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Research

Characterizing early Canadian federal, provincial, territorial and municipal nonpharmaceutical interventions in response to COVID-19: a descriptive analysis

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Abstract

Background: Nonpharmaceutical interventions (NPIs) are the primary tools to mitigate early spread of the coronavirus disease 2019 (COVID-19) pandemic; however, such policies are implemented variably at the federal, provincial or territorial, and municipal levels without centralized documentation. We describe the development of the comprehensive open Canadian Non-Pharmaceutical Intervention (CAN-NPI) data set, which identifies and classifies all NPIs implemented in regions across Canada in response to COVID-19, and provides an accompanying description of geographic and temporal heterogeneity.

Methods: We performed an environmental scan of government websites, news media and verified government social media accounts to identify NPIs implemented in Canada between Jan. 1 and Apr. 19, 2020. The CAN-NPI data set contains information about each intervention's timing, location, type, target population and alignment with a response stringency measure. We conducted descriptive analyses to characterize the temporal and geographic variation in early NPI implementation.

Results: We recorded 2517 NPIs grouped in 63 distinct categories during this period. The median date of NPI implementation in Canada was Mar. 24, 2020. Most jurisdictions heightened the stringency of their response following the World Health Organization's global pandemic declaration on Mar. 11, 2020. However, there was variation among provinces or territories in the timing and stringency of NPI implementation, with 8 out of 13 provinces or territories declaring a state of emergency by Mar. 18, and all by Mar. 22, 2020.

Interpretation: There was substantial geographic and temporal heterogeneity in NPI implementation across Canada, highlighting the importance of a subnational lens in evaluating the COVID-19 pandemic response. Our comprehensive open-access data set will enable researchers to conduct robust interjurisdictional analyses of NPI impact in curtailing COVID-19 transmission.

Since the first case of coronavirus disease 2019 (COVID-19) was reported in Canada in January 2020, there have been 122 669 cases and 9044 reported deaths as of Aug. 13, 2020.[1] In the absence of population immunity, an effective vaccine or medical treatment, traditional public health interventions (e.g., physical distancing, testing, contact-tracing and hand hygiene) are critical to protect population health.[2,3] These nonpharmaceutical interventions (NPIs) have been the primary tool employed by governments and organizations to "flatten the curve" and reduce the spread of the virus, avoiding the possibility that peak case numbers overwhelm health care capacity.[2,4,5]

In Canada, NPIs have included the closure of borders and bans on nonessential travel, as well as the imposition of voluntary or mandatory physical distancing measures. Although some NPI policies have been implemented at a national scale, much of the authority and responsibility to oversee rollout of these policies falls on provincial, territorial and municipal governments.[6] As such, there has been substantial variability in the type, duration and implementation of NPIs across Canada — highlighting the importance of a subnational (i.e., provincial, territorial and municipal) lens of data gathering and analysis. Understanding the nature and impact of the NPI response is central to understanding the series of natural experiments that have occurred across Canada's first wave of the COVID-19 outbreak, and extracting lessons to inform ongoing policy-making.[7]

Although most interventions have been publicly announced through various media, there is no single comprehensive data

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set cataloguing the breadth and depth of interventions that have been implemented at all 3 levels of government in Canada; prominent global data sets lack data on the subnational scale.[8,9] To fill this gap, we describe the development of a comprehensive open data set — Canadian Non-Pharmaceutical Intervention (CAN-NPI) — containing detailed information about all publicly available Canadian NPIs in response to COVID-19. We describe the type and frequency of NPIs implemented in Canada, and characterize the temporal and geographic heterogeneity in their implementation across the federal, provincial or territorial, and municipal levels.

Methods

Study design

A pan-Canadian team of medical and graduate health professionals and students conducted an environmental scan to identify all COVID-19–related NPIs. This methodology is appropriate for the rapidly evolving nature of the ongoing pandemic and the variety of avenues through which information is announced (Appendix 1, Figure S1, available at www.cmajopen.ca/content/8/3/E545/suppl/DC1). The initial collection period between Jan. 1, 2020 and the date of paper submission (Apr. 19, 2020) is presented in this paper. Data collected after this date continue to be updated online as per the data sharing statement.

In this data set, we defined an NPI as any publicly announced program, statement, enforceable order, initiative or operational change originating from any government body in response to COVID-19 — whether to curtail its transmission or mitigate its social and economic ramifications.[3] This includes distancing measures (including closures), infection control measures (excluding vaccination or medical treatment), testing strategies, public announcements and social and fiscal measures, among others.

Data sources

A hierarchy of sources was used to identify interventions implemented by private and governmental organizations at 3 levels: the Canadian federal level, provincial and territorial level, and the municipal level for the 20 largest census metropolitan areas in Canada (with Ottawa-Gatineau separated into 2 municipalities in the data set) (Appendix 1, Table S1).

Official government sources (including releases from official websites of governments, ministries of health or public health commissions [Table 1]) were considered the highest calibre sources; these were reviewed in full and any COVID-19–related announcements were identified as the gold standard for data inclusion. Additional information was identified using purposive search methods for COVID-19–related articles and online reports from accredited news agencies. Additional information was identified using purposive search methods for COVID-19-related articles and online reports from accredited news agencies (local or national news services with a regular publishing schedule and genuine circulation, as determined by a subset of the authors [L.G.M. and J.S.]). Finally, we identified updates provided by the official social media accounts of governmental or public health institutions on Twitter or Facebook, and these were included if no other source was found.

Data collection

A team of 34 reviewers (including medical and health professionals) were involved in data collection. To ensure reviewer consistency, we established a streamlined data extraction protocol and a step-wise data-entry process. We used a standardized data extraction form to record information systematically for each NPI (Appendix 1, Table S2).

Characteristics of NPIs collected included start and end date, location, a free-text summary and categorical classifiers based on the intervention type, target population and nature of enforcement. Given the shifting nature of the pandemic response, our list of categorical classifiers was iteratively expanded and adjusted as novel classes of NPIs were identified, resulting in a total of 63 categories. Where applicable, interventions were also assigned a label that aligned with the Oxford COVID-19 Government Response Tracker (OxCGRT Version 4.0),[8] a previously developed measure of government response. Interventions were recorded only for the administrative level for which they were implemented (e.g., provincial interventions were not recorded for municipalities). If an NPI was modified, an "end date" was added for the original version of the NPI, with the modified version recorded as a novel NPI.

Discrepancies in data extraction were discussed collectively by a subset of 5 authors (L.G.M., J.S., K.A., J.P. and I.B.) until consensus was reached. A focused second review of the data set was performed by the same subset of authors to identify and resolve discrepancies and to improve consistency across reviewers and jurisdictions.

Data analysis

We conducted a series of descriptive analyses to summarize NPI implementation spatially and temporally in Canada. We compared the proportion of different types of NPIs implemented in various jurisdictions. To assess and compare the rigor of COVID-19 responses enacted by each province and territory, we calculated Oxford Stringency Index (OSI) scores using previously developed methods,[8] and visually present geographic and temporal variations (Appendix 1, Table S3). We compared the time-to-implementation of NPIs relative to case and death announcements in each jurisdiction. Finally, at the census metropolitan areas-level, we evaluated heterogeneity in NPI response by comparing the implementation of the 10 most frequently reported NPIs over time, as well as specifically for the implementation of event restrictions by size.

Ethics approval

Data were extracted from publicly available online sources, and therefore, according to Tri-Council Policy Statement (TCPS 2 2018; article 2.2), this type of research based solely on publicly available information is exempt from research ethics board approval.

Table 1: Summary of nonpharmaceutical intervention counts and sources by region

Region	No. of total interventions	No. of unique intervention categories	No. of unique Oxford categories[8]	No. of unique reporting organizations	Government source, no. (%)	Accredited news source, no. (%)	Social media source, no. (%)
Federal							
Canada	42	18	8	3	40 (95.2)	2 (4.8)	0
Province or territory							
Alberta	58	28	8	2	48 (82.8)	10 (17.2)	0
British Columbia	214	46	10	33	211 (98.6)	3 (1.4)	0
Manitoba	116	32	9	8	114 (98.3)	2 (1.7)	0
New Brunswick	151	41	10	1	150 (99.3)	1 (0.7)	0
Newfoundland and Labrador	50	30	9	5	45 (90.0)	4 (8.0)	1 (2.0)
Northwest Territories	76	33	11	19	76 (100.0)	0	0
Nova Scotia	103	30	9	0	103 (100.0)	0	0
Nunavut	64	28	7	13	64 (100.0)	0	0
Ontario	136	42	9	21	135 (99.3)	1 (0.7)	0
Prince Edward Island	81	24	7	4	81 (100.0)	0	0
Quebec	103	32	10	12	97 (94.2)	6 (5.8)	0
Saskatchewan	78	36	10	3	77 (98.7)	1 (1.3)	0
Yukon	58	30	8	1	57 (98.3)	1 (1.7)	0
Census metropolitan area							
Calgary	26	15	4	7	10 (38.5)	14 (53.8)	2 (7.7)
Edmonton	18	13	5	3	17 (94.4)	1 (5.6)	0
Kelowna	134	33	7	10	23 (17.2)	81 (60.4)	30 (22.4)
Vancouver	65	22	7	9	59 (90.8)	6 (9.2)	0
Victoria	35	23	5	5	19 (54.3)	12 (34.3)	4 (11.4)
Winnipeg	30	19	5	2	30 (100.0)	0	0
St. John's	11	8	4	1	11 (100.0)	0	0
Halifax	31	13	5	1	31 (100.0)	0	0
Hamilton	77	29	6	4	70 (90.9)	7 (9.1)	0
Kitchener-Waterloo	98	32	10	22	39 (39.8)	53 (54.1)	6 (6.1)
London	36	15	3	4	28 (77.8)	8 (22.2)	0
Niagara	33	19	4	5	32 (97.0)	0	1 (3.0)
Oshawa	19	10	2	1	19 (100.0)	0	0
Ottawa	126	26	5	2	126 (100.0)	0	0
Toronto	101	28	5	1	101 (100.0)	0	0
Windsor	66	27	6	2	66 (100.0)	0	0
Québec City	45	20	6	4	44 (97.8)	1 (2.2)	0
Montréal	111	25	11	53	73 (65.8)	38 (34.2)	0

Results

Temporal distribution of NPI implementation

Between Jan. 1, 2020 (24 d before the first case was reported in Canada[10]) and Apr. 19, 2020 (inclusive), we identified 2517 unique NPIs as summarized in Table 1. The temporal distribution of NPI implementation by daily count is displayed in Figure 1, indicating a sharp peak in NPI implementation during mid-March following minimal response in early March (5.48% [138] of NPIs implemented before the Mar. 11 WHO pandemic declaration[11]). The median NPI implementation date for Canada was Mar. 24, 2020, followed by a gradual decline in the announcement of new NPIs into April.

Types of NPIs implemented most frequently

Of the 63 distinct NPI categories recorded in CAN-NPI, the 15 most frequently reported categories — along with illustrative examples — are listed in Table 2. The most common

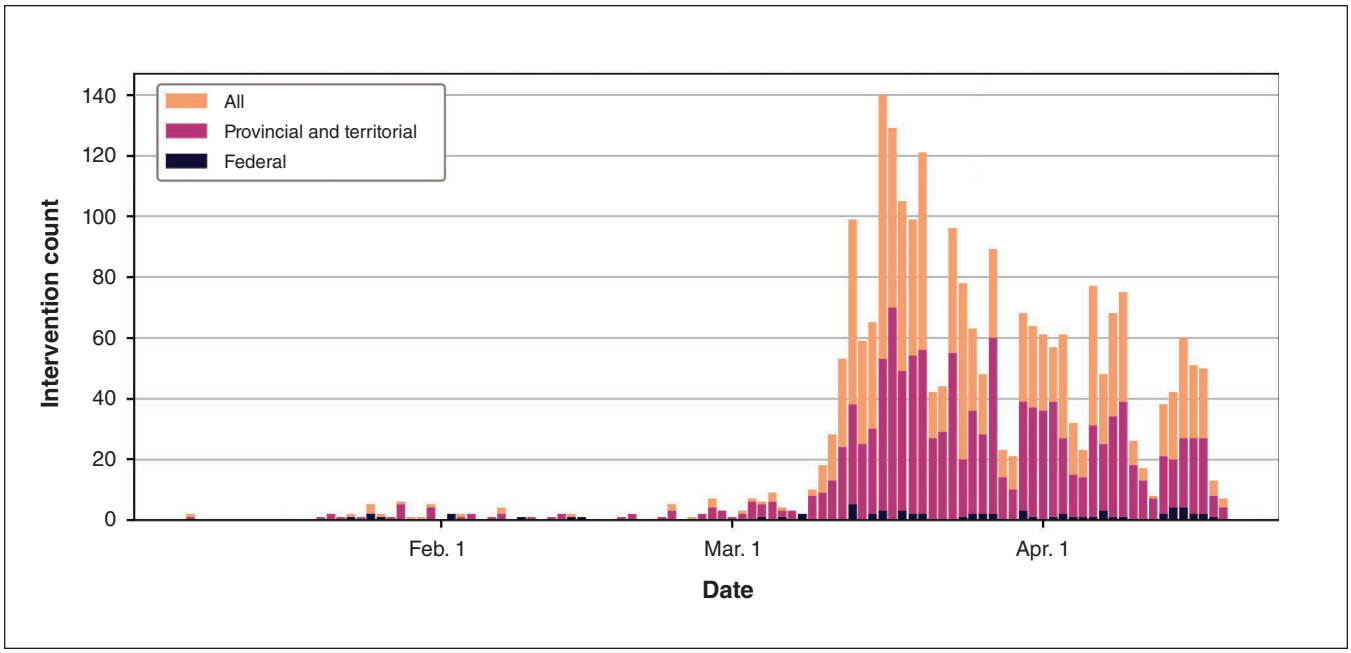

Figure 1: Temporal distribution of nonpharmaceutical interventions implemented across Canada from Jan. 1 to Apr. 19, 2020, in response to the coronavirus disease 2019 (COVID-19) pandemic (n = 2517).

NPIs took the form of announcements for instructing or informing the public. There was variation among provinces and municipalities in the number of NPI categories implemented, as not all categories were implemented within each jurisdiction and some jurisdictions used more NPI categories than others (Table 1).

Oxford Stringency Index scores

A subset of 37% (920) of the NPIs in our data set were additionally categorized under the OxCGRT labels suitable for calculating an OSI. We found that OSI scores evolved over time across the country (Figure 2). Overall, Canada's OSI score was 19.05 on Mar. 10, 28.57 on Mar. 11, 38.1 on Mar. 15 and 57.14 on Mar. 18, 2020. In early March, provinces and territories responded to COVID-19 at varying degrees of stringency, with British Columbia enacting the most rigorous measures before the WHO pandemic declaration. All provinces and territories heightened their responses following the declaration, with both BC and Newfoundland and Labrador scoring highest on the OSI by Mar. 31, 2020. There were minimal changes in OSI scores between Mar. 31 and Apr. 11, 2020 (1 month after the WHO's pandemic declaration), excepting slight increases for Manitoba and the Yukon.

Time-to-implementation

Relative to first case and death announcements, we found regional variation in the time-to-implementation of 2 major types of NPI: declaration of state of emergency (including public health emergency) and school closure (Figure 3). Quebec was the first province in the country to enact a state of emergency (Mar. 13, 2020) and Nova Scotia was the last (Mar. 22, 2020). Five provinces and territories declared their states of emergency on the same day, Mar. 18, 2020, while all 3 territories declared a state of emergency before their first case. Ontario was the first to mandate school closures (Mar. 13, 2020), while Manitoba was last (Mar. 23, 2020).

NPI responses by municipalities

There was also variation among municipalities in the timing and categories of NPIs implemented. Of the 10 most frequently reported NPI categories at the municipal level, Montréal, Vancouver and Ottawa enacted all 10 by Apr. 19, 2020 (Figure 4). The earliest response came in Toronto and Kitchener-Waterloo, each enacting 1 NPI by Mar. 8, 2020, after which more municipalities followed suit and implemented NPIs in a stepped fashion. This increase in stringency over time is reflected in event size restrictions (Figure 5). On Mar. 12, 2020, Toronto and Vancouver began restricting all events with more than 250 attendees, followed by 5 other municipalities in the following 2 days. Later, all municipalities issued stricter restrictions.

Interpretation

We present a comprehensive data set and descriptive analysis of NPIs implemented in Canada in the early response to COVID-19 at the federal, provincial or territorial, and municipal levels. We identified 2517 unique interventions implemented between Jan. 1 and Apr. 19, 2020, with temporal and spatial heterogeneity present among jurisdictions. Generally, all jurisdictions increased the stringency of their response after the WHO's pandemic declaration on Mar. 11, 2020.[11] British Columbia was the first province to act with a high degree of stringency and declare an outbreak, but in the following 3 weeks all other provinces and territories also increased their stringency. Declarations of states of emergency generally followed first case announcements and were

Table 2: The 15 most frequently recorded nonpharmaceutical intervention categories by count with descriptive examples

Intervention category	Definition	Count	Sample intervention summary
Public announcement	Any announcement or recommendation that does not fit elsewhere	298	Recommendation for residents to be vigilant, to refer to Santé Montréal (https://tinyurl.com/CANNPI-public-announcement)
General case announcement	Any announcement on a COVID-19 case that is not the first case announcement in a region	217	Announce 9 new cases, total 73 in BC (https://tinyurl.com/CANNPI-general-case)
Emergency economic funding	Stimulus or funding to mitigate the economic effects of COVID-19	166	Government to pay Alberta Energy Regulator industry levy for 6 months, totaling $113 million (https://tinyurl.com/CANNPI-emergency-econ)
Social distancing announcement	Any announcement of a social distancing policy	130	Government of Saskatchewan "strongly recommends" companies take travel and distancing measures (https://tinyurl.com/CANNPI-social-dist)
Emergency social services funding	Stimulus or funding to enhance social service capacity	104	$3-million Arts and Culture Resilience Supplement to be administered by the British Columbia Arts Council (https://tinyurl.com/CANNPI-emergency-soc)
Administrative flexibility	Any relaxation of government, bureaucratic or other regulations	90	Deferral of timber dues for 6 months by Government of Alberta to help ensure forestry companies can continue operations (https://tinyurl.com/CANNPI-admin-flex)
Nonessential workplace closure	Any decision or order closing workplaces deemed "nonessential"	83	Dominion Diamond Mines voluntarily suspends activity (https://tinyurl.com/CANNPI-work-close)
Public event or meeting cancellation or postponement	Cancellation of any public events	76	All March Break programming, camps and drop-in activities are cancelled in Oshawa (https://tinyurl.com/CANNPI-event-cancel)
Health care facility restrictions	Any changes in or restrictions on the functioning or processes of health care facilities	75	Whitehorse General Hospital will suspend any nonurgent surgery procedures starting Mar. 23, 2020 (https://tinyurl.com/CANNPI-healthcare-restrict)
Recreational or entertainment facility closure	The closure of any nonretail recreational or entertainment facility	74	GoodLife Fitness clubs close across Kelowna (https://tinyurl.com/CANNPI-rec-closure)
Emergency health care funding	Funding to enhance health care service capacity	69	Government of British Columbia announces $5-million funding to expand virtual mental health access during pandemic (https://tinyurl.com/CANNPI-emergency-health)
Recommended self-isolation	Recommendation from public health authorities for certain groups or individuals to isolate for 2 weeks	64	Nunavut Department of Health recommends self-monitoring for returning travellers from conference in Toronto where there was a sick contact (https://tinyurl.com/CANNPI-self-isolation)
School closure	Announcement of class cancellations and ongoing suspension of in-person events	60	Newfoundland and Labrador English School District suspends all in-school class instruction (https://tinyurl.com/CANNPI-school-close)
Declaration of emergency (or similar)	Announcement of state of emergency by organizational body	57	Declaration of state of emergency in Manitoba (https://tinyurl.com/CANNPI-declare-emerg)
Government building closure	Announcement of closure of workplaces related to government organizations	55	Closure of recycling centres in Québec City until further notice (https://tinyurl.com/CANNPI-govt-bldg-close)

Note: COVID-19 = coronavirus disease 2019.

implemented after school closures. Notably, all 3 territories declared a state of emergency before the first case announcement. There was also considerable variation at the municipal level in the number and timing of NPI announcements, but similarities in how they restricted the sizes of public events.

Although NPIs were implemented at different times across the world, the order of NPI implementation in Canada is similar to that found in other locations in Europe and Asia.[12] With travel restrictions being among the first NPIs implemented at the national and territorial level, and school closures being among the most common NPI implemented at the provincial and municipal level. Similarly, NPI implementation was preemptive in smaller regions while implementation in urban hubs tended to occur in response to large increases in numbers of cases.[12] Globally, NPI implementation, as measured by the OSI, increased after the WHO pandemic declaration,[11] with

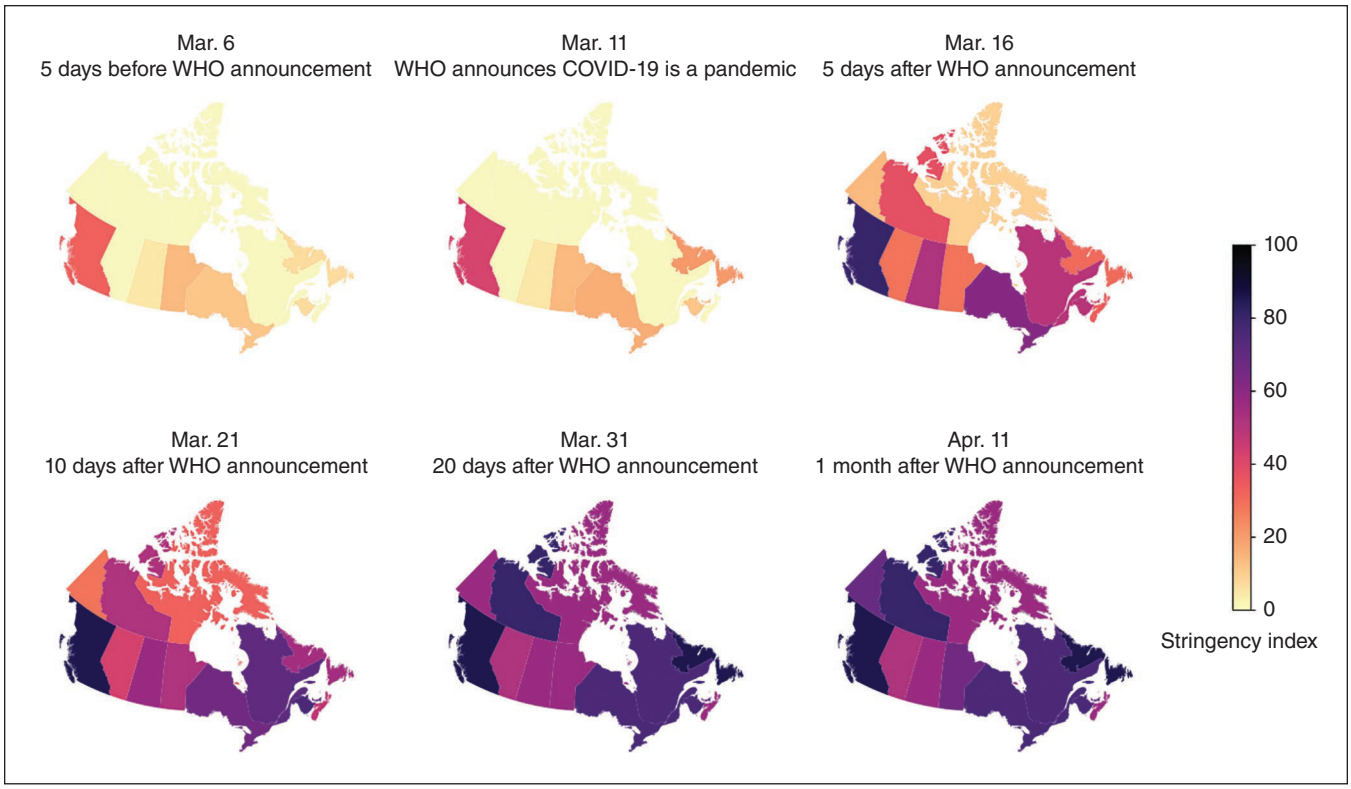

Figure 2: Oxford Stringency Index[8] in Canada by province and territory over time (n = 841). Note: COVID-19 = coronavirus disease 2019, WHO = World Health Organization.

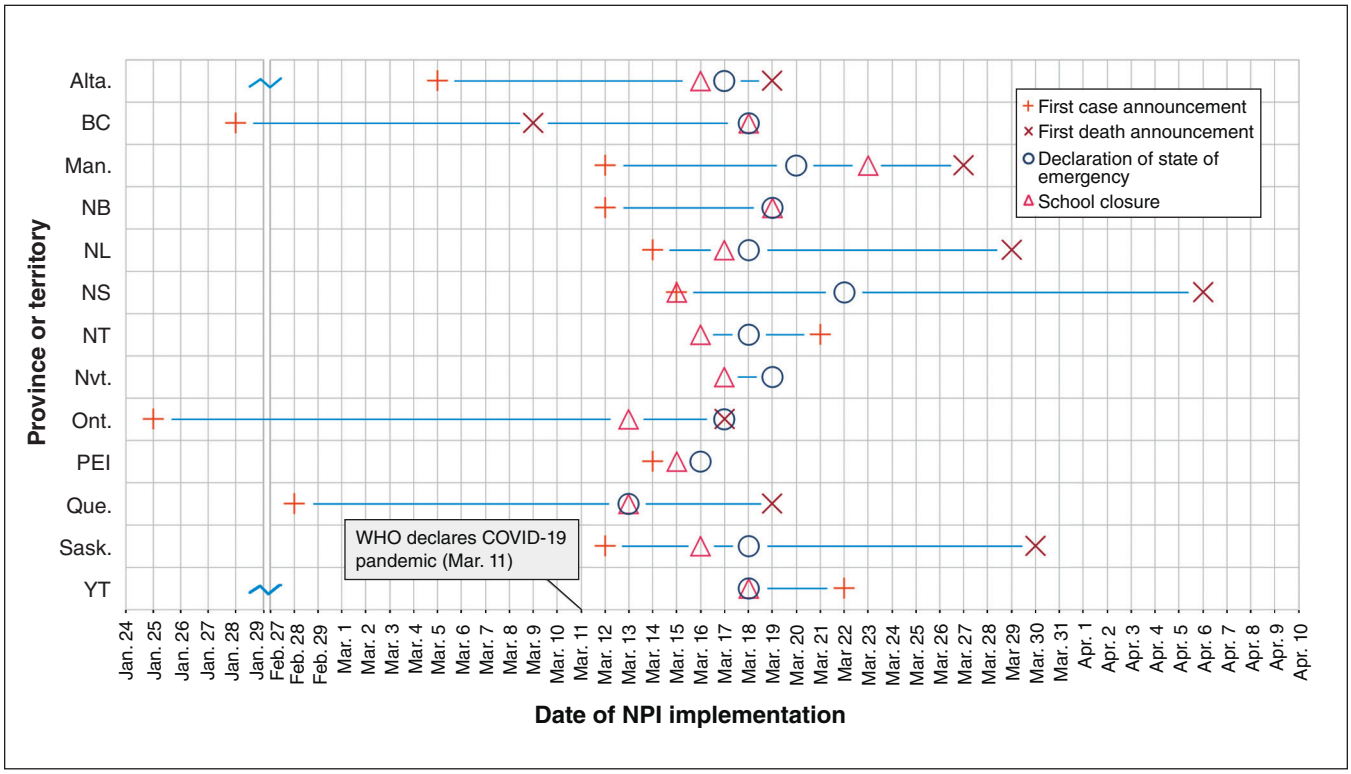

Figure 3: Variation in time-to-implementation for 2 major nonpharmaceutical interventions (NPIs) — declaration of state of emergency and school closure — shown relative to 2 descriptors of the local coronavirus disease 2019 (COVID-19) outbreak (dates of first case and first death) by Canadian province and territory. Note: WHO = World Health Organization.

rapid implementation of measures despite their high economic implications.[8] This pattern was also reflected in Canada's response overall, as its OSI[8] rose rapidly following the WHO pandemic declaration.

Compared with state-level US literature, we found less provincial- and territorial-level variation in NPI implementation in Canada.[13,14] In Canada, we consistently found that school closures were among the first NPIs implemented at the

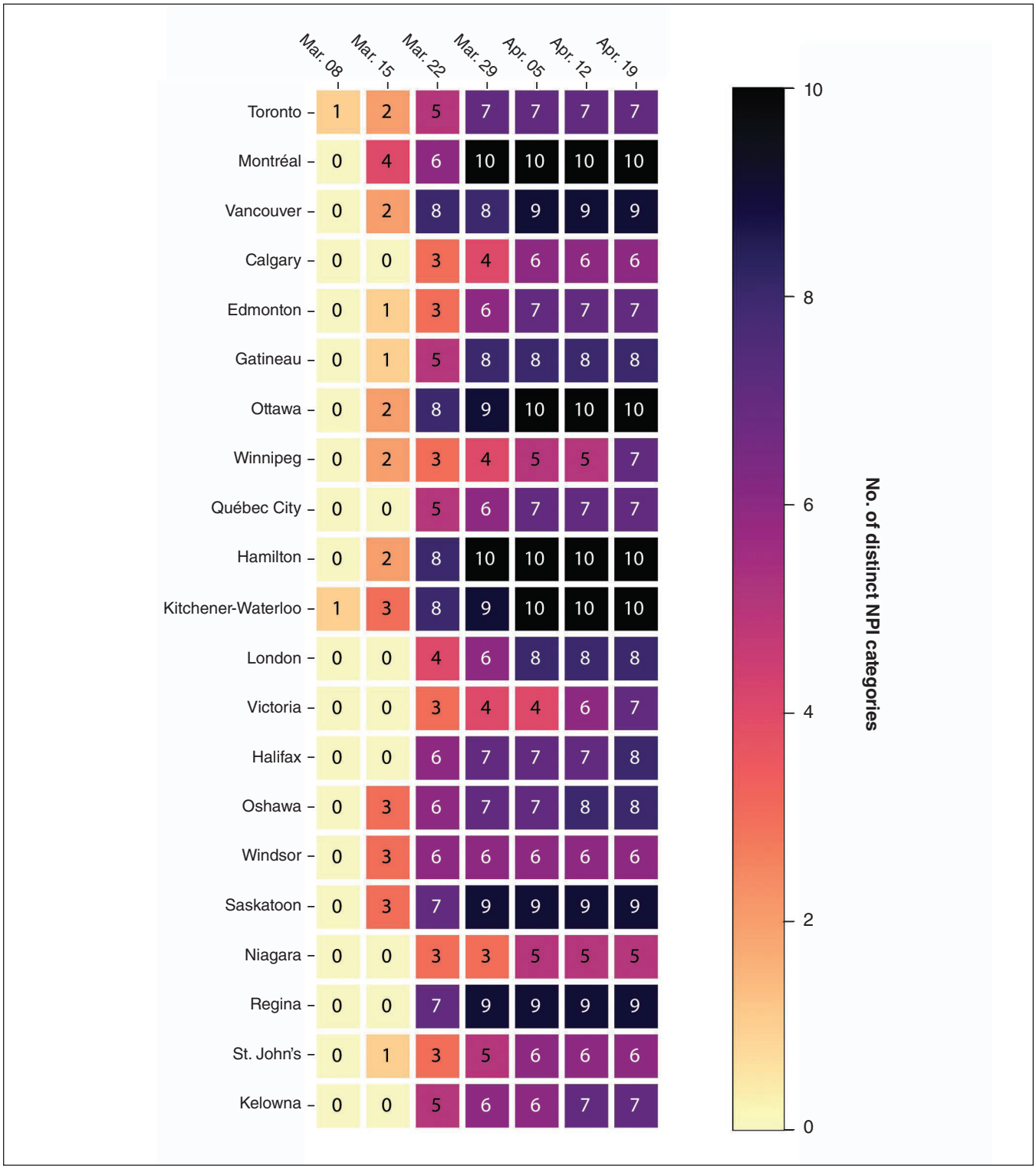

Figure 4: Implementation of 10 most frequently reported nonpharmaceutical interventions (NPIs) at the municipal level in Canada by census metropolitan areas (ranked by population size) over time.

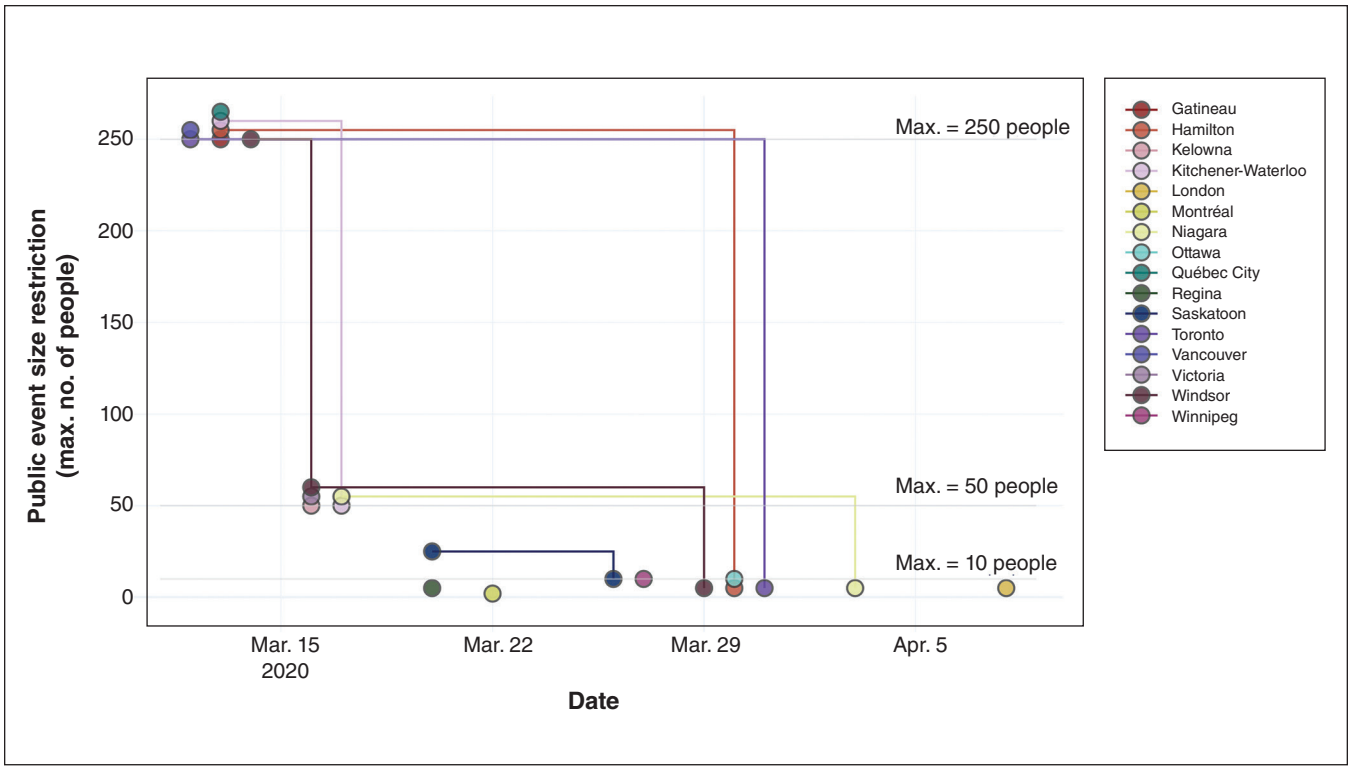

Figure 5: Public event size restrictions over time in Canada reported by census metropolitan area. Lines connect nonpharmaceutical interventions from the same municipality. Overlapping points indicate the same value as the lowest point. Census metropolitan areas that did not announce event size restrictions at the municipal level are excluded.

subnational level, which was either concurrent with, or closely followed by, declarations of states of emergency (with the notable exception of the territories, which declared states of emergency first). However, in the US, states tended to declare a state of emergency as their first NPI (a prerequisite to federal support under the *Stafford Act*[15]), and there was greater variance when states closed public schools.[13] There was also variability in the implementation of measures to limit social gatherings, restrict nonessential businesses, and shelter-at-home, all of which were NPIs that tended to be declared at later dates in the US.[13]

Although not explored here, there are numerous factors that may influence provincial or territorial and municipal implementation of NPIs. Research on these factors conducted in the US determined that dominant predictors of physical distancing policies were political, including the political party of a state's governor and the concentration of partisan leaning within a state.[14] A better understanding of these factors in Canada warrants further exploration.

There is also a growing body of literature evaluating the effect of NPIs using mathematical models[2,4] as well as collating regional collections of NPIs in COVID-19 hotspots to interrogate their effectiveness.[5,16,17] Where available, subnational NPI data sets have allowed for robust analyses, particularly when combined with case data and real-time mobility data.[16,17] These linkages and analyses are needed both urgently as decision-makers are tasked with evaluating the impact of these NPIs in real time to inform Canada's immediate pandemic response, and in the long term as retrospective work seeks to understand the nature of this response and how it may be improved for future outbreaks.[7]

Our study highlights the importance of NPIs to combat COVID-19 and shows that their rollout is fundamentally a local issue, in which decision-makers are best guided by data or circumstances specific to their own locale. Although the scope and scale of initiatives such as OxCGRT[8] or the Assessment Capacities Project government measures data set[9] is commendable, these data sets lack uniform granularity in subnational coverage (neither data set includes subnational entries for Canada at the time of writing). Thus, a strength in this work is its applicability to the Canadian context at both the national and subnational level.

Limitations

Owing to our reliance on public information to record NPIs, it is possible that interventions that were not publicly announced or covered by media outlets may have been omitted from our analysis. This may include interventions such as shifts in internal government or hospital procedures for testing and contact tracing. However, we expect that most interventions targeting the daily behaviour of Canadians will have been associated with public announcements. We also did not assess levels of compliance or the real-world implementation of these NPIs outside of government policy decisions.

There is also inherent variability in how different jurisdictions choose to report and describe their NPIs, as well as the

range of information that is included. This may have introduced a degree of variability in our labelling, and thus, our analysis. We sought to minimize inconsistencies across jurisdictions and reviewers through our standardized onboarding process, stepwise data entry and a secondary, focused review by a subset of reviewers before conducting analysis.

Moreover, we do not aim to make any causal or associative conclusions around the impact of these NPIs and COVID-19 dynamics and burden in Canada in this first work, but this data set will enable this important future work by any researcher. Finally, the analyses in this paper account for changes in the first month after a global pandemic was declared using data available at the time of submission, with subsequent data included in the online data set but not within this paper.

Conclusion

Responsibility for implementing NPIs to control COVID-19 is shared among the federal, provincial or territorial, and municipal levels of government in Canada. Characterization of the subnational elements of response, however, is critical in guiding analysis of the effect of these NPIs on health outcomes. We have developed and released a comprehensive data set, CAN-NPI, including information about NPIs at all Canadian governmental levels, and derived insights related to the classes and temporal and spatial distribution of these NPIs early in the course of the pandemic. Further research to connect this work with additional data sources regarding the spread and economic impact of the pandemic is critical both to guide the ongoing policy response and to enable effective retrospective research to capture the impact of the COVID-19 pandemic in Canada.

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Contributors: Liam McCoy, Jonathan Smith and Benjamin Fine designed the study. Liam McCoy, Jonathan Smith, Kavya Anchuri, Isha Berry, Joanna Pineda, Vinyas Harish, Andrew Lam, Seung Eun Yi and Sophie Hu curated and extracted data. Jonathan Smith, Kavya Anchuri, Joanna Pineda and Seung Eun Yi conducted data analysis. All of the authors revised the manuscript critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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Data sharing: Our data set of Canadian non-pharmaceutical interventions is openly available to all under a CC BY 4.0 licence available at https://howsmyflattening.ca/#/data. All code used to generate the figures is available at https://github.com/jajsmith/cannpi-cmaj.

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