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Two-year retrospective review of costs associated with COVID-19 case management in Regina, Saskatchewan

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Abstract

Background The COVID-19 pandemic, declared in March 2020, caused significant morbidity and mortality globally. This study aims to estimate the costs associated with managing COVID-19 infected patients in Regina.

Method The study focuses on the direct and indirect healthcare costs of managing a COVID-19 case. Costing elements included are diagnostic, public health, inpatient and outpatient management costs. The costing analysis estimates the total cost of COVID-19 case management in Regina, the average cost per case based on disease severity, and the costs for diagnostics, public health management, and clinical areas.

Results Severe cases, representing 1.3% of cases, accounted for a quarter of the total cost of illness, while moderate cases (1.8%) contributed to less than 5% of the overall cost. Mild cases (96.9%) were responsible for three-quarters of the associated illness costs.

Over two years, approximately $85 million was spent on the care of 28,733 cases, primarily due to hospitalization costs. Annual per-patient expenses increased from $45 in 2020 to $183 in 2021, reflecting a higher case burden and greater health care utilization. Furthermore, the Omicron variant accounted for 44% of the disease burden and 36% of the illness costs.

Patients older than 80 accounted for 10% of illness costs, while children aged less than 18 accounted for about 17%.

Conclusion The primary costs were human resources and hospitalizations for older individuals, significantly impacting the Saskatchewan Health Authority's budget due to the pandemic. This analysis does not fully capture the effects in Regina.

Keywords COVID-19, Cost of illness, Health economics

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Background

On January 30, 2020, the World Health Organization (WHO) declared the novel coronavirus outbreak a Public Health Emergency of International Concern [1]. This was later formally identified as Coronavirus Disease 2019 (COVID-19), and on March 11, 2020, it was declared a pandemic [2]. The declaration consequently advised the member states to prepare for containment and prevention of the disease's onward spread.

Globally, as of January 2024, there had been 773 million confirmed cases of COVID-19, with over 6.5 million deaths [3]. Similarly, in January 2024, Canada reported almost 4.8 million cases of COVID-19, with about 56,000 deaths reported [4]. Over a similar time, Saskatchewan reported about 140,000 cases with 1,400 deaths since the pandemic was declared [4, 5].

COVID-19 presents along a spectrum ranging from asymptomatic disease to severe. Although not limited to these groups, severe disease was most often seen in persons who were older or had underlying medical conditions [6].

The global response to the pandemic included a comprehensive set of interventions aimed at reducing morbidity and mortality associated with COVID-19. The starting point and anchor for these interventions were the public health measures that aimed to break the chains of person-to-person transmission through early case identification, isolation, testing, and clinical care for all cases. It also included the prompt and complete tracing and quarantine of contacts and the use of appropriate personal protective equipment, and other social distancing measures. Finally, the strategies implemented in responding to the pandemic included the protective effects of vaccines following the availability of COVID-19 vaccines in late 2020.

Implementing these interventions globally and in Regina has come at a significant cost to the individual, the health care system, and society. In a programmatic sense, at the outset of the pandemic, with the significant numbers, there was a need to scale back other health care programs, including childhood immunization programming, sexually transmitted infection testing and investigations, as well as other acute care services, to focus on COVID-19 case and contact identification, investigation, and management. These had significant financial costs to individuals and the healthcare system, and this study aims to estimate the diagnostic costs, costs of public health, and clinical management of COVID-19-infected patients in Regina. There are also associated costs with the management of COVID-19 outbreaks in schools, workplaces, and other congregate living settings. This study will provide a total costing of all the reported COVID-19 cases and stratified costs based on disease severity and outcome. The study will not consider the COVID-19 vaccine-related costs or costs of outbreak management and will exclude the societal costs associated with COVID-19.

Method

This study is a multicenter retrospective cost analysis of the public health and clinical management of COVID-19 cases and contacts in the Regina area of the Saskatchewan Health Authority (SHA). The city of Regina, with an estimated 275,000 population, is the second largest city in the province and serves the surrounding communities included in this analysis [7]. The analysis was conducted from the perspective of the third-party payer, in this case, the SHA.

The cases associated with the area were obtained from the integrated public health information system, Panorama, which is used for tracking and managing cases of reportable diseases, as well as immunizations and vaccine inventory [8].

Data from a previous unpublished analysis of COVID-19 cases in Regina from the onset of the pandemic to December 2022 was stratified based on severity into three levels: mild, moderate and severe disease. The clinical spectrum used is a modification of the disease spectrum suggested by the National Institutes of Health [9]. Mild disease is thus considered asymptomatic and mildly symptomatic patients who require minimal medical intervention; moderate disease is described as persons who, in addition to clinical symptoms, required a clinical assessment either telephonically or in-person, with possible hospitalization but not requiring mechanically assisted ventilation; and severe disease is described as persons who required mechanically assisted ventilation or disease led to death.

This costing study focuses on the direct and indirect health care costs of managing a case of COVID-19. Direct costs are those directly attributable to patient care, including the costs due to health care workers providing care to a COVID-19 patient from diagnosis to ICU, and death-associated costs if applicable. A patient costing approach, where individual-level utilization data would be reviewed to provide the most specific estimate of resource utilization, would have been preferred; however, as this is a retrospective study, the data required for this approach is unavailable [10]. Therefore, a variation of this approach was used relying on estimated patient-specific resource consumption stratified by disease severity. These estimates account for assessment center costs, inpatient nursing, outpatient nursing, laboratories, radiology, physician, and pharmacy-related costs.

Indirect costs, also known as overheads, refer to non-direct care costs associated with care delivery,

including facility, utility, and other operational costs. As these costs would be difficult to quantify, individual patient-related indirect healthcare costs are estimated.

The associated costs of COVID-19 testing, care, and treatment are Saskatchewan-specific. Where Saskatchewan data is not available, publicly available cost data and consult with content experts was used. In addition, appropriate probability distributions were assigned to the input parameters and randomly selected values for each parameter from their distribution [10, 11]. Normally distributed parameters were defined by a mean and standard error, and the gamma distribution was characterized by shape and scale. This allows for assessing the impact of uncertainty around the input data and provides a more realistic estimate.

The report provides a timeline of events with a breakdown of costs for each month and the cost per case over time for trend analysis. The estimated cost per case and cost per month by the dominant SARS-CoV-2 variant are also provided. The costing analysis was performed in Microsoft Excel and presents the total cost of COVID-19 case management, the average cost per case based on disease severity, and the costs for diagnostics, public health management, and clinical areas Table 1.

Table 1 Demographic characteristics of COVID-19 patients in the Regina area, 2020–2022

Variable	Number of patients (%)
Demographics	
Female	14,281 (49.88%)
Male	14,334 (50.06%)
NA[a]	118 (< 0.5%)
Age, median (range)	33.2 (0–108.3)
Network location of disease	
Regina 1 (North)	7377 (25.7)
Regina 2 (East)	6098 (21.2)
Regina 3 (South)	6386 (22.2)
Regina 4 (Central)	4500 (15.7)
Regina NA1	4372 (15.2)
Cases by dominant variant	
Ancestral	2918 (10.1)
Alpha	7004 (24.4)
Delta	6086 (21.2)
Omicron	12,725 (44.3)
Cases by severity	
Mild	27,827 (96.9)
Moderate	527 (1.8)
Severe	379 (1.3)

[a] NA refers to either insufficient information to make a determination of residential address or gender identification

Results

Between March 1, 2020 and June 2, 2022, there were 28,733 COVID-19 cases in the Regina area. These cases were evenly split between males and females, with 14,334 (50.1%) and 14,281 (49.9%), respectively. People of all ages were affected, from newborns to seniors, with a median age of 33. The vast majority of cases, 96.9%, were classified as mild, while moderate and severe cases accounted for 1.8% and 1.3%, respectively. The cases were distributed throughout the city, with Regina 1 (North) having the highest proportion of cases at 26%.

Cases ranged in age from newborn to 108 years with a median age of 33.2 years. The majority of Regina's cases were older than 20 years of age.

There were a number of risk factors identified in the COVID-19 cases seen in the Regina area, including hypertension, which was most prevalent, occurring in about 6.5% of cases. See Table 2. We note that relative to the prevalence of hypertension in Saskatchewan and the city of Regina, 6.5% is low and likely reflects issues with the data quality [12].

Mild COVID-19 cases required minimal medical care, typically an emergency room or dedicated COVID assessment clinic visit of less than one day, while moderate cases ranged from 0–3 days. For severe cases as defined above, the average ICU stay duration was 9.36 days, with a range of one to 118 days. During the study duration, there were 255 COVID-19-related deaths, which accounted for less than 1% of all cases across the different waves of the pandemic.

Our analysis showed that over the two years studied, a total cost of $85 million in healthcare dollars was spent to care for 28,733 COVID-19 cases of varying severity, for an average cost of $3,124. For the two complete years during the pandemic, the per capita cost due to management of COVID-19 cases ranged from $45 to $183 in 2020 and 2021, respectively. Hospitalization costs accounted for the bulk of this expense, with human

Table 2 Risk factor profile of the COVID-19 cases in the Regina area, 2021—2022

Risk factors in Regina area COVID-19 cases	Number of patients (%)
Hypertension	1870 (6.51%)
Lung Disease	1331 (4.63%)
Diabetes Mellitus	1217 (4.24%)
Cardiac Disease	662 (2.3%)
Morbid Obesity	446 (1.55%)
Immunocompromised due to underlying disease or treatment	369 (1.28%)
Pregnancy	232 (0.81%)
Malignancies/Cancer	39 (0.14%)

resources costs accounting for the remaining component. Diagnostic costs, identified as the testing costs excluding human resources, accounted for about one million dollars.

Upon further analysis, it was found that severe cases, which made up 1.3% of all cases, accounted for a quarter of the total cost of illness, while moderate cases contributed to less than 5% of the overall cost. Mild cases, which represent 97% of all cases, are responsible for three-quarters of the associated illness costs. See Table 3. The costs due to COVID-19 varied significantly by disease severity, with mild cases costing an average of $2344 per case, moderate cases $10,230 and severe cases costing almost 25 times more than mild cases at almost $51,000 per case.

Ancestral COVID-19, which accounted for 10% of the disease burden, accounted for about 12% of the cost of illness. Conversely, the Omicron variant accounted for approximately 44% of disease burden and 36% of illness costs. Patients older than 80 years accounted for 10% of illness costs, while at the other end of the age spectrum, children aged less than 18 years accounted for about 17% of illness costs (See Fig. 1). When we considered the cost per case by age group, this ranged from $2,374 in children under the age of 12, increasing to $4,605 in patients between 60—69 years and peaking in persons older than 80 years at $10,067 per case. Gender did not appear to impact COVID-19 costs with females accounting for 49% of costs versus 51% in males.

To further account for variability, we varied our inputs, excluding laboratory costs by 10%. The results showed that healthcare costs could be as low as $79 million or as high as $105 million. The most significant driver of the change in cost estimates was hospitalization costs. In the 10% lower scenario, this was estimated at $16 million compared to $39 million when the input estimates were 10% higher Table 4.

Table 3 COVID-19-associated costs by component

Disease severity	Diagnostic costs	Diagnostic staffing costs	Hospitalization costs	Public health costs	Total cost
Mild	$788,671.90	$417,574.40	$5,837,258.17	$23,999,470.26	$65,252,426.11
Moderate	$14,923.03	$7,896.07	$1,759,291.58	$455,017.83	$4,769,297.33
Severe	$11,029.43	$5,676.49	$12,638,922.92	$324,451.17	$14,366,455.94
Total	$814,624.36	$431,146.96	$20,235,472.68	$24,778,939.26	$84,388,179.38

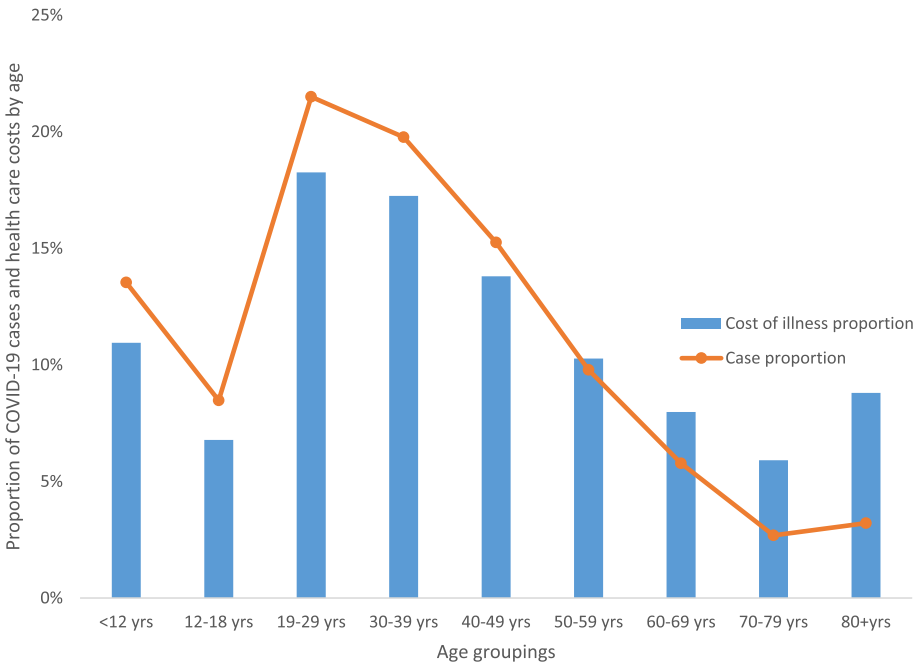


Fig. 1 Proportion of cases and cost of illness by age groups

Table 4 Input parameters

Parameter	Base estimate	Probability distribution	Reference
Average laboratory testing cost	$28.41	Gamma ($12.74, $2.23)	1
Average daily outpatient cost	$420.05	Gamma ($10.94, $38.38)	2
Average daily inpatient cost	$1514.00	Gamma ($1183.99, $1.28)	2
Average daily ICU cost	$4835.00	Gamma ($174.50, $27.71)	2
Duration in or receiving care			
Average duration of ICU stay	9.36	Gamma (176.24, 0.05)	3
No of visits for mild COVID-19 cases	0.5	Normal (0.50, 0.05)	4
No of healthcare visits for moderate COVID-19 cases	3	Normal (3, 0.3)	4
Diagnostic human resources costs per case			
Microbiologist	$1.00	Normal ($1.00, $0.10)	5
Technologist	$150.65	Normal ($150.65, $15.07)	1
Other lab costs	$1.00	Normal ($1.00, $0.10)	1
Public health human resources costs per case			
Public health physician	$122.38	Normal ($122.38, $12.24)	2
Public health nursing	$150.65	Normal ($150.65, $15.07)	2
Public health inspection	$193.39	Normal ($193.39, $19.34)	2
Contact tracing	$395.74	Normal ($395.74, $39.57)	2
Clinical human resources costs per patient			
Physician inpatients	$1568.81	Normal ($1568.81, $156.88)	2
Physician ICU	$4737.50	Normal ($4737.50, $473.75)	2
Other service lines inpatient	$141.00	Normal ($141.00, $14.10)	2
Other service lines ICU	$367.00	Normal ($367.00, $36.70)	2

[1] Roy Romanow Provincial Laboratory cost per test inclusive of extraction and PCR reagents excluding shipping, labour, and overhead costs

[2] Saskatchewan Health Authority inpatient, outpatient and out of province and country rates, 2020–2022

[3] Regina area ICU data analysis

[4] Based on communication with clinical experts

[5] Nominal cost of $1 was assigned for costs due to the microbiologist and other laboratory related costs because it was impossible to disaggregate these costs per case tested

Discussion

This retrospective study estimated the healthcare system's economic burden due to providing care for approximately 28,733 COVID-19 cases in the Regina area, the first of its kind in Saskatchewan. We observed that the ancestral COVID-19 variant accounted for only 10% of the cases, and the burden increased with successive variants, except for the Delta variant, which was lower than the Alpha variant. This is unsurprising since increased infectivity and immune escape were reported with successive variants [13, 14]. As successive dominant variants emerged, the average cost per case decreased from $3,645 for the ancestral COVID-19 variant to about $2,500 per case when Omicron was the dominant circulating variant. This reduced cost per case is reflective of a combination of factors, including reduced virulence of successive variants and increased efficiencies through optimization of clinical practices for management of cases [15].

When the cases were plotted by the reporting month, an epidemic curve that was consistent with a propagated outbreak with increasingly high peaks that roughly correlated with each new variant was observed. A correlation is also seen with the prevailing public health measures (See Appendix 2). It is observed that early in the pandemic, the restrictive measures, including indoor capacity limits, were associated with reduced case numbers. Later in the pandemic, the effect of public health measures such as capacity limits and mask and vaccine mandates appeared less effective, with either no changes or a significant increase observed in case trends. These observations are likely due to a combination of factors, including non-compliance by the public and the increased viral infectivity of the circulating variants.

As the pandemic progressed and the number of cases grew, it is unsurprising that resource utilization increased. Human resources, including public health and diagnostic staff, were the main drivers of the total cost. Additional cost drivers in the Regina pandemic experience were hospitalization and associated costs, where severe cases accounted for 70% of hospitalization costs. Conversely, due to the large number of mild and

moderate cases, these accounted for a higher proportion of public health and diagnostic staffing costs.

It has been established that COVID-19 poses a greater risk to individuals as they age, and the analysis supports this finding [16]. The data shows that the proportion of cases among those under 50 years old was consistently higher than the proportion of healthcare resources required for this group. This indicates that younger individuals experienced less severe illness and needed fewer resources for treatment. However, after the age of 50, there were fewer cases overall, but those affected required more healthcare resources. Therefore, it can be inferred that the age bracket of 50–59 years marks the turning point in this trend.

As a proportion of the combined Saskatchewan Health Authority budget, for population health, primary health care, acute and continuing care, the costs due to COVID-19 response ranged from 8% in 2020–21 to 15% for the 2021–22 fiscal year. In comparison to the population health budget, COVID-19 expenses accounted for 60% of the budget in 2020–21 and almost 150% in 2021–22. This highlights the resource intensity that occurred due to the pandemic response at the expense of other public health and clinical priorities.

Given that this response pertained to a novel virus with limited knowledge available initially, it was crucial to provide care regardless of disease severity. However, as understanding of the virus improved and for future pandemics, it may be beneficial to prioritize care and treatment for severe cases, rather than concentrating on mild cases, which can increase healthcare costs based on case numbers rather than disease severity.

COVID-19 healthcare-associated cases were similarly significant in other regions, accounting in 2020 for approximately $89.8 million and $504 million in BC and Ontario. These amounts account for 0.7% and 1.3% of total costs in BC and Ontario [17]. Other estimates of COVID-19 showed a significant variation in daily hospitalization costs, ranging from US$101 to US$2,364 in Turkey and the United States, respectively [18].

Limitations

It is important to note that this cost of illness study analyzed only the costs of cases for residents of Regina and the surrounding area within the Saskatchewan Health Authority boundaries. This does not include cases transferred to Regina for treatment, as the two hospitals in Regina are referral centers providing care to people from across the province. Therefore, these costs cannot be assumed as the total costs for all COVID-19 cases. Since the population of the Regina area is about one-quarter of the provincial population, extrapolating this cost estimate from this study would represent at least a quarter of the total cost of illness related to COVID-19 cases, assuming the case distribution holds the same.

Our analysis does not account for all costs associated with the management of COVID-19 cases. First, the costs analyzed in this study do not incorporate administrative expenses related to the COVID-19 response. Moreover, the analysis does not account for the cost of consumables such as personal protective equipment, staff screening equipment, emergency hardware purchases, and cleaning supplies. Second, evacuation costs and local transportation, such as to testing sites or isolation accommodations within Regina, have not been factored into the analysis. Third, the expenses of external partners, including the costs due to the assisted isolation locations and other supports involved in the COVID-19 response, particularly during a surge response, are not covered by the analysis. Therefore, while this expense was significant, it is probable that the actual costs are underestimated.

In addition, the laboratory costs in this study only account for technologist-related costs of laboratory-confirmed COVID-19 cases. Therefore, the expenses incurred by medical microbiologists and epidemiologists for test development and validation, equipment purchases, quality control activities, surveillance sequencing, and the testing of individuals who were not positive are not included in this analysis. Over the two-year study period, the test positivity rate ranged from less than five percent to higher than forty percent, indicating that the costs of laboratory testing could be twenty times higher.

Although many COVID-19 cases were observed in older populations, some of whom resided in congregate care settings like long-term care homes, which experienced significant outbreaks and adverse outcomes, we were not able to include associated costs in these settings, such as staffing changes, increased screening, and use of personal protective equipment (PPE) as this may have resulted in some measure of double costing as the case management costs were already captured.

To summarize, our analysis reveals that the COVID-19 pandemic response in Regina and surrounding areas resulted in a significant expense and burden on the healthcare system; however, given the inputs not included, this represents an overall underestimate of the COVID-19-associated costs.

Appendix 1

COVID-19 public health measures timeline in Saskatchewan

March 13, 2020: Restrictions on gatherings of more than 250 people indoors and gatherings of more than 50 people if they include people who had travelled internationally.

March 18, 2020: State of emergency implemented in Saskatchewan along with ordering the closure of non-essential businesses including gyms, casinos and bingo halls, and bringing capacity at restaurants and bars down to 50 per cent. Also restricting gatherings of more than 50 people.

March 20, 2020: Primary and secondary schools closed.

March 23, 2020: Gatherings of 25 people or more no longer allowed unless everyone is able to socially distance. Recreational, entertainment and personal service facilities must close and restaurants, bars and nightclubs restricted to pick-up or delivery only. Medical services like chiropractors and dentists restricted to non-elective appointments.

March 26, 2020: Gatherings restricted to 10 people.

April 23, 2020: The Re-Open Saskatchewan plan unveiled.

May 4, 2020: Phase 1 of the Re-Open Saskatchewan Plan implemented. Medical clinics can resume appointments, outdoor recreation activities can begin and boat launches and fishing can resume.

May 15, 2020: Golf courses can reopen.

May 19, 2020: Phase 2 of the Re-Open Saskatchewan plan implemented. Some business and personal care services like hairdressers and massage therapists can reopen.

June 1, 2020: Campgrounds can reopen.

June 8, 2020: Phase 3 of the Re-Open Saskatchewan plan implemented. Gathering limits rise to 15 indoors and 30 outdoors. Remaining non-essential personal care service can open, restaurants can allow dine-in again at half-capacity, and gyms can re-open.

June 12, 2020: Beaches and playgrounds can reopen.

June 22, 2020: Phase 4 of the Re-Open Saskatchewan plan begins to be implemented in further phases. Private indoor gathering limits raised to 30, outdoor sports allowed to begin.

June 29, 2020: Libraries, museums and cinemas allowed to open.

July 6, 2020: Capacity limits removed at bars and restaurants with appropriate distancing, indoor recreation and performing arts allowed to resume.

Oct. 28, 2020: Curfew for sale of alcohol and bar opening hours limited in Saskatoon, limit of six people per table at bars.

Nov. 6, 2020: Masks now required in public places in Regina, Prince Albert and Saskatoon. Gathering limits reduced to 10 at homes province-wide.

Nov. 16, 2020: Masking mandate expanded to communities in Regina, Prince Albert and Saskatoon metropolitan areas and any community with a population above 5,000.

Nov. 19, 2020: Masking mandate extended to the whole province, at-home gatherings limited to five people.

Nov. 27, 2020: Masking mandatory at schools, gyms while exercising and in workplaces. Limit of four people per table at restaurants as well as a requirement that restaurants must collect contact tracing information from customers. All group and team sports suspended.

Dec. 17, 2020: Public outdoor gatherings reduced to 10 people, no private indoor gatherings allowed.

March 9, 2021: Social bubbles of 10 people from up to two households recommended.

March 28, 2021: New restrictions targeted to Regina, with art galleries, conference centres, theatres and dine-in at restaurants and bars closed, no private gatherings.

April 16, 2021: Restrictions on private gatherings and worship service limits reinstated across the province.

May 4, 2021: Re-Opening Roadmap announced.

May 17, 2021: Bars and restaurants open for in-person dining in Regina.

May 30, 2021: Step one of new reopening plan implemented. Public indoor gatherings of 30 people allowed, outdoor gatherings of 150 people allowed, private gatherings of 10 people allowed, six people allowed at a table at restaurants.

June 20, 2021: Step two of new reopening plan implemented. Public indoor and outdoor gatherings allowed 150 people, private indoor gatherings allowed 15 people, no limits to retail and personal care services, no table size limits in restaurants.

July 11, 2021: All remaining restrictions, including masking in indoor public places, lifted.

Sept. 17, 2021: Indoor public mask mandate reinstated.

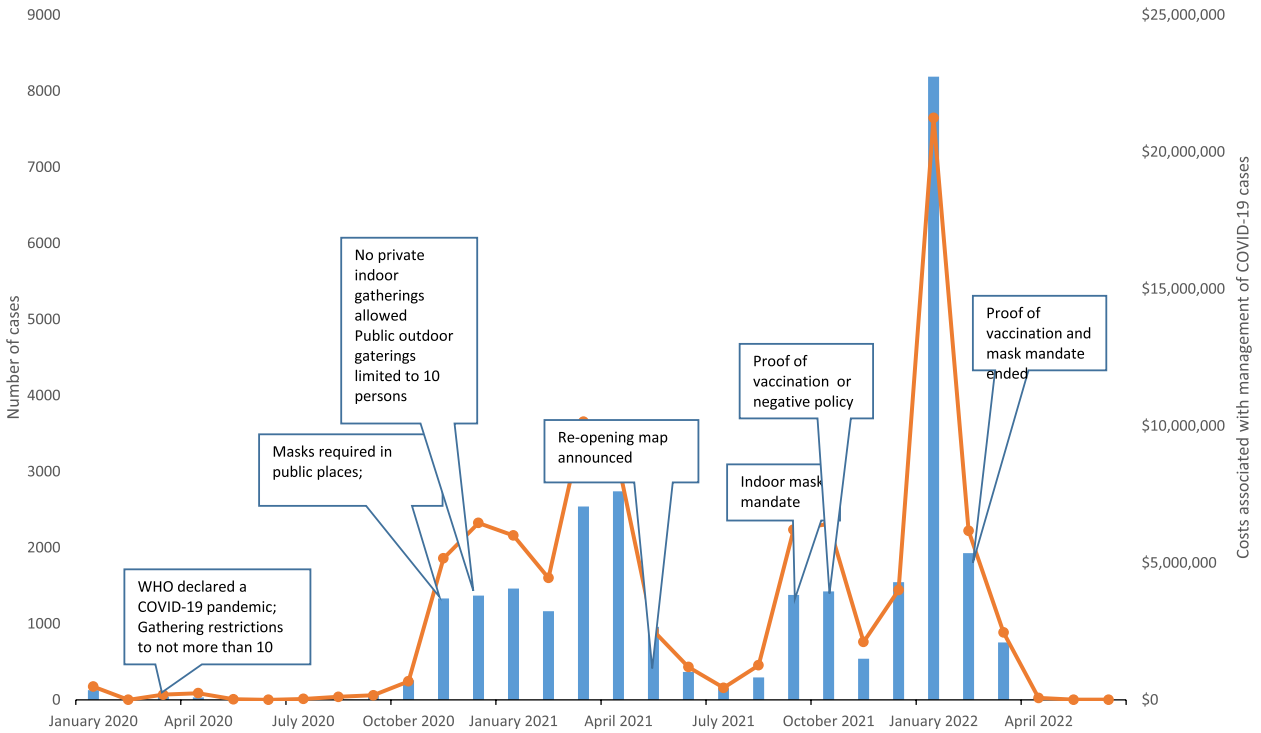
Oct. 1, 2021: Proof of vaccination or negative test policy implemented for things like dining in at restaurants, event venues and indoor gyms.

Feb. 14, 2022: Proof of vaccination or negative test mandates ended.

Feb. 28, 2022: Mandate requiring masking in public indoor spaces ended.

Appendix 2

Regina COVID-19 cases by month and prevailing public health measures



Authors' contributions
OM and MT conceived the idea for the manuscript and led the analysis, and writing. OM and DC were involved in the economic model building that informed the costing study. TD, MH, JM, CB, AL, MA, TS and TaS were involved in various aspects of COVID-19 programming in the Regina area, including public health, laboratory and acute care services. They were also involved in the preparation of the drafts and revised the final version of the manuscript. All authors participated in preparing the final draft of the manuscript, revised the manuscript, and critically evaluated the intellectual contents. All authors read and approved the final manuscript.

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Data availability
Anonymized data used during this study is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
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Competing interests
The authors declare no competing interests.

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