervention was designed by Public Health Services, SHR. It began in October 2007 and involved calling the parents/caregivers of children 14 months and 20 months old in SHR who were behind on their immunizations. After five telephone calls and if the parent/caregiver could not be reached, a letter was mailed to the last known address. If there was no response to the letter, a reminder home visit was attempted for families residing in the core neighbourhoods in Saskatoon. Because of staffing changes, the intervention protocol changed in January 2009 and all reminders for families not residing in the core neighbourhoods were made through mailed letters.

Table 1. Subgroups in Study Population*

	2003	2004	2005	2006	2007	2008	2009
Foster children							
Children in SIMS who resided in SHR at time of turning 2	62	54	64	66	70	76	70
Children in SIMS with up-to-date coverage in month turning 2	26	26	26	24	38	44	34
Core neighbourhoods							
Children in SIMS who resided in SHR at time of turning 2	236	200	226	227	237	259	284
Children in SIMS with up-to-date coverage in month turning 2	98	93	99	110	108	152	161
Non-core neighbourhoods							
Children in SIMS who resided in SHR at time of turning 2	2103	2001	2212	2102	2062	2118	2316
Children in SIMS with up-to-date coverage in month turning 2	1365	1277	1424	1418	1441	1526	1797
Rural SHR							
Children in SIMS who resided in SHR at time of turning 2	1126	1057	1069	1061	1048	1017	1084
Children in SIMS with up-to-date coverage in month turning 2	808	736	763	747	760	801	849

* SIMS=Saskatchewan Immunization Management System; SHR=Saskatoon Health Region.

Table 2. MMR Complete Coverage Rates (%) and Confidence Intervals for 2-Year-Olds in Saskatoon Health Region, 2003-2009

	2003	2004	2005	2006	2007	2008	2009
SHR overall	65.0 (63.4-66.6)	64.1 (62.5-65.7)	64.7 (63.1-66.2)	66.4 (64.8-68.0)	68.6 (67.0-70.1)	72.7 (71.3-74.2)*	75.7 (74.3-77.1)*
Core neighbourhoods	41.5 (35.2-47.8)	46.5 (39.6-53.4)	43.8 (37.3-50.3)	48.5 (42.0-55.0)	45.6 (39.2-51.9)	58.7 (52.7-64.7)*	56.7 (50.9-62.5)
Non-core neighbourhoods	64.9 (62.9-67.0)	63.8 (61.7-65.9)	64.4 (62.4-66.4)	67.5 (65.5-69.5)	69.9 (67.9-71.9)	72.1 (70.1-74.0)	77.6 (75.9-79.3)*
Rural SHR	71.8 (69.1-74.4)	69.6 (66.9-72.4)	71.4 (68.7-74.1)	70.4 (67.7-73.2)	72.5 (69.8-75.2)	78.8 (76.3-81.3)*	78.3 (75.9-80.8)*

* Indicates statistically significant difference between when the intervention was applied during an entire year (2008 and 2009) and previous years (2003-2007).

Table 3. Rate Ratios and Confidence Intervals for MMR Coverage Among Two-Year-Olds in Saskatoon Health Region, 2003-2009

	2003	2004	2005	2006	2007	2008	2009
Saskatoon's core neighbourhoods* vs. non-core neighbourhoods	0.64 (0.51-0.77)†	0.73 (0.58-0.88)†	0.68 (0.54-0.82)†	0.72 (0.58-0.86)†	0.65 (0.53-0.78)†	0.82 (0.68-0.95)†	0.73 (0.61-0.85)†
Saskatoon city* vs. rural SHR	0.87 (0.80-0.95)†	0.89 (0.82-0.98)†	0.88 (0.80-0.96)†	0.93 (0.86-1.02)	0.93 (0.85-1.02)	0.90 (0.83-0.98)†	0.96 (0.89-1.04)

* Reference group.

† Statistically significant.

To determine the effectiveness of the Immunization Reminders Project, coverage rates for MMR were extracted in 2010 from the Saskatchewan Immunization Management System (SIMS) for all children who a) resided in SHR at the time of turning 2 and b) were born in 2001 or later. Details on all children who do not live on-reserve are entered in SIMS at birth or when they begin to reside in Saskatchewan.

SHR considers complete coverage for MMR to be two doses of MMR by 2 years of age. Incomplete coverage in this study is defined as more than 6 months behind schedule. Complete coverage rates were calculated by determining the number of children in SIMS considered up to date in the month they turned 2 divided by the number of children who were in SIMS and born 2 years previously.

We assessed MMR complete coverage rates from 2003 to 2009 for SHR overall and also among three geographical subgroups: core neighbourhoods in Saskatoon, non-core neighbourhoods in Saskatoon and rural SHR. Foster children were included in the SHR overall numbers, but they are not captured in any of the geographical subgroups since their residential address is not recorded in SIMS. This is because the Ministry of Social Services restricts access to the addresses of foster children in Saskatchewan for confidentiality purposes.

Early childhood complete coverage rates for MMR in SHR overall and in each subgroup were assessed for significant differences over time using CIs. If the CIs between years were not overlapping, they were considered statistically different.¹⁹ We also constructed moving average trend lines for complete coverage rates in each geographical subgroup using Excel 2003. A moving average uses a spe-

cific number of data points, averages the specified number of data points and uses the average value as a point in the line. In this study, the number of data points specified for the moving average was 12. Significant differences between the complete coverage rates of subgroups were assessed using rate ratios. If the CI for the rate ratio did not include 1, the rate ratio was considered statistically significant.²⁰ If the CIs between the rate ratios from one year to the next did not overlap, the difference between years was considered statistically different. In this study, the significance level was set at 0.05 (two-sided).

The study was approved by the University of Saskatchewan's Behavioural Research Ethics Board (Beh #06-213).

OUTCOMES

In total, 24,540 children were included in the study (Figure 2). Table 1 presents the number of children who were included in each subgroup, as well as the number of foster children who were included in the SHR overall numbers.

Table 2 shows that, overall, MMR complete coverage rates among 2-year-olds significantly increased in SHR from 2007 to 2009. They also increased significantly from 2007 to 2009 in the non-core neighbourhoods and rural SHR. There was more than a 10% increase in the core neighbourhoods from 2007 to 2009, although this increase was not statistically significant.

Figure 3 illustrates coverage rates over time and the 12-month moving averages in the geographical subgroups. The coverage rates in the subgroups varied from month to month, especially in the core neighbourhoods. Large variation in the core neighbourhoods

was likely due to small samples. However, Figure 3 also shows that the general trend is of an increase in coverage rates across all subgroups. As noted earlier, 12 data points were used per moving average.

Table 3 shows the results of our assessment of complete coverage rate disparities among the subgroups over time. Significant differences between core and non-core neighbourhood children were found for all years (2003-2009). In 2007, when the intervention was implemented, the rate ratio between core and non-core neighbourhood children was 0.65, indicating that core neighbourhood children were 35% less likely to be completely immunized; in 2009, this rate ratio was 0.73, indicating that core neighbourhood children were 27% less likely to be completely immunized than non-core neighbourhood children. Although there appeared to be a trend in the reduction of differences between core and non-core neighbourhood children from 2007 to 2009, this trend was not significant, since confidence intervals continued to overlap over time. Significant differences between Saskatoon and rural SHR children were also found, with the exception of 2006, 2007 and 2009. Comparison of the rate ratios from 2007 to 2009 between Saskatoon and rural SHR children shows that the confidence intervals also overlapped, indicating no significant reduction in disparity over time.

DISCUSSION

The Immunization Reminders Project has likely contributed to increased complete coverage rates for MMR in SHR overall and in subgroups. Since 2007, when the intervention was introduced, complete coverage rates have significantly increased in SHR and in all subgroups except the core neighbourhoods. Yet even in the core neighbourhoods, where the increase in complete coverage rates was not statistically significant, there was more than a 10% increase. Moreover, there appears to be a general trend towards disparity reductions for both core neighbourhoods versus non-core neighbourhoods and for Saskatoon versus rural SHR, although these reductions were not statistically significant. Our findings are similar to those of US studies that have assessed the effectiveness of childhood immunization reminder systems in terms of both increasing coverage and decreasing disparities.^{5,13-16}

Although the Immunization Reminders Project has not yet significantly decreased the disparity between the core and non-core neighbourhoods in Saskatoon, it is anticipated that targeted interventions will serve this purpose. For example, the Building Health Equity (BHE) Database was implemented by SHR in June 2008 and targets only the core neighbourhoods in Saskatoon. The BHE Database alerts staff when a child is 2 weeks overdue for its 2-, 4- or 6-month-old immunizations. The parent is first contacted through a telephone call. If the child has not been immunized within 2 weeks or the family is not reached by telephone, subsequent reminder calls, letters and/or home visits are made. The results regarding the effectiveness of the BHE Database in terms of increasing MMR complete coverage rates are still too preliminary to present, since the full effects of the BHE Database did not begin to emerge until June 2010, when the first children targeted reached the age of 2.

There are some limitations associated with this study that deserve mention. First, it is difficult to attribute increases in immunization rates solely to the Immunization Reminders Project, as there could be other explanations for the increase. For example, more clinic locations, increased awareness about immunization coverage

among providers or increased awareness about immunization coverage among those families reached by the BHE Database also could have positively affected coverage rates. Attribution is a limitation from a research perspective, although from a public health perspective an increase in immunization rates regardless of cause is extremely positive. Where feasible and ethical, control groups will be used in future studies to overcome the challenge of attribution.

Another limitation is that contact information on health cards is often not up to date. It is often not clear whether a child has remained in SHR or moved to another region/province. There may be children whose details remain in SIMS even though they no longer reside in SHR, and this could potentially decrease coverage rates.

Another issue is how to contact people from vulnerable populations. Challenges include lack of telephone, lack of a permanent residence, as well as high mobility rates. Some families have not been located through our intervention, and their current location of residence remains unknown. The children who were not located could, in fact, have been fully immunized in another region or province and be falsely pulling SHR immunization coverage rates down.

A further limitation of note is that First Nations health organizations do not have access to SIMS. While these organizations immunize a significant number of children, regional health authorities do not routinely have access to the immunization records. To retrospectively minimize this limitation, when a child presents to a regional health authority public health clinic and has been immunized through a First Nations health organization in the past, the clinic obtains the individual's consent, contacts the other provider and records previous immunizations in SIMS.

A final limitation is that when children from another province relocate to Saskatchewan, their records – which are entered into SIMS – may not be an accurate reflection of their immunization history because of different recording practices in other jurisdictions. As a result, SIMS may not be a completely accurate reflection of the number of children immunized. Additionally, children who come from another province or country do not always follow the same immunization schedule as in Saskatchewan. These children can then lower the immunization rates, both current and historical, if they are not up to date with the Saskatchewan schedule.

CONCLUSION

A universal intervention, such as the Immunization Reminders Project, can likely contribute to increasing coverage rates overall. However, there is still room for improvement in SHR since overall coverage rates are still below the rates required for herd immunity, and the disparities among subgroups have not significantly decreased over time. On the basis of feedback from SHR staff and clients, there are a number of next steps that will be pursued in order to further improve coverage rates and decrease disparities: extending hours in immunization clinics, exploring other means of connecting with young families (e.g., social media, texting, e-mails), addressing the issues with SIMS mentioned previously and expanding the BHE Database to cover other areas in SHR with low immunization coverage rates. In terms of research, next steps will include evaluating the effects of the targeted intervention (i.e., the BHE Database), further cleaning SIMS to ensure that it is accurate, and evaluating the cost-effectiveness of our whole suite of interventions.

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RÉSUMÉ

Objectif : Déterminer l'efficacité d'un projet appelé *Immunization Reminders* pour ce qui est : a) d'améliorer les taux de couverture vaccinale de la rougeole, de la rubéole et des oreillons (RRO) chez les enfants de 2 ans et b) de réduire les disparités géographiques dans la couverture vaccinale des jeunes enfants.

Population cible : Les enfants de 14 mois et de 20 mois de la Région sanitaire de Saskatoon qui n'avaient pas encore reçu leurs vaccins.

Lieu : La Région sanitaire de Saskatoon (RSS).

Intervention : L'intervention a consisté à téléphoner aux parents/aidants des enfants de la population cible pour leur rappeler que leurs enfants avaient besoin d'être vaccinés. Si l'on n'arrivait pas à joindre le parent/l'aidant après cinq appels, on postait une lettre à la dernière adresse connue. Si l'on ne recevait pas de réponse à la lettre, on essayait de faire une visite au domicile des familles habitant les quartiers à faible revenu de Saskatoon. Depuis janvier 2009, tous les rappels aux familles n'habitant pas dans les quartiers à faible revenu de Saskatoon se font par la poste.

Résultats : Après le lancement du projet *Immunization Reminders*, les taux de couverture du vaccin RRO chez les enfants de 2 ans ont significativement augmenté dans l'ensemble et dans la plupart des zones géographiques examinées. Les disparités entre les sous-groupes géographiques ont semblé diminuer, mais pas de façon significative.

Conclusion : Une approche universelle à la vaccination des jeunes enfants peut probablement contribuer à accroître les taux de couverture, mais il y a encore matière à amélioration dans la RSS. Les constatations de l'étude ont entraîné des changements dans les pratiques et dans les politiques.

Mots clés : immunisation; enfant; études d'intervention