



This is the 2nd affidavit of
Valerie Christopherson
in this case and was made on
25 February 2021

No. S-210209
Vancouver Registry

In the Supreme Court of British Columbia

Between

ALAIN BEAUDOIN, BRENT SMITH, JOHN KOOPMAN, JOHN VAN MUYEN,
RIVERSIDE CALVARY CHAPEL, IMMANUEL COVENANT REFORMED
CHURCH and FREE REFORMED CHURCH OF CHILLIWACK, B.C.

Petitioners

and

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH
COLUMBIA and DR. BONNIE HENRY IN HER CAPACITY AS PROVINCIAL
HEALTH OFFICER FOR THE PROVINCE OF BRITISH COLUMBIA

Respondents

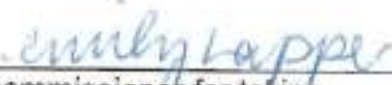
AFFIDAVIT

I, Valerie Christopherson, Paralegal for the Legal Services Branch, Ministry of
Attorney General, 1301 – 865 Hornby St., Vancouver, B.C. SWEAR THAT:

1. I provide paralegal support to Emily Lapper, counsel for the respondents Her Majesty the Queen in right of the Province of British Columbia (the "Province") and Dr. Bonnie Henry, in her capacity as Provincial Health Officer, and as such have personal knowledge of the facts and matters hereinafter deposed except where stated to be made on information and belief, and where so stated, I believe the same to be true.

2. Attached as **Exhibit "A"** is a true copy of a media transcript dated February 12, 2021 titled "Media Availability: Dix/Henry – COVID-19 BC update".
3. Attached as **Exhibit "B"** is a true copy of a letter with enclosures, from Dr. Bonnie Henry to Paul Jaffe, counsel for the Petitioners, dated February 25, 2021.

SWORN BEFORE
ME at Vancouver British Columbia
on February 25, 2021.


A commissioner for taking
affidavits for British Columbia


Valerie Christopherson

Emily Lapper
Barrister and Solicitor, Legal Services Branch
Ministry of Attorney General
1301 - 865 Hornby Street
Vancouver BC V6Z 2G3 (604) 660-3093
COMMISSIONER FOR TAKING
AFFIDAVITS FOR BRITISH COLUMBIA

Christopherson, Valerie L AG:EX

From: Today's News Online GCPE:EX
Sent: Friday, February 12, 2021 4:32 PM
Subject: Media Availability: Dix/Henry - COVID-19 BC update

This is Exhibit "A" referred to in the

affidavit of V. Christopherson

sworn before me at Vancouver
in the Province of British Columbia this

25 day of FEB, 2021

Valerie L. Christopherson

A Commissioner for taking Affidavits
within the Province of British Columbia

Media Availability

2021-02-12 15:01

Adrian Dix: . . . Provincial Health Officer. This is our COVID-19 briefing for British Columbia for Friday, February 12. We're honoured to be here on the territories of the Musqueam, of the Squamish, of the Tsleil-Waututh people; honoured to be here on their lands today. Dr Henry and I will be briefing again next Tuesday, which is February 16, from the press theatre in Victoria.

And with that, it's my honour to introduce Dr Bonnie Henry.

Dr Bonnie Henry: Thank you and good afternoon, and a Happy Lunar New Years to everybody. Kung hei fat choy to everyone. For today, we have 445 new cases that have been diagnosed with COVID-19, 6 of whom were epidemiologically linked cases, bringing our total number of people with COVID-19 in BC to 72,750. Of the new cases, 135 are people in the Vancouver Coastal Health region, 218 are people who reside in the Fraser Health region, 15 are in the Vancouver Island Health region, 44 people live in the Interior Health region, and 30 are in the Northern Health region. In addition, we have three new cases in people who normally reside outside of Canada.

We now have 4,347 active cases across the province, of whom 226 people are in hospital, 61 of whom are in critical care or ICU. And an additional over 7,035 people continue to be under public health monitoring with 67,008 people recovered from COVID-19. Again, today, unfortunately, we have ten new deaths to report of people, mostly seniors in LTC, who've died from COVID-19, bringing the total number of people in BC to 1,288. Our condolences go out to the families and the care providers and the communities who have lost their loved ones during this very difficult time.

We have one new health care outbreak in an assisted living facility, the Chartwell Carrington Place, where we have a single staff member and a single resident affected so far, and two outbreaks have been declared over, at the University Hospital of Northern BC where there were several units that had outbreaks, and at the Royal Columbian Hospital. And I do also want to note one of the more tragic outbreaks that we've had in LTC, at the Jubilee Lodge in Northern Health, was finally declared over yesterday and our thoughts are with the community and that facility.

We now have 16 active outbreaks in LTC and assisted living and six in acute care units involving 541 residents and 344 staff. In addition, we have a new community outbreak in the Brucejack Mine in Northern Health.

Since the start of our immunization program, we're now up to 162,982 doses of COVID-19 vaccine that has been administered in BC and of these, 17,562 people have received two doses of the vaccine. As we know, in the last couple of weeks we've had very limited vaccine supply, but, thankfully, starting next week, deliveries of our Pfizer BioNTech vaccine will start to resume at much higher levels and we expect to have a significant bump in supply in the coming weeks.

This will allow us to fully resume our province wide immunization program focusing, as we have been in phase one, on those most at risk of having severe illness or dying and people that are on the front lines of our health care system. And we're very excited that we're going to be wrapping that up in the next few weeks, and very soon we'll be able to expand into the community groups, particularly our seniors and elders.

As I'm sure many people have noticed, we've also seen a notable decrease in transmission and outbreaks in LTC and assisted living facilities as immunization has rolled out and this is clear evidence of the effectiveness of the vaccines and extremely encouraging news, and I know a relief to everyone that has family members in the care homes. As new cases continue to decrease in LTC, we also need to continue to decrease our transmission in our communities.

We are trending in the right direction, pushing our curve down, but slowly, and we need to ensure our success sticks. This means staying the course with our layers of protection and continuing to follow all of our public health restrictions and guidance. This weekend, we need to pay particular attention to ensure that the progress we have made is not wasted and I think Mother Nature's going to be on our side there, where it is going to be a challenging weekend for many people to travel.

This is even more important as variants of concern, that we've talked about, are circulating in our community. To date, we've had a total of 46 confirmed variant cases in BC – 29 of the B.117 originally found in the UK, and 17 of the B.1.351 originally associated with South Africa. In the past week and a bit, the BC CDC lab, in conjunction with our provincial labs, have been doing ongoing surveillance to help us better understand how many of these variants of concern – people infected with these variants of concern we have in the province and they did what's called a point prevalence assessment where we screened every positive case between January 30 and February 5 with a marker to see if they might contain the variants of concern, and of 3,099 positive cases that were screened there were three that were confirmed by whole genome sequencing to be variants of concern, one of which was a South African-associated variant and the other two were from the UK.

So this is reassuring. It tells us that we don't have high levels of transmission in our communities, but that we still need to be cautious and continue to monitor. In addition, in the past week, we've identified another variant that is under investigation internationally and across Canada. We've had a single case of this variant. It's been associated with Nigeria and travel to Nigeria, and the single case that we've had here in BC was a person who had travelled to Nigeria, and it's been labelled the B.1.525 variant, so it's a new one to add to our lexicon.

We aren't entirely clear yet whether this variant also has increased transmissibility or causes more severe illness, but our lab team is working with their counterparts across the country and internationally to get a better understanding of what this can mean. The emergence of these variants, of course, makes us all concerned here in BC. They've shown in many places across the world that they do confer an advantage in that these viruses tend to spread more quickly and now more evidence that they might cause more severe illness.

As we have seen, the choices that we make today, as well as the plans we make for tomorrow, make a difference to all of us. We are in some ways playing catch up with this virus and breaking those chains of transmission, preventing that next infection, is what we need right now to buy us that time to get our immunization programs back up to speed again and to help us give that protection buffer against these new variant viruses that are emerging around the world and here in BC.

I know so many people in BC are doing just that, doing their part every day, and you've chosen things like fewer faces and fewer places to keep your local community, your family safe. I know you'll be doing the same this long weekend and I am so appreciative of that. Thank you to everyone.

On this first day of the Lunar New Year it's a time to reflect on the challenges that we have overcome since this time last year and the progress that we have made. It's also our time to look to our brighter days ahead. I hope everybody has an enjoyable Family Day weekend and please remember to be kind, be calm, and to be safe.

Adrian Dix: Thank you very much Dr Henry, and I went to join Dr Henry and on behalf of the Premier and the government and the people of BC to pass on my condolences to the families, friends and caregivers of the ten people that passed away from COVID-19 in the last 24 hours in BC. Many of them in long term care, as we deal with outbreaks that occurred in long term care in November and December and January that are ongoing.

I wanted to note that we have 226 people currently diagnosed positive for COVID-19 in the acute care hospitals across BC. 61 of those people are in ICU at present, and if we look at the overall hospitalization rate for COVID-19 and all the other things that bring people into hospital, our base bed occupancy rate is 90.3%, leaving us 910 empty base beds in our hospital system. 72% occupancy rate amongst all beds. That includes the significant number of surge beds that were added to prepare for COVID-19. That leaves 3,337 beds in ICU. Our occupancy rate is 77.1%, which leaves 122 ICU beds available for new patients that are effectively empty at present.

And our occupancy rate, including surge beds, is 54.7%, which is 344 additional beds that are currently vacant. So that situation continues as it has been. That doesn't mean that especially in hospitals in BC, such as St Paul's, such as Royal Inland, there are not profound stresses, as there are in all of our hospitals as a result of COVID-19, but we continue in our acute care sector to have the ability to manage that.

Dr Henry talked about the 162,982 immunizations that have taken place in BC, including 17,562 who have received both doses. As Dr Henry noted, over the last three weeks, we have received about 21,000 doses of the Pfizer vaccine over three weeks, and next week we are expecting to receive considerably more according to federal government, 54,990. And obviously, because we are doing first and second doses because of the interval, about half of the Pfizer immunizations in the coming week will be second doses and most of the Moderna, which has also been slowed, as all of you will know.

But what we are hoping to do and continue to do is continue to now complete second doses in long term care, and Dr Henry has spoken about the extraordinary success of immunization in long term care in BC, and we want to acknowledge everyone who is part of that effort and obviously move on there to second doses, and that is what is happening. So that gives you a sense of what to expect.

And this briefing every week will bring you up to date on the progress of the surgery renewal commitment. As people will know, non-urgent surgeries were cancelled no March 16th to May 17th in BC. The health authority has resumed non-urgent surgeries on May 18th and have completed a total of 244,245 surgeries as of February 7th, 2021, of which 191,120 were urgent and non-urgent scheduled surgeries and 53,125 were unscheduled or emergency surgeries. With each week, we build on these achievements. Our surgical renewal progress shows what is possible when we come together as health care providers and administrators and community members, and I for one am grateful.

With that, here is the latest weekly report. The total surgeries completed by health authorities since May 18th, 66,675 in Fraser Health, 45,136 in Interior Health, 14,012 in Northern Health, 57,961 in Vancouver Coastal Health, 50,641 on Vancouver Island, 9,820 in the Provincial Health Services Authority.

Weekly totals of surgeries completed from January 25th to January 31st was 7,314 or 165 more surgeries than in the same year last year, and we are so appreciative of everyone who has worked on this initiative and who are making this ongoing progress possible, and know what it means to families everywhere.

This is a significant weekend for many people in BC. The beginning of Lunar New Year celebrations, of course today -- gong hei fat choy, chuc mung nam moi to everyone out there. And I went to express my appreciation to the Chinese-Canadian community in Vancouver, in Greater Vancouver, in Richmond, and all of the communities across BC. The Vietnamese-Canadian community, and many other communities celebrating Lunar New Year who have been, as communities, extraordinarily committed to following provincial health guidelines, who have been leaders in that regard, and I know this weekend, we are going to celebrate in our communities Lunar New Year in a way that is safe for everybody. And I appreciate everyone's contribution to that.

Sunday is Valentine's Day and then Family Day, which means that we have to understand the need to operate and to continue to operate differently, consistent with the pandemic to make this a BC Family Household Day long weekend, gathering with only those that you live with. And if we're on our own, it is one or two people that we have been with all along. COVID-19 and its variants mean we cannot vary our COVID fighting routine. COVID-19 is all around in BC. You see that in the numbers today. So for us, it's essential travel only.

Low risk is where we need to be and staying local is the way to get there. That means that until COVID-19 is in the past tense, we must live in the moment and keep using our COVID sense this weekend, next weekend, and beyond. Let's make it a happy and safe Lunar New Year and BC Family Household Day long weekend. Let's use our COVID sense. Let's stop the spread. Let's play our key role in the vaccination plan. And by doing all of that, to save lives together and to celebrate our families, our communities, in these extraordinary and important days.

Q & A

Reporter: Just a follow up on talking about the Moderna situation. Is it a possibility that seniors in long-term care homes that had Moderna on the first dose will not be getting Moderna as a second dose. You talked about mixing and matching, and I don't know if there was a final decision has been made. I'm just wondering if there's an update on that.

Henry: That's something that our national advisory committee on immunization has been addressing, as are other immunization committees around the world, and we're looking at that as well. And it is permissive in terms of using the same type of vaccine, so a messenger RNA vaccine can be used, but it is preferable to use the same product that you receive the first dose for the second dose. And right now we're still on track to be able to do that. It may mean that there may be a slight more delay for some people in receiving their second dose of the Moderna vaccine, but we will be monitoring that as we go, and as we find out for sure how much Moderna we are getting when, over the coming weeks and into March, in particular. We still are a little bit uncertain of how much is going to be coming, when, in March. So that's something that we are monitoring very carefully.

We now know more about how to use these vaccines and the effectiveness and the interchangeability, both from what is happening here in Canada and around the world, so we will be watching that really carefully. I think the other really positive thing is that the UK has started a study looking at mixing and matching of not just the same type of vaccine, but looking at whether you can start with a messenger RNA vaccine or a viral vector vaccine, the AstraZeneca, then follow up with a messenger RNA vaccine as a booster dose. And they are also, as part of that study, looking at what the optimal interval of that might be, whether it's four weeks or six weeks or nine weeks, etc. So those are things that we will be watching very carefully in the coming weeks.

Reporter: On long term care, I know it is good news that the number of outbreaks has dropped dramatically. That had been hoped for. Was that anticipated, though? Was there an expectation this would happen this fast?

Henry: Absolutely. I think we all were hopeful, especially when we saw how effective these vaccines are in older people. As soon as we started to see, particularly second doses in older people, that protection will last for some time. But I will still say, we have immunized health care workers who work in long term care, and had very high uptake, so that's a protective buffer, but we also have maintained the restrictions, so we are not out of that worrisome zone yet. I will be much more comfortable when everybody in long term care has their second doses and then we can allow more people in. So that will be happening soon.

Reporter: For Dr Henry first, Minister Dix talked about that point in time when we can refer to COVID-19 in the past tense, and I think there is an expectation that that point comes once we have all had our vaccines, and I'm wondering if that is realistic. Could you talk a bit about what we should be preparing for with these variants? Will vaccines and other measures likely be needed in the long haul?

Henry: I wish I knew the answer to that simple question. You know what, I believe that this pandemic will be slowed and stopped by our immunization programs. We are in such a tricky place right now, because we don't yet know the impact of these variants. We are monitoring carefully and the point prevalence that I mentioned that was done by our laboratory colleagues this week, that gives us some reassurance that we're not seeing a lot of transmission. But it only takes a few introductions for it to take off.

We talk about the reproductive number as an average, but most people don't spread to anybody, but there are some people who spread to large numbers of people. So that's what we are trying to effect, to protect people from with the

measures that we have in place, the public health measures about not coming together in large groups, particularly indoors, with poor ventilation, etc. So I do believe that if we can get through this next few weeks and get our immunization program up and running, protect people, and then once we have a lot of vaccine, which you know, is more and more likely that we will be able to immunize larger numbers of people by the summer, I think we will be in a very different place. We will get back to small gatherings.

But we don't know how long the protection from each individual vaccine series is going to last. There is a possibility that we might need boosters at some point in the future, and that's why I think it is important for us to start planning for altering vaccines and the messenger RNA vaccines are ones that can be changed fairly easily and be more effective. But whether that is going to be yearly like we see with influenza, or whether that might be periodically every three to five years or whatever, we don't yet know that. That's a possibility.

The way this virus has been shown to change, the mutations are slower than what we see with influenza and some of the other respiratory viruses. There is a growing sense from most of us that we will see it as a reoccurring respiratory virus in the respiratory season, so fall and winter for us over the coming years. But whether we have enough immunity that it will not cause these explosive outbreaks and lead to hospitalizations and overwhelming of health care systems, as we've seen in this past year. We hope that is not going to happen, that things will settle down as immunity increases. And it may change to become a more benign respiratory virus we've seen with some of the other coronaviruses over the years.

Reporter: Minister Dix, Premier Pallister is going to buy vaccine for Manitobans. It won't likely come by the end of the year, but at least we'll have a Canadian company on its feet that can manufacture vaccines and from Dr Henry's answer it sounds like that's probably a good idea in the long-term. Wondering what you're doing, what BC is doing to ensure Canadians and British Columbians will have some domestic capacity so we don't end up in the same bind in the future?

Dix: In all aspects of COVID-19 there is enormous research efforts going on right here in British Columbia; we appreciate the work done at the BCCDC, the work by the Michael Smith Foundation, by Genome British Columbia, by BC Academic Health Science Network and so on. There are more than 600 research projects underway, a lot of work to understanding what we've been through, but also ensuring we learn the lessons from a health perspective, a social perspective of COVID-19. We're very interested to see what happens with the agreement announced in Manitoba; we're certainly interested in anything that would create stronger domestic capacity in the long run. Dr Henry and I will be meeting with the company in question as well on that question to take a look at that.

But right now it should be said that we're focusing on the immunization of 4.3 million British Columbians, this is our top priority. This coming week we have 55,000 doses of Pfizer coming in, we're not sure at what point during the week so ensuring that our acute care settings are safe, that we're reaching out to people and community health in the coming week. Then, led by Dr Ballem with an enormous amount of support across the country, delivering one but essentially two doses to 4.3 million British Columbians. We're really focused on doing that and doing that well. It's going to be an extraordinary thing that's going to involve everyone in BC, but what happens in Manitoba is something we need to look at because the COVID-19 pandemic is at a critical point now; 445 cases with cases coming down in long-term care and somewhat lower levels of hospitalization and vaccines on the horizon, but the absolute need right now for all of us is to focus on stopping transmission and following public health guidance, which is more important now. Or at least as important as it has ever been since the beginning of the pandemic. That's the position we're in now, but we also have to prepare for the future; we're interested in what Manitoba is doing and we're doing a lot of work at every level in BC to ensure that we prepare ourselves not just for the immediate and the now, but for the years to come.

Reporter: I've got a question about workplace gatherings, specifically to celebrate the Lunar New Year. We got a tip about an office in downtown Vancouver organizing a Lunar New Year meal in the office. They seemed to think it's fine because they'll be distancing and servers will be wearing masks, although this is breaching COVID rules. There may be happenings in multiple workplaces -- what's your reaction to people gathering outside of their core bubbles?

Henry: Right now all gatherings are risky and these are not within the guidance that we have. Workplaces need to have their COVID safety plans and they need to adhere to them. There are ways of having gatherings with your work mates, with your family, your friends that are not risky, and I know people are doing for certain meetings where they have a small number of people in the room and others participating virtually. Those are the things you need to do through this Lunar New Year and if workers are concerned about risk, they can contact WorkSafeBC. There's some advertisements they've been putting out and the number to contact; there is a hotline where you can get advice from WorkSafeBC about your concerns about the workplace.

Dix: Just one further thing on that -- if people are thinking of doing a gathering that breaches COVID rules this week. In Vancouver Coastal Health there's 135 new cases announced today and if people are planning anything, our message -- and I think Dr Henry said it, but I want to say it very plainly -- don't do it. This is not the time. This is particularly important time for COVID-19 and if you're thinking of something that you're concerned is past the line, there's a really simple answer -- don't do it, don't do it this weekend, don't do it right now. That message should go to everybody.

Reporter: As you know, a number of cases at schools in the North Shore may be linked to social gatherings between students over the weekend. We're also hearing about kids gathering in large groups on the beach, or groups of six who are not in the same household going out for dinner -- do you have any suggestions to parents who may not know their kids are doing this? Or for parents who are allowing this to happen?

Henry: We know this has been hard on young people -- young people are social by nature, so these are conversations to have with your children. We also know that young people -- the young people in my life care about their families, they care about their communities and they want to do the right thing. We as a community need to support them in being able to do the right thing. There is sometimes a lot of pressure on young people and it's hard for them to know how to react and how to say no to things.

This is a time where it is important and okay for you to say no to going out with your friends right now. It's not okay to go in a group and spend the weekend at Whistler, it's not okay to go out and party with your group right now because that's putting your family, your community at risk. There will be a time for this, there will be a time when we'll be able to get back together, we'll be able to hang out with our friends and it'll be exciting and fun and new, but this is not that time.

Reporter: I'm just following up on what you were talking about in terms of possible higher herd immunity needed with the variants of concern. What does that mean for long-term care when last week you said 89% of long-term care staff have received the first dose and 87% of residents? But if all long-term care staff have been offered the vaccine there's 11% or so that either can't get it for medical reasons or turned it down. Is that 11% acceptable to you given the higher immunity needed with these variants of concern?

Henry: Yes. So I have been releasing them weekly, actually twice this week. But we will be updating those on a weekly basis as we continue our surveillance. And I just reported them again today. Usually I do that on Mondays, but I reported it today because we're off until Tuesday, and I also wanted to give the results of the point prevalence.

But yes, the new variant under investigation -- there's another term for us to use -- is this one associated with Nigeria, with a young person who is in the Interior Health region who returned from travel to Nigeria, and has been isolating. And there is no transmission that we're aware of from that person, and public health is following up, and the investigation continues.

Reporter: I'm just wondering, with regards to all of these variant cases, are they individual cases? Or is there a potential cluster of cases anywhere?

Henry: Yeah. There has been a couple of both. So I can tell you with some detail -- of the 29 cases that are associated with the B117, the UK variant, all but one were either directly related to travel or somebody who was a close contact of

somebody who travelled, or has been a confirmed case. So a cluster in the community that was known and then in retrospect was found to be associated with this variant.

As you know, we have only started looking for the variants quite recently. So a number of these cases had already been past their infectious period when we found them. So the investigation identified other people that were involved in their cluster. So there have been a couple of those associated with the UK variant.

With the 17 that we have seen that have been associated with the South African variant, again, there are a few that are travel related, but the majority are actually part of a cluster locally. Again, that has been investigated, and we have not seen ongoing transmission once we have identified the case, but we have retrospectively identified people that that person also was in contact with.

And there are a couple, though, that we do not yet know how they acquired it, or where they acquired it from in the community. So two in particular of the South African variant that are concerning, although what we do know is they have not passed it on to others. So there are three active cases so far. The rest of them are all retrospective cases, or people who have been beyond their infectious period.

Reporter: Just given the prevalence test that you spoke about, what is your estimate of the total number of variant cases that could potentially be out there in BC right now?

Henry: Good question. I didn't do that math before I came out here. But what we have found is .1% of the positive cases that we did in this point prevalence over that five-day period were confirmed to be a variant. So that's a very small number. So if we have 4,000 active cases, we're talking about maybe four or five additional people potentially with a variant in the community right now.

So we will continue to do these point prevalence studies periodically to see if that's increasing. We will also be continuing to do targeted surveillance. But the good news is that right now, with those 3,099 cases that were screened, and the whole genome sequencing, it was .1% that we're seeing right now.

Reporter: Dr Henry, I would like to ask you if churches were able to put in the same safety protocols as bars, restaurants, and health clubs, what is it about churches or other religious gathering points that still makes them more of a public health threat for the spread of the virus?

Henry: I think we need to look back on what we were seeing. And this is something that is not unique to this pandemic. We have seen it with other outbreaks as well -- that the nature of the interaction, the social interaction that you have with a faith group is fundamentally different than some of the transactional relationships we have if we're going to a store or even an individual working out in a gym, an individual going to a restaurant, or with your small group of people.

Having said that, we engaged very early with faith leaders across this province. And they recognize the important role that they play. I just want to reiterate, we now how important -- essential -- faith services are for people and for communities across BC. And that is why we have been working with faith community leaders since March of last year.

And we stopped all of those types of interactions when we were learning about this virus, and what was happening with this virus, and how it was transmitted, and in what situations it was being transmitted last March. And then when we reopened gatherings, and particularly faith gatherings, we did talk with the community about what were the things that made it safer.

And those measures were in place. We limited numbers, we had spacing, we introduced masks when that we needed. We talked about the different things that happen in different -- whether it's a church, or a gurdwara, or a temple, or a synagogue -- and tried to make rational approaches that would support people.

We also know that there is a demographic that goes to many faith services that is older and more at risk in some cases. So we needed to take that into account. And we were able to allow and to have active in-person services through most of the summer and into the fall.

As with many other things, as we got into the respiratory season, we saw the transmissibility of the virus increasing. And what we were seeing was that there was transmission in a number of faith settings despite having those measures in place. So that spoke to us about there was something about those interactions that meant that the measures that we thought were working were no longer good enough to prevent transmission of the virus in its highly transmissible state during the winter respiratory season.

So it was because of that that we put in additional measures to stop the in-person services starting in the end of November. It really was because we were seeing, despite people taking their best precautions, we were still seeing transmission. We were seeing people ending up in hospital, and sadly, we had some deaths in particularly older people who were exposed in their faith settings.

I want to get back -- and I have been talking with the faith leaders -- as soon as we can. Once we're out of that danger zone; once we understand what's happening with these variants; once we get our community levels low enough that it's not that risky any more, then absolutely. We will be going back to those safety precautions that we know work.

Reporter: You have mentioned over the last week a lot about Lunar New Year and Family Day. But there hasn't been a lot of mention about Valentine's Day. I know there are restrictions on everything. I get that. But is there not any specific concerns associated with the way that people typically gather and celebrate on Valentine's Day?

Henry: Well I will tell you that -- this is harkening back to last year -- but we have had some discussions with the restaurant and the food and beverage industry about Valentine's Day and about some of the concerns. But it's a fundamentally different vibe to Valentine's Day.

It's generally couples, families, young people together -- small groups. It's not a party in the same way that the Super Bowl or some of those events are. But again, we know this virus is transmitted when we have close contact with people. And this is a time to have close contact, to enjoy your Valentine's Day with your sweetheart, your loved one, and keep it small.

Reporter: My question is about the low prevalence of variants that the data you cited today is showing in BC. With Alberta our neighbour, our border-sharing province, supporting, I believe, in the hundreds or two-hundreds of cases of variants, are you concerned that we could see importation of those potentially more transmissible variants into BC?

Henry: Absolutely I am. And not only from Alberta, from Ontario. There is a considerably higher rate in some areas of Ontario as well. And we know that there is still travel back and forth. It comes back to the fundamental thing that we know about this virus. It is transmitted between people. And when we -- inadvertently or not -- when we travel we take the risk that we have with us, and we pick up the risk from where we're going and bring it home with us.

So it is people moving that spreads this virus, including the variants. And I have also said a few times, we know that the more transmission you have; the more cases there are the more opportunities there are for the virus to change; for a mutation to happen as it replicates.

So it's not surprising to me that we started to see the variants arise in countries that were having a lot of transmission in some communities. And then, of course, it takes off. So that's what we're concerned about right now.

We're coming down, but we're at a fairly high level, still. We had over 200 cases just in Fraser Health. And it's a large population in the Fraser Health region. We started to see a little bit of an uptick there. That's where we need to be careful because it can change so rapidly, and it grows exponentially when we start to let our guard down.

So that's one of the reasons why it's so important to stay small so that we don't give the virus a chance to spread and to replicate in many more people, and we don't travel right now.

Reporter: I've heard from a number of cleaning staff, porting staff in hospitals around Vancouver particularly, but around the province that they're concerned that they haven't been vaccinated in a lot of cases when they're coming into contact and regularly serving as a vector between wards in our health care facilities while management and people with more office facing jobs have been.

Is it your intention that these staff would be included in the current phase two vaccination roll out and why would they not be vaccinated before or at the same time as management?

Henry: There's a couple of things.

One, we're in phase one still and phase one focuses on health care workers who have patient contact in particular wards, and that is really important. Those are the people who are being immunized first. So, management, cleaning staff, others are not in that priority group.

We know that there are some nurse managers, for example, who ... I know some of the people who have been immunized are people that work and help with the outbreak management in long-term care homes. Things like that.

So, we don't always know the reason why an individual may have received the vaccine, but we also have to remember there are other things in place. We've had limited amount of vaccine, so we are focussing on those people who have direct patient contact, and particularly in the highest risk areas in hospitals right now. So the focus has been in the last little while in emergency departments, ICU, the medical and surgical wards to keep the hospital running, and the primary focus has been on people with patient contact.

We have other things in place that protect other workers, including cleaners, people who work in food services, security, all of the essential workers that we have in our hospital system. And yes, it is important and they are in the next phases of our immunization program, but with the limited vaccine we're focusing on people who have direct patient contact and we're making sure that things like access to personal protective equipment, the fact that cleaners don't go into the room with an active case unless they have certainty precautions and protections in place.

So, there are many other things that keep people safe in the system that need to continue, and we have said that many times. We need to continue doing what we are doing in the hospital system, in long-term care until we have enough vaccine to protect everybody.

Reporter: Dr Henry, we have heard from people who are in mandatory isolation right now who were shocked to find out from their contact tracer that they're allowed to take their dog for a walk, even if they have COVID. The BCCDC's website doesn't specifically mention walks or answer other specific questions about isolation, like whether someone can use their building's elevator to take out the garbage or if someone can get something from their car in the parkade.

How can people in quarantine find out some of the answers to these specific questions like these and why is it not more clear?

Henry: I thought it was quite clear, but there is the person that you are connecting with from the health authority for people that are in quarantine who are a case of COVID. So it depends a little bit.

If you're somebody who's sick with the virus or somebody who's a contact and not sick. And yes, there are some things that we allow people to do. You know, going outside, if you are in a house and you don't have any contact with anybody else, you can go into your backyard. We know that sometimes people need to get supplies, and we try and support them to be able to do that without having to go themselves.

So there are many things that we do to try and support people to be able to quarantine safely and to isolate safely.

Reporter: This is just about folks who already have had COVID-19. Do you plan on giving one dose of the vaccine to people who've already had COVID?

Henry: Good question. The jury is still out on that. We have seen now that people who've had COVID, particularly if it's been within the three months or so, they get a nice booster response from their first dose of the vaccine. So they would not necessarily be a priority for getting a second dose right away, particularly in a time where we have a shortage of vaccine. So, that's something that we will continue to monitor, but yes, right now, we are still intending on giving everybody a second dose because that's the way the vaccine program is designed, and whether it means that we can wait a bit longer for people who are getting a boost from natural infection, as well.

[adv, agg, mjag, mcf, ctz, edu, embc, empr, env, fin, forr, hlth, tn, jtst, lbrr, mhaa, maz, pjh, pssg, msd, tacz, tran, dbc]

TNO

This e-mail is a service provided by Government Communications and Public Engagement and is only intended for the original addressee.



February 25, 2021

1189520

Paul Jaffe,
Barrister and Solicitor,
Suite 200-100 Park Royal,
West Vancouver, B.C., V7T 1A2

VIA EMAIL
jaffelawfirm@gmail.com

Dear Paul Jaffe:

Re: Beaudoin, Alain, et al. v. HMQ, et al.
Supreme Court of British Columbia Vancouver Registry No. 210209

I am writing in response to your *Public Health Act* section 43 application on behalf of the petitioners in this proceeding, as conveyed in your correspondence with Gareth Morley of the Ministry of Attorney General, dated January 29, February 3, and February 17, 2021.

I understand the Petitioners to be seeking a variance of the Gatherings and Events Order dated February 10, 2021 (the "Gatherings and Events Order") to permit in-person worship gatherings on two grounds:

1. Under s. 43 (1) (a) of the *Public Health Act*, that a proposal to maintain physical distancing of at least 2 metres between members of different households, maintain contract tracing, maintain the use of hand sanitizer and at all times of ingress and egress from the buildings, maintain the use of masks and discontinue the practice of before- and after-worship social events will meet the objectives of the order and be suitable as a basis for a written agreement under s. 38 of the *Act*; and
2. Under s. 43 (1) (b) of the *Act*, that the Affidavits of Dr. Dr. Joel Kettner and Dr. Thomas Warren, and the material appended to them, constitute additional relevant information that was not available to the health officer when the order was made.

In response to your proposal under s. 43 (1) (a), I am not prepared to give the variance requested. I am prepared to give a conditional variance to the Gatherings and Events Order to the Petitioners allowing outdoor weekly worship services, subject to the adherence of the conditions below.

The conditions of the variance to the Gatherings and Events Order are:

This is Exhibit * B * referred to in the
affidavit of V. CHRISTOPHERSON
sworn before me at VANCOUVER
in the Province of British Columbia this
25 day of FEB 2021
Emily Lappin
A Commissioner for taking Affidavits
within the Province of British Columbia

Capacity, Setting and Attendee Limitations

1. The maximum number of people attending a service is 25.
2. Services are to be held outdoors.
3. Due to higher risk of serious complications of COVID-19 infection, the organizer must advise and encourage the following people to NOT attend in-person services:
 - a. People over the age of 70 (even if immunized, as there is currently uncertainty about the timing and duration of protection from immunization);
 - b. People who are living with someone with COVID-19, or upper respiratory or flu-like symptoms;
 - c. People with underlying medical conditions or compromised immune systems that put them at higher risk of severe illness or complications from COVID-19;

Preparation

1. To support contact tracing in case of an exposure to an infected participant, the organizer must:
 - a. pre-register participants to assure maximum number of attendees is not exceeded
 - b. collect the first and last names and telephone number, or email address, of every participant who attends a service;
 - c. retain this information for thirty days, in case there is a need for contact tracing on the part of the medical health officer, in which case the information must be provided to the medical health officer; and
 - d. destroy the information after thirty days.
2. Before attending the service, all participants must carry out a health check, which means reviewing the questions on the health check poster at <https://www.worksafebc.com/en/resources/health-safety/posters/help-prevent-spread-covid-19-entry-check-workers/lang=en>.
3. If a participant has not carried out or passed the health check, they must not be present at the service.
4. If a participant exhibits [symptoms of COVID-19](#) they must not attend the service;
5. Hand sanitation supplies are to be readily available.

Conduct of Services

1. Every participant will wear a non-medical face covering or mask.
2. Celebrants may remove their mask when speaking, but there must be at least a three-metre separation between them and other participants or there must be a physical barrier between them and other participants which blocks the transmission of droplets.
3. Each participant is to maintain 2 metres physical distance from one another, unless they reside in the same household.

4. No service will last more than one hour.
5. There will be no social gatherings or social interaction among participants before or after the services, whether indoors or outdoors.
6. There is to be no passing of a collection bag or plate and no sharing of ceremonial objects.
7. Participants are not permitted to sing or chant.
8. Participants must disperse immediately after a service and must not congregate with patrons who are leaving the service or arriving for a subsequent service.

Please note that this variance does not have an expiry date but may be withdrawn at any time by me should conditions exist that warrant doing so in the interests of protecting public health.

Reasons

A health order will be varied if a proposal is suitable to be a written agreement and if it meets the objectives of the order that is varied.

The objectives of the Gatherings and Events Order have been set out in the recitals to the Order and in oral statements to the public. They include preventing loss of life, serious illness and disruption of our health system and society by reducing the transmission of SARS-CoV-2 in gatherings. The Gatherings and Events Order recognizes that there are also societal effects of the measures put in place and that constitutionally-protected interests include the rights and freedoms guaranteed by the *Canadian Charter of Rights and Freedoms*, including specifically freedom of religion and conscience. While these freedoms are not absolute, I recognize the need for restrictions to be proportionate to the public health benefits, assessed in a manner consistent with the principles set out in the Ethical Decision-Making Framework specific to COVID-19.

As I noted on November 7, from the outset of the pandemic, an objective of the COVID-19 response has been to prevent the substantial spread of SARS-CoV-2 leading to preventable disease, deaths and the loss of the ability to contact trace effectively. Another objective is to maintain capacity within our health care system to provide care to all those suffering from COVID-19 and other illnesses. A breakdown would especially affect the most vulnerable, including seniors.

It was a further objective of the order to avoid closure of schools and workplaces.

Exponential growth in SARS-CoV-2 infections implies more serious illness and death and, if unchecked will lead to exceeding the capacity of the health care system and the ability to keep track of its spread. Evidence of exponential growth means that urgent action must be taken to "flatten the curve." If the number of cases is steady and elevated, then this requires maintaining the course and, at most, cautiously reducing restrictions.

Over the course of the pandemic, the scientific community and public health officials have learned that the likelihood of transmission of SARS-CoV-2 is greater:

- 1) when people are interacting in communal settings (e.g. gatherings, events, celebrations) than in transactional settings (e.g. at retail outlets);

- 2) when people are close to each other;
- 3) in crowded settings;
- 4) in indoor settings due to less ventilation than outdoor settings; and
- 5) when people speak, and especially when they sing, chant, or engage in excited expression (e.g. shouting or speaking at higher than conversational volume).

The likelihood of transmission also increases exponentially in a population when a number of people are simultaneously infected in a group setting, and subsequently infect their contacts, who infect their contacts and so on. This can, and has, quickly result in a scenario where local public health resources can be overwhelmed such that they are no longer able to trace all the contacts of such an exposure and require them to self-isolate. If this occurs, community spread can quickly become rampant, leading to increased case counts and, in time, has the potential to overwhelm our healthcare system as hospitalizations increase. As well transmission in religious settings have led to introductions of the virus into vulnerable community settings such as long term care homes leading to serious outbreaks with resultant deaths.

Based on the latest scientific and epidemiological evidence available to us, factors leading to elevated risk of COVID-19 transmission risk in religious settings are understood to include that they:

- 1) generally occur in indoor settings;
- 2) often involve the assembly of a large number of people from different households;
- 3) usually last for an extended duration (defined as longer than 15 minutes) which results in a greater duration of exposure and therefore a higher risk of infection and chance of viral spread;
- 4) often include individuals within high risk groups, including older adults and those with comorbidities; and
- 5) often involve loud talking and singing, which may represent greater risk for viral transmission.

Clusters of COVID-19 cases stemming from religious gatherings and religious activities have been noted since the onset of the pandemic globally, nationally and in British Columbia. You have already been made aware of the cases and clusters of COVID-19 cases in religious settings in BC in the Affidavit of Dr. Brian Emerson #1 at paragraphs 102 to 108. British Columbia's experience is consistent with that in other provinces and globally. A multi-jurisdictional outbreak connected to a series of events in a faith community in Saskatchewan in September resulted in 174 cases in

19 communities – including more than a dozen cases in Northern BC; this included 68 cases among individuals attending events, and 106 infected through secondary transmission. In an Ontario community, more than 30 active cases were confirmed in relation to a church gathering, with an additional 300 people put into isolation. Additional clusters related to attendance at religious gatherings have occurred across the provinces in Kingston (24 cases), Lethbridge (15 cases), 2 outbreaks in Calgary (24 and 54 cases, respectively), and Edmonton (99 cases).

In addition, a global analysis of COVID clusters found that religious settings frequently served as fertile ground for ‘first generation’ clusters of 10-50 people, and that large clusters – although infrequent – were commonly associated with religious activities. I am enclosing a published article by Leclerc Q et al.¹ that indicates this danger.

We have also begun to see the emergence of COVID-19 variants of concern (VOCs) that have been reported globally here in BC. To date, 80 BC cases have been identified with the B.1.1.7 variant, originally identified in the United Kingdom and 20 BC cases with the B.1.351 variant, originally located in South Africa.

Modelling suggests that if these VOCs were to become established or predominant in our province, case counts will rise quickly and significantly. The enclosed presentation from the Public Health Agency of Canada notes that “With spread of VOC, current public health measures will be insufficient, and epidemic resurgence is forecast” (see slide 12) and “In all provinces current controls may not be sufficient to fully control the variants of concern. The early lifting of public health measures could lead to a resurgence of the epidemic, including the community transmission of variants of concern” (slide 16). There is much debate about how likely modelling is to reflect reality, as there are many variables in predicting the trajectory of transmission in BC. However, it is clear that the new variants inject uncertainty into any projections.

If our case volumes were to increase significantly, it would create a real risk of overwhelming our contact tracing capacity and healthcare system, which in turn puts at risk not only those requiring COVID-19-related care, but all users of our healthcare system. We have been fortunate so far during BC’s second wave not to have had to cancel or delay scheduled surgical procedures for non-COVID-19 patients (other than some limited cancellations in the Northern Health Authority and Fraser Health Authority due to high hospitalization rates and outbreaks in hospitals), but if our hospitals were to become overwhelmed with COVID-19 patients, cancellations may be required.

At present, case numbers remain elevated, and since February 16 there has been a reversal in the trend such that there has been an increase with the seven-day moving average increasing from 409 cases/day to 505 cases/day at present. The region in which the houses of worship are seeking this variance, Fraser Health, has consistently had the highest rates of COVID-19 and currently has a

¹ Leclerc, Q. et al. What settings have been linked to SARS-CoV-2 transmission clusters? Wellcome Open Research 2020, 5:83 Last updated: 02 OCT 2020.

high rate of positive tests at 8.1%, compared to Vancouver Coastal region at 5.8%. This indicates increased rates of community transmission of virus. Hospitalizations are staying steady but elevated, while outbreaks in long term care facilities have come down but are also staying steady. We are continuing to see virus variants of concern with 100 now identified, and we are aware that they can rapidly escalate.

In summary, the indicators we are monitoring show that there is still concerning amounts of SARS-CoV-2 virus circulating in communities. Fortunately, vaccine supplies are increasing and are being rapidly administered and we are expecting to substantially increase immunization activities in the next few weeks. However, until we achieve widespread vaccine coverage of vulnerable members of our population, we must continue to exercise caution.

In short, we are not yet seeing the kind of reduction in new cases that would justify a significant relaxation in restrictions, most specifically in the Fraser Health region where the risk is greatest. Recognizing both the mental health benefits and constitutional status of collective religious activity, I am, however, prepared to cautiously allow careful outdoor in-person worship services on the basis of the conditions listed above. This must necessarily be reassessed if the variants of concern proliferate in the general population. I must emphasize that restrictions, as preventative public health measures, may be required even if your clients' own congregations do not experience infections.

This variation adds to the existing permitted activities, which include individual prayer, outdoor services in automobiles and online services.

The affidavits of Dr. Kettner and Dr. Warren do not represent information that was not available to me that would alter these findings and decisions. While it is not possible to exactly quantify, there is some transmission risk when people get together and that risk is elevated indoors. In the context of the existing epidemiological situation and the crucial objective of avoiding growth in the number of cases, especially of the variants of concern, which could have the effects I have discussed, my judgment is that lessening restrictions further than as provided for here would pose an unacceptable risk to public health.

I am enclosing "Assessing request for variance on restrictions on faith-based gatherings" authored by Dr. Naomi Dove, Public Health and Preventive Medicine Specialist and Physician Consultant with the Office of the Provincial Health Officer and a literature review "COVID-19 transmission risk in faith-based gatherings" prepared by her, which has informed my judgment in this regard.

I must emphasize that I have taken my decisions to restrict in-person religious services very seriously. I have listened to faith leaders and I recognize how important in-person services are to the congregants. However, I must also take actions to protect people and their communities, hence the need to be very cautious at this critical time by granting this conditional variance to my order.

17

Please let me know if you have any questions or concerns about this decision.

Sincerely,



Bonnie Henry
MD, MPH, FRCPC
Provincial Health Officer

Cc: Gareth Morley, Barrister and Solicitor, Ministry of Attorney General
Jacqueline Hughes, Q.C., Ministry of Attorney General
Dr. Brian Emerson, Deputy Provincial Health Officer, Ministry of Health

Enclosures

Update on COVID-19 in Canada: Epidemiology and Modelling

February 19th, 2021

Canada.ca/coronavirus



Public Health
Agency of Canada

Agence de la santé
publique du Canada



Canada

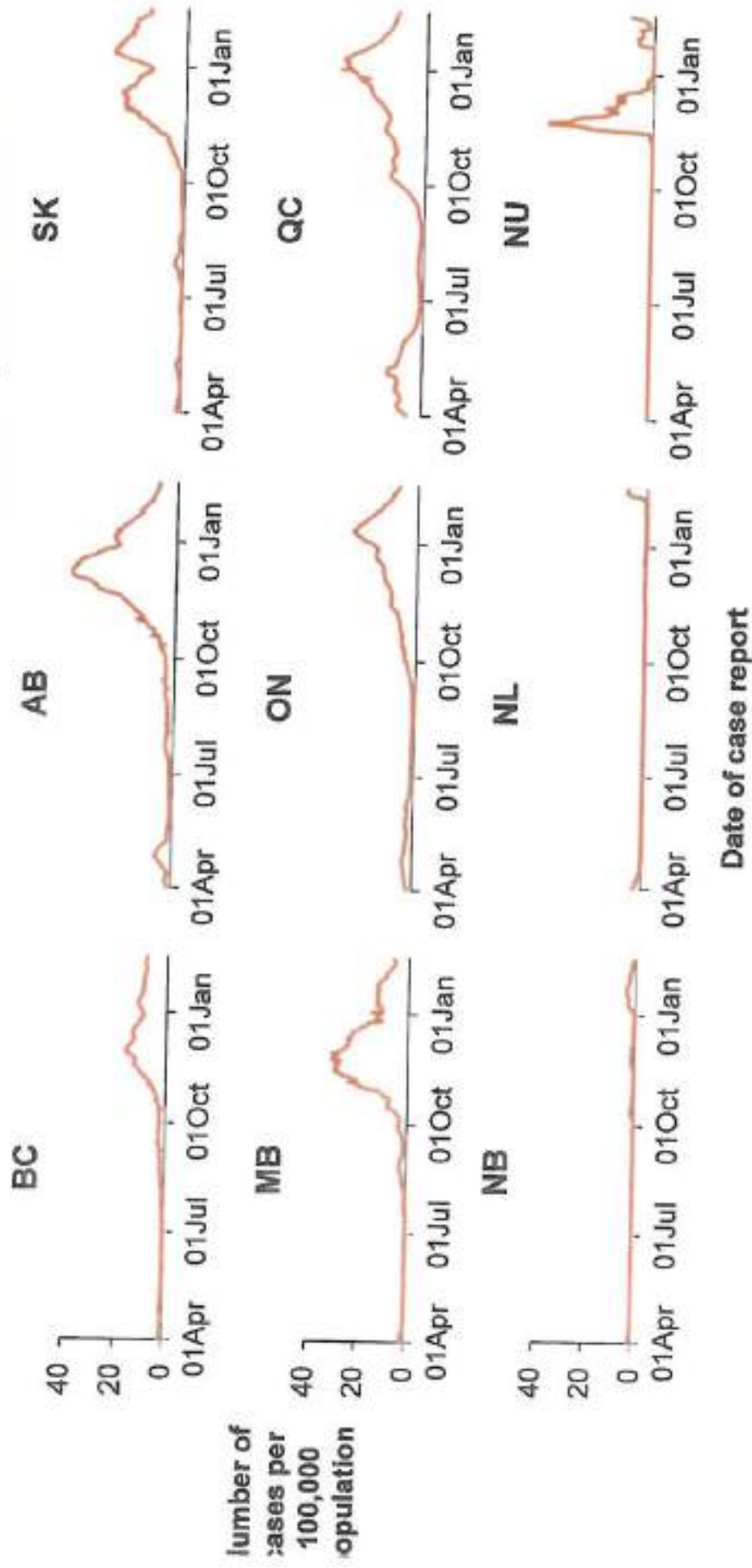
COVID-19 daily case counts continue to decline nationally



Data as of February 16, 2021



COVID-19 incidence rate over time in nine Canadian jurisdictions



Data as of February 16, 2021



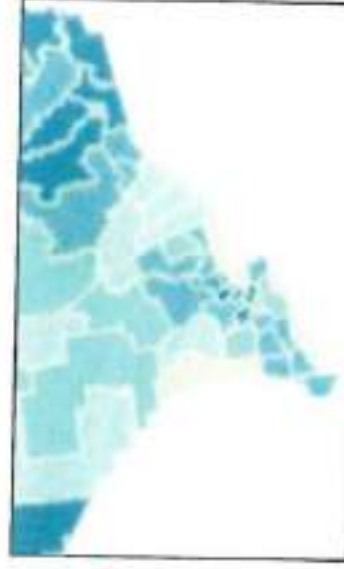
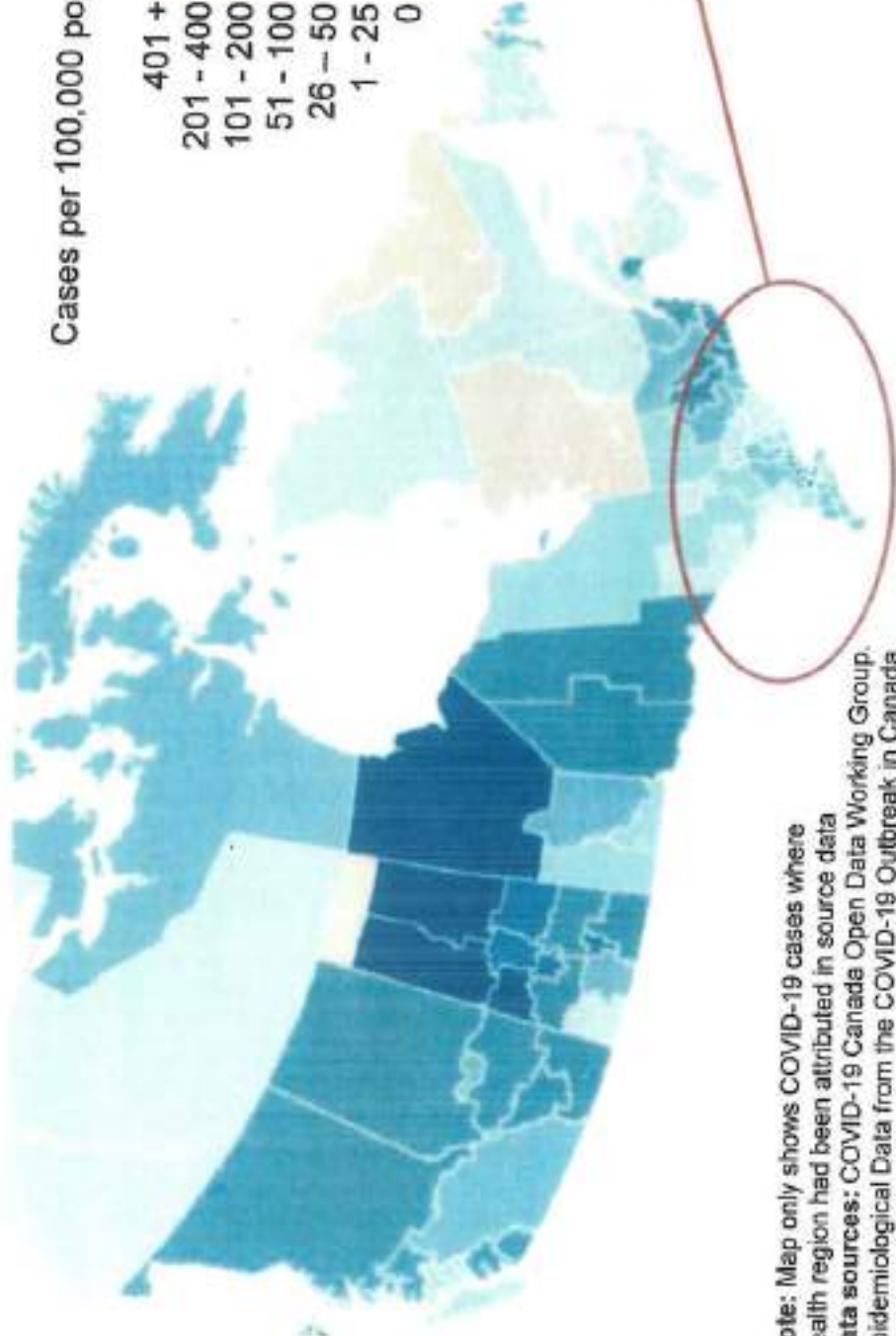
Fewer health regions reporting high rates of COVID-19 infection

Cases per 100,000 population (Feb 3 – Feb 16, 2021)



35 of 99 health regions with **> 100 cases per 100,000** population over a 14-day period

Down from 59 of 99 regions with > 100 cases per 100,000 population on January 15th

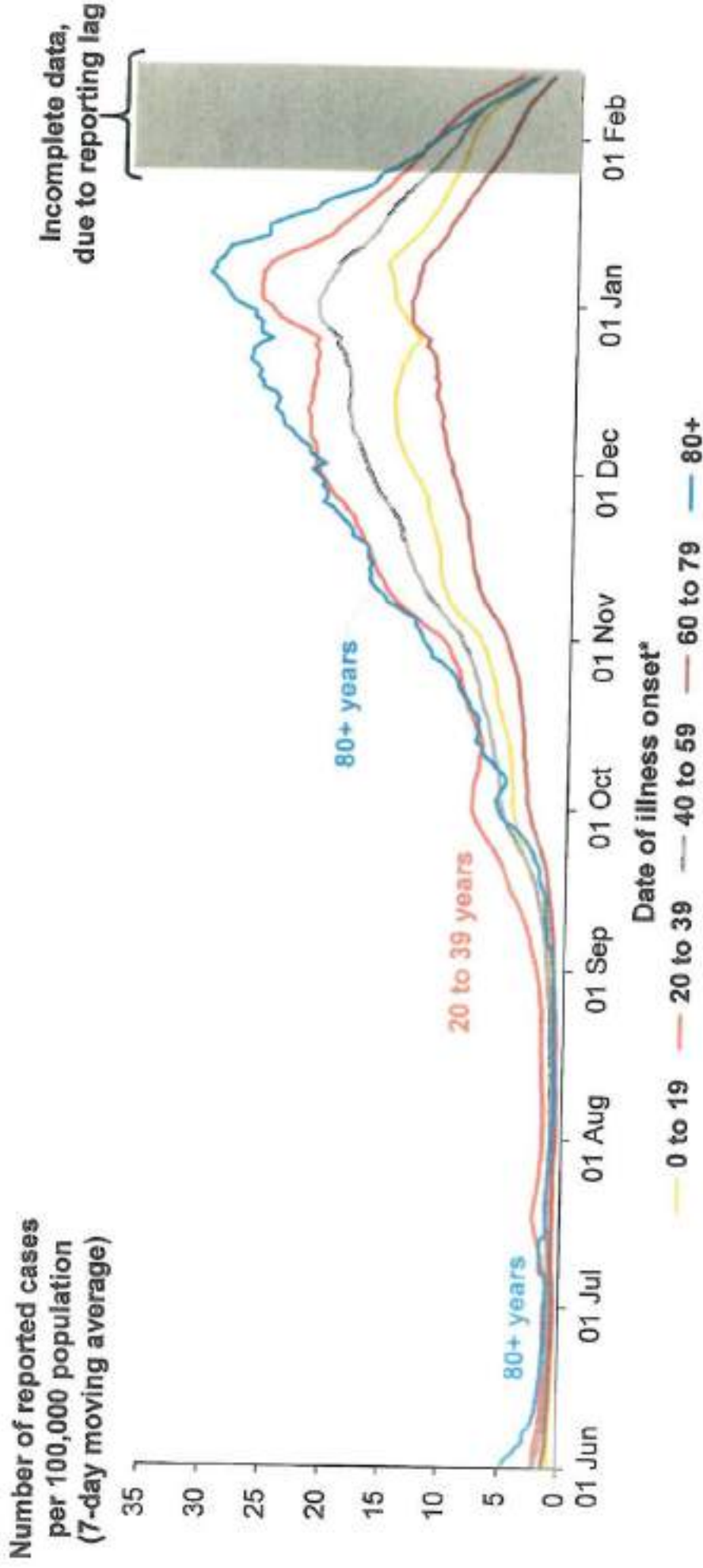


Note: Map only shows COVID-19 cases where health region had been attributed in source data
 Data sources: COVID-19 Canada Open Data Working Group, epidemiological Data from the COVID-19 Outbreak in Canada

Data as of February 16, 2021



Incidence rates declining across all age groups

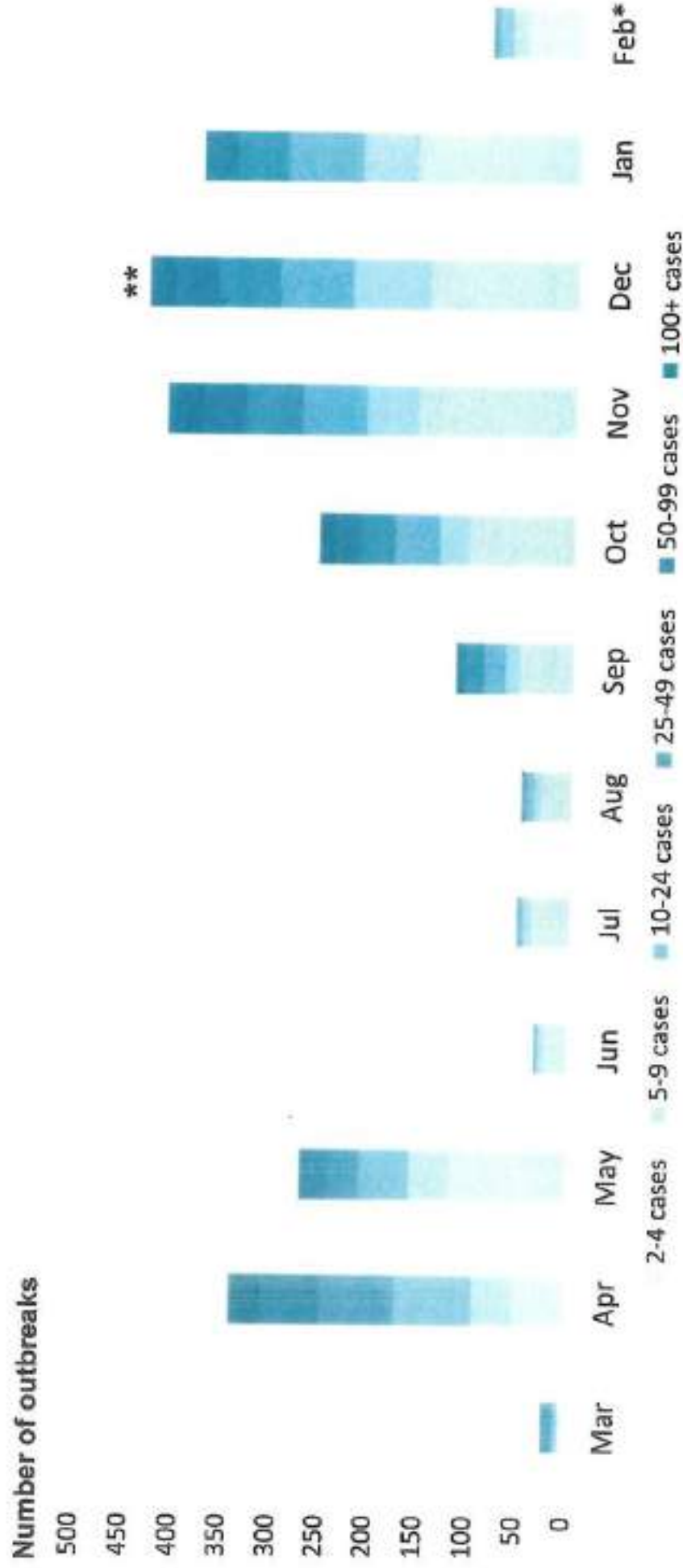


Data as of February 16, 2021

*Note: First available of illness onset, specimen collection, laboratory test date



Number of outbreaks in long term care homes* appears to be declining



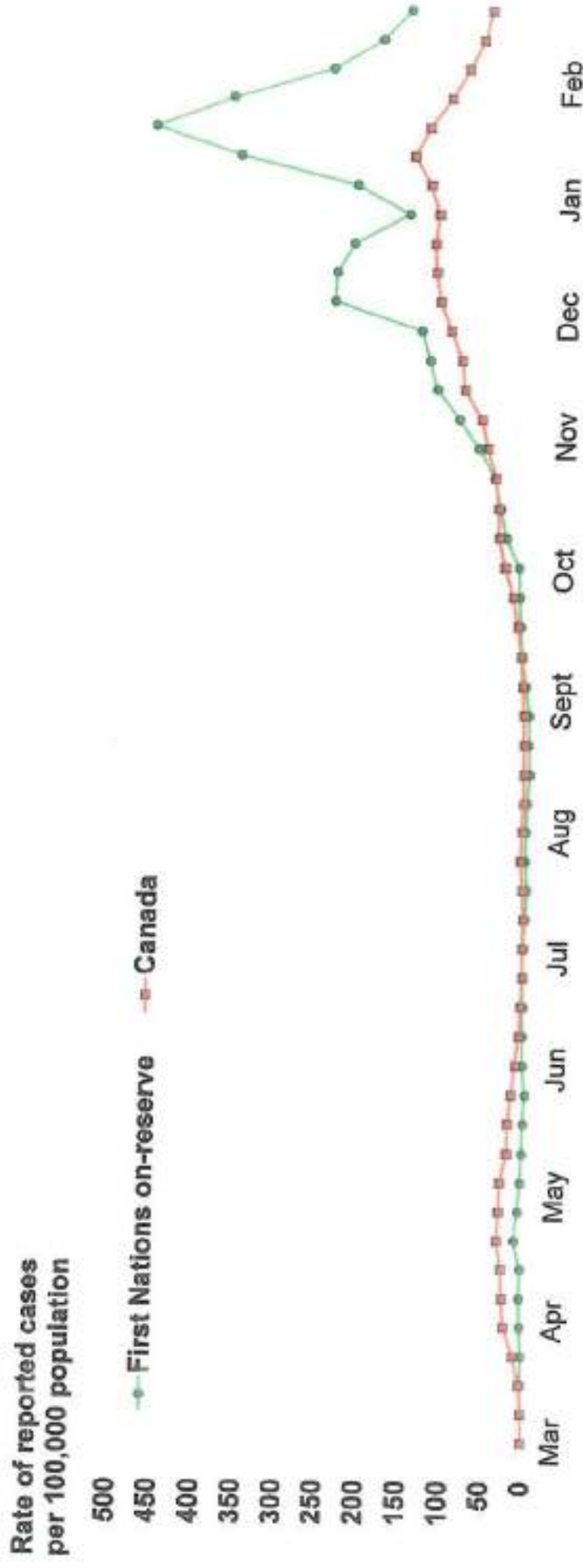
Data as of February 10, 2021

*Note: By date outbreak was first reported publicly. Including retirement residences. Data for the month of February is incomplete.

**Underestimated due to reduced reporting in December.



Impact of COVID-19 is higher among Indigenous populations



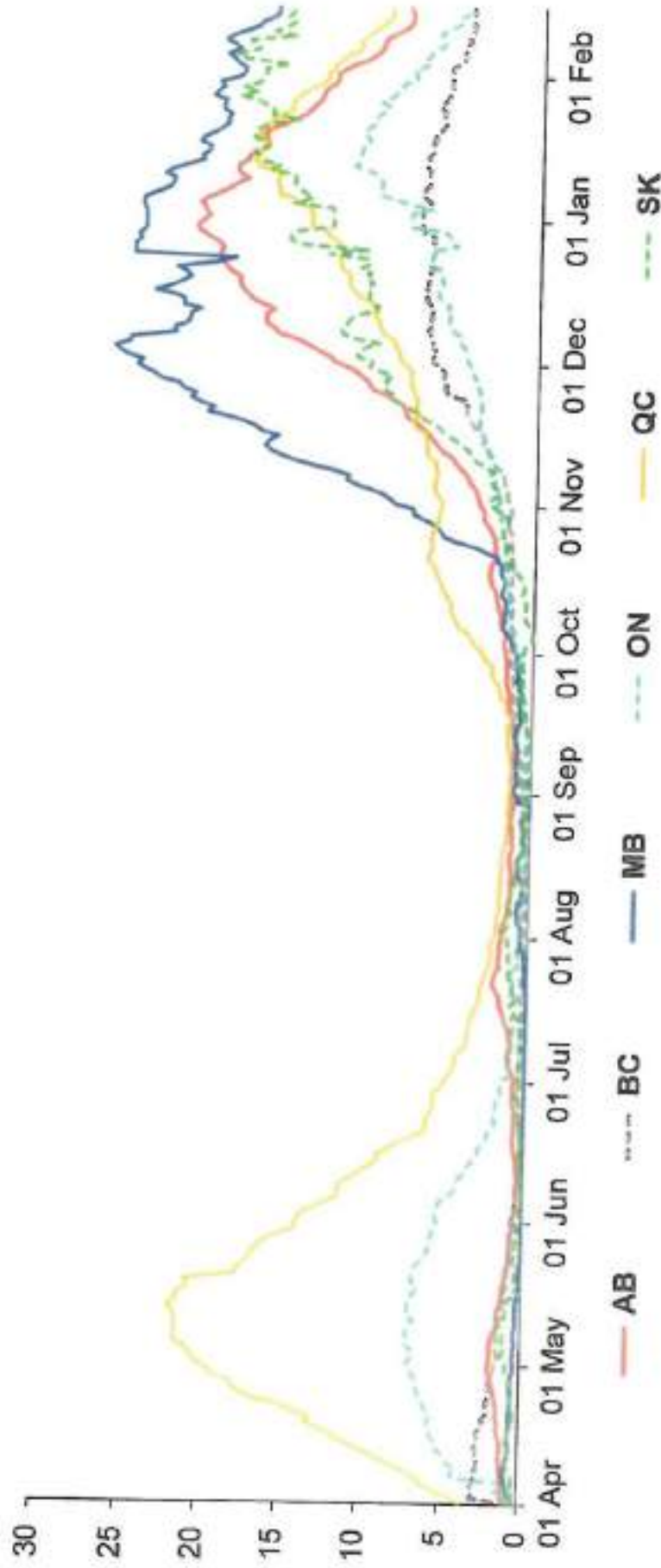
COVID-19 incidence in First Nations on reserve and general Canadian population

Data as of February 16, 2021
 Note: By episode date



Hospitalization rates declining in most provinces across the country

Number of cases in
hospital per
100,000 population



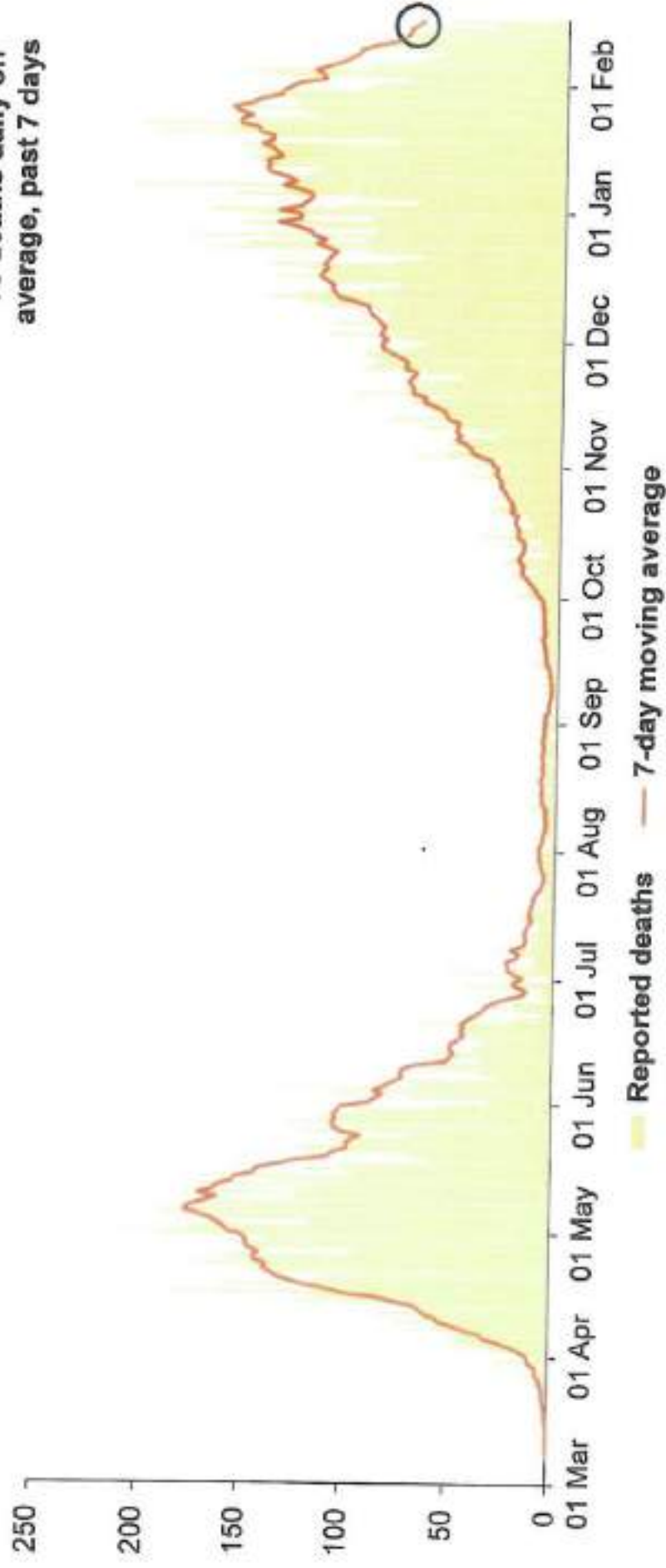
Data as of February 16, 2021
Note: 7-day moving average



Daily COVID-related deaths continuing to decline nationally

Number of deaths

70 deaths daily on average, past 7 days



Data as of February 16, 2021



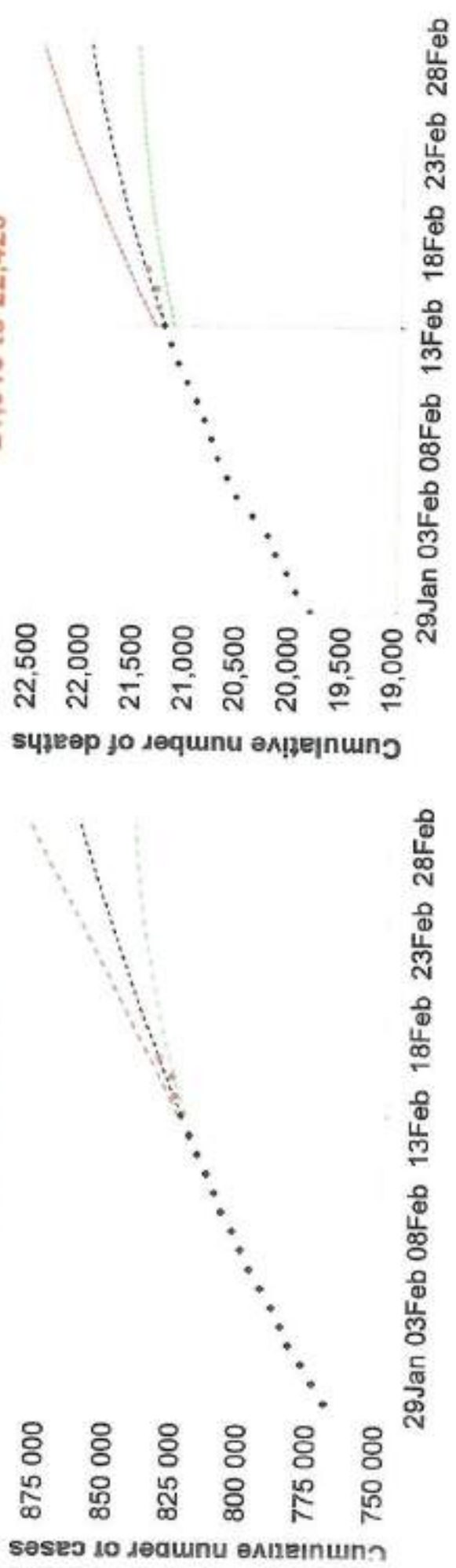
Short-term forecast predicts a flattening of the trajectory, reflecting the slowdown in the rate of epidemic growth

Cumulative cases predicted to February 28, 2021:

841,650 to 878,850

Cumulative deaths predicted to February 28, 2021:

21,510 to 22,420



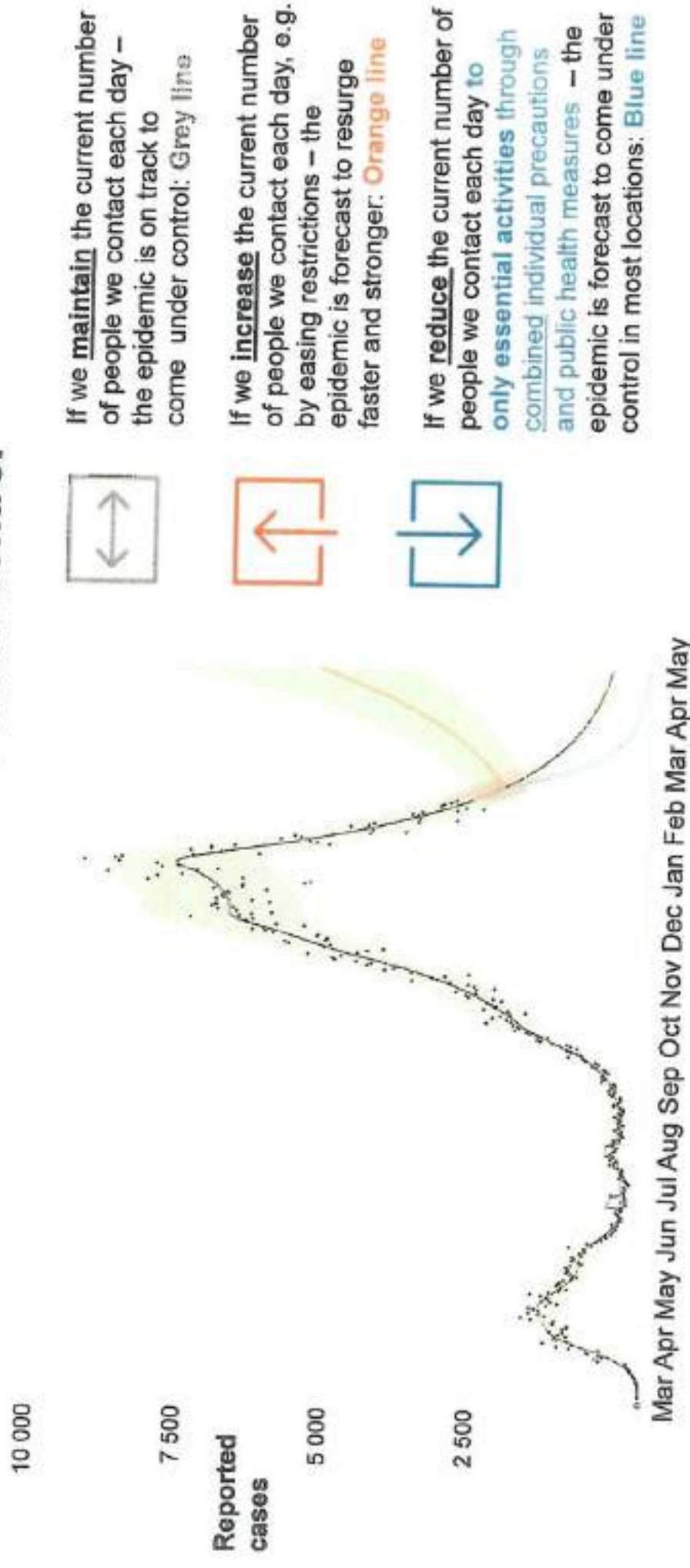
- ◆ Cumulatively reported cases in Canada by Feb 13, 2021
- Cases added since Feb 13 when the prediction was made
- Prediction to Feb. 28, 2021
- - - Lower 95% prediction limit
- - - Upper 95% prediction limit

Data as of February 16, 2021

Note: Extrapolation based on recent trends using a forecasting model (with ranges of uncertainty).



Longer-range forecast based only on non-variant COVID-19 indicates Canada's epidemic is on track to come under control

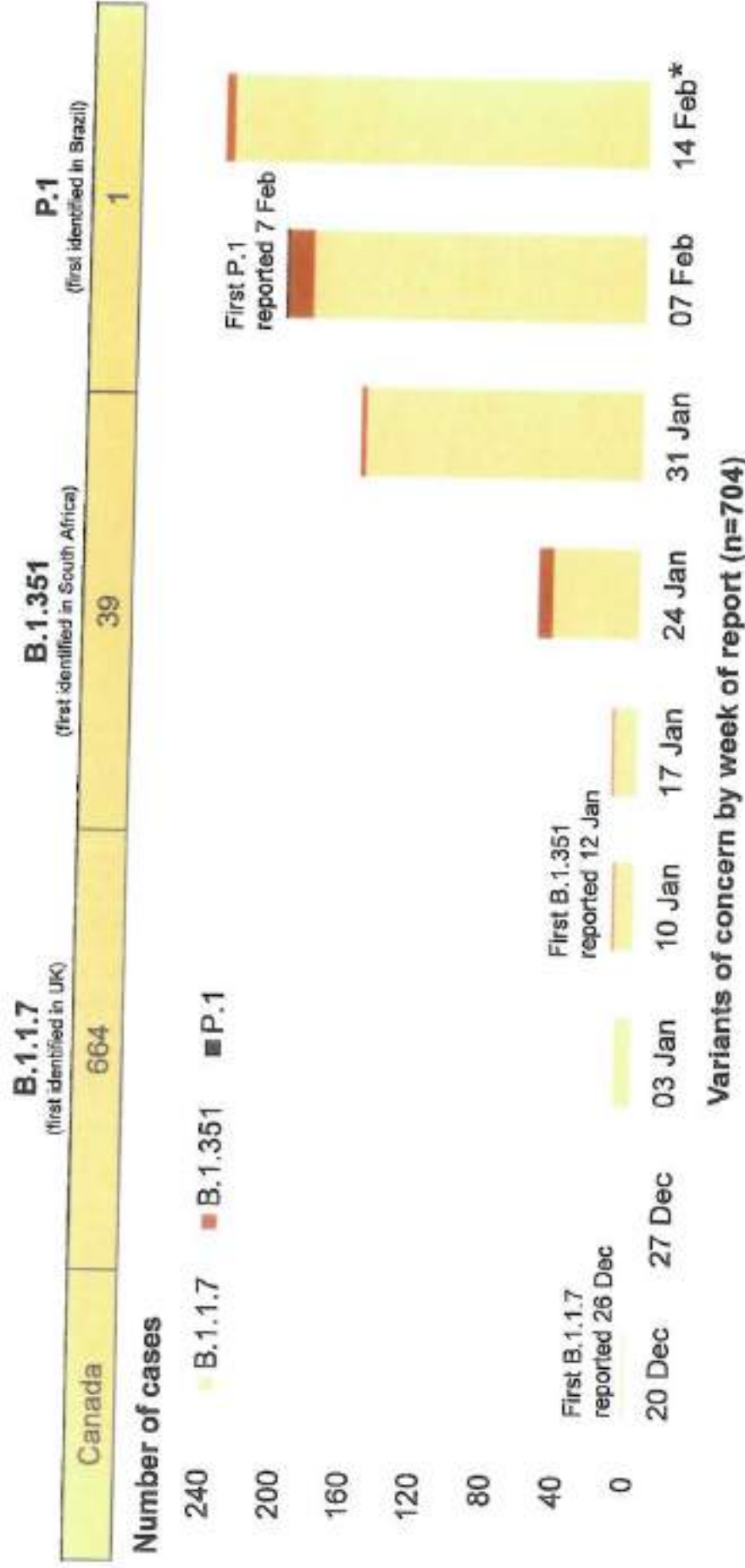


Data as of February 16, 2021

Methods: Anderson SC et al. 2020. Estimating the impact of COVID-19 control measures using a Bayesian model of physical distancing. <https://www.medrxiv.org/content/10.1101/2020.04.17.20070066v1>



More contagious SARS-CoV-2 Variants of Concern detected in all provinces with increasing prevalence and spread

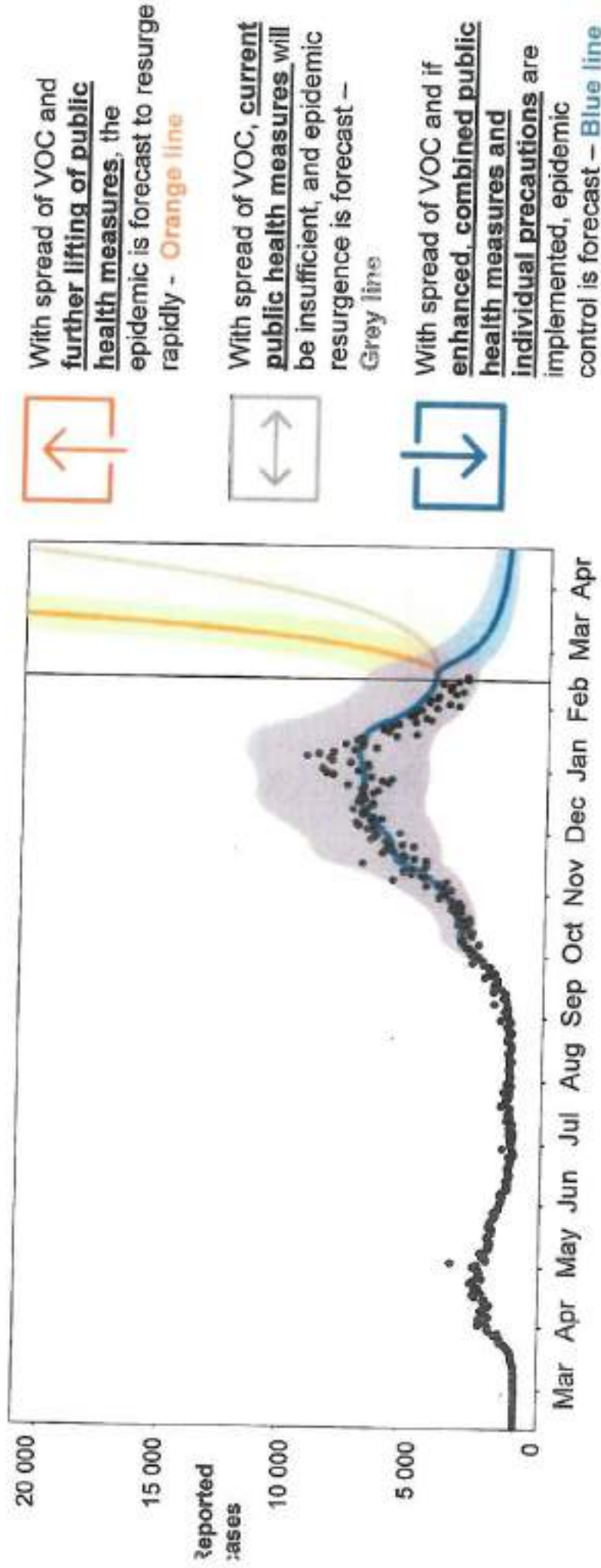


Data as of February 18, 2021

Data sources: Official provincial and territorial press releases *Week of February 14th includes data from February 14-18, 2021.



New longer-range forecast that includes Variants of Concern indicates a strong resurgence unless we have stringent measures and strict adherence



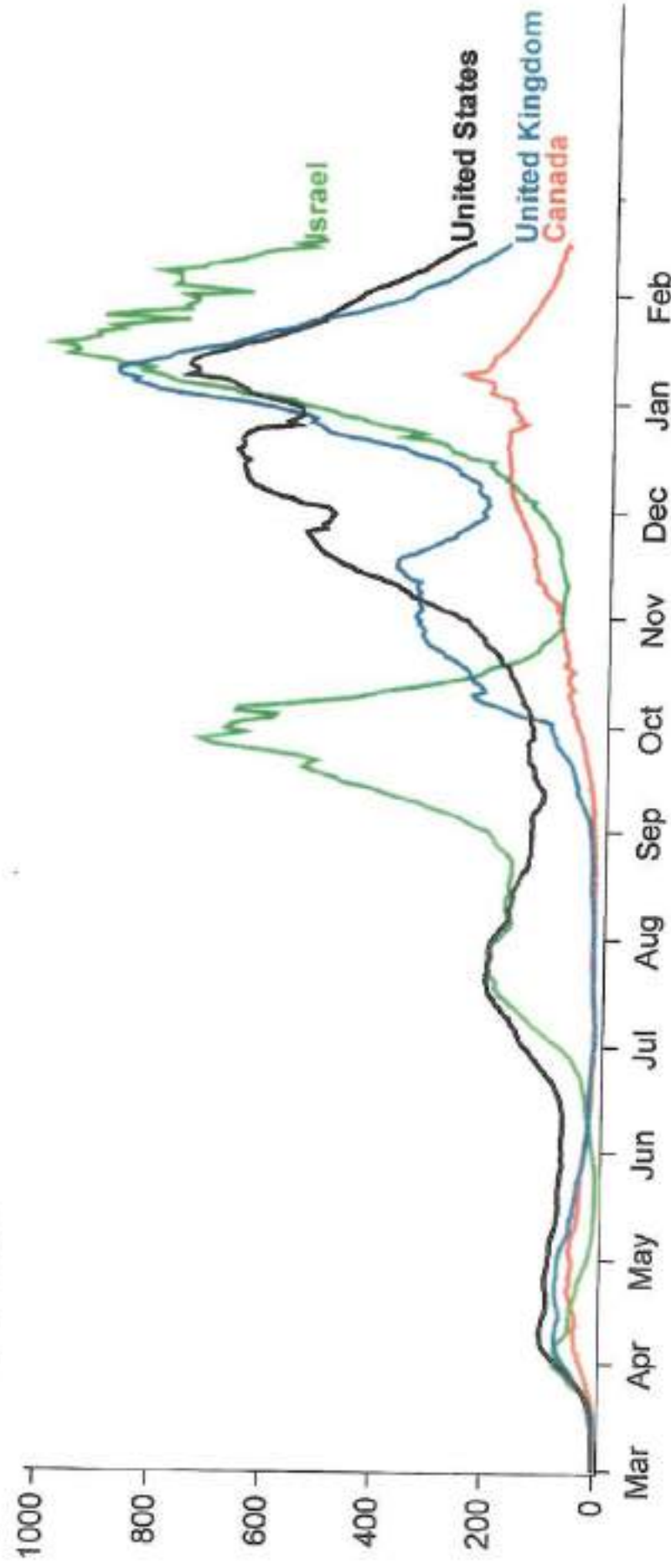
Data as of February 16, 2021

Notes: Variants of concern introduced in mid-Dec (~1 week prior to first detected case in Canada) at very low prevalence. Variants of concern assumed to be 50% more transmissible compared to wildtype. The growth rates AND replacement rate are negatively correlated with the strength of public health measures in place.



International experience shows that stringent measures and strict adherence to an control spread of variants of concern while vaccine programs expand

Rate per 1 million population



Data as of February 16, 2021
Note: 7-day moving average



Variants of Concern increase the threat for a spring resurgence, but a strong collective effort can see us through

- With a combination of strong **public health measures AND** strict adherence to **individual precautions**, we can prevent a resurgence.
- For individual Canadians, this means following public health advice and doing our personal best by aiming to have:
 - the **FEWEST** interactions,
 - with the **FEWEST** people,
 - for the **SHORTEST** time,
 - at **GREATEST** distance possible,
 - while wearing the best-fitting face-mask.



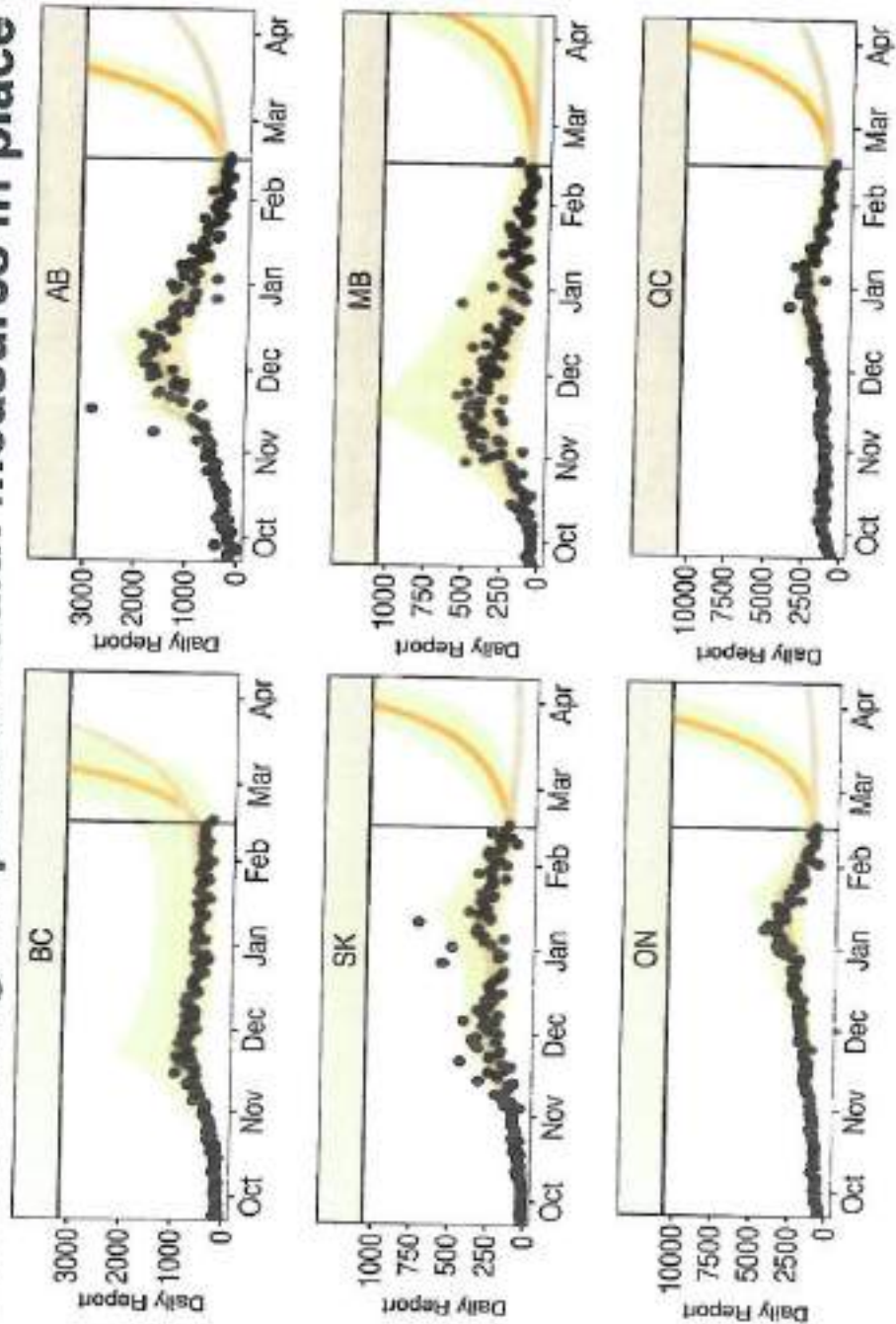
The path to control COVID-19 may not be easy, but WE are stronger!



Appendix



Longer-range forecasts predict strong resurgence with Variants of Concern unless stringent public health measures in place and sustained



- In all provinces current controls may not be sufficient to fully control the variants of concern
- The early lifting of public health measures could lead to a resurgence of the epidemic, including the community transmission of variants of concern

— With lifting of public health measures
— With current public health measures

Data as of February 16, 2021

Notes: Variants of concern introduced in mid-Dec (~1 week prior to first detected case in Canada) at very low prevalence. Variants of concern assumed to be 50% more transmissible compared to wildtype. The growth rates AND replacement rate are negatively correlated with the strength of public health measures in place.





RESEARCH ARTICLE

What settings have been linked to SARS-CoV-2 transmission clusters? [version 2; peer review: 2 approved]

Quentin J. Leclerc^{1,2}, Naomi M. Fuller^{1,2}, Lisa E. Knight³,
CMMID COVID-19 Working Group, Sebastian Funk^{1,2}, Gwenan M. Knight^{1,2}

¹Department of Infectious Disease Epidemiology, Faculty of Epidemiology and Population Health, London School of Hygiene & Tropical Medicine, London, UK

²Centre for Mathematical Modelling of Infectious Diseases, London School of Hygiene & Tropical Medicine, London, UK

³GP registrar, Brecon Surgery, Gwent Deanery, UK

v2 First published: 01 May 2020, 5:83
<https://doi.org/10.12688/wellcomeopenres.15889.1>
Latest published: 05 Jun 2020, 5:83
<https://doi.org/10.12688/wellcomeopenres.15889.2>

Abstract

Background: Concern about the health impact of novel coronavirus SARS-CoV-2 has resulted in widespread enforced reductions in people's movement ("lockdowns"). However, there are increasing concerns about the severe economic and wider societal consequences of these measures. Some countries have begun to lift some of the rules on physical distancing in a stepwise manner, with differences in what these "exit strategies" entail and their timeframes. The aim of this work was to inform such exit strategies by exploring the types of indoor and outdoor settings where transmission of SARS-CoV-2 has been reported to occur and result in clusters of cases. Identifying potential settings that result in transmission clusters allows these to be kept under close surveillance and/or to remain closed as part of strategies that aim to avoid a resurgence in transmission following the lifting of lockdown measures.

Methods: We performed a systematic review of available literature and media reports to find settings reported in peer reviewed articles and media with these characteristics. These sources are curated and made available in an editable online database.

Results: We found many examples of SARS-CoV-2 clusters linked to a wide range of mostly indoor settings. Few reports came from schools, many from households, and an increasing number were reported in hospitals and elderly care settings across Europe.

Conclusions: We identified possible places that are linked to clusters of COVID-19 cases and could be closely monitored and/or remain closed in the first instance following the progressive removal of lockdown restrictions. However, in part due to the limits in surveillance capacities in many settings, the gathering of information such as cluster sizes and attack rates is limited in several ways: inherent recall bias, biased media reporting and missing data.

Open Peer Review

Reviewer Status

Invited Reviewers

	1	2
version 2		
(revision)		
05 Jun 2020		
version 1		
01 May 2020		

1. Joël Messong , Laboratoire National de Santé, Dudelange, Luxembourg

2. Samuel V. Scarpino , Northeastern University, Boston, USA

Any reports and responses or comments on the article can be found at the end of the article.

Keywords

SARS-CoV-2, COVID-19, coronavirus, cluster, transmission, settings, lockdown



This article is included in the [Coronavirus \(COVID-19\)](#) collection.

Corresponding authors: Quentin J. Leclerc (quentin.leclerc@lshtm.ac.uk), Gwenan M. Knight (gwen.knight@lshtm.ac.uk)

Author roles: **Leclerc QJ:** Data Curation, Formal Analysis, Investigation, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Fuller NM:** Data Curation, Investigation, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Knight LE:** Data Curation, Investigation, Validation, Writing – Review & Editing; **Funk S:** Conceptualization, Methodology, Supervision, Validation, Writing – Review & Editing; **Knight GM:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: QJL is funded by a Medical Research Council London Intercollegiate Doctoral Training Program studentship (MR/N013638/1). NMF is funded by the Biotechnology and Biological Sciences Research Council London Interdisciplinary Doctoral Programme, SF is supported by a Wellcome Trust grant (210758), GMK is supported by a Medical Research Council grant (MR/P014658/1).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2020 Leclerc QJ et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Leclerc QJ, Fuller NM, Knight LE et al. **What settings have been linked to SARS-CoV-2 transmission clusters?** [version 2; peer review: 2 approved] Wellcome Open Research 2020, 5:83 <https://doi.org/10.12688/wellcomeopenres.15289.2>

First published: 01 May 2020, 5:83 <https://doi.org/10.12688/wellcomeopenres.15289.1>

REVISED Amendments from Version 1

This article has been updated in response to reviewer comments, and to include 49 new transmission events which have been added to our online database. We now discuss a total of 201 transmission events (previously 152), classified into 22 setting types (previously 16).

Any further responses from the reviewers can be found at the end of the article

Introduction

The novel coronavirus SARS-CoV-2, responsible for coronavirus disease 2019 (COVID-19), was first identified in Wuhan, China at the end of 2019, and has since spread around the world (European Centre for Disease Prevention and Control, 2020). The capacity of the virus for human-to-human transmission, coupled with the lack of immunity in the population due to the novelty of SARS-CoV-2, has led to the implementation of severe restrictions in people's movements in an effort to reduce disease impact. These strong measures are broadly described as "lockdowns". Due to the highly restrictive nature of lockdowns, and their impact on people's health, wellbeing and finances, it is likely that such interventions cannot be sustained for prolonged periods of time, and will have to be lifted, at least to some extent, before an effective vaccine becomes available.

To successfully remove these lockdown restrictions while avoiding a resurgence in SARS-CoV-2 transmission, we must better understand in which types of settings the virus is most likely to be transmitted. Determining particular places that are linked to clusters of cases could reveal settings that are responsible for amplifying the heterogeneity in transmission that has been reported: potentially 80% of transmission is being caused by only 10% of infected individuals (Finkenstädt *et al.*, 2020). Notably, the difference in transmission risk between households and larger communal settings is unclear, as is the difference between indoor and outdoor transmission.

Quantifying these differences in transmission can be further facilitated by the fact that, in many countries now under lockdown, intensive contact tracing of imported cases was performed in the early stages of the epidemic, resulting in the detection of clusters of cases. This data, on the first detected clusters in a country, can give knowledge of the types of settings facilitating transmission before intensive social and physical distancing took place.

The aim of our work is therefore to gather information on reported clusters of COVID-19 cases to determine types of settings in which SARS-CoV-2 transmission occurred. This could inform post-lockdown strategies by identifying places which should be kept under close surveillance and/or should still remain closed to avoid a resurgence in transmission.

Methods**Outline**

We searched for scientific literature and media articles detailing clusters of SARS-CoV-2 transmission (details below) and extracted

data into a Google Sheets file (accessible at <https://bit.ly/3ar390k>; archived as *Underlying data* (Lockhart *et al.*, 2020)). We defined "settings" as sites where transmission was recorded resulting in a cluster of cases. We restricted our definition of "cluster" to the first-generation cases that acquired the infection due to transmission in a single specific setting at a specific time. For example, if a person was infected on a cruise ship, and later infected additional people after disembarking, we would not consider that the latter were part of that "cruise ship cluster", since they were not infected on the ship. We recorded the country and further details about the type of setting, the numbers of primary and secondary cases in the cluster, cluster sizes, and attack rates. We defined a case as a person reported to be infected with the SARS-CoV-2 virus, regardless of symptoms.

Search strategy

References were found in four ways. Firstly, we performed a systematic literature review for COVID-19 clusters in PubMed on the 30th March 2020 (search term below). A total of 67 papers were found. Two reviewers (GMK and QJL) performed data extraction into the online database. We chose to only search this database and use peer reviewed articles as a quality threshold. We included data from English abstracts (where possible), but otherwise excluded non-English publications.

PubMed search: ("COVID-19"[All Fields] OR "COVID-2019"[All Fields] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[All Fields] OR "2019-nCoV"[All Fields] OR "SARS-CoV-2"[All Fields] OR "2019nCoV"[All Fields] OR ("Wuhan"[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND (2019/12[PDAT] OR 2020[PDAT])) AND cluster [All Fields]

Secondly, we used the online Google search engine to find media articles detailing settings of SARS-CoV-2 transmission in general. We searched for combinations of either "COVID", "COVID-19", "COVID-2019", "severe acute respiratory syndrome coronavirus 2", "2019-nCoV", "SARS-CoV-2", "2019nCoV" or "coronavirus", and the words "transmission cluster" (e.g. "COVID transmission cluster" or "SARS-CoV-2 transmission cluster"). We only included online articles in English. From the collated list of settings, we then performed a further search for transmission in each of these settings (week beginning 6th April 2020).

Thirdly, we investigated whether information on the settings in which the first 100 "transmission events" in countries with current COVID-19 outbreaks existed by searching for publicly available data sources. As substantial investigation of cases often occurs early in an outbreak, any clusters linked to the first ~100 cases in countries outside China could give information on the transmission of SARS-CoV-2 in the absence of any social distancing measures.

Finally, following the original publication of this article on 01/05/2020, we included a "Suggested updates" tab in our publicly available database (<https://bit.ly/3ar390k>). This allows other individuals to suggest new clusters we should include in our analysis. We review these suggestions regularly, and add

those with sufficient detail to our "Latest updated results" tab. In this revised version, we have updated our analysis to include suggestions we reviewed up to 26/05/2020.

Cluster characteristics and setting definition

With the above data, we then aimed to estimate both the final (proportion of people in that setting who became infected) and secondary (proportion of contacts of one case who became infected) attack rates in each setting. These were previously identified as key metrics, particularly within households, to estimate whether transmission is driven by a relatively small number of high-risk contacts (Lau *et al.*, 2020).

We defined a setting when several reports mentioned clusters linked to spaces with certain characteristics. For example, "Religious" includes churches and mosques, while "Public" here means public communal shared spaces such as markets or welfare centres. Where settings were a mixture of indoor and outdoor spaces, we used a mixed indoor/outdoor classification.

Results

We found evidence of SARS-CoV-2 transmission clusters for 201 events, which we classified into 22 types of settings (Table 1 and Table 2). All the studies with relevant data are compiled in an online database (accessible at <https://bit.ly/3a39ky>; see also *Underlying data* (Lackey *et al.*, 2020)). Many of the published reports with setting specific data came from China (47/201) and Singapore (51/201).

The vast majority of these clusters were associated with indoor or indoor/outdoor settings (21/22). Large clusters, such as those linked to churches and ships, were infrequently reported. Almost all clusters involved fewer than 100 cases (181/201), with the outliers being transmission in hospitals, elderly care, worker dormitories, food processing plants, prisons, schools, shopping and ship settings. Religious venues provided a further setting with large cluster sizes: there were separate clusters in South Korea, France, India and Malaysia (Ananthakrishnan & Sigalan, 2020; BBC, 2020; Sabado, 2020; Shen *et al.*, 2020). In addition to these settings with maximum cluster sizes of more than 100 cases per cluster, we identified five further settings with maximum cluster sizes between 50 and 100: sport (65 cases) (Korean Centre for Disease Control & Prevention, 2020), bar (80 cases) (Sun, 2020), wedding (98 cases) (Ministry of Health - New Zealand, 2020), work (97 cases) (Park *et al.*, 2020) and conference (89 cases) (Marcello & O'Brien, 2020).

We found a notably high number of transmission events reported in worker dormitories (21/201), although all of these were from Singapore. This type of setting had the second highest total cluster size out of all the recorded events we found, with 797 cases reported in the S11 dormitory cluster in Singapore (Data Against COVID-19 SG, 2020).

We found only a small number of clusters linked to schools (8/201), and there the SARS-CoV-2 cases reported were most often in teachers or other staff. For example, for two school clusters in Singapore (Ministry of Health - Singapore, 2020),

16/26 and 7/8 cases were staff. Some children were also found to be infected in these clusters, as was the case in the Salanter Akiba Riverdale school in New York, USA (Ailsworth & Ilieva, 2020), although testing for infection was not always universal. In a retrospective close cohort study in a French high school however, 133 children and staff were seropositive for anti-SARS-CoV-2 antibodies, 92 of whom were pupils (Vincent *et al.*, 2020).

We identified 9 clusters linked to food processing plants in 4 different countries (USA, Germany, Canada, Netherlands). These transmission events have led to large clusters, such as in a meat processing plant in South Dakota where a total of 518 employees were infected by SARS-CoV-2 (Cannon, 2020).

The setting with the greatest number of reported clusters of SARS-CoV-2 transmission was households (36/201). Again, most were from China (25/36) with all cluster sizes being less than 10. However, for 27 out of 36 studies, we were unable to calculate either the secondary or final attack rates due to a lack of information on total household size.

We aimed to estimate secondary and final attack rates in other settings but, as for households, we found that there was substantial missing data. In particular, the number of individuals in a setting was missing, and so we were unable to perform this analysis. Where attack rates could be estimated for individual clusters, these are reported in the online database.

Although information on the index and early cases in a setting was often reported, further information on the subsequently reported 10–100 cases in a country was difficult to extract. Moreover, the index cases were often quarantined and hence not linked to further transmission in most settings.

Discussion

In this review of SARS-CoV-2 transmission events, we found that clusters of cases were reported in many, predominantly indoor, settings. Note that we restrict cluster size to only include individuals infected within a specific setting, and exclude secondary infections which occurred outside the settings. Most clusters involved fewer than 100 cases, with the exceptions being in healthcare (hospitals and elderly care), large religious gatherings, food processing plants, schools, shopping, and large co-habiting settings (worker dormitories, prisons and ships). Other settings with examples of clusters between 50–100 cases in size were weddings, sport, bar, shopping and work. The majority of our reports are from China and Singapore.

Limitations

The settings collated here are biased due to the nature of our general search for SARS-CoV-2 transmission described above. Although based on a systematic review of published peer-reviewed literature, many of the reports included came from media articles where relevant epidemiological quantities were not always reported, resulting in many missing data. Many of the more detailed studies originated from the early outbreak in China, especially those providing household information. The settings

Table 1. Summary of gathered reported events as of 20th April 2020. Where only one study for this setting is reported, the minimum, maximum and median number of secondary cases in the cluster and/or total cluster size correspond to this single reported number (if given). Total cluster size accounts for all primary and secondary cases in the cluster. For references see the online database, accessible at <https://covid19-cluster-size-reporter.com>.

Setting type	Number of reported events	Secondary cases			Total cluster size			Total number of cases across all clusters	Countries	Indoor / outdoor
		Min	Median	Max	Min	Median	Max			
Bar	12	2	9	16	3	13	80	319	Germany, Austria, Italy, Singapore, Japan, USA, Australia, New Zealand, Brazil	Indoor / outdoor
Building site	4	/	/	/	5	20.5	49	95	Singapore	Indoor / outdoor
Conference	5	/	/	/	3	10	89	148	Canada, Singapore, Japan, USA, New Zealand	Outdoor
Elderly care	17	/	/	/	5	19	167	638	UK, Canada, Scotland, France, Germany, Italy, USA, Japan, New Zealand, Luxembourg	Indoor / outdoor
Food processing plant	9	2	2	2	3	84	518	1207	USA, Germany, Canada, Netherlands	Indoor
Funeral	1	3	3	3	4	4	4	4	USA	Indoor / outdoor
Hospital	9	1	3	14	2	10	118	224	China, Singapore, Italy, Taiwan, South Korea, Japan	Indoor
Hotel	2	/	/	/	3	5	7	10	Singapore	Indoor
Household	36	1	3	11	2	4	12	188	China, Italy, Vietnam, Taiwan, South Korea, Hong Kong, France	Indoor
Meal	17	1	3	10	2	5	47	134	Singapore, USA, Vietnam, China, South Korea, Japan	Indoor
Prison	4	351	351	351	66	226	353	871	USA, Ethiopia	Indoor
Public	4	/	/	/	10	10	27	57	China, Japan	Indoor / outdoor
Religious	15	1	18	52	2	23	130	570	USA, Singapore, South Korea, US, China, India, Netherlands, Germany	Indoor / outdoor
School	8	1	1	131	2	22	133	349	Singapore, France, USA, New Zealand, Australia, Sweden	Indoor / outdoor
Ship	5	619	619	619	78	662	1156	3597	Grand Princess, Diamond Princess, Ruby Princess, USS Theodore Roosevelt, Charles de Gaulle aircraft carrier	Indoor
Shipyards	1	/	/	/	22	22	22	22	Singapore	Indoor / outdoor
Shopping	9	5	10	19	7	20	163	361	China, Singapore, Peru, Mexico	Indoor / outdoor
Sport	6	1	1	1	2	7.5	65	95	South Korea, Singapore, Italy, Japan	Indoor / outdoor
Transport	1	1	1	1	3	3	3	3	China	Indoor
Wedding	3	/	/	/	13	43	98	154	Australia, New Zealand	Indoor / outdoor
Work	12	6	7	11	4	8.5	97	195	China, Singapore, South Korea, Germany	Indoor
Worker dormitories	21	/	/	/	3	24	797	1702	Singapore	Indoor

Table 2. Definitions used for each of our transmission setting types. The definitions describe in what environment transmission was deemed to occur.

Transmission setting	Definition
Bar	Indoor space such as a bar, club, pub, small live music venues etc.
Building site	Outdoor space where construction work takes place.
Conference	Indoor professional event with many people interacting and meeting, shaking hands, eating together, team activities, etc.
Elderly Care	Care homes for the elderly; includes staff and residents. Transmission can occur between staff and residents but also from visitors.
Food processing plant	Any establishment that processes food for human consumption, such as a meat or vegetable packing plant.
Funeral	Indoor or outdoor burial ceremony; includes close contact with others such as hugging, shaking hands, eating together, singing, praying, etc.
Hospital	Any transmission that occurs within a hospital between patients and/or staff, in a COVID19 ward or not.
Hotel	Any transmission that occurs within the hotel e.g. hotel rooms, shared spaces, reception desk, etc.
Household	Transmission between individuals in a shared living space
Meal	When people eat together. Meals included took place in restaurants, hotels, cafes, home, etc. Transmission occurs over a meal by speaking, sharing foods, touching the same surfaces, etc.
Prison	Any transmission that occurs within a prison between prisoners and/or staff.
Public	Where transmission occurs on public property and does not fall into any of the other settings e.g. park, welfare centre, foodbank, etc.
Religious	Transmission occurs at a religious event such as at mass, services, prayer time, choir practice, etc.
School	Childcare or learning environments (schools, nurseries, kindergartens etc). Includes staff and children.
Ship	Any ship at sea. Includes crew and/or passengers onboard.
Shipyards	Large indoor or outdoor space where ships are made or repaired. Includes those working on the ship as well as customers
Shopping	A shop or shopping centre. Includes customers and those working in the shop.
Sport	Participation in a sporting activity indoor or outdoor e.g. gym or running.
Transport	Any means of public transportation, such as bus, plane, metro etc.
Wedding	Indoor or outdoor wedding celebration.
Work	In the workplace, typically an office.
Worker dormitories	A shared living space for workers.

we identified here therefore might not be representative of settings from a global perspective. Bias is present when relying on media coverage - a cluster is more likely to be reported if controversial or if there is an interesting social narrative. This is then compounded by the method search engines use to provide results where priority is given to high traffic stories. Overall, this can lead to some settings being overly represented in our database, which is why the numbers of clusters per settings should be compared cautiously.

Similarly, there is a bias in our reports which means that attendance in settings with many individuals is more likely to be linked to a cluster: recall bias (Smeets *et al.*, 2017). The accuracy of memories is influenced by subsequent events and experiences such that special, one-off events may be more likely to be

remembered and potentially reported. If multiple single transmission events had occurred whilst walking in a park, for example, these would be less likely to be remembered, and more difficult to detect and hence record. Networks of close contacts also tend to be small, resulting in multiple opportunities for transmission, and hence potentially increase the importance of households or workplace for transmission instead of single outstanding settings of potential transmission. Hence, we cannot determine with any reliability the relative importance of the reported different types of settings beyond the record that clusters have been linked to such places.

Other events, such as large music concert (Gilling, 2019), political (Jones, 2020) and sporting (Hogg, 2020; Ross, 2020; Wood & Carroll, 2020) gatherings, could potentially have been

linked to clusters of COVID-19. But, in the absence of rigorous surveillance systems and widespread testing that would allow countries to link and report the transmissions of such events, such connections remain speculation. An example of this lack of surveillance would be the UK, where only 4/201 clusters have been recorded. The outlier for this is Singapore which appears to investigate clusters systematically and provides a well-designed online dashboard with details of all clusters detected ([Chen Agnand COVID19-SGL 2020](https://data.gov.sg/datasets/sg-sql-2020)).

In many settings, only symptomatic cases of disease severe enough to require hospitalization are tested and ultimately reported. This misses those infections that result in mildly symptomatic or asymptomatic symptoms, although there is mounting evidence for a significant proportion of infections to remain asymptomatic ([Gudbjartsson et al., 2020](#); [He et al., 2020](#); [Lavezzo et al., 2020](#)). For some of the clusters, primarily households, all contacts were tested for infection; but for most of the data collated here, the number of COVID-19 symptomatic cases was the only information provided. These reported cases are a subset of all infections and in the absence of more comprehensive data, such as could be collated through widespread cluster investigation and community testing, we cannot conclude anything about clusters of infections, nor that we have included all relevant settings in which transmission can occur. We were also unable to estimate attack rates from the available data, meaning that comparison between rates of transmission in settings is impossible to achieve.

Settings associated with large cluster sizes

One type of setting that was associated with large numbers of eventual cases was religious venues. The common features of these meetings are the large number of attendees, confined spaces and physical contact. For example, there were eventually more than 5000 COVID-19 cases linked to transmission at the Shincheonji Church of Jesus in South Korea ([Shin et al., 2020](#)). In this particular religious venue, no preventative action was taken despite knowing members were infected with SARS-CoV-2. In other venues, transmission events took place without prior knowledge of any infections and before the WHO declared pandemic status. Other large clusters in this setting type were associated with annual religious events that took place over a few days or weeks ([Ananthakrishnan & Sridhar, 2020](#); [BBC, 2020](#); [Nahata, 2020](#)). Attendees returned to their home countries where they continued to transmit. This generated many secondary cases internationally as well as locally. However, it is clear from smaller "first-generation" clusters, which our analysis focuses on, that these settings provide ideal conditions for transmission; we found 7/16 identified religious clusters had 10 cases or less, whilst 9/16 had 23 or more (see online database <https://bit.ly/3ar30ky> and [Underlying data](#) ([Lockhart et al., 2020](#)) for more information). The number of cases in each cluster is an approximation, and little is known about the number of index cases in these religious meetings to begin with, with the exception of the South Korea cluster. Religious events are well known sources of heightened transmission; there is a focus on vaccination recommendations for attendees to the annual Hajj pilgrimage for example, which is currently being postponed for 2020 ([Alqahtani, 2020](#)).

Worker dormitories have been recognised as key places linked to transmission in Singapore, with 893 out of 942 new cases recorded on April 18th being residents in such dormitories ([Asia, 2020](#)). We found 21 reported clusters, one of which had the second largest cluster size of all the events we report here; 797 cases which from the data we believe is a first-generation cluster. Worker dormitories are similar to households ([Dalling, 2020](#)) in the sense that they are places where people live together and come in frequent close contact; however, the number of residents in dormitories is higher than in most other households. This probably contributes to the higher cluster sizes seen in this setting. Additionally, hygiene facilities can be limited in worker dormitories ([Paul et al., 2020](#)), which could also explain the higher transmission. These points also apply to prisons, another type of large co-habiting setting for which we have identified 4 clusters with a maximum cluster size of 353 cases. It would be beneficial to compare attack rates across households, worker dormitories and prisons, to better understand which factors influence the risk of transmission between people who share a living space. Unfortunately, we were unable to identify the total number of residents in these dormitories and prisons, which prevented us from deriving attack rates and making this comparison.

In addition to religious events and worker homes, we also identified clusters of more than 100 cases in elderly care homes, hospitals and ships. These are all known to be at risk of clusters of infectious disease ([Blanco et al., 2019](#); [Kak, 2017](#); [Lansbury et al., 2017](#)). Moreover, people in these settings are often older than the general population and hence at greater risk of severe forms of COVID-19 disease ([U.S. Centers for Disease Control and Prevention, 2020](#)). The increased mortality and likely dependence on availability of personal protective equipment (PPE) mean that healthcare clusters are more politically sensitive and hence more likely to be reported.

A more unexpected setting type is perhaps food processing plants, in which we identified clusters of up to 518 cases ([Cannon, 2020](#)). These plants have been the source of clusters in multiple countries. It is possible that the cold atmosphere in this setting has facilitated the spread of the virus ([Molteni, 2020](#)). Other possible explanations include the close proximity of workers for prolonged periods shared welfare spaces, as well as the need to speak loudly to communicate over the noise of the machines, which could lead to an increased projection of viral particles. Another explanation is that we may not be seeing clusters from other manufacturing settings with similar working environments, as fewer have been in operation due to lockdown guidelines during the pandemic, whereas food production has continued.

We identified seven additional setting types with cluster sizes above 50 or 100 cases (school, sport, bar, shopping, wedding, work and conference), which shared characteristics with the settings described above (see online database for more information <https://bit.ly/3ar30ky> and [Underlying data](#) ([Lockhart et al., 2020](#))). Notably, sport, bars, shopping areas and conferences are predominantly indoor settings, where people are in close proximity. For conferences and work, like religious events, transmission within the cluster is facilitated by the duration

of the events over several days, as well as the combination of interactions there (workshops, dinners etc...). This can also apply to weddings, where transmission is further increased due to the close-proximity interactions between people (kissing, hugging, dancing etc...). As for bars and shopping areas, these are places with important fluxes of people, which increases the diversity of contacts. Finally, schools, like religious groups, can sometimes represent tightly knit communities which facilitates disease transmission amongst individuals, as was the case with the Salanter Akiba Riverdale school in New York, with a cluster size of at least 60 cases (Aitworth & Berzon (2020)).

The first 100 transmission events & under reporting

The pursuit of the first 100 transmission events revealed little on settings of transmission. This reflects the wider issue we found of under reporting and is likely to reflect the fact that many public health surveillance systems were quickly overwhelmed and could not continue outbreak investigations. An example of this is the UK where only limited information on case follow-up and cluster investigation appears to be available. The impact of such under reporting is that we cannot say with certainty what contribution each setting had to overall transmission – we do not have the denominator information on time and contact in all settings. Nor do we have universal screening for detection of all infections, many of which will be asymptomatic. The importance of such universal testing for infection in interpreting whether transmission has occurred in a setting is highlighted by the difference between the low number of clusters linked to schools and the high level of infection reported in one French high school study (Fornacek et al. 2020).

Further work could pursue data from early investigation of cases where available, to explore the relative importance of different settings to transmission. Importantly, this may counter a bias towards small cluster sizes: with a lack of follow-up only some of the cases actually linked to a setting may be reported and linked. Detailed outbreak investigations should also be explored to get information on the places where transmission is unlikely to have occurred, e.g. if a COVID-19 patient reports 30 contacts at place “A”, “B” and “C”, but only contacts in “C” subsequently become infected this reflects reduced risk in settings “A” and “B”.

Implications for further work

We found that many clusters of cases were linked to indoor settings, but this may be because early spread in China was during their winter, with people naturally spending more time inside close spaces. Increasing evidence suggests that transmission of SARS-CoV-2 can occur via airborne droplets (Shawna & Lee, 2020); however, it is likely that outdoor transmission risk is lower (Vibiana et al. 2020). Further work is needed to clarify this. We found only few clusters in school settings. However, there were many clusters associated with household transmission, and children could be the entry point for the virus into this setting. Although it should be noted in this context that the Report of the WHO-China Joint Mission on Coronavirus Disease 2019

(COVID-19) did not find a single instance where people recalled transmission from a child to an adult (WHO-China Joint Mission Members, 2020). More generally, the role of children in widespread transmission of the virus is unclear, and whether reopening schools could trigger increased introductions of the virus into households and further within-household spread will have to be carefully monitored.

Further investigation of settings that facilitate clusters of transmission could provide important information for containment strategies as countries lift some of the current restrictions. Previous work has suggested that there might be considerable heterogeneity in individual transmission, which would imply a disproportionate impact from preventing large transmission events from occurring (Linda et al. 2020). Whilst widespread contact tracing is often considered part of future containment strategies, there is a need for this to be complemented with retrospective investigation of clusters in order to better understand the extent to which certain settings and behaviours are at particular risk of generating clusters of transmission. This could, in turn, inform contact tracing efforts and might be particularly relevant in the context of contact tracing using mobile phone apps, which has recently been suggested in support of more traditional contact tracing (Veroni et al. 2020). For example, past co-location in certain settings could be a trigger for notification of risk from an app instead of, or in addition to, individual contacts.

Online database of collected reports

The online database (accessible at <https://bit.ly/3at396y>) provides information on all collected reports, references and information on cluster sizes as well as notes about the study. This database will be kept as a static source linked to this report, but with an additional tab for newly reported settings. Readers can submit information in the “Suggested updates” tab and we will aim to update information if evidence for substantial new clusters are found linked to a setting that was not in this study.

Conclusions

In conclusion, we found evidence of SARS-CoV-2 transmission in many types of settings. Our results provide a basis to identify possible places that are linked to clusters of cases and could be closely monitored, for example by linking to app-based contact tracing, and/or remain closed in the first instance following the progressive removal of lockdown restrictions. However, reporting should be improved in the majority of settings, with implementation of systematic reporting on the number of potentially exposed individuals and the number of confirmed and suspected cases from these settings, to allow the estimation of attack rates.

Data availability

Underlying data

Figshare: COVID19 settings of transmission - collected reports database. <https://doi.org/10.6084/m9.figshare.12173483.v1> (Figshare, et al. 2020).

This project contains 'COVID-19 settings of transmission - database.xlsx', which contains the data extracted from the initial search, as well as an updated version of the dataset from 26/05/2020.

Up to date information on all collected reports is provided in an open-access online database (accessible at <https://bit.ly/3ar39ky>).

This database provides references and information on cluster sizes as well as notes about the studies.

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

Acknowledgments

We would like to thank Dr Joël Mossong for his review of our article. We would also like to thank all the anonymous individuals who suggested updates for transmission events in our online database.

The members of the LSHTM CMMID COVID-19 working group are: Graham Medley, Kevin van Zandvoort, Rein M G J Houben, Fiona Yueqian Sun, Jon C Emery, Simon R Procter, James D Munday, Hamish P Gibbs, Aminder K Deol, Mark Jit, Adam J Kucharski, Nikos I Bosse, Damien C Tully, W John Edmunds, Stefan Flasche, Christopher I Jarvis, Anna M Foss, Kathleen O'Reilly, Thibaut Jombart, Kiesha Prem, Nicholas G. Davies, Julian Villabona-Arenas, Yang Liu, Alicia Rosello, Sam Abbott, Billy J Quilty, Joel Hellewell, Petra Klepac, Carl A B Pearson, Timothy W Russell, Charlie Diamond, Rosalind M Eggo, Eleanor M Rees, Amy Gimma, Samuel Clifford, Akira Endo, Stéphane Hué, Megan Auzenberg, Katherine E. Atkins, Emily S Nightingale, Sophie R Meakin.

LSHTM CMMID COVID-19 working group funding statements: Graham Medley (Gates (OPP1184344)), Kevin van Zandvoort

(Elrha's Research for Health in Humanitarian Crises (R2HC) Programme), Rein M G J Houben (European Research Council Starting Grant (Action Number #757699)), Fiona Yueqian Sun (NIHR EPIC grant (16/137/109)), Jon C Emery (European Research Council Starting Grant (Action Number #757699)), Simon R Procter (Gates (OPP1180644)), James D Munday (Wellcome Trust (210758/Z/18/Z)), Hamish P Gibbs (NIHR (ITCRZ 03010)), Mark Jit (Gates (INV-003174)), NIHR (16/137/109), European Commission (101003688)), Adam J Kucharski (Wellcome Trust (206250/Z/17/Z)), Nikos I Bosse (Wellcome Trust (210758/Z/18/Z)), W John Edmunds (European Commission (101003688)), Stefan Flasche (Wellcome Trust (grant: 208812/Z/17/Z)), Christopher I Jarvis (RCUK/ESRC (ES/P010873/1)), Kathleen O'Reilly (Gates (OPP1191821)), Thibaut Jombart (RCUK/ESRC (ES/P010873/1)), UK PH RST; NIHR HPRU Modelling Methodology), Kiesha Prem (Gates (INV-003174), European Commission (101003688)), Nicholas G. Davies (NIHR (HPRU-2012-10096)), Julian Villabona-Arenas (European Research Council Starting Grant (Action Number #757688)), Yang Liu (Gates (INV-003174), NIHR (16/137/109), European Commission (101003688)), Alicia Rosello (NIHR (PR-OD-1017-20002)), Sam Abbott (Wellcome Trust (210758/Z/18/Z)), Billy J Quilty (NIHR (16/137/109)), Joel Hellewell (Wellcome Trust (210758/Z/18/Z)), Petra Klepac (Gates (INV-003174), European Commission (101003688)), Carl A B Pearson (Gates (OPP1184344)), Timothy W Russell (Wellcome Trust (206250/Z/17/Z)), Charlie Diamond (NIHR (16/137/109)), Rosalind M Eggo (HDR UK (MR/S003975/1), MRC (MC_PC_19065)), Eleanor M Rees (MRC LID Training Program studentship (MR/N013638/1)), Amy Gimma (RCUK/ESRC (ES/P010873/1)), Samuel Clifford (Wellcome Trust (208812/Z/17/Z)), Akira Endo (The Nakajima Foundation, The Alan Turing Institute), Megan Auzenberg (Gates (OPP1191821)), Katherine E. Atkins (European Research Council Starting Grant (Action Number #757688)), Emily S Nightingale (Gates (OPP1183986)), Sophie R Meakin (Wellcome Trust (210758/Z/18/Z)).

References

Alworth E, Barzon A: How Coronavirus Invaded One New York Community: 'We Weren't Expecting It to Be Ground Zero'. 2020.

[Reference Source](#)

Aljazeera: Saudi tells Muslims to wait on Hajj plans amid coronavirus crisis. 2020.

[Reference Source](#)

Ananthakrishnan A, Siphan J: How mass pilgrimages at Malaysian mosque became coronavirus hotpot. 2020.

[Reference Source](#)

Asia CN: Daily high of 842 new COVID-19 cases reported in Singapore. 2020.

[Reference Source](#)

BBC: Coronavirus: Search for hundreds of people after Delhi prayer meeting. 2020.

[Reference Source](#)

Blanco N, O'Hara LM, Harris AD: Transmission pathways of multidrug-resistant organisms in the hospital setting: a scoping review. *Infect Control Hosp Epidemiol*. 2019; 44(4): 447-456.

[PubMed Abstract](#) | [PubMed Full Text](#) | [Free Full Text](#)

Cannon A: Spike in COVID-19 cases in Iowa packing plants a big part of 389

new cases, state's largest single-day increase. 2020.

[Reference Source](#)

Dalling R: Stereophonics heavily criticised for not cancelling their gig in Cardiff. 2020.

[Reference Source](#)

Data Against: COVID-19 SG: Dashboard of the COVID-19 Virus Outbreak in Singapore. 2020.

[Reference Source](#)

Endo A, Abbott S, Kucharski AJ, et al: Estimating the overdispersion in COVID-19 transmission using outbreak sizes outside China [version 1; peer review: 1 approved, 1 approved with reservations]. *Wellcome Open Res*. 2020; 5.

[PubMed Abstract](#)

European Centre for Disease Prevention and Control: Situation update worldwide, as of 21 April 2020. 2020.

[Reference Source](#)

Ferrari L, Wymant C, Kendall M, et al: Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. *Science*. 2020; pii: eabb3226.

[PubMed Abstract](#) | [PubMed Full Text](#) | [Free Full Text](#)

Fontanet A, Tondou L, Mades Y, et al: Cluster of COVID-19 in northern France: A retrospective closed cohort study. *medRxiv*. 2020.

[Publisher Full Text](#)

Gudbjartsson DF, Helgason A, Jonsson H, et al: Spread of SARS-CoV-2 in the Icelandic Population. *N Engl J Med*. 2020.

[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

He X, Liu EHY, Wu P, et al: Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med*. 2020.

[PubMed Abstract](#) | [Publisher Full Text](#)

Hoppe R: Coronavirus: Champions League match a 'biological bomb' that infected Bergamo, experts say. 2020.

[Reference Source](#)

Jones S: How coronavirus took just weeks to overwhelm Spain. 2020.

[Reference Source](#)

Kak V: Infections on Cruise Ships. *Microbiol Spectr*. 2015; 3(4).

[PubMed Abstract](#) | [Publisher Full Text](#)

Korean Centre for Disease Control & Prevention: Investigation of COVID-19 outbreaks through Zumba dance classes in Korea. 2020.

[Reference Source](#)

Lansbury LE, Brown CS, Nguyen-Van-Tam JS: Influenza in long-term care facilities. *Influenza Other Resp*. 2017; 11(5): 335-350.

[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

Lavazzo E, Franchin E, Ciavarella C, et al: Suppression of COVID-19 outbreak in the municipality of Vo, Italy. *medRxiv*. 2020.

[Publisher Full Text](#)

Locero QJ, Fuller NM, Knight LE, et al: COVID19 settings of transmission - collected reports database. *Figshare*. Dataset. 2020.

<https://www.doi.org/10.6084/m9.figshare.12172043.v3>

Liu Y, Eggo RM, Kucharski AJ: Secondary attack rate and superspreading events for SARS-CoV-2. *Lancet*. 2020; 395(10227): e47.

[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

Mercato P, O'Brien M: Cluster of Coronavirus Cases Tied to U.S. Biotech Meeting. 2020.

[Reference Source](#)

Ministry of Health - New Zealand: COVID-19 - Significant clusters. 2020.

[Reference Source](#)

Ministry of Health - Singapore: 16 More Cases Discharged; 35 New Cases Of Covid-19 Infection Confirmed. 2020.

[Reference Source](#)

Mollen N: Why Westpacking Plants Have Become Covid-19 Hot Spots. 2020.

[Reference Source](#)

Morawska L, Cao J: Airborne transmission of SARS-CoV-2: The world should face the reality. *Environ Int*. 2020; 138: 105735.

[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

Nishiura H, Oshitani H, Kobayashi T, et al: Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19). *medRxiv*. 2020.

[Publisher Full Text](#)

Park SY, Kim YM, Yi S, et al: Early Release-Coronavirus Disease Outbreak in Cell Center, South Korea. *Emerg Infect Dis*. 2020; 26(3).

[Publisher Full Text](#)

Paul R, Koustav S, Aradhana A: The S11 dormitory: Inside Singapore's biggest coronavirus cluster. 2020.

[Reference Source](#)

Ryan D: Coronavirus: Liverpool v Atletico Madrid virus link an 'interesting hypothesis'. 2020.

[Reference Source](#)

Salain T: Special Report: Five days of worship that set a virus time bomb in France. 2020.

[Reference Source](#)

Shin Y, Berkowitz B, Kim MJ: How a South Korean church helped fuel the spread of the coronavirus. 2020.

[Reference Source](#)

Sin W: Japan identifies 15 clusters as Covid-19 cases mount. 2020.

[Reference Source](#)

Spencer BA, Broseley J, Mahtani K: Recall bias. 2017.

[Reference Source](#)

U.S. Centers for Disease Control and Prevention: People Who Are at Higher Risk for Severe Illness. 2020.

[Reference Source](#)

WHO-China Joint Mission Member: Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). World Health Organization. 2020.

[Reference Source](#)

Wood G, Campbell R: Cheltenham faces criticism after racegoers suffer Covid-19 symptoms. 2020.

[Reference Source](#)

Open Peer Review

Current Peer Review Status:  

Version 2

Reviewer Report 30 June 2020

<https://doi.org/10.21956/wellcomeopenres.17583.r39003>

© 2020 Scarpino S. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.



Samuel V. Scarpino 

Network Science Institute, Northeastern University, Boston, MA, USA

In this manuscript, the authors conduct a thorough literature review and identified SARS-CoV-2 transmission clusters. After assembling their data set, the authors discuss the possible similarities in settings associated with transmission. As stated, understanding how transmission risk varies across settings is critical for the safe relaxation of measures implemented to control the spread of COVID-19. This paper provides a valuable resource and synthesis of what is currently known. I should note that this article has already been evaluated and I believe the authors have adequately addressed the points raised by the previous reviewer. However, I do have a few additional comments/questions, which I hope the authors find constructive.

1. While Google Sheets is a convenient tool for entering and sharing small data sets, it is not "permanent" and also has the potential to be corrupted or heavily modified. There is also no easy way for authors to cite the "version" of the sheet used. The authors do provide a Figshare, but that appears to date back prior to the revised version. I would strongly suggest regularly archiving a version of the data set and assigning each update a version number. At a minimum, please provide a DOI for the revised data set.
2. I am concerned that one reason we don't see more evidence for transmission at schools is that schools were closed early in nearly all locations. To my knowledge, Sweden is not reporting data on whether there have been significant transmission in their schools (as the authors know not all of which are open). I believe the authors should provide a strong disclaimer, either in the abstract or early in the discussion that we really don't have much to go on w.r.t. schools. (Of course this is my opinion and likely subject to debate).
3. The authors state, "More generally, the role of children in widespread transmission of the virus is unclear, and whether reopening schools could trigger increased introductions of the virus into households and further within-household spread will have to be carefully monitored." But, I also feel that given the uncertainty in whether children are import for ongoing transmission, there are other settings we should caveat.
4. The authors note that they, "use peer reviewed articles as a quality threshold," and, while I

strongly disagree with the exclusion of pre-prints, I think the authors should at least provide some information on how many studies or clusters were excluded. Given the long (and increasing lag) between pre-print and publication, is this study missing half of all clusters that are currently published or in-review? 10% 95%? Providing information around what's been excluded is standard practice for such reviews and feels critical in this case.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 05 June 2020

<https://doi.org/10.21956/wellcomeopenres.17583.r38985>

© 2020 Mossong J. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.



Joël Mossong

Epidemiology and Microbial Genomics, Laboratoire National de Santé, Dudelange, Luxembourg

My comments and suggestions have been adequately addressed.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology of infectious diseases

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 18 May 2020

<https://doi.org/10.21956/wellcomeopenres.17429.r38734>

© 2020 Mossong J. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

? **Joël Mossong** 

Epidemiology and Microbial Genomics, Laboratoire National de Santé, Dudelange, Luxembourg

This manuscript aims to provide a descriptive analysis of transmission settings of Covid19 based on published articles or media reports, which is of major interest for controlling the epidemic.

I have several major concerns:

1. Most settings reported herein are not representative of settings from a global perspective, most are from the initial epidemic in Asia (mainly from the Singapore dashboard and <20% of settings in the manuscript are outside of Asia). This needs to be added to the discussion as a major limitation.
2. Some important and widely reported outbreaks in particular settings are missing. e.g. the

outbreak of the megachurch in Mulhouse France (<https://www.dailymail.co.uk/news/article-8168819/French-megachurch-meeting-blamed-sparking-countrys-biggest-cluster-Covid-19-cases.html>) and the Ruby Princess outbreak (reported in <https://www1.health.gov.au/internet/main/publishing.nsf/Content/1D03BCB527F40C8BCA2585030003>) or the cluster in the french ski resort (<https://www.bbc.com/news/uk-51425702>). This somehow questions the completeness of the systematic review. The authors could have widened their search terms to include the settings (church, ship, etc.) and outbreak when searching media reports.

3. Given that this manuscript from a team in the UK, it is surprising that only 4 outbreak settings were reported for the UK. The authors need to discuss why they were not able to find more reports from the local and national media outlets in English speaking countries like UK, Ireland, and possibly also Australia, Canada and the US.
 4. The authors should discuss reasons for under reporting: public health surveillance systems in many countries were quickly overwhelmed to investigate transmission settings and chains of transmissions. Transmission clusters in elderly care and hospitals homes due to political sensitivity, linked to increased mortality, lack of adequate PPE equipment
 5. Meat factories and slaughter houses have recently emerged as high risk setting in the US (<https://edition.cnn.com/2020/04/08/business/meat-plant-closures-coronavirus/index.html>) and Germany (<https://www.dw.com/en/coronavirus-breaks-out-in-third-german-slaughterhouse/a-53389860>). This setting should be included separately in Table 1.
- Minor comments:
1. Add the sum of cases for all clusters per setting in table 1.
 2. p.3.& p. 7 "the first 100 transmission events". While this is an interesting concept, it isn't really being addressed in this article. No country presented herein has collected more than 100 events. The paragraph in the discussion on this seems therefore irrelevant and could be deleted.
 3. p. 7. The authors mention that there is increasing evidence for airborne transmission. The current consensus is that most transmission occurs via airborne droplets, which is different to aerosol transmission. I suggest to replace "be airborne" by "occur via airborne droplets".

References

1. COVID-19, Australia: Epidemiology Report 9: Reporting week ending 23:59 AEDT 29 March 2020. COVID-19 National Incident Room Surveillance Team, 2020. [Publisher Full Text](#) | [Reference Source](#)

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology of infectious diseases

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 01 Jun 2020

Quentin Leclerc, London School of Hygiene & Tropical Medicine, London, UK

This manuscript aims to provide a descriptive analysis of transmission settings of Covid19 based on published articles or media reports, which is of major interest for controlling the epidemic.

Thank you for taking the time to review our article. Please note that we have now updated our analysis to include an additional 49 transmission events (201 events total) and 4 new settings type ("Food processing plant", "Prison", "Transport" and "Wedding"; 22 setting types total). Some of these new elements overlap with your suggestions. Our Discussion section has also been updated to reflect these new results.

I have several major concerns:

- 1. Most settings reported herein are not representative of settings from a global perspective, most are from the initial epidemic in Asia (mainly from the Singapore dashboard and <20% of settings in the manuscript are outside of Asia). This needs to be added to the discussion as a major limitation.**

Thank you for raising this point. We already mentioned in the Discussion - Limitations section that many studies originated from the early outbreak in China, but have included an additional sentence there to clarify that this could prevent our results from being directly applicable to other countries. That said, please note that in our updated analysis, 98/201 (50%) events are from China and Singapore, compared to 92/152 (60%) in our original analysis, which improves the coverage of our results.

The added sentence is "The settings we identified here therefore might not be representative of settings from a global perspective."

- 1. Some important and widely reported outbreaks in particular settings are missing. e.g. the outbreak of the megachurch in Mulhouse France**

(<https://www.dailymail.co.uk/news/article-8168819/French-megachurch-meeting-blamed-sparking-countrys-biggest-cluster-Covid-19-cases.html>) and the Ruby Princess outbreak (reported in <https://www1.health.gov.au/internet/main/publishing.nsf/Content/1D03BCB527F40C8BCA251> or the cluster in the french ski resort (<https://www.bbc.com/news/uk-51425702>). This somehow questions the completeness of the systematic review. The authors could have widened their search terms to include the settings (church, ship, etc.) and outbreak when searching media reports.

Thank you for suggesting these additional clusters; we have now added the Ruby Princess and the French ski resort events.

Our initial analysis was focused on trying to find distinct *settings* in which transmission had occurred. Hence we were initially trying to prioritise examples of new *settings* linked to clusters rather than gathering all data on all outbreaks linked to all settings. This has changed somewhat with the open source database and we are happy to act as a gathering point for cluster data.

For the outbreak in Mulhouse, this falls into the category of events that we do not include in our analysis. This because we are interested in understanding transmission only within specific settings; for example, for a cruise ship, the cluster size we report corresponds to the number of people infected on that ship only, not the people that these might have infected after disembarking. If we included people infected by passengers after disembarking, this would not reflect the "cruise ship" setting, as this additional transmission could occur in a variety of other settings (household, meal etc...).

We had already highlighted this in the Methods – Outline section, but have now repeated that point at the beginning of the Discussion to hopefully make this distinction clearer ("Note that we restrict cluster size to only include individuals infected within a specific setting, and exclude secondary infections which occurred outside the settings.")

1. **Given that this manuscript from a team in the UK, it is surprising that only 4 outbreak settings were reported for the UK. The authors need to discuss why they were not able to find more reports from the local and national media outlets in English speaking countries like UK, Ireland, and possibly also Australia, Canada and the US.**

Our initial search was at the end of March. At that time, the number of confirmed cases in the UK was around 20,000, compared to more than 200,000 now. Therefore, there was little information at the time on clusters in these countries compared with Asia, which is why we were less likely to find media reports on that topic for the UK. For similar reasons, we had little information for English-speaking countries. In addition, because of the lack of widespread testing in the UK and/or follow-up of cases, information on clusters does not appear to be widely available in the UK.

As of 26/05/2020, we have now identified 39 transmission events in English-speaking countries (19% of all the transmission events we have identified so far). Therefore, our updated analysis is more geographically balanced.

1. **The authors should discuss reasons for under reporting: public health surveillance systems in many countries were quickly overwhelmed to investigate transmission settings and chains of transmissions. Transmission clusters in elderly care and hospitals homes due to political sensitivity, linked to increased mortality, lack of adequate PPE equipment**

Thank you for this suggestion. In line with your comments on the "first 100 transmission

events" we have adapted the paragraph in the discussion to discuss reasons for under reporting.

We have also added a sentence to the paragraph on healthcare clusters in the discussion to reflect the likely increased reporting of clusters linked to these settings due to political sensitivity.

1. **Meat factories and slaughter houses have recently emerged as high risk setting in the US (<https://edition.cnn.com/2020/04/08/business/meat-plant-closures-coronavirus/index.html>) and Germany (<https://www.dw.com/en/coronavirus-breaks-out-in-third-german-slaughterhouse/a-53389860>). This setting should be included separately in Table 1.**

Thank you for raising this point. Our online database had been updated to reflect this, and we have now added the "Food processing plant" setting type in our analysis, and comment on this in the Results and Discussion sections of our article.

This also applies to our new "Prison", "Transport" and "Wedding" setting types.

Minor comments:

1. **Add the sum of cases for all clusters per setting in table 1.**

We have now implemented this suggestion in the revised article.

1. **p.3.& p. 7 "the first 100 transmission events". While this is an interesting concept, it isn't really being addressed in this article. No country presented herein has collected more than 100 events. The paragraph in the discussion on this seems therefore irrelevant and could be deleted.**

We agree it was frustrating not to find this data, which would have been an interesting angle, giving us "denominator" information. In line with the comments above we have adapted this paragraph to link to under reporting.

1. **p. 7. The authors mention that there is increasing evidence for airborne transmission. The current consensus is that most transmission occurs via airborne droplets, which is different to aerosol transmission. I suggest to replace "be airborne" by "occur via airborne droplets".**

Thank you for this suggestion, we have now rephrased this accordingly.

Competing Interests: No competing interests were disclosed.

Comments on this article

Version 2

Reader Comment 23 Jun 2020

Barney Duncan, Ex-Wellcome Biotechnology Ltd, Abermaw, Gwynedd, UK

Back in the 1980's Wellcome Biotechnology Ltd (owned & operated by the Wellcome Trust) expended much effort in trying to eliminate the use of blood fractions from nutrient media used for growing and maintenance of animal & human cell lines prior to inoculation with virus in the

making of rabies and foot & mouth disease vaccines as well as interferon. At the time, it was found that without blood, cell growth and virus titres were poorer.

I have recently observed locally in North Wales 2 major clusters from the 2 Sisters Poultry processing plant on Anglesey and a meat processing plant in Wrexham. This caused me to look further into commonality of Covid outbreaks in other meat processing plants. It resulted in me coming across your paper.

I am mindful of the fact that the first outbreak was traced back to a food market in Wuhan China. The *coronavirus* likely jumped to people in a wet *market* there where meat, seafood, and live animals were handled.

I believe there may be real significance in the quantities of blood on workers overalls and working surfaces in slaughterhouses & meat processing factories. Blood deposits would surely provide a site where virus impregnated droplets from an infected worker could act as inoculum and allow virus to replicate rapidly

In consequence of these facts I would suggest the following recommendations for the next update

- 1 Add wet/cattle markets to the transmission settings list
- 2 Split food processing plant into two fractions meat and non-meat

Thank you to all participants/contributors to your paper. It is most creditable & worthwhile and I believe will prove most valuable line of research.

Barney Duncan
Chemical Engineer (ret'd)

Competing Interests: None unless you consider being a Wellcome pensioner influences my judgement but I'm sure Bill Castell (former CEO of Wellcome Biotechnology and Chairman of Wellcome Trust) could & would readily dispel any such notions !

Reader Comment 08 Jun 2020

David Henry, Bond University, Gold Coast, Queensland, Australia

This is an important topic. I am concerned about your search. I may have missed it, but I think having done this scoping exercise that you should rerun your searches with specific terms (and synonyms) for the settings of interests: schools churches, weddings, meatworks (lots of synonyms) etc. I am guessing that you will get a lot more hits. I don't think that 'transmission cluster' is a sufficiently sensitive term. I'd also like to see a PRISMA flow diagram.

Competing Interests: None

Version 1

Reader Comment 21 May 2020

María Margarita Ronderos Torres, Independent Consultant in Epidemiology, Colombia

I would like to draw to your attention the football match between Atalanta from Bergamo and Valencia from Spain on the 19th Feb at the San Siro Stadium in Milan. Aprox 40,000 fans from the Region attended the match. 35% of the Valencia team delegation when returning to Spain tested positive for COVID19. The region only went into lockdown on the 4th of March. This gave ample time (1.5 to 2 incubation periods) for household transmission with high intergeneration mix and known high elderly population. Further study is needed but this could be very well explain the explosion of cases that followed and is in line with your proposed explanation for super spread of the virus.

Competing Interests: NO competing interests

Literature Review: COVID-19 transmission risk in faith-based gatherings

Updated Feb. 23, 2021 | Author: Dr. N. Dove MD MPH FRCPC

In-person gatherings have been subject to public health orders in BC during the COVID-19 pandemic, including in faith settings. This rapid review assesses evidence to determine COVID-19 risk for faith-based gatherings in BC including: epidemiological data regarding COVID-19 transmission associated with religious activities globally, nationally and in BC; current understanding of SARS-CoV-2 transmission and disease; factors leading to elevated transmission risk in faith based settings, and COVID-19 epidemiology in BC.

A. COVID-19 transmission associated with religious gatherings – Global, Canada and BC

Clusters of COVID-19 cases stemming from religious gatherings, worship services and faith-based activities have been noted since the onset of the pandemic globally, nationally and in BC. A global analysis of COVID-19 clusters found that religious venues frequently served as fertile ground for 'first generation' clusters of 10-50 people, and that large clusters – although infrequent – were commonly associated with religious activities.¹ These have included 'superspreading events' in Eastern France and Korea at the onset of the pandemic, with over 2500 and 5000 confirmed cases respectively, both linked to multi-day faith events with significant numbers in attendance with further international spread.² Additional COVID-19 clusters were associated with religious gatherings as the pandemic progressed, including in Marseilles,³ Malaysia⁴ and Singapore.⁵ A notable outbreak stemming from multiple events over a 2-day period at an Arkansas church resulted in COVID transmission in ~ 40% of attendees (n=35), linked to an additional 26 community cases.⁶ Early indications of transmission associated with religious gatherings prompted the temporary cessation of religious gatherings globally and in BC in spring 2020 as a precautionary measure to halt viral spread in the context of broader lockdown measures.⁷

As pandemic lockdown measures were relaxed globally during the summer and fall of 2020, localized outbreaks associated with religious gatherings continued to accrue. In Germany, two outbreaks with 100 and 40 individuals, respectively, were linked to church services in early June, ostensibly with hygiene and physical distancing precautions in place.^{8,9,10} In the US, recent reports suggest 650 COVID cases have been linked to over 40 religious events.¹¹ These include an outbreak of over 230 cases stemming from events at a small town church¹² and another cluster of 25 cases with rapid and sustained community transmission linked to a close knit faith community in Ohio.¹³

A number of clusters have been linked to religious services and gatherings across Canadian provinces since the summer of 2020, as in person services resumed along with guidance for infection control precautions. A multi-jurisdictional outbreak connected to a series of events in a faith community in Saskatchewan in September resulted in 174 cases in 19 communities – including more than a dozen cases in Northern BC¹⁴ – with 68 cases among individuals attending events, and 106 infected through secondary transmission.¹⁵ More than 30 active cases were confirmed in an Ontario community related to a church gathering, with an additional 300 people put into isolation.¹⁶ An October outbreak of 15 cases was linked to an Ontario community church, noting inconsistent following of public health measures.¹⁷ Additional clusters related to attendance at religious gatherings have occurred across the provinces in Kingston (24 cases),¹⁸ Lethbridge (15 cases),¹⁹ 2 outbreaks in Calgary (24 and 54 cases, respectively),^{20,21} and Edmonton (99 cases).²² In BC, an outbreak of 5 cases were linked to a Kelowna church in September with 5 confirmed linked cases, despite the use of infection control precautions.²³ Notably, COVID clusters have occurred globally despite the reported presence of infection control protocols^{24,25} (e.g. physical

distancing, masking, environmental cleaning) although the degree and consistency of implementation across settings is unclear.

Provincial data from BC indicates that, following lifting of restrictions on religious gatherings from the first pandemic wave, numerous outbreaks and clusters have continued to occur, many despite the reported presence of infection control precautions. To date, there have been clusters of COVID-19 associated with faith-based across regional health authorities in BC, including:²⁶

- VCH 25 clusters, with 61 associated cases
- Fraser Health Authority – 7 clusters, associated with 59 associated cases
- Interior Health Authority – 11 clusters, associated with 20 cases
- Northern Health Authority, 5 clusters associated with 40 cases (including weddings and funerals), including 24 cases associated with an event in Alberta

B. COVID-19 Burden, Epidemiology & Transmission

Burden & distribution

SARS-CoV-2 causes mild or asymptomatic illness in most cases, however severe illness and death can occur in a smaller proportion of infected individuals.²⁷ Estimates of case fatality rates range from 0.23% in seroprevalence studies²⁸ to 2%, based on incidence data from the Canada and US from the first pandemic wave²⁹ (noting estimates are influenced by methodology and biases).³⁰ Globally, those who have a higher risk of severe COVID illness include people over age 65 and those with chronic health conditions, medical complexity or immune suppression.^{31,32} Individuals over age 50 accounted for 79% of hospital admissions and 76% of ICU admissions, respectively, in a Canadian jurisdiction during Wave 1.³³ Compared to influenza, patients admitted to hospital for COVID-19 in this study had a significantly greater mortality (adjusted RR 3.46, [95% CI 2.56-4.68]), ICU admission (adjusted RR 1.50, [95%CI 1.25-1.80]) and hospital length of stay (adjusted rate ratio 1.45, 95% CI [1.25-1.69]) than for influenza.³⁴

Transmission dynamics

The incubation period for SARS-CoV-2 averages 5-6 days up to 14 days,³⁵ with asymptomatic and pre-symptomatic spread responsible for ~16%³⁶ and ~6%³⁷ of cases, respectively. SARS-CoV-2 has high infectivity, with a recent global systematic review and meta-analysis estimating a reproductive number of 2.87,³⁸ meaning that each infected individual is likely to transmit the virus to another 2 to 3 people.

Transmission routes

The majority of SARS-CoV-2 transmission occurs via droplet spread in close contact with an infected symptomatic case,³⁹ where exhaled liquid droplets containing infectious virus particles can hang briefly in the air and settle on surfaces, where contact transfer to another person's nasal or oral passages can occur.⁴⁰ However emerging evidence suggest SARS-CoV-2 may have the potential for aerosol spread under certain conditions.^{41,42} Studies have reported sustained measurement and dispersion of SARS-CoV-2 viral particles in the air after speech emission, posing a potential inhalation risk within enclosed spaces.^{43,44} Global epidemiological evidence of recent clusters of COVID-19 among choirs suggest possible aerosol spread related to singing⁴⁵ - including one in Washington notable for its high attack rate⁴⁶ - though other transmission routes may have been a factor. Factors facilitating the potential for the spread of aerosolized droplets include exposure to an infected person with expiratory exertion (eg. singing), enclosed spaces and inadequate ventilation.⁴⁷

Seasonality

SARS-CoV-2 is a novel pathogen emerging in late 2019, thus data regarding temporal trends and epidemiology are still being established. However, evidence of seasonal variation in the transmission in

the related *Coronaviridae* family of viruses,⁴⁸ well documented seasonal transmission patterns of infectious respiratory viruses,⁴⁹ as well as global COVID-19 data to date⁵⁰ strongly suggest that a seasonal pattern with enhanced transmission of SARS-CoV-2 in winter months is likely.

A confluence of environmental, host and behavioural factors lead to seasonal cycles for respiratory viruses.⁵¹ In particular, colder temperature and reduced humidity make it more likely that viruses will persist in environments for a longer duration and are more easily transmitted due to varying respiratory droplet dynamics and size. During winter months, human hosts are more susceptible and have decreased barriers to prevent infection (due to reduced airway antiviral defenses, fluctuating levels of sunlight influencing Vitamin D status - and therefore immunity - and the need to battle multiple competing viruses). Indoor environments in particular may be susceptible to fluctuating temperatures, humidity and air exchange during the winter months. Finally, changes in patterns of behaviour affect contact rates between infected and susceptible individuals, with gatherings more likely to be indoors in winter months. The rise in infections nationally in Canada during late fall 2020 may be reflective of changing SARS-CoV-2 transmission dynamics indicative of more efficient viral spread during winter months.⁵²

This coincides with a projected 'second wave' of rising COVID-19 infections in Canada and globally.^{53,54,55} Predictions suggest increasing infections as pandemic restrictions are lifted and social interactions resume, uncertainty regarding the persistence of natural immunity following SARS-CoV-2 infection, and co-infection with other seasonal respiratory pathogens that make acquisition of SARS-CoV-2 more likely.⁵⁶

SARS-CoV-2 Variants

Strain surveillance suggests that SARS-CoV-2 variants have emerged and are circulating globally since the fall 2020 (such as the UK and South African variants),⁵⁷ including in BC. SARS-CoV-2 variants may be problematic due to a number of factors including: increased transmissibility; evading detection by usual diagnostic tests; changing ability to cause severe disease (less or more); and/or increased ability to evade natural or vaccine-induced immunity.⁵⁸

Epidemiology – Canada and BC

To date, over 750,000 individuals have tested positive for COVID-19 in Canada – representing a test positivity rate of 4% - with over 19,000 deaths.⁵⁹ To date, 1, 336 individuals have died of COVID-19 in BC, while 71,753 have recovered.⁶⁰ Cases, hospitalizations and deaths increased precipitously in BC during November and December 2020, and while declining in January 2021, still remain high. New COVID-19 cases in BC increased in fall 2020 from 130 cases/day in October to 420 cases/day on Nov. 7; peaking at 780 cases/day on Nov. 26. On Dec. 4, there were 687 cases/day, 338 hospital admissions and 61 ICU admissions. As of Feb. 22, 2021, there were 507 new cases/day, with 217 people hospitalized and 61 in ICU care. While incident cases have decreased since the onset of public health orders, they remain well above levels seen in the summer and early fall and indicate that COVID-19 transmission is ongoing in communities. SARS-CoV-2 variants have been detected in 28 cases, as of Feb. 5, 2021.⁶¹

Transmission risk in religious settings:

Religious gatherings historically have been prone to viral outbreaks, evidenced during the COVID-19 pandemic.^{62,63} A convergence of risk factors interacting together can predispose faith-based gatherings to the rapid dispersion and transmission of infectious viral particles to a large number of people.

Firstly, religious gatherings often occur in indoor settings, with a dense mixing of people who may be in close contact for an extended duration.⁶⁴ A recent review of 201 SARS-CoV-2 clusters globally found the majority were associated with indoor or indoor/outdoor settings.⁶⁵ Congregating indoors, particularly in close proximity, is a risk for COVID transmission due to the potential for droplet spread via infected

people and contaminated surfaces, as well as the potential for aerosolized transmission in certain conditions.^{66,67} Larger groups have a greater likelihood of people who may be infected with COVID or susceptible to becoming infected. In addition, religious gathering may include members within high-risk groups, including older adults and those with comorbidities. Staying in one place for a long time, during a service or ceremony for example, may result in a greater duration of exposure and therefore a higher risk of infection. Prolonged close contact increases the chance of viral spread, defined as more than 15 minutes.⁶⁸ Furthermore, loud talking and singing may result in the expulsion of more oral fluid droplets which remain in the air longer and travel further,^{69,70} which may represent greater risk for viral transmission. A small fraction of individuals release significantly more fluid particles when speaking – known as ‘super emitters’ – postulated as a mechanism by which some individuals may disproportionately contribute to infectious clusters.⁷¹ Finally, a dose-response relationship has been postulated for SARS-CoV-2, whereby high concentrations of infectious viral inoculum are related to the development of more severe disease and greater transmission potential, which can greatly facilitate transmission at a community level.⁷² The likelihood of SARS-CoV-2 transmission during these types of gatherings can be increased due to a greater number of susceptible individuals (influenced by the number and nature of interactions – such as the dense mixing of people in enclosed space for extended duration) combined with an increased transmission probability per contact (e.g. due to talking or loud singing).⁷³

C. COVID-19 Prevention

BC COVID-19 Pandemic Response

The overall goal of the COVID-19 pandemic response in BC is to minimize serious illness and death for populations at risk while minimizing societal disruption and to maintain health care system capacity.⁷⁴ Specific objectives include to reduce the incidence and community transmission of COVID-19 infection, to protect high risk populations and communities from morbidity and mortality related to COVID-19, to preserve the capacity of the health care system to provide treatment while maintaining continuity of health and essential services, to apply evidence informed decision-making to the use of public health measures and to reduce negative consequences of COVID-19 response actions. Strategies to ‘flatten the curve’ with universal restrictive measures were recognized to have significant societal costs in spring 2020, and therefore more targeted strategies to prevent transmission in high-risk settings have been adopted during the second pandemic wave. The goal of a long-term sustainable response to living with COVID-19 is to minimize burden and mortality, while allowing society to function to the degree possible, and to target interventions selectively according to where transmission and burden may be best prevented. However, when less restrictive interventions fail, more restrictive measures may be necessary to protect the health of the population.

Ethical considerations in a pandemic response

Ethical considerations are paramount when applying public health pandemic response measures, as guided by the BCCDC Ethical Frameworks for Decision-Making.⁷⁵ Namely, the need to pursue timely action to protect population health can infringe upon individual autonomy – this is particularly evident in the case of a pandemic sparked by a novel pathogen with rapid global spread in which data continues to emerge. Precautionary action may be necessary, in the absence of full or complete information that would be helpful, based on values and a responsibility to act on what is known to prevent further harm. Interventions need to have stated goals and have evidence of effectiveness. Interventions should be proportional, such that the benefits of an intervention outweigh the burden and risks, and the latter fairly distributed. When possible, more coercive means should only be used when less restrictive means fail. A principle of reciprocity seeks to mitigate burdens or harms imposed by public health action.

Effectiveness of interventions to prevent COVID-19 transmission

In the absence of vaccines and effective anti-virals, non-pharmaceutical interventions (NPIs) are the only mitigation measures to reduce and delay spread of infectious emerging respiratory virus in a population. Data quantifying the effectiveness of COVID-19 prevention interventions across settings is limited. To date, there are no published estimates of the risk of COVID-19 related to in-person attendance at faith-based settings. Conversely there are no published studies of the effectiveness of interventions in these settings. A December 2020 global modelling study ranked restrictions on small gatherings as among the most effective interventions to prevent COVID-19 spread, reducing R by -0.22 to -0.35, while prohibitions on mass gatherings reduced R by 0.13 to -0.33 (noting that the assessment of relative merits of NPIs is statistically challenging due to confounding, concurrency and sequencing of interventions across settings).⁷⁶ The effectiveness of other measures is largely dependent on behavioural compliance as well as prevalence of transmission in the community.

While a constellation of infection prevention and control precautions can reduce SARS-CoV-2 droplet and contact transmission in the community,⁷⁷ effectiveness can be limited due to a number of reasons. While the use of cloth face masks may slow or reduce viral spread, a recent systematic review and meta-analysis found limited effectiveness in preventing community COVID-19 transmission, largely due to variations in usage.⁷⁸ Uptake and adherence to measures, such as handwashing, physical distancing measures and self-isolation, can vary by a number of factors⁷⁹ including the need to establish new social norms, habits, and surmount active resistance.⁸⁰ A recent analysis suggested that 'viral identity' associated with group affiliation, social and political beliefs may be a core driver of COVID-19 prevention behaviour.⁸¹

Anecdotal reports suggest inconsistent compliance with infection control precautions, including in a religious gathering in BC.⁸² In an Ontario church cluster, adherence to public health guidelines was noted, raising questions about the adequacy of ventilation, venue capacity and role of singing.⁸³ Finally, while there is no clear scientific consensus on the role or how to minimize the potential for SARS-CoV-2 aerosol spread, understanding and controlling indoor routes of transmission is likely key to prevent transmission events, including optimizing ventilation,^{84,85} which may not be widely available in some settings.

D. Conclusion

Restricting in-person attendance at faith-based settings is a necessary and time limited measure to protect the health of the population. In-person attendance at faith-based gatherings can increase COVID transmission risk due to the assembly of a large number of people indoors in close contact with each other for an extended duration. The occurrence of activities, such as loud talking and singing, can increase the release and dispersion of infectious viral particles implicated in transmission. The presence of continuing COVID outbreaks in faith congregations throughout the summer and fall of 2020, nationally and in BC, despite public health guidance for infection control measures, suggest that the implementation of current preventive precautions is not infallible. Recent global modelling data of COVID-19 response measures suggests restrictions on gatherings are among the most effective measure at reducing community transmission. Other prevention measures are largely dependent on willingness to comply, influenced by social norms and values, and circulating community prevalence. Studies directly quantifying SARS-CoV-2 transmission risk within specific settings, as well as the effectiveness of specific infection control interventions across settings during the COVID-19 pandemic are lacking. The combination of escalating community transmission of an infectious virus in peak seasonal transmission, mass vaccination in its early stages with the majority of the population still susceptible, recent introduction of variants to BC with increased transmissibility and as yet unknown implications, and increased transmission risk associated with indoor gatherings with activities that have greater likelihood of viral spread greatly increase the risk for population health. Thus, the temporary suspension of in-

person attendance at religious services is a necessary and time-limited measure to protect the health of the population and control disease spread in line with BC's pandemic response goals. Alternative measures to mitigate the burden of unintended harms from restrictions on congregating collectively should be considered.

¹ Leclerc, Q. et al. What settings have been linked to SARS-CoV-2 transmission clusters? Wellcome Open Res. 2020; 5: 83.

² Salaun, T. Special Report: Five days of worship that set a virus time bomb in France. Reuters. March 30, 2020. Accessed online Jan. 17, 2021 at: <https://www.reuters.com/article/us-health-coronavirus-france-church-spec/special-report-five-days-of-worship-that-set-a-virus-time-bomb-in-france-idUSKBN21H0Q2>

³ Aherfi S, Gautret P, Chaudet H, Raoult D, La Scola B. Clusters of COVID-19 associated with Purim celebration in the Jewish community in Marseille, France, March 2020. *Int J Infect Dis.* 2020;100:88-94.

⁴ Nor Fazila Che Mat, PhD, Hisham Atan Edinur, PhD, Mohammad Khairul Azhar Abdul Razab, PhD, Sabreena Safuan, PhD, A single mass gathering resulted in massive transmission of COVID-19 infections in Malaysia with further international spread, *Journal of Travel Medicine*, Volume 27, Issue 3, April 2020.

⁵ Pung, R. et al. Investigation of three clusters of COVID-19 in Singapore: Implications for surveillance and response measures. *The Lancet.* 2020; 395 (10229): 1039-1046.

⁶ James A, Eagle L, Phillips C et al. High COVID-19 Attack Rate Among Attendees at Events at a Church – Arkansas, March 2020. *MMWR Morb Mortal Wkly Rep.* 2020; 69: 632-635.

⁷ Quadri, S. COVID-19 and religious congregations: Implications for spread of novel pathogens. *Int J Infect Dis.* 96 (2020): 219-221.

⁸ Martyr, K. German church at the centre of over 100 coronavirus cases. DW Akademie. June 14, 2020. Accessed online Jan. 17, 2021 at: <https://www.dw.com/en/german-church-at-the-center-of-over-100-coronavirus-cases/a-53804687>

⁹ DW Akademie. Coronavirus cluster traced to German church. May 23, 2020. Accessed online Jan. 17, 2021 at: <https://www.dw.com/en/coronavirus-cluster-traced-to-german-church/a-53546434>

¹⁰ Porterfield, C. Church-related coronavirus outbreaks as Trump pushes for re-opening. *Forbes*, May 23, 2020. Accessed online Jan. 17, 2021 at: <https://www.forbes.com/sites/carlporterfield/2020/05/23/church-related-coronavirus-outbreaks-reported-as-trump-pushes-for-reopening/?sh=7e7a7b338b45>

¹¹ Conger, K. Healy J. and L. Tompkins. Churches were eager to reopen. Now they are confronting coronavirus cases. *The New York Times*. July 8, 2020. Accessed online Jan. 17, 2021 at: <https://www.nytimes.com/2020/07/08/us/coronavirus-churches-outbreaks.html>

¹² Vondracek, C. Over 230 members of Oregon church get COVID-19. *Washington Times*. June 18, 2020. Accessed online Jan. 17, 2021 at: <https://www.washingtontimes.com/news/2020/jun/18/over-230-members-oregon-church-get-covid-19/>

¹³ Ali, H. et al. COVID-19 Outbreak in an Amish community – Ohio, May 2020. *MMWR Morb Mort Wkly Rep.* 2020 Nov 13; 69 (45): 1671-1674.

¹⁴ Giesbrecht, L. "Particularly concerning:" Cases linked to Prince Albert church expected to rise. *Regina Leader-Post*. Oct. 9, 2020. Accessed online Jan. 17, 2021 at: <https://leaderpost.com/news/saskatchewan/particularly-concerning-cases-linked-to-prince-albert-church-outbreak-expected-to-rise>

¹⁵ Saskatchewan Health Authority. Multi-jurisdictional community outbreak declared. Oct. 7, 2020. Accessed online Jan. 17, 2021 at: <https://www.saskhealthauthority.ca/about-us/news/Pages/2020/October/Multi-jurisdictional-community-outbreak-declared.aspx>

¹⁶ Paylinawan, D. Outbreak declared at church in Chatham-Kent after 31 cases reported: health officials. *Toronto Star*. Oct. 30, 2020. Accessed online Jan. 17, 2021 at: <https://www.thestar.com/news/canada/2020/10/30/outbreak-declared-at-church-in-chatham-kent-after-31-cases-reported-health-officials.html>

¹⁷ Leung, W. Places of worship forced to adapt during COVID-19 pandemic. *The Globe and Mail*. Nov. 20, 2020. Accessed online Jan. 17, 2021 at: <https://www.theglobeandmail.com/canada/article-places-of-worship-forced-to-adapt-during-covid-19-pandemic/>

¹⁸ Canadian Press. Public Health Unit declares outbreak at Kingston, Ont. Church. Dec. 8, 2020. Accessed online Jan. 17, 2021 at: <https://www.thestar.com/news/canada/2020/12/08/public-health-unit-declares-outbreak-at-kingston-ont-church.html>

¹⁹ Opinko, D. COVID-19 outbreak declared at church in Coaldale. Oct. 16, 2020. *Lethbridge News Now*. Accessed online Jan. 17, 2021 at: <https://lethbridgenewsnow.com/2020/10/16/covid-19-outbreak-declared-at-church-in-coaldale/>

²⁰ Kury de Castillo, C. COVID-19: Choir of Calgary church thrives despite illness and online rehearsals. *Global News*. Dec. 7, 2020. Accessed online Jan. 17, 2021 at: <https://globalnews.ca/news/7506848/calgary-church-choir-coronavirus-pandemic/>

²¹ Rieger, D. 57 cases of COVID-19 linked to outbreak at Calgary church. *CBC*. Aug. 31, 2020. Accessed online at Jan. 17, 2021 at: <https://www.cbc.ca/news/canada/calgary/calgary-church-outbreak-covid-1-5707121>

²² Boothby, L. Edmonton church outbreak rises to 99 cases; 127 new cases in Alberta, no deaths. *Edmonton Journal*. Aug. 27, 2020. Accessed online Jan. 17, 2021 at: <https://edmontonjournal.com/news/health/covid-19-127-new-cases-99-cases-in-alberta-on-wednesday-as-additional-deaths>

²³ Canadian Broadcasting Corporation. 5 cases of COVID linked to outbreak at Kelowna church. Sep. 28, 2020. Accessed online Jan. 17, 2021 at: <https://www.cbc.ca/news/canada/kelowna/covid-19-linked-to-outbreak-at-kelowna-church-1.5747590>

²⁴ Conger, K. Healy J. and L. Tompkins. Churches were eager to reopen. Now they are confronting coronavirus cases. *The New York Times*. July 8, 2020. Accessed online Jan. 17, 2021 at: <https://www.nytimes.com/2020/07/08/us/coronavirus-churches-outbreaks.html>

²⁵ DW Akademie. Coronavirus cluster traced to German church. May 23, 2020. Accessed online Jan. 17, 2021 at: <https://www.dw.com/en/coronavirus-cluster-traced-to-german-church/a-53546434>

²⁶ Affidavit – Dr. Brian Emerson.

²⁷ Heneghan C et al. SARS-CoV-2 viral load and severity of COVID-19. Oxford, UK: University of Oxford, Centre for Evidence-Based Medicine, Nuffield Department of Primary Care Health Sciences; 2020 Mar 26. Available from: <https://www.cebm.net/covid-19/sars-cov-2-viral-load-and-the-severity-of-covid-19/>.

28. Ioannidis, J. Infection fatality rate of COVID-19 inferred from seroprevalence data. *Bulletin of the World Health Organization*. Article ID: BLT.20.265892. p. 1-37. Accessed online Feb. 16 at: https://www.who.int/bulletin/online_first/BLT.20.265892.pdf
29. Abdollahi, E. et al. Temporal estimates of case-fatality rate for COVID-19 outbreaks in Canada and the United States. *CMAJ* 2020 June 22;192:E666-70. doi: 10.1503/cmaj.200711
30. Gotzsche, P. Rapid response: Is the infection fatality rate for COVID-19 worse than that for influenza? *BMJ*. 2020; 371:m4509.
31. BC Centre for Disease Control. Priority Populations. Accessed online Jan. 20, 2021 at: <http://www.bccdc.ca/health-info/diseases-conditions/covid-19/priority-populations/people-with-chronic-conditions>
32. Chow, N. et al. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019 – United States, February 12–March 28, 2020. *MMWR Morb Mort Wkly Rep*. 2020; 69 (13): 382–386.
33. Verma, A. et al. Characteristics and outcomes of hospital admissions for COVID-19 and influenza in Toronto-area. *CMAJ*. 93 (8): 2021. 1-9.
34. *ibid.*
35. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. *Ann Int Med*. 2020;172:577–82.
36. Byambasuren, O. et al. Estimating the extent of asymptomatic COVID-19 and its potential for community transmission: systematic review and meta-analysis. *JAMMI*. 2020; 5 (4): 223-234.
37. Wei WE, Li Z, Chiew CJ, Yong SE, Toh MP, Lee YI. Presymptomatic Transmission of SARS-CoV-2 – Singapore, January 23–March 16, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(14):411–5.
38. Bilal MA, Miah MM, Khan MN (2020) Reproductive number of coronavirus: A systematic review and meta-analysis based on global level evidence. *PLoS ONE* 15(11): e0242128.
39. Centre for Disease Control. Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission. Oct. 5, 2020. Accessed online Jan. 17, 2021 at: <https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html>
40. Meselson, M. Droplets and aerosols in the transmission of SARS-CoV-2. *N Engl J Med*. 2020; 382: 2063.
41. Anderson, E. Consideration of the aerosol transmission for COVID-19 and public health. *Risk Analysis*. 2020; 40 (5): 902-907.
42. Environmental Protection Agency, 2020.
43. Anfinrud, P. et al. Visualizing speech-generated oral fluid droplets with laser light scattering. *NEJM*. 2020; 382: 2061-2063.
44. Klompas, M. Airborne transmission of SARS-CoV-2: Theoretical considerations and available evidence. *JAMA*. 2020; 324: 441-442.
45. McKie, R. Did singing together spread coronavirus to four choirs? *The Guardian*. May 17, 2020. Accessed online Jan. 17, 2021 at: <https://www.theguardian.com/world/2020/may/17/did-singing-together-spread-coronavirus-to-four-choirs>
46. Hamner, L. et al. High SARS-CoV-2 attack rate following exposure at a choir practice – Skagit County, Washington, March 2020. *MMWR Morb Mort Wkly Rep*. 2020 May 15; 69 (19): 606-610.
47. Centre for Disease Control. Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission. Oct. 5, 2020. Accessed online Jan. 17, 2021 at: <https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html>
48. Peterson, E. et al. Comparing SARS-CoV-2 with SARS-CoV and influenza pandemics. *The Lancet*. August 2020; 20: e238-e244.
49. Moriyama, M. et al. Seasonality of Respiratory Viral Infections. *Annual Review of Virology* 2020 7:1, 83-101.
50. Sajadi MM, Habibzadeh P, Vintzileos A, Shokouhi S, Miralles-Wilhelm F, Amoroso A. Temperature, Humidity, and Latitude Analysis to Estimate Potential Spread and Seasonality of Coronavirus Disease 2019 (COVID-19). *JAMA Netw Open*. 2020;3(6):e2011834.
51. Moriyama, 2020.
52. Government of Canada. Coronavirus disease 2019 (COVID-19): Epidemiology update. Jan. 25, 2021. Accessed online Jan. 25 at: <https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html#a4>
53. Middleton, J., Lopes, H., Michelson, K. et al. Planning for a second wave pandemic of COVID-19 and planning for winter. *Int J Public Health* 65, 1525–1527 (2020). <https://doi.org/10.1007/s00038-020-01455-7>
54. Academy of Medical Sciences. Preparing for a challenging winter 2020/21. 14 July 2020. Accessed online Jan. 21, 2021 at: <https://ecomeds.ac.uk/file-download/51353957>
55. Xu, S. and Y. Li. Beware of the second wave of COVID-19. *The Lancet*. 2020; 395 (10233): 1321-1322.
56. Norris, S. What we know about a potential second wave of COVID-19. *HillNotes: Research and Analysis from Canada's Library of Parliament*. Aug. 12, 2020. Accessed online at: <https://hillnotes.ca/2020/08/12/what-we-know-about-a-potential-second-wave-of-covid-19/>
57. World Health Organization. SARS-CoV-2 Variants. *Disease Outbreak News*. 31 December 2020. Accessed online Jan. 25, 2021 at: <https://www.who.int/csr/don/31-december-2020-sars-cov-2-variants/en/>
58. Centre for Disease Control. Emerging SARS-CoV-2 Variants. Jan. 28, 2021. Accessed online Feb. 21, 2021 at: <https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/scientific-brief-emerging-variants.html>
59. Government of Canada. Coronavirus disease 2019 (COVID-19): Epidemiology update. Jan. 25, 2021. Accessed online Jan. 25 at: <https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html#a4>
60. BC Centre for Disease Control. COVID-19 Dashboard. Accessed Feb. 23, 2021 at: <https://experience.arcgis.com/experience/a6f23959a8b14bfa989c3cda29297ded>
61. Office of the Provincial Health Officer of BC. COVID-19 Monthly Update. Feb. 5, 2021. Accessed online Feb. 21 at: http://www.bccdc.ca/Health-Info-Site/Documents/CovidBriefing_20210205.pdf
62. Memish, Z. et al. Mass gatherings medicine: public health issues arising from mass gathering religious and sporting events. *The Lancet*. 2019; 393 (10185): 2073-2084.
63. Van-Thuan, H. and P. Gautret. Infectious diseases and mass gatherings. *Curr Infect Dis*. 2018; 20 (11): 44.
64. Quadri, 2020.
65. Leclerc, Q. et al. What settings have been linked to SARS-CoV-2 transmission clusters? *Wellcome Open Res*. 2020; 5: 83.
66. Environmental Protection Agency. Indoor Air and Coronavirus (COVID-19). Accessed online Jan. 17, 2021 at: <https://www.epa.gov/coronavirus/indoor-air-and-coronavirus-covid-19>
67. Centre for Disease Control, 2020.

- ⁶⁸ Centre for Disease Control. Public health guidance for community related exposure. Dec. 3, 2020. Accessed online at: <https://www.cdc.gov/coronavirus/2019-nCoV/php/public-health-recommendations.html>
- ⁶⁹ Anfirud, P. et al. Visualizing speech-generated oral fluid droplets with laser light scattering. *NEJM*. 2020; 382: 2061-2063.
- ⁷⁰ Asadi S, Wexler AS, Cappa CD, Barrera S, Bouvier NM, Ristenpart WD. Aerosol emission and superemission during human speech increase with voice loudness. *Sci Rep* 2019;9:2348-2348.
- ⁷¹ *ibid*.
- ⁷² Van Damme, W. et al. COVID-19: Does the infectious inoculum dose-response relationship contribute to understanding heterogeneity in disease severity and transmission dynamics? *Med Hypotheses*. 2021 Jan 146: 110431.
- ⁷³ Althouse, B. et al. Superspreading events in the transmission dynamics of SARS-CoV-2: Opportunities for interventions and control. *PLOS Biology*. Nov. 12, 2020. <https://doi.org/10.1371/journal.pbio.1008007>
- ⁷⁴ Public Health Agency of Canada. Federal/Provincial/Territorial Public Health Response Plan for Ongoing Management of COVID-19. Aug. 19, 2020.
- ⁷⁵ BC Centre for Disease Control. BCCDC Ethics Framework and Decision-Making Guide. May, 2015. Accessed online Feb. 21, 2021 at: https://www.bccdc.ca/wp-content/uploads/2020/04/BCCDC_Ethics_Framework_Decision_Making_Guide.pdf
- ⁷⁶ Haug, N. et al. Ranking the effectiveness of worldwide COVID-19 government interventions. *Nat Hum Behav*. 2020; 4: 1303-1312.
- ⁷⁷ Government of Canada. Community based measures to mitigate the spread of coronavirus disease (COVID-19) in Canada. Oct. 15, 2020. Accessed online Jan. 17, 2021 at: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/public-health-measures-mitigate-covid-19.html>
- ⁷⁸ Sharma, S. et al. Efficacy of cloth face masks in prevention of novel coronavirus transmission: a systematic review and meta-analysis. *J Educ Health Promot*. 2020; 9: 192.
- ⁷⁹ Ebrahimi, O. et al. Factors associated with adherence to social distancing protocols and hygienic behaviour during the COVID-19 pandemic. Dec. 2020. DOI: 10.31234/osf.io/h7wmj
- ⁸⁰ West, R. et al. Applying principles of behaviour change to reduce SARS-CoV-2 transmission. *Nature Hum Behav*. 2020; 4 (5): 1-9.
- ⁸¹ Lam, M.E. United by the global COVID-19 pandemic: divided by our values and viral identities. *Humanit Soc Sci Commun* 8, 31 (2021). <https://doi.org/10.1057/s41599-020-00679-5>
- ⁸² Little, S. Langley business owner frustrated by neighbouring church's in person services. Jan. 4, 2021. Accessed online Jan. 17, 2021 at: <https://globalnews.ca/news/7552869/langley-coronavirus-church-frustration/>
- ⁸³ Paglinawan, D. Outbreak declared at church in Chatham-Kent after 31 cases reported: health officials. *Toronto Star*. Oct. 30, 2020. Accessed online Jan. 17, 2021 at: <https://www.thestar.com/news/canada/2020/10/30/outbreak-declared-at-church-in-chatham-kent-after-31-cases-reported-health-officials.html>
- ⁸⁴ Wang, Z. et al. Transmission and prevention of SARS-CoV-2. *Biochem Soc Trans*. 2020 Oct. 30; 48 (5): 2307-2316.
- ⁸⁵ Morawska, L. and J. Cao. Airborne transmission of SARS-CoV-2: The world should face the reality. *Environ Int*. 2020 Jun; 139: 105730.

Assessing request for variance on restrictions on faith-based gatherings

Feb. 24, 2021 Author: Dr. N. Dove MD MPH FRCPC

Purpose: To assess a request for variance originating from a petitioner located in the Fraser Valley to lift ongoing public health restrictions on faith-based gatherings in the context of current data and epidemiology of the COVID-19 pandemic in BC. Additional objectives include to evaluate whether current gathering restrictions are serving the goals and objectives of BC's provincial pandemic response and ensure accordance with public health ethics obligations.

Background:

- Orders restricting gatherings of more than 50 people, including in religious settings, have been in place since March 2020. Orders restricting all gatherings and events, including in religious settings, were re-instituted Nov. 7, 2020 for Vancouver Coastal and Fraser Health. These were updated on Nov. 30, 2020 to include restrictions for the entire province, which continue to the present day. ([PHO order on gatherings and events](#))
- Orders were instituted in response to changing COVID-19 epidemiology. New COVID-19 cases in BC increased from 130 cases/day in October 2020 to 420 cases/day on Nov. 7, 2020; peaking at 780 cases/day on Nov. 26, 2020. On Dec. 4, 2020, there were 687 cases/day, 338 hospital admissions and 61 ICU admissions. ([BCCDC COVID-19 Dashboard](#))
- These restrictions are aligned with the goals and objectives of the BC COVID-19 pandemic response to prioritize and protect population health, specifically including: to reduce community COVID-19 transmission, prevent morbidity and mortality, and preserve health system capacity.
- Current epidemiology, as environment, host and pathogen factors, suggest that religious settings may be at increased risk of SARS-CoV-2 transmission. This assessment is based on the following data:
 - Global, international, national and provincial data show that outbreaks and clusters of COVID-19 are frequently associated with religious settings, with resulting secondary transmission in the broader community
 - Evidence suggests that a confluence of factors may render religious settings at higher risk of SARS-CoV-2 transmission, including: a higher density of people congregating in enclosed, indoor spaces with variable ventilation; occurrence of high-risk activities predisposed to viral spread (i.e. loud speaking and singing); multi-generational attendees vulnerable to more severe outcomes (including those over age 65); in addition to SARS-CoV-2 pathogen characteristics (ie. seasonality, circulating variants with greater transmissibility) that may result in risk of transmission and serious disease at the present time
 - Over 48 COVID-19 clusters associated with 180 cases have occurred across BC associated within faith-based settings since the lifting of restrictions on gatherings during the summer and fall 2020. Compliance with infection control precautions in settings experiencing clusters is unknown.
 - Over 100 cases of SARS-CoV-2 variant have been detected to date in BC.

- Data quantifying the effectiveness of COVID-19 prevention interventions across settings is limited at the present time, including estimates of risk reduction specific to faith settings. A December 2020 global modelling study ranked prohibition on small gatherings as among the most effective interventions to prevent SARS-Cov-2 community spread (reducing R by -0.22 to -0.35) while prohibitions on mass gatherings over 50 individuals reduced R between -0.13 and -0.33 ([Haug, 2021](#))
- Other infection control measures are largely dependent on behavioural compliance with measures as well as prevalence of transmission in the community. A recent analysis suggests that 'viral identity' associated with social and political beliefs and group affiliation may be a primary driver of COVID-19 prevention behaviour ([Lam, 2021](#))
- Public health ethics principles are paramount in any pandemic response. The following considerations are current public health decision-making in the COVID-19 pandemic:
 - Precautionary principle: stipulates the need for pragmatic and timely action to protect the population from risk. Action can be necessary despite scientific uncertainty and/or the absence of complete data to inform decision-making – this is not unexpected in the context of a global pandemic with a novel pathogen for whom our scientific understanding is still evolving. ([BCCDC COVID-19 Ethical Decision-Making Framework](#); and [BCCDC Ethics Framework and Decision-Making Guide](#))
 - Proportionate: ensuring that the benefits and harms of an intervention are commensurate, particularly for younger populations who may experience harms of restrictions despite not being at high risk of serious outcomes of COVID-19. Efforts have been made to mitigate the impacts of restrictions, through the provisions of alternatives (proposing drive-in events for <50 people, virtual services, and being able to hold weddings/funerals with under 10 people etc.)
 - Transparency: regarding available information, including what is not known currently
 - Engagement: Ongoing consultation is occurring with faith leaders representing religious communities across BC

Current situation:

- Current epidemiology
 - On Feb. 23, 2021, there were 559 new cases, with 237 hospitalizations and 64 in ICU care. While incident cases have decreased since the onset of public health orders, they remain well above previous levels seen in the summer and early fall, indicating that COVID-19 transmission is ongoing in communities. ([BCCDC COVID-19 Dashboard](#))
 - In early February, test positivity in BC has been declining overall however remains elevated at 5-10%. Test positivity remains high in key local regions, including in Metro Vancouver and the Fraser Valley (testing positivity of 5.8% and 8.1% respectively on Feb. 24, 2021) ([PHO COVID-Briefing](#), communication Dr. Henry)
 - Incident cases are highest under age 50, while hospitalizations and ICU admissions are at or above predicted for ages 50 and over, while deaths are highest among those age 70 or over. ([PHO COVID-Briefing](#))

- In early February 2021, R estimates were relatively stable or declining in all RHA, remaining close to 1. ([PHO COVID-Briefing](#))
- Spread of variants in BC: Variants have been detected in 100 cases as of Feb. 24, 2021, predominantly the UK 1.1.7 variant ([PHO COVID-Briefing](#)). These variants have been implicated in recent outbreaks and have the potential to spread rapidly, cause more severe disease and impacts on immunity.
- 145,000 doses of vaccine have been distributed/received, as of Feb. 3, 2021, mainly among long term care and assisted living residents and staff. ([PHO COVID-Briefing](#))
- Seasonal projections suggest that we remain in the peak prevalent period. Cases are expected to decline approaching summer months, particularly with ongoing compliance with infection control precautions
- Identified harms of prohibitions on in-person religious gatherings including being unable to participate collectively in faith practices, social isolation and mental health concerns, including for vulnerable members

Conclusions

While there has been a recent downward trend in COVID-19 infections and burden across BC from peak levels in November 2020 - represented by incident cases, hospital admissions, ICU admissions – these indicators remain significantly elevated compared to summer and early fall 2020. Based on early February data, the number of infected contacts per individual appears to be declining and stabilizing in most health authorities with adherence to public health restrictions, although localized outbreaks continue to occur. However, new COVID-19 cases and test positivity remain elevated in recent days, particularly in the Fraser Valley area.

In-person attendance at faith-based gatherings can increase the risk of COVID-19 transmission and community spread. In-person attendance at faith gatherings can facilitate COVID-19 transmission due to the assembly of a large number of people indoors in close contact with each other for an extended duration. The occurrence of activities common in faith gatherings, such as loud talking and singing, can increase the dispersion of infectious viral particles implicated in transmission. Current data suggests we are in a period of peak seasonal and community transmission for COVID-19. New variants have been introduced recently in BC with the potential for greater transmissibility and as yet unknown ramifications. Mass vaccination is still in its early stages, with the majority of the population still susceptible.

The presence of continuing COVID-19 outbreaks in faith congregations throughout the summer, fall and winter of 2020, nationally and in BC, despite public health guidance for infection control measures, suggest that preventive precautions are not infallible. Recent global modelling of COVID-19 response measures suggests restrictions on gatherings are among the most effective measure at reducing community transmission. Other prevention measures are largely dependent on willingness to comply, influenced by social norms and values, and circulating community prevalence. However, studies directly quantifying SARS-CoV-2 transmission risk within specific settings and the effectiveness of setting specific infection control interventions during the COVID-19 pandemic are lacking.

It is important to balance the prevention of community transmission of SARS-CoV-2 and with a need to reduce unintended harms. Ongoing consultation and collaboration with leaders of faith communities have highlighted the potential for an accumulating burden of harms with prolonged restrictions on faith gatherings, impacting freedom to participate in faith practices collectively, connection to community and mental well-being.

The COVID-19 pandemic – characterized by the rapid global spread of a novel pathogen – has required BC's public health leaders to make timely and pragmatic decisions informed by evidence to protect population health, often in the context of emerging data. COVID-19 cases and hospitalizations remain elevated provincially - with a recent increase in cases and test positivity in the Fraser Valley – as well as an expanding percentage of cases and clusters implicating new variants of concerns suggesting enhanced transmissibility, while the majority of the population remains unvaccinated. The continued suspension of in-person attendance at religious services across BC is a necessary, time-limited measure and precautionary measure to protect the health of the population and control disease spread. We are not yet seeing the stabilization and reduction in new infections that would allow for a significant relaxation in restrictions, particularly in the Fraser Health region where the risk is greatest.

Options

1. Continue with current orders restricting in-person gatherings, including in faith-based settings.
 - Continue with engagement with faith leaders to determine alternatives to reduce unintended burdens of ongoing restrictions
 - Such alternatives may include facilitating gatherings that can maximize physical distancing, with consideration for virtual services, drive in services and /or outdoor services with strict physical distancing and infection control precautions
2. When trends in COVID-19 indicators stabilize, may consider selectively lifting restrictions to allow gatherings for religious purposes only to resume in a limited way, with maximal efforts to prevent COVID-19 transmission and vulnerable populations. Stipulations could include, but are not limited to:
 - Commitment to implement COVID-19 prevention safety plans and protocols including promoting physical distancing, hand hygiene, isolating when ill and environmental cleaning, among others (see [Worksafe BC – Faith Based Organizations: Protocols for Returning to Operation](#); and [BCCDC Guidance for Faith Based, Spiritual and Worship Practices](#))
 - Promoting alternates for inclusion other than in-person attendance for those at higher risk (i.e. those above age 65, with comorbidities – see [BCCDC priority populations](#))
 - Restrict activities at higher risk (i.e. singing, passing around objects that would be touched by many people, such as collection plates) and physical contact

Response to petitioner affidavits

We appreciated the opportunity to review thoughtful affidavits from Drs. Warren and Kettner. While there are important points for consideration, after careful review, this does not change our position in this case. Please refer to the complete literature review for evidence assessed to date.

Importantly, the goals of BC's pandemic response include, but are not limited to, preventing mortality, particularly for vulnerable populations. Key primary goals also include to prevent morbidity, to reduce COVID-19 incidence and community transmission, as well as averting unchecked exponential growth in SARS-CoV-2 infections that could exceed the capacity of the health care system to provide treatment, or of the public health system to conduct contact tracing to prevent further infection.

A key difference in assessing communicable compared to non-communicable disease burden is the potential for population spread and amplification, particularly without adequate controls. The comparison was made with motor vehicle collision (MVC) mortality. In 2017 there were 5 MVC deaths/100,000 population in Canada.¹ Contrasting MVC vs. COVID-19 mortality rates for those under 60 years of age removes one fifth of the population from consideration, which is neither practical nor equitable. Compared to other countries globally, Canada has a comparatively low mortality rate from COVID-19 with ~58 deaths/100,000 population to date, with other countries globally experiencing rates up to 4 times higher, influenced by differences in testing, characteristics of the health care system, demographics, as well as fluctuations in public health and government responses."

Maintaining a responsive public health system functioning at capacity is essential to keep SARS-CoV-2 infections in check, through early case detection, contact tracing and targeted interventions that are imperative to break the chains of transmission that can lead to exponential growth. We rely on a comprehensive system of indicators to assess community transmission and the level of population health risk, including monitoring local epidemiology, in order to target timely and proactive interventions to prevent rapid disease spread (refer to [Public Health Ontario](#) for examples of epidemiologic indicators used to inform COVID-19 response measures).

The COVID-19 pandemic – characterized by the rapid global spread of a novel pathogen – has required public health leaders to make timely and pragmatic decisions informed by evidence to protect population health, often in the context of emerging or incomplete data. To date, published data regarding the risk of COVID-19 in faith-based settings specifically is limited. A global analysis of COVID-19 clusters found that religious settings were common sites for first generation clusters of 10-50 people and that large clusters – although infrequent – were commonly associated with religious activities ([Leclerc, 2020](#)). Conversely there are limited published studies of the effectiveness of preventive interventions specific to faith settings. A December 2020 global modelling study ranked restrictions on small gatherings as among the most effective public health measures to date in preventing SARS-CoV-2 spread (noting that assessment of relative merits of public health interventions is statistically challenging due to confounding, concurrency and sequencing of interventions across settings).¹¹ The effectiveness

of other measures, such as personal protective measures, is largely dependent on behavioural compliance as well as prevalence of transmission in the community.

As the pandemic progresses, our scientific understanding of SARS-CoV-2 pathogen and effective transmission prevention will continue to evolve. In the interim, we have an obligation to act in a timely way with current available data, guided by local epidemiology, to protect the population and those most at risk, to actively apply ethical principles, and to incorporate new evidence as it evolves. The combination of elevated community transmission in the Fraser Region of an infectious virus in peak seasonal transmission, characteristics of faith settings and activities that may facilitate viral spread indoors, early stages of mass vaccination with the majority of the population still susceptible, and the recent introduction of highly transmissible variants to BC increase the risk for COVID-19 transmission and further community spread, with the potential to escalate case counts and overwhelm the capacity of the public health and health care system.

The temporary suspension of in-person indoor gatherings, including in religious settings, is a necessary measure to protect the health of the population and control disease spread at this time. Another identified pandemic response goal is to minimize negative consequences of pandemic measures. Careful consideration of how to mitigate potential harms from restrictions is warranted, exploring alternatives to in-person gatherings, such as drive in, outdoor or virtual options, as well as continued engagement with faith leaders to explore collaborative solutions until restrictions can be lifted.

¹ Transport Canada. Canadian Motor Vehicle Collisions, 2017. Updated Jan. 29, 2021. Accessed online Feb. 24, 2021 at: <https://tc.canada.ca/en/canadian-motor-vehicle-traffic-collision-statistics-2017>

² John Hopkins University. Mortality Analysis. Feb. 24, 2021. Accessed online Feb. 23, 2021 at: <https://coronavirus.jhu.edu/data/mortality>

³ Haug, N. et al. Ranking the effectiveness of worldwide COVID-19 government interventions. *Nat Hum Behav.* 2020; 4: 1303-1312.