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Quantifying contact patterns: development and characteristics of the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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Cohort profile: the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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ABSTRACT

Purpose

Several non-pharmaceutical interventions such as physical distancing, hand washing, self-isolation, and schools and business closures, were implemented in British Columbia (BC) following the first laboratory-confirmed case of coronavirus disease 2019 (COVID-19) on January 26, 2020, to minimize in-person contacts that could spread infections. The BC COVID-19 Population Mixing Patterns survey (BC-Mix) was established as a surveillance system to measure behaviour and contact patterns in BC over time to inform the timing of the easing/re-imposition of control measures. In this paper, we describe the BC-Mix survey design and the demographic characteristics of respondents.

Participants

The ongoing repeated online survey was launched in September 2020. Participants are mainly recruited through social media platforms (including Instagram, Facebook, YouTube, WhatsApp). A follow up survey is sent to participants two to four weeks after completing the baseline survey. Survey responses are weighted to BC's population by age, sex, geography, and ethnicity to obtain generalizable estimates. Additional indices such as the material and social deprivation index, residential instability, economic dependency, and others are generated using census and location data.

Findings to date

As of July 26, 2021, over 61,000 baseline survey responses were received of which 41,375 were eligible for analysis. Of the eligible participants, about 60% consented to follow up and about 27% provided their personal health numbers for linkage with healthcare databases. Approximately 50% of respondents were female, 39% were 55 years or older, 65% identified as white and 50% had at least a university degree.

Future plans

Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccine acceptance, hesitancy and uptake will soon be published.

Strength and Limitations

- The sample size for this study is larger than comparable studies.
- Our methodology allows us to consider many auxiliary variables to enhance the representativeness of our sample to the general population.
- We employ an efficient and cost-effective recruitment strategy providing real time data
- Some population groups are underrepresented in the survey possibly due to lack of access to social media
- Our survey responses may be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day

Introduction

The novel coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has spread worldwide since December 2019. A global pandemic was declared by the World Health Organization in March 2020 and, as of July 2021, there have been over 200 million cases of COVID-19 infections and over 4.3 million resultant deaths globally (1). As vaccine rollouts continue at varying rates worldwide, physical distancing measures (2) remain among the most effective methods for COVID-19 prevention and control (3). Many governments have put in place physical distancing measures such as travel restrictions, closure of schools and workplaces, and the banning of large group gatherings to interrupt the transmission of SARS-CoV-2. These measures attempt to reduce contact between infected and healthy individuals in order to minimize disease spread and the impact on the healthcare system.

British Columbia (BC) is located on the West Coast of Canada and covers almost a million square kilometres. It has a diverse population of approximately 5.15 million as of July 1, 2020 (4). Public health officials in BC began urging the public to practice physical distancing and avoid any non-essential travel in early March 2020. By March 17, 2020, a public health emergency was declared in the province and various physical distancing measures were implemented (5). These included restriction of indoor and outdoor gatherings, closure of businesses that were unable to meet physical distancing measures, self-isolation requirements after travelling outside the country, and general physical distancing in all public space. While these measures were important for controlling the rapid spread of disease, they also had sweeping economic, social, and mental health impacts.

Assessing the impact of physical distancing measures on person-to-person contact can provide valuable information for refining control measures and help minimize both COVID-19-related disease burden and the related economic, social, and mental health impacts. Early detection of COVID-19 resurgences requires mechanisms for tracking precursors of transmission, including changes in social contacts, mixing patterns and physical distancing behaviours as well as early signals of a COVID-19 spread. Although methods such as

mathematical modelling can estimate the potential for resurgences, these methods often lack population-based empirical data on contact patterns, especially on the varying levels of contact patterns exhibited by different demographic groups in the population. These population-specific data could better inform mathematical models by incorporating explicit knowledge of contact patterns that are driving transmission rather than inferring these from reported cases and hospitalizations (6,6). Ultimately, they serve as an evidence-base to guide targeted measures that are amenable to actions by the government to ensure that the COVID-19 cases remain below the resurgence thresholds.

Various studies have assessed the impact of physical distancing measures imposed by governments on local contact patterns and behaviours during the COVID-19 pandemic in Belgium (7), Greece (8), Kenya (9), Luxembourg (10), the Netherlands (11), and the U.K (12). Such surveys can measure the public's compliance with the physical distancing measures and provide valuable information to inform other public health measures that may be necessary to avoid further waves of COVID-19 infections. In addition, the impact of physical distancing measures on mixing patterns and contact behaviours may vary across different age groups, and by individuals' primary place of activity such as schools or workplaces (8,13–15).

Here, we describe the development the BC COVID-19 Population Mixing Patterns survey (BC-Mix), an ongoing online survey to monitor and assess social contact behaviours and mixing patterns in BC, Canada, during the COVID-19 pandemic. We detail the development of the survey and recruitment of respondents, as well as the characteristics of the participants.

Cohort description

Survey design and methodology

The BC-Mix (http://www.bccdc.ca/our-research/projects/bc-mix-covid-19-survey) uses a cross-sectional survey design with longitudinal follow-up. Eligible population include residents of BC who are at least 18 years of age. The survey began on September 4, 2021, and as of August 2021 is ongoing. Once a participant has completed the survey for the first time, they are invited for repeated follow-up. The first-time responses are referred to as the 'baseline'. Participants responding to the baseline survey are invited to complete the first follow-up survey after two weeks. Subsequent follow-up surveys are then sent in four-week intervals, following the completion of the previous survey.

Participant recruitment

To capture participants from a broad demographic range, the survey invitation and survey are disseminated through Instagram, Facebook, YouTube, WhatsApp, Twitter, and Google search engine results pages. The Google Ads Audience manager and Facebook Ads manager allow for paid advertisements to be targeted at specific audiences. We use these tools to target the survey advertisement campaigns to only residents of BC who are 18 years and above. We also monitor

the demographic profile of survey participants and occasionally use these functions to target recruitment to age groups or sex that may be under-represented (16).

To help capture underrepresented groups, we promote the survey to various ethnic populations. For instance, a South Asian community organization promotes the survey on their social media pages and also sends the survey to individuals on their mailing list. Although the survey is in English, it is also promoted in different languages (specifically, Korean and Farsi) to members of minority community groups in BC on their social media pages. Flyers are also distributed at grocery stores and restaurants particularly including those frequented by minority groups.

Participant and public involvement

The initial version of the BC-Mix survey was first piloted with a randomly selected sample of the BC population and feedback received was incorporated in the final version before the official launch. Methods of recruitment and priority of research questions were also informed by discussions with members of the public and with a community group. We also receive input from survey participants on an ongoing basis through a dedicated e-mail address. We plan to create dashboards and other infographics of the study results on the study website. A newsletter suitable for non-specialist audience will also be sent to participants.

Survey domain and case definitions

The BC-Mix survey instrument was adapted from the POLYMOD study (14) and the Berkeley Interpersonal Contact Study [BICS] (17) and was administered through Qualtrics (18), an online survey tool. The baseline survey comprises 94 questions across six key domains:

1. **Demographic information**: This domain includes age, sex, gender, ethnicity, education, employment, household characteristics, and postal code.
2. **COVID-19 testing and results, symptoms, and health behaviours:** This domain captures COVID-19 testing information, symptoms, and behaviours such as doctor visits following symptoms.
3. **Activities and behaviour in and outside of the home:** This domain captures social contact and mixing behaviours such as number of contacts, location, and duration of contact during the past 24 hours. Other questions in this domain include age and sex of contact, and relationship of respondent to the contact persons, physical distancing behaviour (e.g., handwashing) and personal protective equipment use. Initially, respondents were asked to provide this information for up to three of their reported contacts. We began collecting data for up to 10 contacts from December 11, 2020. Also from December 11, 2020, we began collecting general information about greater than 10 contacts i.e., if a participant reports more than 10 contacts per day, they are asked general questions about these contacts for e.g., age group, duration, and location of the majority of those contacts. If majority of contacts took place at a workplace setting, a follow up question asks respondents to report the type of work setting where the contacts occurred.

4. **Internet and social media use:** This domain captures information on internet and social media use in terms of most frequently used platform and frequency of use.
5. **Perceptions and attitudes around COVID-19:** This domain measures the respondent's perception of the physical distancing measures, and their self-confidence or ability to carry out them.
6. **COVID-19 vaccine acceptance sub-questionnaire:** This sub-questionnaire was added on March 8, 2021. Items from this domain were developed using a vaccine acceptance behavioral framework, which synthesizes constructs from the Theory of Reasoned Action (TRA)(19), Theory of Planned Behavior (TPB)(20,21) and the Health Belief Model (HBM) (22), to understand and predict the uptake of COVID-19 vaccine. According to the TRA, the best single predictor of behaviour is an individual's intention (23). Intentions, in turn, are an outcome of the individual's attitude toward performing the behavior in question, and/or the individual's perceptions of support from family and friends (subjective norms) for engaging in the behavior (24). Perceived control or self-efficacy, the confidence that one has the ability to perform the intended behavior (25), is another important construct taken from TPB. The TPB assumes that an individual's perception of whether they can successfully engage in a particular behavior often has a direct effect on their intentions, such as getting a vaccine (26). The widely-used HBM, has previously been used to evaluate beliefs and attitudes toward seasonal influenza and pandemic swine flu vaccines as well as the COVID-19 vaccine (27–29). Relevant constructs from HBM were applied to develop questionnaire items to assess perceived threat of contracting the COVID-19, perceived severity of disease if infected and belief in the safety and effectiveness of getting the vaccine. Overall, this sub-questionnaire is meant to provide an understanding of some of the individual level health beliefs, perceptions and attitudes that may influence vaccine uptake. The vaccine acceptance sub-questionnaire has the following the domains: *Attitude (perceived susceptibility, severity, benefits and barriers)*, *Descriptive and Subjective Norms, Perceived Control* and *Intention.*

Location data is used to generate other indicators at the area level. For example, the Quebec Material and Social Deprivation combines six indicators related to health and welfare that represent material or social deprivation based on Canadian Census data, including 1) proportion of persons without high school diploma 2) ratio of employment to population 3) average income 4) proportion of persons separated, divorced, widowed 5) proportion of single-parent families and 6) proportion of people living alone (30).

A full list of key variables in the survey and definitions is presented in S1 Table in the Supplementary file.

Analysis, data cleaning and weighting

A survey completion rate of at least 33% of questions, valid non-missing responses for the sex and age questions are required for inclusion for weighting the survey data and further analysis. All duplicates are removed.

To ensure that the BC-Mix sample is representative of the BC population, survey data are weighted to obtain generalizable estimates (Table 1). Using the 2016 Census data (31), the survey is weighted with the following auxiliary variables: age, sex, geography, and ethnicity using the weighting adjustment technique (32) in the following hierarchy: As our first criterion, we consider age, sex, geography and ethnicity as our auxiliary variables. If a record has valid responses for all these variables except the ethnicity variable, then the survey weight is generated using only age, sex, and geography (second criterion). If a record does not meet the first and second criteria, then we apply the third criterion which uses age, sex, and ethnicity as the auxiliary variables. Finally, we use only age and sex as auxiliary variables if a record does not satisfy the first three criteria.

Survey weights are estimated separately for baseline and for each follow-up. To assess participant profile, we computed un-weighted and weighted frequency and percentages of key demographic variables using SAS Software version 9.4. Baseline survey data was used to provide the survey participant profile and in comparison, with BC population profile (Table 1). To assess potential systematic differences between eligible and ineligible responses, a comparison of the baseline eligible participants versus ineligible participants is presented the S2 Table in the Supplementary file. Participant profile of follow up surveys is also presented in S3 Table in the Supplementary file.

Ethics and dissemination

Informed consent was sought on the survey start page. The study was reviewed and approved by the University of British Columbia Behavioral Research Ethics Board (No: H20-01785). Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccination levels, vaccine acceptance, hesitancy, and uptake will soon be published.

Preliminary results

As of July 26, 2021, there were 61,183 respondents who participated in the baseline survey of which 41,375 were eligible for analysis. There were 15,194 (eligible=10,993) participants in the first follow-up survey, 11,343 (eligible n=8,164) in the second, 8,521 (eligible n=6,375) in the third, 6,487 (eligible n=4,981) in the fourth, 5,014(eligible=3,891) in the fifth, 4,094 (eligible=3,184) in the sixth, 3,125 (eligible n= 2,417) in the seventh and 2,317 (eligible n=1,760) participants in the eighth follow-up survey (Figure 1).

Considering the baseline sample (Table 1), there were approximately equal number of male and female (weighted % of female =50.0%). Majority of participants were 55 years or older (weighted %= 39.4%), self identified as White (weighted %= 64.6%), had at least a university degree (weighted %= 50.0%) and lived in the Fraser Health region (weighted %= 36.2%).

Almost 63.8% (unweighted n=20,633) consented to a follow-up after the baseline survey and at least 94.2% (unweighted n=10,357) consented to receiving subsequent follow-up surveys (Table 1 and S3 Table in the Supplementary File). Approximately 27.3% (unweighted n=7,290) of respondents in the baseline provided their personal health numbers for linkage with other healthcare utilization databases.

After weighting, the baseline survey sample is representative of the general BC population in terms of age, sex, health region, and ethnicity (Table 1). The distribution of the eligible participants was also similar to the distribution of ineligible participants in terms of sex, age, race/ethnicity and geography/health region (S2 Table in the Supplementary file).

Findings to date

Following the identification of COVID-19 cases in BC, several interventions including physical distancing measures were implemented to limit the spread of COVID-19 in the province. Subsequently, the BC-Mix was developed by the BC Centre for Disease Control (BCCDC)(33) as part of an early warning system for monitoring social and physical interactions between individuals of different age-groups and demography, and to help predict when COVID-19 transmission might further increase. This paper describes BC-Mix survey methods and the profile of survey respondents.

Recent studies similar to the BC-Mix have assessed social contact patterns relevant to the spread and control of COVID-19 in different countries(7–12,34,35) many of which have adapted features of the POLYMOD project (14). The 2020 Belgian CoMix survey (7) is an online longitudinal survey that closely monitors changes in social mixing behaviours among a sample of Belgian adults (aged 18 years and above). The U.K CoMix survey assesses contact patterns of a representative sample of U.K adults. Launched on March 24, 2020, participants are followed up every 2 weeks to monitor changes in their self reported behaviours (12). In Canada, the Quebec-based CONNECT study uses population-based survey to assess social contacts and mixing patterns (34). Brankston and colleagues (35) also used paid panel representative of Canadian adults to construct contact patterns to determine the impact of physical distancing measures on COVID-19 transmission. Most of these studies commissioned market research companies or used survey panels to recruit participants (7,12,17,35). While market companies or survey panels offer a convenient approach to sampling, they have some challenges. Panels are made of membership in loyalty programs or other panels constituting a select group of population and may therefore not represent complete random recruitment from a population of interest.

The use of targeted social media advertisement for participant recruitment has gained prominence in health research (16,36), having been applied in areas such as mental health (37), cannabis use (38), smoking behaviour (39) and in other health related studies (40). For our survey, we use social media advertisement and other recruitment strategies. Although social media-based recruitment does not necessarily generate a random sample of the general

population given the characteristics of people who are on social media may differ from those who are not, social media channels like Facebook, Instagram, Twitter, and others have powerful targeting capabilities that allow researchers to target advertisements to users with specific demographic characteristics. They also have the advantage of reaching hard-to-reach populations (37–39).

Quota sampling has been used by other studies to achieve representativeness (7,44). We used two approaches to achieve the same goal: adaptive recruitment through promotion and targeting to specific populations and then post hoc weighting. Our survey tool does not set quotas on recruitment but uses targeted advertisements to improve representativeness.

Strengths and limitations

The following issues should be considered for interpretation of results from BC-Mix. Some population groups are underrepresented in the survey possibly due to lack of access to social media. These are people who are economically marginalised and less likely to have access to a computer/electronic device or to have access to the internet/cellular data, e.g., people living in poverty, people who are unemployed, people who are unhoused, etc. Also, people who are in prison (sentenced or on remand) or people who are under immigration detention may not have access to the internet or cellular devices. Our survey responses may be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day. Other studies have used diaries (14) to overcome this weakness but this may be logistically challenging and attrition with this method may be quite high. Another potential bias inherent in our survey is the issue of reporting bias, as respondents may respond in ways consistent with the laws around physical distancing. In addition, the BC-Mix is available only in English, thus excluding individuals who cannot communicate in English. This notwithstanding, according to the 2016 Census, 96.6% of BC's population indicated that they can converse in English (31). Therefore, we do not believe that any bias associated with language would be significant. Another limitation to mention is the large number of recruits that were ineligible and the attrition between successive rounds of survey. This could be related to survey fatigue, or the time required to complete the survey.

Our survey has several strengths. Web-based surveys like the BC-Mix provide timely information for pandemic response (45). Also, during an infectious disease pandemic, web-based surveys offer a more convenient approach to data collection compared to in-person or other modes of data collection. We also found paid advertisements to be more cost effective compared to the cost of panel data from survey companies (36). An additional strength of our study is its large sample size. Our total recruited sample of over 61,000 participants compares to the 1,356 participants in the U.K CoMix study (12), the 9,743 participants in the BICS study (17) study, 1,542 participants in the Belgian CoMix study (7) and the 7,290 participants in the POLYMOD study (14). In addition, because we opted to achieve representativeness post-data collection (at the analysis stage), we were able to consider many important variables besides age and sex in our

weighting strategy. It would have been logistically challenging to consider all these variables had we used quota-sampling given that many market research company panels were limited in terms recruitment by age, sex, and geography. Using many auxiliary variables in our weighting strategy increased the representativeness of the BC population.

Collaboration

The BC-Mix will continue to collect relevant data on behaviour and contact patterns in BC to reflect the changing dynamics of the COVID-19 pandemic. The BC-Mix has an overarching governance structure. We welcome further collaboration from interested researchers. Data requests should be sent to the Principal Investigator, Dr. Naveed Z. Janjua (corresponding author).

Conclusion

To our knowledge, the BC-Mix is the first and largest surveillance tool providing real time quantitative data on mixing patterns and contact characteristics in BC and one of the largest in North America. Tools such as the BC-Mix are integral to the COVID-19 pandemic response to provide critical data to inform the timing of loosening or re-imposition of physical distancing measures. Further analyses on contact patterns, relationship of contact patterns with transmission, disparities in contact patterns, facemask use, are in progress and will be published soon.

Supporting information

S1 Table. BC-Mix variable names and definitions
S2 Table. Comparison of baseline eligible and ineligible participants, frequencies, and proportions
S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)

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Competing interests statement

None declared

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Table 1. Participant profile of BC-Mix baseline data (n=41,375), September 04, 2020-July 26, 2021

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
Sex							
	Male	6,823	16.5	21,293	50.0	1,805,105	48.5
	Female	34,552	83.5	21,261	50.0	1,914,755	51.5
	Missing						
Age							
	18-34	4,978	12.0	11,575	27.2	1,002,745	27
	35-54	12,110	29.3	14,194	33.4	1,251,835	33.7
	55+	24,287	58.7	16,784	39.4	1,465,280	39.4
Race/ethnicity							
	Indigenous	1,757	4.4	2,180	5.3	186,705	5
	Chinese	882	2.2	4,451	10.9	418,035	11.2
	White	35,026	87.5	26,383	64.6	2,448,155	65.8
	South Asian	606	1.5	3,473	8.5	280,470	7.5
	Other	1,766	4.4	4,352	10.7	386,495	10.4
	Missing/Unknown	1,338	n/a	1715	n/a	n/a	n/a
Health region							
	Fraser Health	8,451	26.1	11,793	36.2	1,347,410	36.2
	Interior Health	6,143	19.0	5,336	16.4	595,105	16
	Northern Island	1,825	5.6	1,828	5.6	213,235	5.7
	Vancouver Coastal	7,315	22.6	8,118	24.9	934,055	25.1
	Vancouver Island	8,640	26.7	5,535	17.0	630,055	16.9
	Missing/Unknown	9,001	n/a	9,943	n/a	n/a	n/a
Education							
	Below high school	807	2.5	1,096	3.0	2,301,030	12.5.
	Below bachelor	16,928	51.7	15,176	47.0	466,295	61.9
	University degree	15,029	45.9	16,273	50.0	952,535	25.6
	Missing/Unknown	8,611	n/a	10,009	n/a	n/a	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	32.0	13,608	40.8	n/a	n/a
	Employed part-time	2,993	9.0	3,131	9.4	n/a	n/a

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
	Self-employed	2,704	8.1	3,013	9.0	n/a	n/a
	Unemployed but looking for a job	952	2.9	1,522	4.6	n/a	n/a
	Unemployed and not looking for a job	406	1.2	510	1.5	n/a	n/a
	Full-time parent, homemaker	879	2.6	740	2.2	n/a	n/a
	Retired	12,757	38.3	8,096	24.3	n/a	n/a
	Student/Pupil	566	1.7	1,197	3.6	n/a	n/a
	Long-term sick or disabled	968	2.9	914	2.7	n/a	n/a
	Prefer not to answer	424	1.3	619	1.9	n/a	n/a
	Missing/Unknown	8,072	n/a	n/a	n/a	n/a	n/a
Material Deprivation Index							
	1 (Privileged)	6,407	22.3	6,100	21.8	n/a	n/a
	2	6,475	22.5	5,873	21.1	n/a	n/a
	3	6,972	24.2	6,010	21.6	n/a	n/a
	4	4,822	16.8	5,187	18.7	n/a	n/a
	5 (Deprived)	4,085	14.2	4,656	16.8	n/a	n/a
	Missing	1,2614	n/a	n/a	n/a	n/a	n/a
Follow up consent							
	Yes	20,633	63.8	19,051	58.9	n/a	n/a
	No	11,689	36.2	13,275	41.1	n/a	n/a
	Missing	9,053	n/a	n/a	n/a	n/a	n/a
Data linkage consent							
	Yes	7,290	27.3	7,318	26.4	n/a	n/a
	No	19,467	72.8	20,362	73.6	n/a	n/a
	Missing	14,618	n/a	n/a	n/a	n/a	n/a

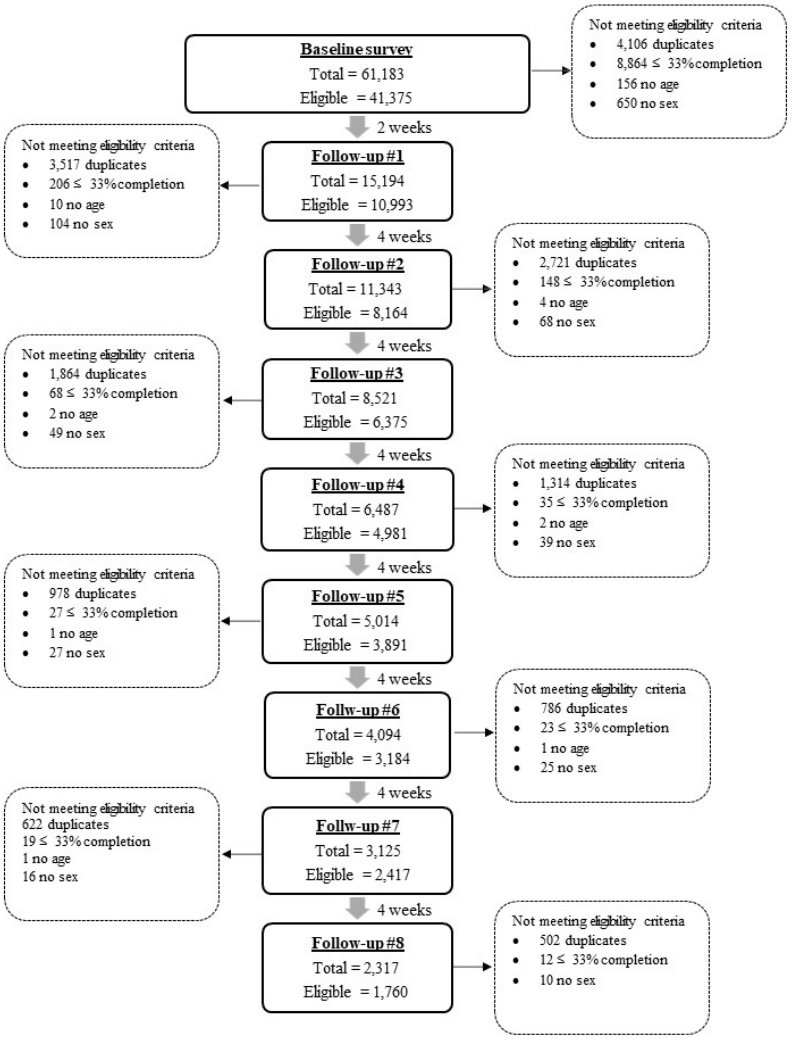

Figure 1. Participant flowchart

215x279mm (96 x 96 DPI)

Supplementary files

Quantifying contact patterns: development and characteristics of the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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S1 Table: BC-Mix variable names and definitions

Domain	Variable	Definition
Demographic information		
	Age, sex, gender, ethnicity, first name, last name, personal health number, postal code, employment status, education, occupation	Age, sex, gender, ethnicity, first name, last name, personal health number, postal code, employment status, education, occupation of respondent
	Number of adults living in respondent's household	How many adults live in your household?
	Number of children living in respondent's household	How many children (under 18 years) live in your household?
Perceptions and attitudes around COVID-19		
	Satisfaction with provincial COVID-19 response	How satisfied are you with how COVID-19 has been managed in the province?
	Knowledge of COVID-19	How much do you know about COVID-19?
	Attitude to COVID-19 #1	To what extent do you agree or disagree with the following statements? - 1) COVID-19 would be a serious illness for me if I caught it 2) I think I am likely to catch COVID-19 3) If I don't follow government advice, I might spread COVID-19 to someone who is vulnerable. 4) My boss expects me to work when I am feeling unwell or sick 5) If I could not work because of COVID-19, I would still get paid 6) If I had to isolate myself for 14 days because of COVID-19, I would have enough food and supplies for 14 days 7) If I had to isolate myself for 14 days because of COVID-19... - Someone else would be able to look after my children
	Attitude to COVID-19 #2	How effective do you think the following are at slowing the spread of COVID-19? -1) Meeting up with fewer people than normal 2) Avoiding crowded spaces 3) Staying at home for 14 days if you have ... - Severe symptoms (e.g., severe cough or high temperature).
	Attitude to COVID-19 #3	How much, if at all, have you changed the number of face-to-face interactions with other people as a result of the COVID19 pandemic?
	Attitude to COVID-19 #4	How well do you think you are doing at keeping physically distanced from people outside your home?
	Attitude to COVID-19 #5	How concerned are you personally about the spread of COVID19?
Attitude toward COVID-19 vaccine		
	Vaccination status (1st or 2nd shot)	Have you received the COVID-19 vaccine (either 1st or 2nd shot)?
	Date of 1st shot	When did you receive your 1st COVID-19 vaccine shot?
	Vaccination status (2nd shot)	Have you received your 2nd COVID-19 vaccine shot?
	Date of 2nd shot	When did you receive your 2nd COVID-19 vaccine shot?
	Perceived risk	I believe I am at risk of becoming infected with COVID-19.
	Perceived susceptibility	With the way my life is, I believe I am at a high risk of getting COVID-19 (e.g., risks at my work, recreational activities, people I live with, etc.)
	Perceived protection 1	I believe a COVID-19 Vaccine will protect me from getting the virus.

	Perceived protection 2	I believe a COVID-19 vaccine will decrease my chance of getting seriously ill from COVID-19.
	Trust	I do not trust the COVID-19 vaccine.
	Effectiveness	I am concerned about the effectiveness of the COVID-19 vaccination.
	Safety	I am concerned about the safety of the COVID-19 vaccination.
	Subjective norm 1	Most of the people I know are getting or have received the COVID-19 vaccine.
	Subjective norm 2	Most of the people who are important to me (my family, relatives and/or friends) think I should get the COVID-19 vaccine.
	Access	If I choose to get the COVID-19 vaccine, I believe it will be easy to get it.
	Intention	I plan to get the COVID-19 vaccine.
COVID-19 testing and results, symptoms, and health behaviours		
	COVID symptoms	Since, January 2020, have you had any of the following symptoms? Check all that apply: headache, fever, stuffy nose/congestion, loss of smell or taste, new or worsening cough, difficulty breathing/shortness of breath, confusion, vomiting, chills, weakness, muscle pain, fatigue, nausea, diarrhea
	Date of first symptoms	When did your first symptom start? (date)
	Action following symptoms	Have you done any of the following for these symptoms? (Please check all that apply). Called family doctor/ GP, visited family doctor's /GP office, visited community/public health clinic, been admitted to hospital etc.
	Actions before symptoms	Before these symptoms, had you been in close contact with anyone who either: (A) had any of those symptoms [fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting]; OR (B) was diagnosed positive for COVID-19 within 14 days before you felt sick?
	Isolation before symptoms	Did you isolate, or stay away from your workplace or educational facility?
	COVID-19 test	Have you been tested for COVID-19?
	Test results	Did you test positive for COVID-19?
	Household symptoms	Has anyone in your household either: (A) had any of the following symptoms: fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting; OR (B) tested positive for COVID-19 since January 2020?
	First symptoms date	When did their first symptom start? If you don't remember, please make your best guess.
	Household isolation	Has anyone in your household been told to quarantine, isolate, or limit time at their school or workplace since January 2020 because: they were sick or exposed to someone with COVID-19?

	Adherence	Did they follow the advice and isolate, quarantine, or stay away from their workplace or educational facility?
Activities and behaviour in and outside of the home		
	Movement out of home	How many times did you leave your home (or property, apartment) yesterday?
	Place of movement	Where did you go when you left your home? (Check all that apply) - Another person's home, a workplace, a hospital, doctor's office etc.
	Distance	What is the farthest distance that you went from your home yesterday?
	Means of transport	How did you travel when you left your home? (Check all that apply) - Selected Choice - I only walked (I did not use other transportation)
	Face mask use	Did you use a face mask yesterday?
	Face mask use location	Where did you use your face mask yesterday? (Check all that apply) - Selected Choice - Everywhere outside my house
	Mask use duration	Take your best guess for the total amount of time you wore a mask yesterday (hours and minutes)?
	Presence at home	In the last 3 hours, have you been in your home?
	Handwashing	In the last 3 hours, have many times did you wash your hands with soap?
	Hand sanitizer	In the last 3 hours, how many times did you use hand sanitizer?
	Transport type	Yesterday, which type of public transportation did you use? (Please check all that apply) - Selected Choice - Airplane, bus, taxi etc
	Transport duration	Yesterday, for about how long were you on public transportation?
	PPE use during transportation	Yesterday, did you wear any of the following while on public transportation? (Please check all that apply) - Selected Choice - A face mask or other covering over your nose and mouth (e.g., face shield, bandana), gloves, etc.
	Travel outside Canada	Have you travelled outside Canada at all since Jan 2020? And if so, to where? - Selected Choice
	Number of contacts	Now we would like to ask you some questions about people you had in-person, face-to-face contact with yesterday. By in-person, face-to-face contact, we mean EITHER: A. An in-person two-way conversation with three or more words OR B. Physical skin-to-skin contact (for example, a handshake, hug, kiss, or contact sports). This includes family members, friends, co-workers, people you spoke to in shops, bus drivers, strangers, etc... and people of ALL ages. Please do not count people you contacted only with things like telephone, text, or online. How many people did you have in-person contact with between 5 am yesterday and 5 am today?
	Contact identifier #1 to #10	Please add a non-identifying "nickname" for each of the people you had face-to-face or physical contact with (e.g., DG, checkout person, bus driver, child #2). This "nickname" will help you to answer questions about this contact. - 1st person label

	Characteristics of contact #1 (gender, age, relationship to respondent)	For the people you "nicknamed" and had in-person contact with between 5am yesterday and 5am today... - I believe this person identifies as… [indicate gender, age, relationship to you, location of contact,
	Characteristics of contact #2	Distance during contact, duration of contact, contact prior to COVID-19, PPE use during contact, distance during contact)
	Location of contact of 10+ contacts	You said you had more than 10 in-person contacts. Where did majority of these contacts take place?
	Occupational setting of 10+ contact	You said you had more than 10 in-person contacts. Which of these best describes your work/occupation or the other person's workplace where these contacts took place?
	Age-group of contacts of 10+ contacts	You said you had more than 10 in-person contacts. What was the age-group for most of these contacts you interacted with?
	Duration of 10+ contact	You said you had more than 10 in-person contacts. For most of these contacts, about how long did each contact last?
Internet and social media use and other information		
	Internet use	About how often do you use the internet?
	Social media use	Thinking about the social media sites that you use; about how often do you visit or use each of the following? - Facebook, Instagram, Twitter, Snapchat, YouTube
	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent
Derived variables		
	Health Authority	The health authority of respondent. This was derived using respondents postal code or location data.
	Quebec material index	The material deprivation involves deprivation of the goods and conveniences that are part of modern life, such as adequate housing, possession of a car, access to high-speed internet, or a neighbourhood with recreational areas. This deprivation marks the consequences of lack of material resources associated with low education, insecure job situation and insufficient income (1,2).
	Quebec social index	Social deprivation refers to a fragile social network, starting with the family and encompassing the community. It is characterized by individuals living alone, being a lone parent and being separated, divorced, or widowed (1,2).
	Ethnocultural composition	Ethno-cultural composition refers to the community make-up of immigrant populations, and at the British Columbia-level takes into consideration factors such as the proportion of population who self-identify as visible minority, the proportion of population that is foreign-born, the proportion of population with no knowledge of either official language (linguistic isolation), and the proportion of population who are recent immigrants (arrived in five years prior to Census). (1)

	Situational vulnerability	Situational vulnerability speaks to variations in socio-demographic conditions in the areas of housing and education, while taking into account other demographic characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of population that identifies as Aboriginal, the proportion of population aged 25-64 without a high school diploma, the proportion of dwellings needing major repairs, the proportion of population that is low-income, and the proportion of single parent families (1).
	Economic dependency	Economic dependency relates to reliance on the workforce, or a dependence on sources of income other than employment income. Indicators included in this dimension at the British Columbia-level measure concepts such as the proportion of population participating in labour force (aged 15 and older), the proportion of population aged 65 and older, the ratio of employment to population, and the dependency ratio (population aged 0-14 and aged 65 and older divided by population aged 15-64)(1).
	Residential instability	Residential instability speaks to the tendency of neighbourhood inhabitants to fluctuate over time, taking into consideration both housing and familial characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of dwellings that are apartment buildings, the proportion of persons living alone, the proportion of dwellings that are owned, and the proportion of the population who moved within the past five years (1).

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2. Bureau d'information et d'études En Santé Des Populations (BIESP). Deprivation Index [Internet]. INSPQ. 2019 [cited 2021 May 27]. Available from: https://www.inspq.qc.ca/en/deprivation/material-and-social-deprivation-index

S2 Table. Comparison of baseline eligible and ineligible participants, frequencies and proportions

		Eligible (n=41,375)			Ineligible (n=15, 702) ‡		
		Frequency	Percent (incl. missing)	Percent (excl. missing)	Frequency	Percent (incl. missing)	Percent (excl. missing)
Sex							
	Male	6,823	16.5	16.5	1,697	10.8	18.6
	Female	34,552	83.5	83.5	7,442	47.4	81.4
	Missing	n/a	n/a	n/a	6,563	41.8	n/a
Age							
	18-34	4,978	12.0	12.0	1,726	11.0	17.7
	35-54	12,110	29.3	29.3	3,039	19.4	31.2
	55+	24,287	58.7	58.7	4,981	31.7	51.1
	Missing	n/a	n/a	n/a	5,956	37.9	n/a
Race/ethnicity							
	Indigenous	1,757	4.3	4.4	666	4.2	7.2
	Chinese	882	2.1	2.2	238	1.5	2.6
	White	35,026	84.7	87.5	7,439	47.4	79.9
	South Asian	606	1.5	1.5	315	2.0	3.4
	Other	1,766	4.3	4.4	649	4.1	7.0
	Missing/Unknown	1,338	3.2	n/a	6,395	40.7	n/a
Health region							
	Fraser Health	8,451	20.4	26.1	1,802	11.5	31.0
	Interior Health	6,143	14.8	19.0	1,061	6.8	18.3
	Northern Island	1,825	4.4	5.6	312	2.0	5.4
	Vancouver Coastal	7,315	17.7	22.6	1,329	8.5	22.9
	Vancouver Island	8,640	20.9	26.7	1,300	8.3	22.4
	Missing	9,001	21.8	n/a	9,898	63.0	n/a
Education							
	Below high school	807	2.0	2.5	41	0.3	7.1
	Below bachelor	16,928	40.9	51.7	245	1.6	42.5
	University degree	15,029	36.3	45.9	290	1.8	50.3
	Missing/Unknown	8,611	20.8	n/a	15,126	96.3	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	25.7	32.0	210	1.2	31.6
	Employed part-time	2,993	7.2	9.0	75	0.4	11.3
	Self-employed	2,704	6.5	8.1	64	0.4	9.6

	Unemployed but looking for a job	952	2.3	2.9	24	0.1	3.6
	Unemployed and not looking for a job	406	1.0	1.2	10	0.1	1.5
	Full-time parent, homemaker	879	2.1	2.6	10	0.1	1.5
	Retired	12,757	30.8	38.3	87	0.5	13.1
	Student/Pupil	566	1.4	1.7	67	0.4	10.1
	Long-term sick or disabled	968	2.3	2.9	31	0.2	4.7
	Prefer not to answer	424	1.0	1.3	87	0.5	13.1
	Missing/Unknown	8,072	19.5	n/a	15,037	84.8	n/a
Quebec Material Deprivation Index							
	1 (Privileged)	6,407	15.5	22.3	690	4.4	13.8
	2	6,475	15.6	22.5	1,041	6.6	20.9
	3	6,972	16.9	24.2	1,538	9.8	30.8
	4	4,822	11.7	16.8	751	4.8	15.1
	5 (Deprived)	4,085	9.9	14.2	969	6.2	19.4
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Quebec Social Deprivation Index							
	1 (Privileged)	4,932	11.9	17.2	1,018	6.5	20.4
	2	4,756	11.5	16.5	696	4.4	14.0
	3	6,311	15.3	21.9	1,275	8.1	25.6
	4	5,932	14.3	20.6	897	5.7	18.0
	5 (Deprived)	6,830	16.5	23.8	1,103	7.0	22.1
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Follow up consent							
	Yes	20,633	49.9	63.8	245	1.6	39.6
	No	11,689	28.3	36.2	373	2.4	60.4
	Missing	9,053	21.9	n/a	15,084	96.1	n/a
Data linkage consent							
	Yes	7,290	17.6	27.3	95	0.6	17.3
	No	19,467	47.1	72.8	454	2.9	82.7
	Missing	14,618	35.3	n/a	15,153	96.5	n/a

‡Does not include 4,106 duplicates

S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
Sex								
Male	1590 (14.5)	1115 (13.7)	843 (13.2)	646 (13.0)	495 (12.7)	404 (12.17)	312 (12.9)	217 (12.3)
Female	9403 (85.5)	7049 (86.3)	5532 (86.8)	4335 (87.0)	3396 (87.3)	2780 (87.3)	2105 (87.1)	1543 (87.7)
Age								
18-34	1128 (10.3)	731 (9.0)	497 (7.8)	363 (7.3)	257 (6.6)	199 (6.3)	152 (6.3)	109 (6.2)
35-54	3013 (27.4)	2105 (25.8)	1533 (24.1)	1127 (22.6)	846 (21.7)	662 (20.8)	496 (20.5)	343 (19.5)
55+	6852 (62.3)	5328 (65.3)	4345 (68.2)	3491 (70.1)	2788 (71.7)	2323 (73.0)	1770 (73.2)	1308 (74.3)
Race/ethnicity								
Indigenous	342 (3.1)	229 (2.8)	162 (2.5)	130 (2.6)	91 (2.3)	71 (2.2)	53 (2.2)	38 (2.2)
Chinese	199 (1.8)	124 (1.5)	98 (1.5)	66 (1.3)	48 (1.2)	39 (1.2)	24 (1.0)	16 (0.9)
White	9870 (89.8)	7415 (90.8)	5833 (91.5)	4586 (92.1)	3602 (92.6)	2959 (92.9)	2254 (93.3)	1642 (93.3)
South Asian	79 (0.7)	39 (0.5)	30 (0.5)	20 (0.4)	15 (0.4)	14 (0.4)	13 (0.5)	12 (0.7)
Other	316 (2.9)	229 (2.8)	154 (2.4)	108 (2.2)	86 (2.2)	63 (2.0)	46 (1.9)	35 (2.0)
Missing/Unknown	187(1.7)	128 (1.6)	98 (1.5)	71 (1.4)	49 (1.3)	38 (1.2)	27 (1.1)	17 (1.0)
Health region								
Fraser Health	2748 (25.0)	2039 (25.0)	1590 (24.9)	1243 (25.0)	964 (24.8)	792 (24.9)	613 (25.4)	462 (26.3)
Interior Health	1926 (17.5)	1435 (17.6)	1156 (18.1)	907 (18.2)	703 (18.1)	579 (18.2)	432 (17.9)	317 (18.0)
Northern Island	506 (4.6)	374 (4.6)	280 (4.4)	212 (4.3)	162 (4.2)	116 (3.4)	87 (3.6)	63 (3.6)
Vancouver Coastal	2706 (24.6)	1992 (24.4)	1540 (24.2)	1178 (23.7)	932 (24.0)	758 (23.8)	577 (23.9)	403 (22.9)
Vancouver Island	3059 (27.8)	2303 (28.2)	1794 (28.1)	1430 (28.7)	1122 (28.8)	934 (29.3)	704 (29.1)	513 (29.2)
Missing/Unknown	48 (0.4)	21 (0.3)	15 (0.2)	11 (0.2)	8 (0.2)	5 (0.2)	4 (0.2)	2 (0.1)
Education								
Below high school	173 (1.5)	123 (1.5)	89 (1.4)	68 (1.4)	51 (1.3)	37 (1.2)	27 (1.1)	16 (0.9)
Below bachelor	5236 (47.6)	3835 (47.0)	2979 (46.7)	2303 (46.2)	1771 (45.5)	1453 (45.6)	1108 (45.8)	802 (45.6)
University degree	5529 (50.3)	4169 (51.1)	3283 (51.5)	2594 (52.1)	2057 (52.9)	1683 (52.9)	1278 (52.9)	939 (53.4)
Missing/Unknown	55 (0.5)	37 (0.5)	24 (0.4)	16 (0.3)	12 (0.3)	11 (0.4)	5 (0.2)	31 (0.2)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
Quebec Material Deprivation Index								
1 (Privileged)	1547 (14.1)	1072 (13.75)	896 (14.1)	720 (14.5)	569 (14.6)	435 (13.7)	344 (14.2)	253 (14.4)
2	2078 (18.9)	1547 (19.0)	1198 (18.8)	1008 (20.2)	806 (20.7)	665 (20.9)	501 (20.7)	366 (20.8)
3	2994 (27.3)	2184 (26.8)	1674 (26.3)	1273 (25.6)	973 (25.0)	835 (26.2)	642 (26.6)	450 (25.6)
4	1277 (11.6)	942 (11.64)	748 (11.7)	580 (11.6)	475 (12.2)	379 (11.9)	285 (11.8)	215 (12.2)
5 (Deprived)	1668 (15.2)	1290 (15.8)	1033 (16.2)	728 (15.7)	609 (15.7)	504 (15.8)	375 (15.5)	278 (15.8)
Missing	1429 (13.0)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	366 (11.5)	270 (11.2)	198 (11.3)
Quebec Social Deprivation Index								
1 (Privileged)	2188 (19.9)	1641 (20.1)	1286 (20.2)	1063 (21.3)	830 (20.3)	658 (20.7)	510 (21.1)	368 (20.9)
2	1441 (13.1)	1051 (12.9)	787 (12.4)	603 (12.1)	480 (12.3)	411 (12.9)	314 (13.0)	225 (12.8)
3	2478 (22.5)	1831 (22.4)	1480 (23.2)	1148 (23.1)	922 (23.7)	769 (24.2)	574 (23.8)	419 (23.8)
4	1601 (14.6)	1236 (15.1)	945 (14.8)	743 (14.9)	578 (14.9)	488 (15.3)	370 (15.3)	290 (16.5)
5 (Deprived)	1856 (16.9)	1336 (16.4)	1051 (16.5)	808 (16.2)	622 (16.0)	392 (15.5)	378 (15.7)	260 (14.8)
Missing/Unknown	1429 (13)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	492 (11.5)	271 (11.2)	198 (11.3)
Follow up consent								
Yes	10357 (94.2)	7793 (95.5)	6182 (97.0)	4857 (97.5)	3789 (97.4)	3106 (97.6)	2380 (98.5)	1714 (97.4)
No	262 (2.4)	142 (1.7)	83 (1.3)	49 (1.0)	47 (1.2)	31 (1.0)	18 (0.7)	19 (1.1)
Missing	374 (3.4)	229 (2.8)	110 (1.7)	75 (1.5)	55 (1.4)	47 (1.5)	20 (0.8)	27 (1.5)

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Cohort profile: the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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Cohort profile: the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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ABSTRACT

Purpose

Several non-pharmaceutical interventions such as physical distancing, hand washing, self-isolation, and schools and business closures, were implemented in British Columbia (BC) following the first laboratory-confirmed case of coronavirus disease 2019 (COVID-19) on January 26, 2020, to minimize in-person contacts that could spread infections. The BC COVID-19 Population Mixing Patterns survey (BC-Mix) was established as a surveillance system to measure behaviour and contact patterns in BC over time to inform the timing of the easing/re-imposition of control measures. In this paper, we describe the BC-Mix survey design and the demographic characteristics of respondents.

Participants

The ongoing repeated online survey was launched in September 2020. Participants are mainly recruited through social media platforms (including Instagram, Facebook, YouTube, WhatsApp). A follow up survey is sent to participants two to four weeks after completing the baseline survey. Survey responses are weighted to BC's population by age, sex, geography, and ethnicity to obtain generalizable estimates. Additional indices such as the material and social deprivation index, residential instability, economic dependency, and others are generated using census and location data.

Findings to date

As of July 26, 2021, over 61,000 baseline survey responses were received of which 41,375 were eligible for analysis. Of the eligible participants, about 60% consented to follow up and about 27% provided their personal health numbers for linkage with healthcare databases. Approximately 50% of respondents were female, 39% were 55 years or older, 65% identified as white and 50% had at least a university degree.

Future plans

Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccine acceptance, hesitancy and uptake are either in progress or have been published.

Strength and Limitations

- The sample size for this study is larger than comparable studies.
- Our methodology allows us to consider many auxiliary variables to enhance the representativeness of our sample to the general population.
- We employ an efficient and cost-effective recruitment strategy providing real time data.
- Some population groups are underrepresented in the survey possibly due to lack of access to social media.
- Our survey responses may be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day.

Introduction

The novel coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has spread worldwide since December 2019. A global pandemic was declared by the World Health Organization in March 2020 and, as of July 2021, there have been over 200 million cases of COVID-19 infections and over 4.3 million resultant deaths globally (1). As the rollout of COVID-19 vaccines continue at varying rates worldwide, physical distancing measures (2) remain among the most effective methods for COVID-19 prevention and control (3). Many governments have put in place physical distancing measures such as travel restrictions, closure of schools and workplaces, and the banning of large group gatherings to interrupt the transmission of SARS-CoV-2. These measures attempt to reduce contact between infected and healthy individuals in order to minimize disease spread and the impact on the healthcare system.

British Columbia (BC) is located on the West Coast of Canada and covers almost a million square kilometres. It has a diverse population of approximately 5.15 million as of July 1, 2020 (4). Public health officials in BC began urging the public to practice physical distancing and avoid any non-essential travel in early March 2020. By March 17, 2020, a public health emergency was declared in the province and various physical distancing measures were implemented (5). These included restriction of indoor and outdoor gatherings, closure of businesses that were unable to meet physical distancing measures, self-isolation requirements after travelling outside the country, and general physical distancing in all public space.

Assessing the impact of physical distancing measures on person-to-person contact can provide valuable information for refining control measures and help minimize both COVID-19-related disease burden and the related economic, social, and mental health impacts. Although methods such as mathematical modelling can estimate the potential for resurgences, these methods often lack population-based empirical data on contact patterns, especially on the varying levels of contact patterns exhibited by different demographic groups in the population.

These population-specific data could better inform mathematical models by incorporating explicit knowledge of contact patterns that are driving transmission rather than inferring these from reported cases and hospitalizations (6–8). Ultimately, they serve as an evidence-base to guide targeted measures that are amenable to actions by the government to ensure that the COVID-19 cases remain below the resurgence thresholds.

Various studies have assessed the impact of physical distancing measures imposed by governments on local contact patterns and behaviours during the COVID-19 pandemic in Belgium (8), Greece (9), Kenya (10), Luxembourg (11), the Netherlands (12), and the U.K (13). Others include Verelst and colleagues' SOCRATES-CoMix study (14) and a rapid review of social contact patterns by Liu et al. (15) Such surveys can measure the public's compliance with physical distancing measures and provide valuable information to inform other public health measures that may be necessary to avoid further waves of COVID-19 infections. In addition, the impact of physical distancing measures on mixing patterns and contact behaviours may vary across different age groups, and by individuals' primary place of activity such as schools or workplaces (9,16–18).

Here, we describe the development of the BC COVID-19 Population Mixing Patterns survey (BC-Mix), an ongoing online survey to monitor and assess social contact behaviours and mixing patterns in BC, Canada, during the COVID-19 pandemic. We detail the development of the survey and recruitment of respondents, as well as the characteristics of the participants.

Cohort description

Survey design and methodology

The BC-Mix (http://www.bccdc.ca/our-research/projects/bc-mix-covid-19-survey; https://a4ph.med.ubc.ca/projects-and-initiatives/bc-mix/) uses a cross-sectional survey design with longitudinal follow-up. Eligible population include residents of BC who are at least 18 years of age. The survey began on September 4, 2020, and as at the time of this publication, is still ongoing. Once a participant has completed the survey for the first time, they are invited for repeated follow-up. The first-time responses are referred to as the 'baseline'. Participants responding to the baseline survey are invited to complete the first follow-up survey after two weeks. Subsequent follow-up surveys are then sent in four-week intervals, following the completion of the previous survey.

Participant recruitment

To capture participants from a broad demographic range, the survey invitation is disseminated through Instagram, Facebook, YouTube, WhatsApp, Twitter, and Google search engine results pages. The Google Ads Audience manager and Facebook Ads manager allow for paid advertisements to be targeted at specific audiences. We use these tools to target the survey advertisement campaigns to only residents of BC who are 18 years and above. We also monitor the demographic profile of survey participants and occasionally use these functions to target

recruitment of certain age groups or sex that may be underrepresented using the BC population as our point of reference (19).

To help capture underrepresented groups, we promote the survey to various ethnic populations. For instance, a South Asian community organization promotes the survey on their social media pages and also sends the survey to individuals on their mailing list. Although the survey is in English, it is also promoted in different languages (specifically, Korean and Farsi) to members of minority community groups in BC on their social media pages. Flyers are also distributed at grocery stores and restaurants particularly including those frequented by minority groups.

Participant and public involvement

The initial version of the BC-Mix survey was first piloted with a randomly selected sample of the BC population and feedback received was incorporated in the final version before the official launch of the survey. Methods of recruitment and priority of research questions were also informed by discussions with members of the public and with a community group. We also receive input from survey participants on an ongoing basis through a dedicated e-mail address. We plan to create dashboards and other infographics of the study results on the study's website.

Survey domain and case definitions

The BC-Mix survey instrument was adapted from the POLYMOD study (17) and the Berkeley Interpersonal Contact Study [BICS] (20), and was administered through Qualtrics (21), an online survey tool. The baseline survey comprises 94 questions across six key domains:

1. **Demographic information**: This domain includes age, sex, gender, ethnicity, education, employment, household characteristics, and postal code.
2. **COVID-19 testing and results, symptoms, and health behaviours:** This domain captures COVID-19 testing information, symptoms, and behaviours such as doctor visits following symptoms.
3. **Activities and behaviour in and outside of the home:** This domain captures social contact and mixing behaviours such as number of contacts, location, and duration of contact during the past 24 hours. Other questions in this domain include age and sex of contact, and relationship of respondent to the contact persons, physical distancing behaviour (e.g., handwashing) and personal protective equipment use. Initially, respondents were asked to provide this information for up to three of their reported contacts. We began collecting data on the characteristics of up to 10 contacts from December 11, 2020. Also from December 11, 2020, we began collecting general information about greater than 10 contacts i.e., if a participant reports more than 10 contacts per day, they are asked general questions about these contacts for e.g., age group, duration, and location of the majority of those contacts. If majority of contacts took place at a workplace setting, a follow up question asks respondents to report the type of work setting where the contacts occurred.
4. **Internet and social media use:** This domain captures information on internet and social media use, such as most frequently used platform and frequency of use.

5. **Perceptions and attitudes around COVID-19:** This domain measures the respondent's perception of physical distancing measures, and their self-confidence or ability to carry them out.
6. **COVID-19 vaccine acceptance sub-questionnaire:** This sub-questionnaire was added on March 8, 2021. Items from this domain were developed using a vaccine acceptance behavioral framework, which synthesizes constructs from the Theory of Reasoned Action (TRA)(22), Theory of Planned Behavior (TPB)(23,24) and the Health Belief Model (HBM) (25), to understand and predict the uptake of COVID-19 vaccine. According to the TRA, the best single predictor of behaviour is an individual's intention (26). Intentions, in turn, are an outcome of the individual's attitude toward performing the behavior in question, and/or the individual's perceptions of support from family and friends (subjective norms) for engaging in the behavior (27). Perceived control or self-efficacy, the confidence that one has the ability to perform the intended behavior (28), is another important construct taken from TPB. The TPB assumes that an individual's perception of whether they can successfully engage in a particular behavior often has a direct effect on their intentions, such as getting a vaccine (29). The widely-used HBM, has previously been used to evaluate beliefs and attitudes toward seasonal influenza and pandemic swine flu vaccines as well as the COVID-19 vaccine (30–33). Relevant constructs from HBM were applied to develop questionnaire items to assess perceived threat of contracting the COVID-19, perceived severity of disease if infected and belief in the safety and effectiveness of getting the vaccine. Overall, this sub-questionnaire is meant to provide an understanding of some of the individual level health beliefs, perceptions and attitudes that may influence vaccine uptake. The vaccine acceptance sub-questionnaire has the following domains: *Attitude (perceived susceptibility, severity, benefits and barriers)*, *Descriptive and Subjective Norms, Perceived Control,* and *Intention.*

Location data is used to generate other indicators at the area level. For example, the Quebec Material and Social Deprivation combines six indicators related to health and welfare that represent material or social deprivation based on Canadian Census data, including 1) proportion of persons without high school diploma 2) ratio of employment to population 3) average income 4) proportion of persons separated, divorced, widowed 5) proportion of single-parent families and 6) proportion of people living alone (34).

A full list of key variables in the survey and definitions is presented in S1 Table in the Supplementary file.

Analysis, data cleaning and weighting

Quota sampling has been used by other studies to achieve representativeness (8,35). We used two approaches to achieve the same goal: adaptive recruitment through promotion and targeting to specific populations, and post hoc weighting. Our survey tool does not set quotas on recruitment but uses targeted advertisements to improve representativeness.

All suspected duplicate responses are removed (i.e., a participant filling the survey more than once in a survey round). For suspected duplicates, the most recent record is retained, and others are removed. A survey completion rate of at least 33% of questions, and valid non-missing responses for the sex and age questions are required for inclusion for weighting the survey data and further analysis. To ensure that the BC-Mix sample is representative of the BC population, survey data are weighted using the weighting adjustment technique (36) to obtain generalizable estimates (Table 1). Using the 2016 Census data (37), the survey is weighted with the following auxiliary variables: age, sex, geography, and ethnicity in the following hierarchy: as our first criterion, we consider age, sex, geography and ethnicity as our auxiliary variables. If a record has valid responses for all these variables except the ethnicity variable, then the survey weight is generated using only age, sex, and geography (second criterion). If a record does not meet the first and second criteria, then we apply the third criterion which uses age, sex, and ethnicity as the auxiliary variables. Finally, we use only age and sex as auxiliary variables if a record does not satisfy the first three criteria.

Survey weights are estimated separately for baseline and for each follow-up. To assess participant profile, we computed un-weighted and weighted frequency and percentages of key demographic variables using SAS Software version 9.4. Baseline survey data was used to provide the survey participant profile and in comparison to the BC population profile (Table 1). To assess potential systematic differences between eligible and ineligible responses, a comparison of the baseline eligible participants versus ineligible participants is presented in S2 Table in the Supplementary file. Participant profile of follow up surveys is also presented in S3 Table in the Supplementary file.

Ethics and dissemination

Informed consent was sought on the survey start page. The study was reviewed and approved by the University of British Columbia Behavioral Research Ethics Board (No: H20-01785). Data from BC-Mix contribute to modelling projections to inform COVID-19 control measures in BC (38). Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccination levels, vaccine acceptance, hesitancy, and uptake are either in progress or have been published (39,40).

Preliminary results

As of July 26, 2021, there were 61,183 respondents who participated in the baseline survey of which 41,375 were eligible for analysis. There were 15,194 (eligible=10,993) participants in the first follow-up survey, 11,343 (eligible n=8,164) in the second, 8,521 (eligible n=6,375) in the third, 6,487 (eligible n=4,981) in the fourth, 5,014 (eligible=3,891) in the fifth, 4,094 (eligible=3,184) in the sixth, 3,125 (eligible n= 2,417) in the seventh and 2,317 (eligible n=1,760) participants in the eighth follow-up survey (Figure 1). Examining the eligible baseline

sample by month recruited, June 2021 recorded the highest proportion (19.9%) of recruited participants (S5 Table in the Supplementary File).

Whereas the survey completion rate for the baseline survey was 64.7%, the least completion rate in the follow up surveys was 96.6% (S3 Table in the Supplementary File). Also, excluding duplicates, although 72.5% of the baseline records was eligible, all the follow up surveys had more than 94% eligible (S6 Table in the Supplementary File).

Considering the baseline sample (Table 1), there were approximately equal number of male and female (weighted % of female =50.0%). Majority of participants were 55 years or older (weighted % = 39.4%), self identified as White (weighted % = 64.6%), had at least a university degree (weighted %= 50.0%) and lived in the Fraser Health region (weighted % = 36.2%).

Almost 63.8% (unweighted n=20,633) consented to a follow-up after the baseline survey and at least 94.2% (unweighted n=10,357) consented to receiving subsequent follow-up surveys (Table 1 and S3 Table in the Supplementary File). Approximately 27.3% (unweighted n=7,290) of respondents in the baseline provided their personal health numbers for linkage with other healthcare utilization databases.

After weighting, the distribution of the baseline survey sample was similar to the general BC population in terms of age, sex, health region, and ethnicity (Table 1). The distribution of the eligible participants was also similar to the distribution of ineligible participants in terms of sex, age, race/ethnicity, and geography/health region (S2 Table in the Supplementary file). Moreover, in a sensitivity analysis, we used a cut off threshold of 67% instead of 33% and observed that the distribution of this sample was similar to the distribution obtained in our current eligible sample (S4 Table in the Supplementary file).

Findings to date

Following the identification of COVID-19 cases in BC, several interventions including physical distancing measures were implemented to limit the spread of COVID-19 in the province. Subsequently, the BC-Mix was developed by the BC Centre for Disease Control (BCCDC)(41) as part of an early warning system for monitoring social and physical interactions between individuals of different age-groups and demography, and to help predict when COVID-19 transmission might further increase. This paper describes the BC-Mix survey methods and the profile of survey respondents.

Recent studies similar to the BC-Mix have assessed social contact patterns relevant to the spread and control of COVID-19 in different countries (8–13,42,43), many of which have adapted features of the POLYMOD project (17). The 2020 Belgian CoMix survey (8) is an online longitudinal survey that closely monitors changes in social mixing behaviours among a sample of Belgian adults (aged 18 years and above). The U.K CoMix survey assesses contact patterns of a representative sample of U.K adults. Launched on March 24, 2020, participants are followed up every 2 weeks to monitor changes in their self reported behaviours (13). In Canada, the

Quebec-based CONNECT study uses population-based survey to assess social contacts and mixing patterns (42). Brankston and colleagues (43) also used paid panel representative of Canadian adults to construct contact patterns and determine the impact of physical distancing measures on COVID-19 transmission. Most of these studies commissioned market research companies or used survey panels to recruit participants (8,13,20,43). While market companies or survey panels offer a convenient approach to sampling, they have some challenges. Panels are made of membership in loyalty programs or other panels constituting a select group of the population, and therefore, may not represent complete random recruitment from a population of interest.

The use of targeted social media advertisement for participant recruitment has gained prominence in health research (19,44), having been applied in areas such as mental health (45), cannabis use (46), smoking behaviour (47) and other health related studies (48). For our survey, we use social media advertisement and other recruitment strategies. Although social media-based recruitment does not necessarily generate a random sample of the general population given the characteristics of people who are on social media may differ from those who are not, social media channels like Facebook, Instagram, Twitter, and others have powerful targeting capabilities that allow researchers to target advertisements to users with specific demographic characteristics. They also have the advantage of reaching hard-to-reach populations (49).

Strengths and limitations

The following issues should be considered for interpretation of results from BC-Mix. Some population groups are underrepresented in the survey, possibly due to the lack of access to social media. These are people who are economically marginalised and less likely to have access to a computer/electronic device or to have access to the internet or cellular data, e.g., people living in poverty, people who are unemployed, people who are unhoused, etc. Additionally, people who are in prison (sentenced or on remand) or people who are under immigration detention may not have access to the internet or cellular devices. Our survey responses may also be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day. Other studies have used diaries (17) to overcome this weakness but this may be logistically challenging and attrition with this method may be quite high. Another potential bias inherent in our survey is the issue of reporting bias, as respondents may respond in ways consistent with the laws around physical distancing. In addition, the BC-Mix is available only in English, thus excluding individuals who cannot communicate in English. This notwithstanding, according to the 2016 Census, 96.6% of BC's population indicated that they can converse in English (37). Therefore, we do not believe that any bias associated with language would be significant. Another limitation is the large number of recruits that were ineligible and the attrition between successive rounds of survey. This could be related to survey fatigue, or the time required to complete the survey. Also, although we used survey weights to improve the representativeness of our sample, this was by no means perfect as some differences in the

distribution of some characteristics can still be observed between our weighted sample and the BC population.

Our survey has several strengths. Web-based surveys like the BC-Mix provide timely information for pandemic response (49). Also, during an infectious disease pandemic, web-based surveys offer a more convenient approach to data collection compared to in-person or other modes of data collection. We also found paid advertisements to be more cost effective compared to the cost of panel data from survey companies (44). An additional strength of our study is its large sample size. Our total recruited sample of over 61,000 participants compares to the 1,356 participants in the U.K CoMix study (13), the 9,743 participants in the BICS study (20) study, 1,542 participants in the Belgian CoMix study (8) and the 7,290 participants in the POLYMOD study (17). In addition, because we opted to achieve representativeness post-data collection (at the analysis stage), we were able to consider geography and ethnicity in our weighting strategy. It would have been logistically challenging to consider these variables together with other variables had we used quota-sampling given that many market research company panels were limited in terms recruitment by age, sex, and geography. Using many auxiliary variables in our weighting strategy increased the representativeness of the BC population.

Collaboration

The BC-Mix will continue to collect relevant data on behaviour and contact patterns in BC to reflect the changing dynamics of the COVID-19 pandemic. The BC-Mix has an overarching governance structure. We welcome further collaboration from interested researchers. Data requests should be sent to the Principal Investigator, Dr. Naveed Z. Janjua (corresponding author).

Conclusion

To our knowledge, the BC-Mix is the first and largest surveillance tool providing real time quantitative data on mixing patterns and contact characteristics in BC and one of the largest in North America. Tools such as the BC-Mix are integral to the COVID-19 pandemic response as they provide critical data that can be used to inform the timing of loosening or re-imposition of physical distancing measures. Further analyses on contact patterns, relationship of contact patterns with transmission, disparities in contact patterns, and facemask use, are either in progress or have been published (39,40).

Supporting information

S1 Table. BC-Mix variable names and definitions
S2 Table. Comparison of baseline eligible and ineligible participants, frequencies, and proportions
S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)
S4 Table. Participant profile of BC-Mix baseline data (n=33, 650), using at least 67% survey completion threshold

S5 Table. BC-Mix eligible sample (baseline) by month recruited
S6 Table. Comparison of participant eligibility across survey rounds

Authors' contributions

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Competing interests statement

None declared

Figures

Figure 1. Participant flow chart for British Columbia COVID-19 population mixing patterns survey (BC-Mix) [baseline and first eight follow-up data]

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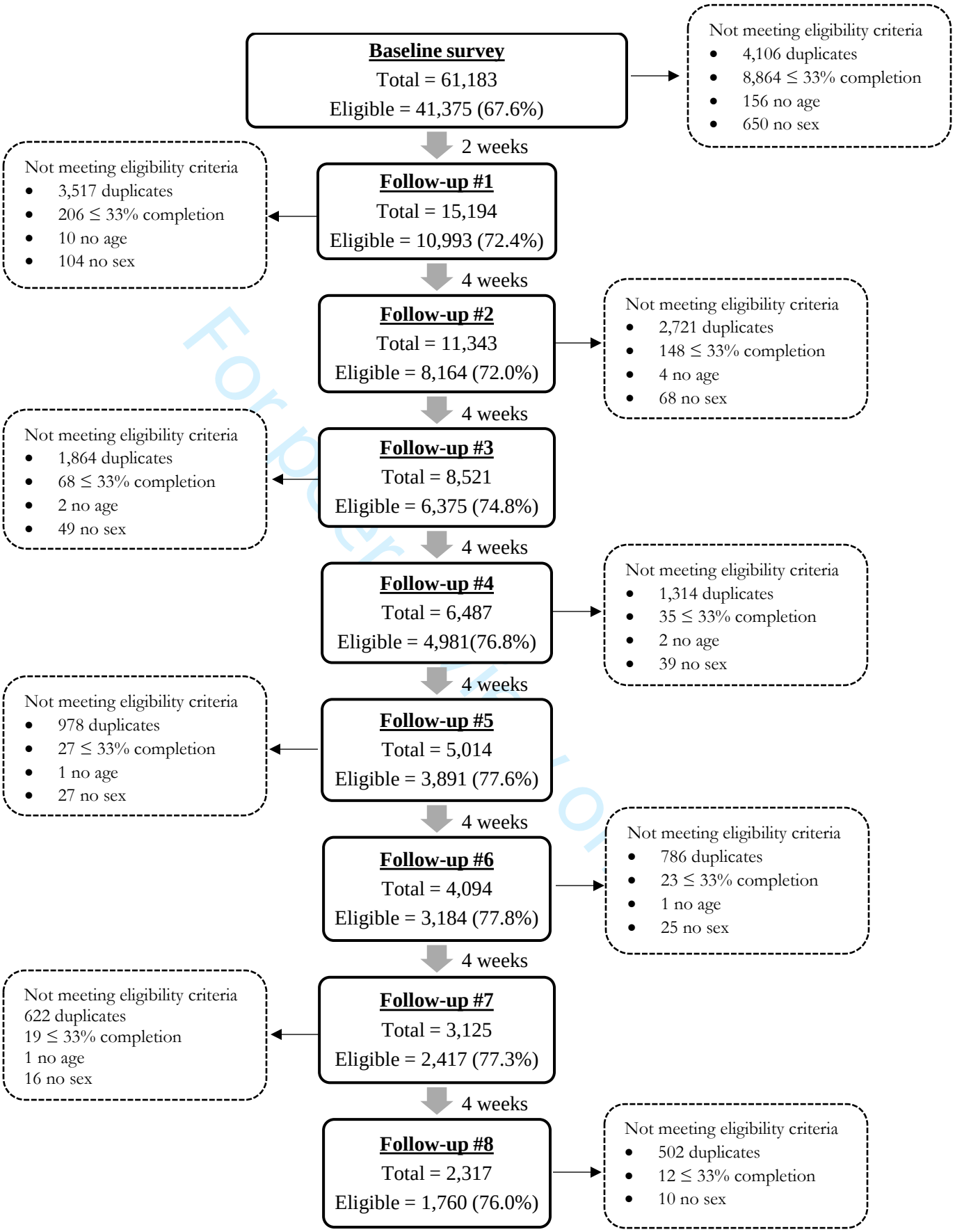
Table 1. Participant profile of BC-Mix baseline data (n=41,375), September 04, 2020-July 26, 2021

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
Sex							
	Male	6,823	16.5	21,293	50.0	1,805,105	48.5
	Female	34,552	83.5	21,261	50.0	1,914,755	51.5
	Missing						
Age							
	18-34	4,978	12.0	11,575	27.2	1,002,745	27
	35-54	12,110	29.3	14,194	33.4	1,251,835	33.7
	55+	24,287	58.7	16,784	39.4	1,465,280	39.4
Race/ethnicity							
	Indigenous	1,757	4.4	2,180	5.3	186,705	5
	Chinese	882	2.2	4,451	10.9	418,035	11.2
	White	35,026	87.5	26,383	64.6	2,448,155	65.8
	South Asian	606	1.5	3,473	8.5	280,470	7.5
	Other	1,766	4.4	4,352	10.7	386,495	10.4
	Missing/Unknown	1,338	n/a	n/a	n/a	n/a	n/a
Health region							
	Fraser Health	8,451	26.1	11,793	36.2	1,347,410	36.2
	Interior Health	6,143	19.0	5,336	16.4	595,105	16
	Northern Island	1,825	5.6	1,828	5.6	213,235	5.7
	Vancouver Coastal	7,315	22.6	8,118	24.9	934,055	25.1
	Vancouver Island	8,640	26.7	5,535	17.0	630,055	16.9
	Missing/Unknown	9,001	n/a	n/a	n/a	n/a	n/a
Education							
	Below high school	807	2.5	1,096	3.0	2,301,030	12.5.
	Below bachelor	16,928	51.7	15,176	47.0	466,295	61.9
	University degree	15,029	45.9	16,273	50.0	952,535	25.6
	Missing/Unknown	8,611	n/a	n/a	n/a	n/a	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	32.0	13,608	40.8	n/a	n/a
	Employed part-time	2,993	9.0	3,131	9.4	n/a	n/a

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
	Self-employed	2,704	8.1	3,013	9.0	n/a	n/a
	Unemployed but looking for a job	952	2.9	1,522	4.6	n/a	n/a
	Unemployed and not looking for a job	406	1.2	510	1.5	n/a	n/a
	Full-time parent, homemaker	879	2.6	740	2.2	n/a	n/a
	Retired	12,757	38.3	8,096	24.3	n/a	n/a
	Student/Pupil	566	1.7	1,197	3.6	n/a	n/a
	Long-term sick or disabled	968	2.9	914	2.7	n/a	n/a
	Prefer not to answer	424	1.3	619	1.9	n/a	n/a
	Missing/Unknown	8,072	n/a	n/a	n/a	n/a	n/a
Material Deprivation Index							
	1 (Privileged)	6,407	22.3	6,100	21.8	n/a	n/a
	2	6,475	22.5	5,873	21.1	n/a	n/a
	3	6,972	24.2	6,010	21.6	n/a	n/a
	4	4,822	16.8	5,187	18.7	n/a	n/a
	5 (Deprived)	4,085	14.2	4,656	16.8	n/a	n/a
	Missing	1,2614	n/a	n/a	n/a	n/a	n/a
Follow up consent							
	Yes	20,633	63.8	19,051	58.9	n/a	n/a
	No	11,689	36.2	13,275	41.1	n/a	n/a
	Missing	9,053	n/a	n/a	n/a	n/a	n/a
Data linkage consent							
	Yes	7,290	27.3	7,318	26.4	n/a	n/a
	No	19,467	72.8	20,362	73.6	n/a	n/a
	Missing	14,618	n/a	n/a	n/a	n/a	n/a



Supplementary files

Quantifying contact patterns: development and characteristics of the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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S1 Table: BC-Mix variable names and definitions

Domain	Variable	Definition	Included in follow up? (Yes/No)
Demographic information			Yes (First name, last name, E-mail only)
	Age, sex, gender, ethnicity, first name, last name, personal health number, postal code, employment status, education, occupation	Age, sex, gender, ethnicity, first name, last name, E-mail, personal health number, postal code, employment status, education, occupation of respondent	
	Number of adults living in respondent's household	How many adults live in your household?	
	Number of children living in respondent's household	How many children (under 18 years) live in your household?	
Perceptions and attitudes around COVID-19			No
	Satisfaction with provincial COVID-19 response	How satisfied are you with how COVID-19 has been managed in the province?	
	Knowledge of COVID-19	How much do you know about COVID-19?	
	Attitude to COVID-19 #1	To what extent do you agree or disagree with the following statements? - 1) COVID-19 would be a serious illness for me if I caught it 2) I think I am likely to catch COVID-19 3) If I don't follow government advice, I might spread COVID-19 to someone who is vulnerable. 4) My boss expects me to work when I am feeling unwell or sick 5) If I could not work because of COVID-19, I would still get paid 6) If I had to isolate myself for 14 days because of COVID-19, I would have enough food and supplies for 14 days 7) If I had to isolate myself for 14 days because of COVID-19... - Someone else would be able to look after my children	
	Attitude to COVID-19 #2	How effective do you think the following are at slowing the spread of COVID-19? -1) Meeting up with fewer people than normal 2) Avoiding crowded spaces 3) Staying at home for 14 days if you have ... - Severe symptoms (e.g., severe cough or high temperature).	
	Attitude to COVID-19 #3	How much, if at all, have you changed the number of face-to-face interactions with other people as a result of the COVID19 pandemic?	
	Attitude to COVID-19 #4	How well do you think you are doing at keeping physically distanced from people outside your home?	
	Attitude to COVID-19 #5	How concerned are you personally about the spread of COVID19?	
Attitude toward COVID-19 vaccine			Yes
	Vaccination status (1st or 2nd shot)	Have you received the COVID-19 vaccine (either 1st or 2nd shot)?	
	Date of 1st shot	When did you receive your 1st COVID-19 vaccine shot?	
	Vaccination status (2nd shot)	Have you received your 2nd COVID-19 vaccine shot?	

	Date of 2nd shot	When did you receive your 2nd COVID-19 vaccine shot?	
	Perceived risk	I believe I am at risk of becoming infected with COVID-19.	
	Perceived susceptibility	With the way my life is, I believe I am at a high risk of getting COVID-19 (e.g., risks at my work, recreational activities, people I live with, etc.)	
	Perceived protection 1	I believe a COVID-19 Vaccine will protect me from getting the virus.	
	Perceived protection 2	I believe a COVID-19 vaccine will decrease my chance of getting seriously ill from COVID-19.	
	Trust	I do not trust the COVID-19 vaccine.	
	Effectiveness	I am concerned about the effectiveness of the COVID-19 vaccination.	
	Safety	I am concerned about the safety of the COVID-19 vaccination.	
	Subjective norm 1	Most of the people I know are getting or have received the COVID-19 vaccine.	
	Subjective norm 2	Most of the people who are important to me (my family, relatives and/or friends) think I should get the COVID-19 vaccine.	
	Access	If I choose to get the COVID-19 vaccine, I believe it will be easy to get it.	
	Intention	I plan to get the COVID-19 vaccine.	
COVID-19 testing and results, symptoms, and health behaviours			Yes
	COVID symptoms	Since, January 2020, have you had any of the following symptoms? Check all that apply: headache, fever, stuffy nose/congestion, loss of smell or taste, new or worsening cough, difficulty breathing/shortness of breath, confusion, vomiting, chills, weakness, muscle pain, fatigue, nausea, diarrhea	
	Date of first symptoms	When did your first symptom start? (date)	
	Action following symptoms	Have you done any of the following for these symptoms? (Please check all that apply). Called family doctor/ GP, visited family doctor's /GP office, visited community/public health clinic, been admitted to hospital etc.	
	Actions before symptoms	Before these symptoms, had you been in close contact with anyone who either: (A) had any of those symptoms [fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting]; OR (B) was diagnosed positive for COVID-19 within 14 days before you felt sick?	
	Isolation before symptoms	Did you isolate, or stay away from your workplace or educational facility?	
	COVID-19 test	Have you been tested for COVID-19?	
	Test results	Did you test positive for COVID-19?	

	Household symptoms	Has anyone in your household either: (A) had any of the following symptoms: fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting; OR (B) tested positive for COVID-19 since January 2020?	
	First symptoms date	When did their first symptom start? If you don't remember, please make your best guess.	
	Household isolation	Has anyone in your household been told to quarantine, isolate, or limit time at their school or workplace since January 2020 because: they were sick or exposed to someone with COVID-19?	
	Adherence	Did they follow the advice and isolate, quarantine, or stay away from their workplace or educational facility?	
Activities and behaviour in and outside of the home			Yes
	Movement out of home	How many times did you leave your home (or property, apartment) yesterday?	
	Place of movement	Where did you go when you left your home? (Check all that apply) - Another person's home, a workplace, a hospital, doctor's office etc.	
	Distance	What is the farthest distance that you went from your home yesterday?	
	Means of transport	How did you travel when you left your home? (Check all that apply) - Selected Choice - I only walked (I did not use other transportation)	
	Face mask use	Did you use a face mask yesterday?	
	Face mask use location	Where did you use your face mask yesterday? (Check all that apply) - Selected Choice - Everywhere outside my house	
	Mask use duration	Take your best guess for the total amount of time you wore a mask yesterday (hours and minutes)?	
	Presence at home	In the last 3 hours, have you been in your home?	
	Handwashing	In the last 3 hours, have many times did you wash your hands with soap?	
	Hand sanitizer	In the last 3 hours, how many times did you use hand sanitizer?	
	Transport type	Yesterday, which type of public transportation did you use? (Please check all that apply) - Selected Choice - Airplane, bus, taxi etc	
	Transport duration	Yesterday, for about how long were you on public transportation?	
	PPE use during transportation	Yesterday, did you wear any of the following while on public transportation? (Please check all that apply) - Selected Choice - A face mask or other covering over your nose and mouth (e.g., face shield, bandana), gloves, etc.	
	Travel outside Canada	Have you travelled outside Canada at all since Jan 2020? And if so, to where? - Selected Choice	

	Number of contacts	Now we would like to ask you some questions about people you had in-person, face-to-face contact with yesterday. By in-person, face-to-face contact, we mean EITHER: A. An in-person two-way conversation with three or more words OR B. Physical skin-to-skin contact (for example, a handshake, hug, kiss, or contact sports). This includes family members, friends, co-workers, people you spoke to in shops, bus drivers, strangers, etc... and people of ALL ages. Please do not count people you contacted only with things like telephone, text, or online. How many people did you have in-person contact with between 5 am yesterday and 5 am today?	
	Contact identifier #1 to #10	Please add a non-identifying "nickname" for each of the people you had face-to-face or physical contact with (e.g., DG, checkout person, bus driver, child #2). This "nickname" will help you to answer questions about this contact. - 1st person label	
	Characteristics of contact #1 (gender, age, relationship to respondent)	For the people you "nicknamed" and had in-person contact with between 5am yesterday and 5am today... - I believe this person identifies as… [indicate gender, age, relationship to you, location of contact,	
	Characteristics of contact #2	Distance during contact, duration of contact, contact prior to COVID-19, PPE use during contact, distance during contact)	
	Location of contact of 10+ contacts	You said you had more than 10 in-person contacts. Where did majority of these contacts take place?	
	Occupational setting of 10+ contact	You said you had more than 10 in-person contacts. Which of these best describes your work/occupation or the other person's workplace where these contacts took place?	
	Age-group of contacts of 10+ contacts	You said you had more than 10 in-person contacts. What was the age-group for most of these contacts you interacted with?	
	Duration of 10+ contact	You said you had more than 10 in-person contacts. For most of these contacts, about how long did each contact last?	
Internet and social media use and other information			No
	Internet use	About how often do you use the internet?	
	Social media use	Thinking about the social media sites that you use; about how often do you visit or use each of the following? - Facebook, Instagram, Twitter, Snapchat, YouTube	
	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent	
Derived variables			Yes

	Health Authority	The health authority of respondent. This was derived using respondents postal code or location data.	
	Quebec material index	The material deprivation involves deprivation of the goods and conveniences that are part of modern life, such as adequate housing, possession of a car, access to high-speed internet, or a neighbourhood with recreational areas. This deprivation marks the consequences of lack of material resources associated with low education, insecure job situation and insufficient income (1,2).	
	Quebec social index	Social deprivation refers to a fragile social network, starting with the family and encompassing the community. It is characterized by individuals living alone, being a lone parent and being separated, divorced, or widowed (1,2).	
	Ethnocultural composition	Ethno-cultural composition refers to the community make-up of immigrant populations, and at the British Columbia-level takes into consideration factors such as the proportion of population who self-identify as visible minority, the proportion of population that is foreign-born, the proportion of population with no knowledge of either official language (linguistic isolation), and the proportion of population who are recent immigrants (arrived in five years prior to Census). (1)	
	Situational vulnerability	Situational vulnerability speaks to variations in socio-demographic conditions in the areas of housing and education, while taking into account other demographic characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of population that identifies as Aboriginal, the proportion of population aged 25-64 without a high school diploma, the proportion of dwellings needing major repairs, the proportion of population that is low-income, and the proportion of single parent families (1).	
	Economic dependency	Economic dependency relates to reliance on the workforce, or a dependence on sources of income other than employment income. Indicators included in this dimension at the British Columbia-level measure concepts such as the proportion of population participating in labour force (aged 15 and older), the proportion of population aged 65 and older, the ratio of employment to population, and the dependency ratio (population aged 0-14 and aged 65 and older divided by population aged 15-64)(1).	
	Residential instability	Residential instability speaks to the tendency of neighbourhood inhabitants to fluctuate over time, taking into consideration both housing and familial characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of dwellings that are apartment buildings, the proportion of persons living alone,	

		the proportion of dwellings that are owned, and the proportion of the population who moved within the past five years (1).	

References

1. Government of Canada SC. Canadian Index of Multiple Deprivation: Dataset [Internet]. 2019 [cited 2021 Jun 10]. Available from: https://www150.statcan.gc.ca/n1/pub/45-20-0001/452000012019002-eng.htm
2. Bureau d'information et d'études En Santé Des Populations (BIESP). Deprivation Index [Internet]. INSPQ. 2019 [cited 2021 May 27]. Available from: https://www.inspq.qc.ca/en/deprivation/material-and-social-deprivation-index

S2 Table. Comparison of baseline eligible and ineligible participants, frequencies and proportions

		Eligible (n=41,375)			Ineligible (n=15, 702) ‡		
		Frequency	Percent (incl. missing)	Percent (excl. missing)	Frequency	Percent (incl. missing)	Percent (excl. missing)
Sex							
	Male	6,823	16.5	16.5	1,697	10.8	18.6
	Female	34,552	83.5	83.5	7,442	47.4	81.4
	Missing	n/a	n/a	n/a	6,563	41.8	n/a
Age							
	18-34	4,978	12.0	12.0	1,726	11.0	17.7
	35-54	12,110	29.3	29.3	3,039	19.4	31.2
	55+	24,287	58.7	58.7	4,981	31.7	51.1
	Missing	n/a	n/a	n/a	5,956	37.9	n/a
Race/ethnicity							
	Indigenous	1,757	4.3	4.4	666	4.2	7.2
	Chinese	882	2.1	2.2	238	1.5	2.6
	White	35,026	84.7	87.5	7,439	47.4	79.9
	South Asian	606	1.5	1.5	315	2.0	3.4
	Other	1,766	4.3	4.4	649	4.1	7.0
	Missing/Unknown	1,338	3.2	n/a	6,395	40.7	n/a
Health region							
	Fraser Health	8,451	20.4	26.1	1,802	11.5	31.0
	Interior Health	6,143	14.8	19.0	1,061	6.8	18.3
	Northern Island	1,825	4.4	5.6	312	2.0	5.4
	Vancouver Coastal	7,315	17.7	22.6	1,329	8.5	22.9
	Vancouver Island	8,640	20.9	26.7	1,300	8.3	22.4
	Missing	9,001	21.8	n/a	9,898	63.0	n/a
Education							
	Below high school	807	2.0	2.5	41	0.3	7.1
	Below bachelor	16,928	40.9	51.7	245	1.6	42.5
	University degree	15,029	36.3	45.9	290	1.8	50.3
	Missing/Unknown	8,611	20.8	n/a	15,126	96.3	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	25.7	32.0	210	1.2	31.6
	Employed part-time	2,993	7.2	9.0	75	0.4	11.3
	Self-employed	2,704	6.5	8.1	64	0.4	9.6

	Unemployed but looking for a job	952	2.3	2.9	24	0.1	3.6
	Unemployed and not looking for a job	406	1.0	1.2	10	0.1	1.5
	Full-time parent, homemaker	879	2.1	2.6	10	0.1	1.5
	Retired	12,757	30.8	38.3	87	0.5	13.1
	Student/Pupil	566	1.4	1.7	67	0.4	10.1
	Long-term sick or disabled	968	2.3	2.9	31	0.2	4.7
	Prefer not to answer	424	1.0	1.3	87	0.5	13.1
	Missing/Unknown	8,072	19.5	n/a	15,037	84.8	n/a
Quebec Material Deprivation Index							
	1 (Privileged)	6,407	15.5	22.3	690	4.4	13.8
	2	6,475	15.6	22.5	1,041	6.6	20.9
	3	6,972	16.9	24.2	1,538	9.8	30.8
	4	4,822	11.7	16.8	751	4.8	15.1
	5 (Deprived)	4,085	9.9	14.2	969	6.2	19.4
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Quebec Social Deprivation Index							
	1 (Privileged)	4,932	11.9	17.2	1,018	6.5	20.4
	2	4,756	11.5	16.5	696	4.4	14.0
	3	6,311	15.3	21.9	1,275	8.1	25.6
	4	5,932	14.3	20.6	897	5.7	18.0
	5 (Deprived)	6,830	16.5	23.8	1,103	7.0	22.1
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Follow up consent							
	Yes	20,633	49.9	63.8	245	1.6	39.6
	No	11,689	28.3	36.2	373	2.4	60.4
	Missing	9,053	21.9	n/a	15,084	96.1	n/a
Data linkage consent							
	Yes	7,290	17.6	27.3	95	0.6	17.3
	No	19,467	47.1	72.8	454	2.9	82.7
	Missing	14,618	35.3	n/a	15,153	96.5	n/a

‡Does not include 4,106 duplicates

S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
Complete responses	10619 (96.6)	7935 (97.2)	6265 (98.3)	4906 (98.5)	3836 (98.6)	3137 (98.5)	2397(99.2)	1733 (98.5)
Sex								
Male	1590 (14.5)	1115 (13.7)	843 (13.2)	646 (13.0)	495 (12.7)	404 (12.17)	312 (12.9)	217 (12.3)
Female	9403 (85.5)	7049 (86.3)	5532 (86.8)	4335 (87.0)	3396 (87.3)	2780 (87.3)	2105 (87.1)	1543 (87.7)
Age								
18-34	1128 (10.3)	731 (9.0)	497 (7.8)	363 (7.3)	257 (6.6)	199 (6.3)	152 (6.3)	109 (6.2)
35-54	3013 (27.4)	2105 (25.8)	1533 (24.1)	1127 (22.6)	846 (21.7)	662 (20.8)	495 (20.5)	343 (19.5)
55+	6852 (62.3)	5328 (65.3)	4345 (68.2)	3491 (70.1)	2788 (71.7)	2323 (73.0)	1770 (73.2)	1308 (74.3)
Race/ethnicity								
Indigenous	342 (3.1)	229 (2.8)	162 (2.5)	130 (2.6)	91 (2.3)	71 (2.2)	53 (2.2)	38 (2.2)
Chinese	199 (1.8)	124 (1.5)	98 (1.5)	66 (1.3)	48 (1.2)	39 (1.2)	24 (1.0)	16 (0.9)
White	9870 (89.8)	7415 (90.8)	5833 (91.5)	4586 (92.1)	3602 (92.6)	2959 (92.9)	2254 (93.3)	1642 (93.3)
South Asian	79 (0.7)	39 (0.5)	30 (0.5)	20 (0.4)	15 (0.4)	14 (0.4)	12 (0.5)	12 (0.7)
Other	316 (2.9)	229 (2.8)	154 (2.4)	108 (2.2)	86 (2.2)	63 (2.0)	45 (1.9)	35 (2.0)
Missing/Unknown	187(1.7)	128 (1.6)	98 (1.5)	71 (1.4)	49 (1.3)	38 (1.2)	27 (1.1)	17 (1.0)
Health region								
Fraser Health	2748 (25.0)	2039 (25.0)	1590 (24.9)	1243 (25.0)	964 (24.8)	792 (24.9)	613 (25.4)	462 (26.3)
Interior Health	1926 (17.5)	1435 (17.6)	1156 (18.1)	907 (18.2)	703 (18.1)	579 (18.2)	432 (17.9)	317 (18.0)
Northern Island	506 (4.6)	374 (4.6)	280 (4.4)	212 (4.3)	162 (4.2)	116 (3.4)	87(3.6)	63 (3.6)
Vancouver Coastal	2706 (24.6)	1992 (24.4)	1540 (24.2)	1178 (23.7)	932 (24.0)	758 (23.8)	577 (23.9)	403 (22.9)
Vancouver Island	3059 (27.8)	2303 (28.2)	1794 (28.1)	1430 (28.7)	1122 (28.8)	934 (29.3)	703 (29.1)	513 (29.2)
Missing/Unknown	48 (0.4)	21 (0.3)	15 (0.2)	11 (0.2)	8 (0.2)	5 (0.2)	4 (0.2)	2 (0.1)
Education								
Below high school	173 (1.5)	123 (1.5)	89 (1.4)	68 (1.4)	51 (1.3)	37 (1.2)	26 (1.1)	16 (0.9)
Below bachelor	5236 (47.6)	3835 (47.0)	2979 (46.7)	2303 (46.2)	1771 (45.5)	1453 (45.6)	1108 (45.8)	802 (45.6)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
University degree	5529 (50.3)	4169 (51.1)	3283 (51.5)	2594 (52.1)	2057 (52.9)	1683 (52.9)	1278 (52.9)	939 (53.4)
Missing/Unknown	55 (0.5)	37 (0.5)	24 (0.4)	16 (0.3)	12 (0.3)	11 (0.4)	5 (0.2)	31 (0.2)
Quebec Material Deprivation Index								
1 (Privileged)	1547 (14.1)	1072 (13.75)	896 (14.1)	720 (14.5)	569 (14.6)	435 (13.7)	344 (14.2)	253 (14.4)
2	2078 (18.9)	1547 (19.0)	1198 (18.8)	1008 (20.2)	806 (20.7)	665 (20.9)	501 (20.7)	366 (20.8)
3	2994 (27.3)	2184 (26.8)	1674 (26.3)	1273 (25.6)	973 (25.0)	835 (26.2)	642 (26.6)	450 (25.6)
4	1277 (11.6)	942 (11.64)	748 (11.7)	580 (11.6)	475 (12.2)	379 (11.9)	285 (11.8)	215 (12.2)
5 (Deprived)	1668 (15.2)	1290 (15.8)	1033 (16.2)	728 (15.7)	609 (15.7)	504 (15.8)	375 (15.5)	278 (15.8)
Missing	1429 (13.0)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	366 (11.5)	270 (11.2)	198 (11.3)
Quebec Social Deprivation Index								
1 (Privileged)	2188 (19.9)	1641 (20.1)	1286 (20.2)	1063 (21.3)	830 (20.3)	658 (20.7)	509 (21.1)	368 (20.9)
2	1441 (13.1)	1051 (12.9)	787 (12.4)	603 (12.1)	480 (12.3)	411 (12.9)	314 (13.0)	225 (12.8)
3	2478 (22.5)	1831 (22.4)	1480 (23.2)	1148 (23.1)	922 (23.7)	769 (24.2)	574 (23.8)	419 (23.8)
4	1601 (14.6)	1236 (15.1)	945 (14.8)	743 (14.9)	578 (14.9)	488 (15.3)	370 (15.3)	290 (16.5)
5 (Deprived)	1856 (16.9)	1336 (16.4)	1051 (16.5)	808 (16.2)	622 (16.0)	392 (15.5)	379 (15.7)	260 (14.8)
Missing/Unknown	1429 (13)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	492 (11.5)	270 (11.2)	198 (11.3)
Follow up consent								
Yes	10357 (94.2)	7793 (95.5)	6182 (97.0)	4857 (97.5)	3789 (97.4)	3106 (97.6)	2380 (98.5)	1714 (97.4)
No	262 (2.4)	142 (1.7)	83 (1.3)	49 (1.0)	47 (1.2)	31 (1.0)	19 (0.7)	19 (1.1)
Missing	374 (3.4)	229 (2.8)	110 (1.7)	75 (1.5)	55 (1.4)	47 (1.5)	25 (0.8)	27 (1.5)

S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%) [continued]

		Follow up#9 (n=1,200)	Follow up #10 (n=488)
Complete responses		1,178 (98.2)	483 (99.0)
Sex			
	Male	136 (11.3)	54 (11.1)
	Female	1064 (88.7)	434 (88.9)
Age			
	18-34	70 (5.8)	30 (6.2)
	35-54	226 (18.8)	87 (17.8)
	55+	904 (75.3)	371 (76.0)
Race/ethnicity			
	Aboriginal	49 (4.1)	18 (3.7)
	Chinese	12 (1.0)	8 (1.6)
	Not a visible minority (White)	1117 (93.1)	453 (92.8)
	South Asian	8 (0.7)	3 (0.6)
	Other	0 (0)	0 (0)
	Missing/Unknown	14 (1.2)	6 (1.2)
Health region			
	Interior Health	223 (18.6)	88 (18.0)
	Fraser Health	319 (26.6)	129 (26.4)
	Vancouver Coastal	268 (22.3)	106 (21.7)
	Vancouver Island	355 (29.6)	152 (31.2)
	Northern Island	33 (2.7)	12 (2.5)
	Missing/Unknown	2 (0.2)	1 (0.2)
Education			
	Below high school	7 (0.6)	3 (0.6)

	Below bachelor	549 (45.7)	205 (42.0)
	University degree	643 (53.6)	279 (57.2)
	Missing/Unknown	1 (0.1)	1 (0.2)
Quebec Material Deprivation Index			
	1 (Privileged)	166 (13.8)	71 (14.6)
	2	257 (21.4)	94 (19.3)
	3	296 (24.7)	125 (25.6)
	4	142 (11.8)	50 (10.3)
	5 (Deprived)	192 (16.0)	85 (17.4)
	Missing	147 (12.3)	63 (12.9)
Quebec Social Deprivation Index			
	1 (Privileged)	253 (21.1)	88 (12.9)
	2	165 (13.8)	63 (12.9)
	3	276 (23.0)	123 (25.2)
	4	192 (16.0)	80 (16.4)
	5 (Deprived)	167 (13.9)	71 (14.6)
	Missing	147 (12.2)	63 (12.9)
Follow up consent			
	Yes	1170 (97.5)	475 (97.3)
	No	8 (0.7)	8 (1.6)
	Missing	22 (1.8)	5 (1.0)

S4 Table. Participant profile of BC-Mix baseline data (n=33, 650), using at least 67% survey completion threshold

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
Sex					
	Male	5,362	15.9	16680	49.4
	Female	28, 288	84.1	17058	50.6
	Missing				
Age					
	18-34	3,957	11.8	9,063	26.9
	35-54	9,674	28.8	11,111	32.9
	55+	20,019	59.5	13564	40.2
Race/ethnicity					
	Indigenous	1,394	4.1	1,718	5.1
	Chinese	711	2.1	3,601	10.7
	White	28,728	85.4	21,216	62.9
	South Asian	405	1.2	2,478	7.3
	Other	1,385	4.1	3,429	10.2
	Missing/Unknown	1,027	3.1	1300	3.9
Health region					
	Fraser Health	8038	26.1	11327	33.6
	Interior Health	5,806	118.9	5023	14.9
	Northern Island	1735	5.6	1732	5.1
	Vancouver Coastal	6993	22.7	7739	22.9

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
	Vancouver Island	8234	26.7	5308	15.7
	Missing/Unknown	2844	n/a	2610	7.7
Education					
	Below high school	807	2.4	1,096	3.2
	Below bachelor	16,928	50.3	15,176	45.0
	University degree	15,029	44.7	16,273	48.2
	Missing/Unknown	886	2.6	1,193	3.1
Employment status					
	Employed full-time (30 hours or more/week)	10,654	32.0	1308	40.8
	Employed part-time	2,993	9.0	3,131	9.4
	Self-employed	2,704	8.1	3,013	9.0
	Unemployed but looking for a job	952	2.9	1,522	4.6
	Unemployed and not looking for a job	406	1.2	511	1.5
	Full-time parent, homemaker	879	2.6	740	2.2
	Retired	12,757	38.3	8,096	24.3
	Student/Pupil	566	1.7	1,197	3.6

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
	Long-term sick or disabled	968	2.9	914	2.7
	Prefer not to answer	424	1.3	620	1.9
	Missing/Unknown	347	n/a	n/a	n/a
Material Deprivation Index					
	1 (Privileged)	6,219	22.8	6,106	22.1
	2	6,199	22.6	5,850	21.1
	3	6,565	24.0	5935	21.4
	4	4,616	16.8	5,179	18.7
	5 (Deprived)	3,810	13.9	4,612	16.7
	Missing	6,241	n/a	n/a	n/a
Follow up consent					
	Yes	20,633	68.8	19,051	58.9
	No	11,689	36.1	13,275	41.1
	Missing	1,328	n/a	n/a	n/a
Data linkage consent					
	Yes	7,290	27.3	7,318	20.4
	No	19,467	72.8	20,362	73.6
	Missing	6,893	n/a	n/a	n/a

S5 Table. BC-Mix eligible sample (baseline) by month recruited

Month	Number of eligible (n=41,375)	% of sample
September, 2020	6,488	15.68
October, 2020	3,516	8.5
November, 2020	1,653	4
December, 2020	3,335	8.1
January, 2021	2,460	6
February, 2021	994	2.4
March, 2021	1,353	3.3
April, 2021	2,507	6.1
May, 2021	4,696	11.4
June, 2021	8,238	19.9
July, 2021	6,135	14.8

S6 Table. Comparison of participant eligibility across survey rounds

	Baseline survey	Follow up#1	Follow up #2	Follow up #3	Follow up #4	Follow up #5	Follow up#6	Follow up#7	Follow up#8	Follow up#9	Follow up#10
Total (eligible+ineligble)	57,077	11,677	8,624	6,657	5,173	4,037	3,309	2,503	1,815	1,234	513
Eligible	41,375	10,993	8,164	6,375	4,981	3,891	3,184	2,417	1,760	1,200	488
% eligible	72.5	94.1	94.7	95.8	96.3	96.4	96.2	96.6	97	97.2	95.1

S7 Table. Comparison of participants with 100% survey completion versus those without 100% completion (baseline data)

		100% completion (n=26, 757)		< 100% completion (n=14,618)	
		Un-weighted Frequency	Un-weighted %	Un-weighted Frequency	Un-weighted %
Sex					
	Male	4,407	16.5	2,416	16.5
	Female	22,350	83.5	12,202	83.5
Age					
	18-34	3,383	12.6	1,595	10.9
	35-54	8,056	30.1	4,054	27.7
	55+	15,318	57.3	8,969	61.4
Race/ethnicity					
	Indigenous	1,072	4.1	685	4.7
	Chinese	627	2.3	255	1.7
	White	22,842	85.4	12,184	83.4
	South Asian	305	1.1	301	2.1
	Other	1,123	4.2	643	4.4
	Missing/Unknown	788	3.0	550	3.8
Health region					
	Fraser Health	6,928	26.1	1,523	26.3
	Interior Health	4,923	18.5	1,220	21.1
	Northern Island	1,465	5.5	360	6.2
	Vancouver Coastal	6,175	23.2	1,140	19.7
	Vancouver Island	7,095	26.7	1,545	26.7
	Missing/Unknown	171	n/a	8,830	n/a

Education					
	Below high school	585	2.2	222	1.5
	Below bachelor	13,155	49.2	3,773	25.8
	University degree	12,634	47.2	2,395	16.4
	Missing/Unknown	383	1.4	8,228	56.3
Follow up consent					
	Yes	16,404	61.3	4,229	76.0
	No	10,353	38.7	1,336	24.0
	Missing	n/a	n/a	9,053	n/a

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Cohort profile: the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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Cohort profile: the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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ABSTRACT

Purpose

Several non-pharmaceutical interventions such as physical distancing, hand washing, self-isolation, and schools and business closures, were implemented in British Columbia (BC) following the first laboratory-confirmed case of coronavirus disease 2019 (COVID-19) on January 26, 2020, to minimize in-person contacts that could spread infections. The BC COVID-19 Population Mixing Patterns survey (BC-Mix) was established as a surveillance system to measure behaviour and contact patterns in BC over time to inform the timing of the easing/re-imposition of control measures. In this paper, we describe the BC-Mix survey design and the demographic characteristics of respondents.

Participants

The ongoing repeated online survey was launched in September 2020. Participants are mainly recruited through social media platforms (including Instagram, Facebook, YouTube, WhatsApp). A follow up survey is sent to participants two to four weeks after completing the baseline survey. Survey responses are weighted to BC's population by age, sex, geography, and ethnicity to obtain generalizable estimates. Additional indices such as the material and social deprivation index, residential instability, economic dependency, and others are generated using census and location data.

Findings to date

As of July 26, 2021, over 61,000 baseline survey responses were received of which 41,375 were eligible for analysis. Of the eligible participants, about 60% consented to follow up and about 27% provided their personal health numbers for linkage with healthcare databases. Approximately 83.5% of respondents were female, 58.7% were 55 years or older, 87.5% identified as White and 45.9% had at least a university degree. After weighting, approximately 50% were female, 39% were 55 years or older, 65% identified as White and 50% had at least a university degree.

Future plans

Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccine acceptance, hesitancy and uptake are either in progress or have been published.

Strength and Limitations

- The sample size for this study is larger than comparable studies.
- Our methodology allows us to consider many auxiliary variables to enhance the representativeness of our sample to the general population.
- We employ an efficient and cost-effective recruitment strategy providing real time data.
- Some population groups are underrepresented in the survey possibly due to lack of access to social media.
- Our survey responses may be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day.

Introduction

The novel coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has spread worldwide since December 2019. A global pandemic was declared by the World Health Organization in March 2020 and, as of July 2021, there have been over 200 million cases of COVID-19 infections and over 4.3 million resultant deaths globally (1). As the rollout of COVID-19 vaccines continue at varying rates worldwide, physical distancing measures (2) remain among the most effective methods for COVID-19 prevention and control (3). Many governments have put in place physical distancing measures such as travel restrictions, closure of schools and workplaces, and the banning of large group gatherings to interrupt the transmission of SARS-CoV-2. These measures attempt to reduce contact between infected and healthy individuals in order to minimize disease spread and the impact on the healthcare system.

British Columbia (BC) is located on the West Coast of Canada and covers almost a million square kilometres. It has a diverse population of approximately 5.15 million as of July 1, 2020 (4). Public health officials in BC began urging the public to practice physical distancing and avoid any non-essential travel in early March 2020. By March 17, 2020, a public health emergency was declared in the province and various physical distancing measures were implemented (5). These included restriction of indoor and outdoor gatherings, closure of businesses that were unable to meet physical distancing measures, self-isolation requirements after travelling outside the country, and general physical distancing in all public space.

Assessing the impact of physical distancing measures on person-to-person contact can provide valuable information for refining control measures and help minimize both COVID-19-related disease burden and the related economic, social, and mental health impacts. Although methods such as mathematical modelling can estimate the potential for resurgences, these methods often lack population-based empirical data on contact patterns, especially on the varying levels of contact patterns exhibited by different demographic groups in the population. These population-specific data could better inform mathematical models by incorporating explicit knowledge of contact patterns that are driving transmission rather than inferring these

from reported cases and hospitalizations (6–8). Ultimately, they serve as an evidence-base to guide targeted measures that are amenable to actions by the government to ensure that the COVID-19 cases remain below the resurgence thresholds.

Various studies have assessed the impact of physical distancing measures imposed by governments on local contact patterns and behaviours during the COVID-19 pandemic in Belgium (8), Greece (9), Kenya (10), Luxembourg (11), the Netherlands (12), and the U.K (13). Others include Verelst and colleagues' SOCRATES-CoMix study (14) and a rapid review of social contact patterns by Liu et al. (15) Such surveys can measure the public's compliance with physical distancing measures and provide valuable information to inform other public health measures that may be necessary to avoid further waves of COVID-19 infections. In addition, the impact of physical distancing measures on mixing patterns and contact behaviours may vary across different age groups, and by individuals' primary place of activity such as schools or workplaces (9,16–18).

Here, we describe the development of the BC COVID-19 Population Mixing Patterns survey (BC-Mix), an ongoing online survey to monitor and assess social contact behaviours and mixing patterns in BC, Canada, during the COVID-19 pandemic. We detail the development of the survey and recruitment of respondents, as well as the characteristics of the participants.

Cohort description

Survey design and methodology

The BC-Mix (http://www.bccdc.ca/our-research/projects/bc-mix-covid-19-survey; https://a4ph.med.ubc.ca/projects-and-initiatives/bc-mix/) uses a cross-sectional survey design with longitudinal follow-up. Eligible population include residents of BC who are at least 18 years of age. The survey began on September 4, 2020, and as at the time of this publication, is still ongoing. Once a participant has completed the survey for the first time, they are invited for repeated follow-up. The first-time responses are referred to as the 'baseline'. Participants responding to the baseline survey are invited to complete the first follow-up survey after two weeks. Subsequent follow-up surveys are then sent in four-week intervals, following the completion of the previous survey.

Participant recruitment

To capture participants from a broad demographic range, the survey invitation is disseminated through Instagram, Facebook, YouTube, WhatsApp, Twitter, and Google search engine results pages. The Google Ads Audience manager and Facebook Ads manager allow for paid advertisements to be targeted at specific audiences. We use these tools to target the survey advertisement campaigns to only residents of BC who are 18 years and above. We also monitor the demographic profile of survey participants and occasionally use these functions to target recruitment of certain age groups or sex that may be underrepresented using the BC population as our point of reference (19).

To help capture underrepresented groups, we promote the survey to various ethnic populations. For instance, a South Asian community organization promotes the survey on their social media pages and also sends the survey to individuals on their mailing list. Although the survey is in English, it is also promoted in different languages (specifically, Korean and Farsi) to members of minority community groups in BC on their social media pages. Flyers are also distributed at grocery stores and restaurants particularly including those frequented by minority groups.

Patient and Public Involvement

The initial version of the BC-Mix survey was first piloted with a randomly selected sample of the BC population and feedback received was incorporated in the final version before the official launch of the survey. Methods of recruitment and priority of research questions were also informed by discussions with members of the public and with a community group. We also receive input from survey participants on an ongoing basis through a dedicated e-mail address. We plan to create dashboards and other infographics of the study results on the study's website.

Survey domain and case definitions

The BC-Mix survey instrument was adapted from the POLYMOD study (17) and the Berkeley Interpersonal Contact Study [BICS] (20), and was administered through Qualtrics (21), an online survey tool. The baseline survey comprises 94 questions across six key domains:

1. **Demographic information**: This domain includes age, sex, gender, ethnicity, education, employment, household characteristics, and postal code.
2. **COVID-19 testing and results, symptoms, and health behaviours:** This domain captures COVID-19 testing information, symptoms, and behaviours such as doctor visits following symptoms.
3. **Activities and behaviour in and outside of the home:** This domain captures social contact and mixing behaviours such as number of contacts, location, and duration of contact during the past 24 hours. Other questions in this domain include age and sex of contact, and relationship of respondent to the contact persons, physical distancing behaviour (e.g., handwashing) and personal protective equipment use. Initially, respondents were asked to provide this information for up to three of their reported contacts. We began collecting data on the characteristics of up to 10 contacts from December 11, 2020. Also from December 11, 2020, we began collecting general information about greater than 10 contacts i.e., if a participant reports more than 10 contacts per day, they are asked general questions about these contacts for e.g., age group, duration, and location of the majority of those contacts. If majority of contacts took place at a workplace setting, a follow up question asks respondents to report the type of work setting where the contacts occurred.
4. **Internet and social media use:** This domain captures information on internet and social media use, such as most frequently used platform and frequency of use.

5. **Perceptions and attitudes around COVID-19:** This domain measures the respondent's perception of physical distancing measures, and their self-confidence or ability to carry them out.
6. **COVID-19 vaccine acceptance sub-questionnaire:** This sub-questionnaire was added on March 8, 2021. Items from this domain were developed using a vaccine acceptance behavioral framework, which synthesizes constructs from the Theory of Reasoned Action (TRA)(22), Theory of Planned Behavior (TPB)(23,24) and the Health Belief Model (HBM) (25), to understand and predict the uptake of COVID-19 vaccine. According to the TRA, the best single predictor of behaviour is an individual's intention (26). Intentions, in turn, are an outcome of the individual's attitude toward performing the behavior in question, and/or the individual's perceptions of support from family and friends (subjective norms) for engaging in the behavior (27). Perceived control or self-efficacy, the confidence that one has the ability to perform the intended behavior (28), is another important construct taken from TPB. The TPB assumes that an individual's perception of whether they can successfully engage in a particular behavior often has a direct effect on their intentions, such as getting a vaccine (29). The widely-used HBM, has previously been used to evaluate beliefs and attitudes toward seasonal influenza and pandemic swine flu vaccines as well as the COVID-19 vaccine (30–33). Relevant constructs from HBM were applied to develop questionnaire items to assess perceived threat of contracting the COVID-19, perceived severity of disease if infected and belief in the safety and effectiveness of getting the vaccine. Overall, this sub-questionnaire is meant to provide an understanding of some of the individual level health beliefs, perceptions and attitudes that may influence vaccine uptake. The vaccine acceptance sub-questionnaire has the following domains: *Attitude (perceived susceptibility, severity, benefits and barriers)*, *Descriptive and Subjective Norms, Perceived Control,* and *Intention.*

Location data is used to generate other indicators at the area level. For example, the Quebec Material and Social Deprivation combines six indicators related to health and welfare that represent material or social deprivation based on Canadian Census data, including 1) proportion of persons without high school diploma 2) ratio of employment to population 3) average income 4) proportion of persons separated, divorced, widowed 5) proportion of single-parent families and 6) proportion of people living alone (34).

A full list of key variables in the survey and definitions is presented in S1 Table in the Supplementary file.

Analysis, data cleaning and weighting

Quota sampling has been used by other studies to achieve representativeness (8,35). We used two approaches to achieve the same goal: adaptive recruitment through promotion and targeting to specific populations, and post hoc weighting. Our survey tool does not set quotas on recruitment but uses targeted advertisements to improve representativeness.

All suspected duplicate responses are removed (i.e., a participant filling the survey more than once in a survey round). For suspected duplicates, the most recent record is retained, and others are removed. A survey completion rate of at least 33% of questions, and valid non-missing responses for the sex and age questions are required for inclusion for weighting the survey data and further analysis. To ensure that the BC-Mix sample is representative of the BC population, survey data are weighted using the weighting adjustment technique (36) to obtain generalizable estimates (Table 1). Using the 2016 Census data (37), the survey is weighted with the following auxiliary variables: age, sex, geography, and ethnicity in the following hierarchy: as our first criterion, we consider age, sex, geography and ethnicity as our auxiliary variables. If a record has valid responses for all these variables except the ethnicity variable, then the survey weight is generated using only age, sex, and geography (second criterion). If a record does not meet the first and second criteria, then we apply the third criterion which uses age, sex, and ethnicity as the auxiliary variables. Finally, we use only age and sex as auxiliary variables if a record does not satisfy the first three criteria.

Survey weights are estimated separately for baseline and for each follow-up. To assess participant profile, we computed un-weighted and weighted frequency and percentages of key demographic variables using SAS Software version 9.4. Baseline survey data was used to provide the survey participant profile and in comparison to the BC population profile (Table 1). To assess potential systematic differences between eligible and ineligible responses, a comparison of the baseline eligible participants versus ineligible participants is presented in S2 Table in the Supplementary file. Participant profile of follow up surveys is also presented in S3 Table in the Supplementary file.

Ethics and dissemination

Informed consent was sought on the survey start page. The study was reviewed and approved by the University of British Columbia Behavioral Research Ethics Board (No: H20-01785). Data from BC-Mix contribute to modelling projections to inform COVID-19 control measures in BC (38). Multiple papers describing contact patterns, physical distancing measures, regular handwashing and facemask wearing, modelling looking at impact of physical distancing measures and vaccination levels, vaccine acceptance, hesitancy, and uptake are either in progress or have been published (39,40).

Preliminary results

As of July 26, 2021, there were 61,183 respondents who participated in the baseline survey of which 41,375 were eligible for analysis. There were 15,194 (eligible=10,993) participants in the first follow-up survey, 11,343 (eligible n=8,164) in the second, 8,521 (eligible n=6,375) in the third, 6,487 (eligible n=4,981) in the fourth, 5,014 (eligible=3,891) in the fifth, 4,094 (eligible=3,184) in the sixth, 3,125 (eligible n= 2,417) in the seventh and 2,317 (eligible n=1,760) participants in the eighth follow-up survey (Figure 1). Examining the eligible baseline

sample by month recruited, June 2021 recorded the highest proportion (19.9%) of recruited participants (S4 Table in the Supplementary File).

Whereas the survey completion rate for the baseline survey was 64.7%, the least completion rate in the follow up surveys was 96.6% (S3 Table in the Supplementary File). Also, excluding duplicates, although 72.5% of the baseline records was eligible, all the follow up surveys had more than 94% eligible (S5 Table in the Supplementary File).

Considering the baseline sample (Table 1), there were approximately equal number of male and female (weighted % of female =50.0%). Majority of participants were 55 years or older (weighted % = 39.4%), self identified as White (weighted % = 64.6%), had at least a university degree (weighted %= 50.0%) and lived in the Fraser Health region (weighted % = 36.2%).

Almost 63.8% (unweighted n=20,633) consented to a follow-up after the baseline survey and at least 94.2% (unweighted n=10,357) consented to receiving subsequent follow-up surveys (Table 1 and S3 Table in the Supplementary file). Approximately 27.3% (unweighted n=7,290) of respondents in the baseline provided their personal health numbers for linkage with other healthcare utilization databases.

After weighting, the distribution of the baseline survey sample was similar to the general BC population in terms of age, sex, health region, and ethnicity (Table 1). The distribution of the eligible participants was also similar to the distribution of ineligible participants in terms of sex, age, race/ethnicity, and geography/health region (S2 Table in the Supplementary file). Moreover, in a sensitivity analysis, we used a cut off threshold of 67% instead of 33% and observed that the distribution of this sample was similar to the distribution obtained in our current eligible sample (S6 Table in the Supplementary file). In addition we compared the characteristics of a sample with 100% completion and < 100% completion and found no systematic differences in demographic characteristics between the two samples (S7 Table in the Supplementary file).

Findings to date

Following the identification of COVID-19 cases in BC, several interventions including physical distancing measures were implemented to limit the spread of COVID-19 in the province. Subsequently, the BC-Mix was developed by the BC Centre for Disease Control (BCCDC)(41) as part of an early warning system for monitoring social and physical interactions between individuals of different age-groups and demography, and to help predict when COVID-19 transmission might further increase. This paper describes the BC-Mix survey methods and the profile of survey respondents.

Recent studies similar to the BC-Mix have assessed social contact patterns relevant to the spread and control of COVID-19 in different countries (8–13,42,43), many of which have adapted features of the POLYMOD project (17). The 2020 Belgian CoMix survey (8) is an online longitudinal survey that closely monitors changes in social mixing behaviours among a sample of Belgian adults (aged 18 years and above). The U.K CoMix survey assesses contact patterns of

a representative sample of U.K adults. Launched on March 24, 2020, participants are followed up every 2 weeks to monitor changes in their self reported behaviours (13). In Canada, the Quebec-based CONNECT study uses population-based survey to assess social contacts and mixing patterns (42). Brankston and colleagues (43) also used paid panel representative of Canadian adults to construct contact patterns and determine the impact of physical distancing measures on COVID-19 transmission. Most of these studies commissioned market research companies or used survey panels to recruit participants (8,13,20,43). While market companies or survey panels offer a convenient approach to sampling, they have some challenges. Panels are made of membership in loyalty programs or other panels constituting a select group of the population, and therefore, may not represent complete random recruitment from a population of interest.

The use of targeted social media advertisement for participant recruitment has gained prominence in health research (19,44), having been applied in areas such as mental health (45), cannabis use (46), smoking behaviour (47) and other health related studies (48). For our survey, we use social media advertisement and other recruitment strategies. Although social media-based recruitment does not necessarily generate a random sample of the general population given the characteristics of people who are on social media may differ from those who are not, social media channels like Facebook, Instagram, Twitter, and others have powerful targeting capabilities that allow researchers to target advertisements to users with specific demographic characteristics. They also have the advantage of reaching hard-to-reach populations (49).

Strengths and limitations

The following issues should be considered for interpretation of results from BC-Mix. Some population groups are underrepresented in the survey, possibly due to the lack of access to social media. These are people who are economically marginalised and less likely to have access to a computer/electronic device or to have access to the internet or cellular data, e.g., people living in poverty, people who are unemployed, people who are unhoused, etc. Additionally, people who are in prison (sentenced or on remand) or people who are under immigration detention may not have access to the internet or cellular devices. Our survey responses may also be subject to recall bias since we ask respondents to recall contacts and other behaviours or activities from the previous day. Other studies have used diaries (17) to overcome this weakness but this may be logistically challenging and attrition with this method may be quite high. Another potential bias inherent in our survey is the issue of reporting bias, as respondents may respond in ways consistent with the laws around physical distancing. In addition, the BC-Mix is available only in English, thus excluding individuals who cannot communicate in English. This notwithstanding, according to the 2016 Census, 96.6% of BC's population indicated that they can converse in English (37). Therefore, we do not believe that any bias associated with language would be significant. Another limitation is the large number of recruits that were ineligible and the attrition between successive rounds of survey. This could be related to survey fatigue, or the time

required to complete the survey. Also, although we used survey weights to improve the representativeness of our sample, this was by no means perfect as some differences in the distribution of some characteristics can still be observed between our weighted sample and the BC population. This limits representativeness of the sample. Additionally, although weighting ensures that a survey sample is similar to the reference population in terms of some known demographic characteristics, this does not guarantee that the weighted data on a particular outcome measure is representative, particularly in situations where the outcome measure is related to unknown factors that were not considered during weighting.

Our survey has several strengths. Web-based surveys like the BC-Mix provide timely information for pandemic response (49). Also, during an infectious disease pandemic, web-based surveys offer a more convenient approach to data collection compared to in-person or other modes of data collection. We also found paid advertisements to be more cost effective compared to the cost of panel data from survey companies (44). An additional strength of our study is its large sample size. Our total recruited sample of over 61,000 participants compares to the 1,356 participants in the U.K CoMix study (13), the 9,743 participants in the BICS study (20) study, 1,542 participants in the Belgian CoMix study (8) and the 7,290 participants in the POLYMOD study (17). In addition, because we opted to achieve representativeness post-data collection (at the analysis stage), we were able to consider geography and ethnicity in our weighting strategy. It would have been logistically challenging to consider these variables together with other variables had we used quota-sampling given that many market research company panels were limited in terms recruitment by age, sex, and geography. Using many auxiliary variables in our weighting strategy increased the representativeness of the BC population.

Collaboration

The BC-Mix will continue to collect relevant data on behaviour and contact patterns in BC to reflect the changing dynamics of the COVID-19 pandemic. The BC-Mix has an overarching governance structure. We welcome further collaboration from interested researchers. Data requests should be sent to the Principal Investigator, Dr. Naveed Z. Janjua (corresponding author).

Conclusion

To our knowledge, the BC-Mix is the first and largest surveillance tool providing real time quantitative data on mixing patterns and contact characteristics in BC and one of the largest in North America. Tools such as the BC-Mix are integral to the COVID-19 pandemic response as they provide critical data that can be used to inform the timing of loosening or re-imposition of physical distancing measures. Further analyses on contact patterns, relationship of contact patterns with transmission, disparities in contact patterns, and facemask use, are either in progress or have been published (39,40).

Supporting information

S1 Table. BC-Mix variable names and definitions
S2 Table. Comparison of baseline eligible and ineligible participants, frequencies, and proportions
S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)
S4 Table. BC-Mix eligible sample (baseline) by month recruited
S5 Table. Comparison of participant eligibility across survey rounds
S6 Table. Participant profile of BC-Mix baseline data (n=33, 650), using at least 67% survey completion threshold
S7 Table. Comparison of participants with 100% survey completion versus those with less than 100% completion (baseline data)

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Competing interests statement

None declared

Figures

Figure 1. Participant flow chart for British Columbia COVID-19 population mixing patterns survey (BC-Mix) [baseline and first eight follow-up data]

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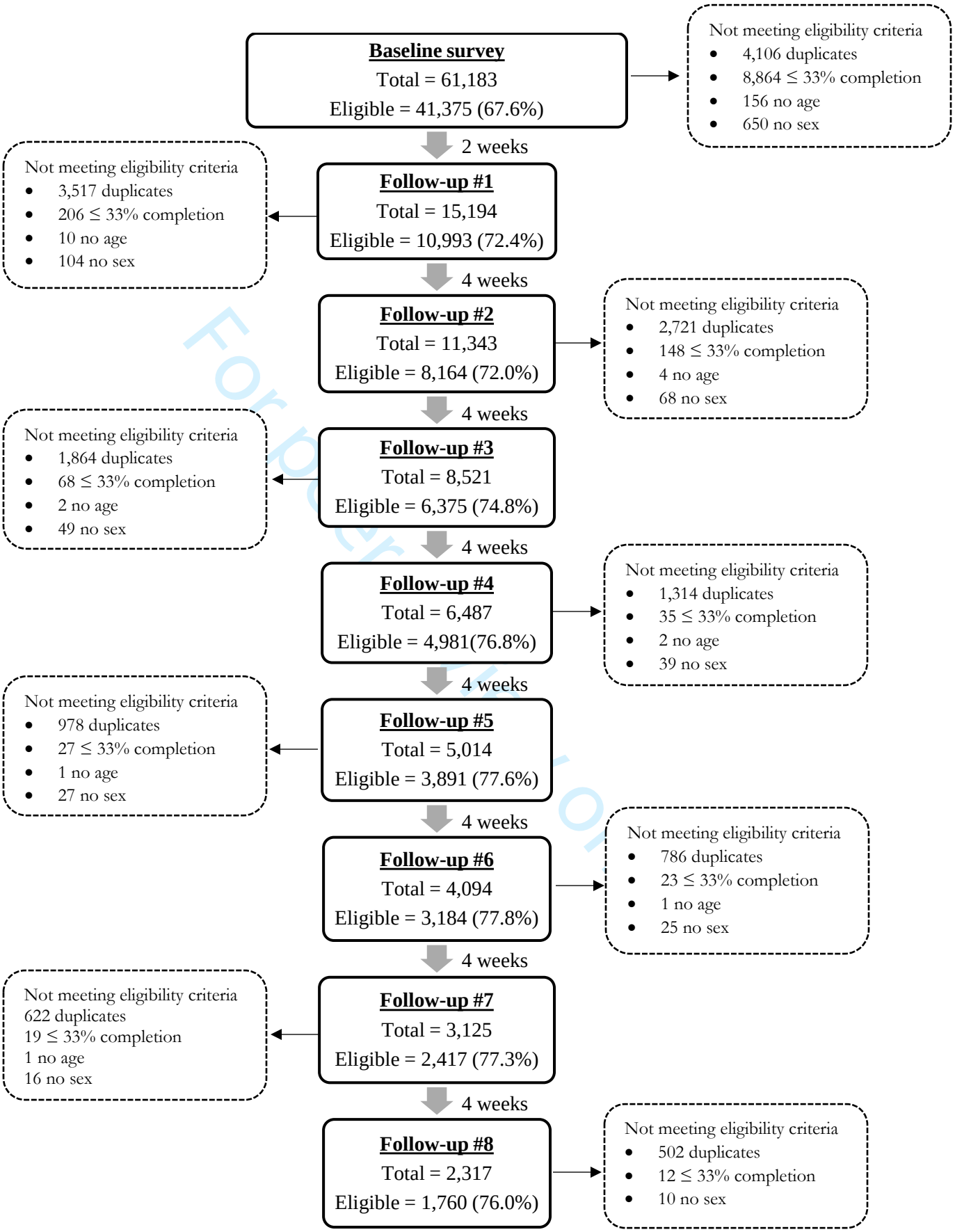
Table 1. Participant profile of BC-Mix baseline data (n=41,375), September 04, 2020-July 26, 2021

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
Sex							
	Male	6,823	16.5	21,293	50.0	1,805,105	48.5
	Female	34,552	83.5	21,261	50.0	1,914,755	51.5
	Missing						
Age							
	18-34	4,978	12.0	11,575	27.2	1,002,745	27
	35-54	12,110	29.3	14,194	33.4	1,251,835	33.7
	55+	24,287	58.7	16,784	39.4	1,465,280	39.4
Race/ethnicity							
	Indigenous	1,757	4.4	2,180	5.3	186,705	5
	Chinese	882	2.2	4,451	10.9	418,035	11.2
	White	35,026	87.5	26,383	64.6	2,448,155	65.8
	South Asian	606	1.5	3,473	8.5	280,470	7.5
	Other	1,766	4.4	4,352	10.7	386,495	10.4
	Missing/Unknown	1,338	n/a	n/a	n/a	n/a	n/a
Health region							
	Fraser Health	8,451	26.1	11,793	36.2	1,347,410	36.2
	Interior Health	6,143	19.0	5,336	16.4	595,105	16
	Northern Island	1,825	5.6	1,828	5.6	213,235	5.7
	Vancouver Coastal	7,315	22.6	8,118	24.9	934,055	25.1
	Vancouver Island	8,640	26.7	5,535	17.0	630,055	16.9
	Missing/Unknown	9,001	n/a	n/a	n/a	n/a	n/a
Education							
	Below high school	807	2.5	1,096	3.0	2,301,030	12.5.
	Below bachelor	16,928	51.7	15,176	47.0	466,295	61.9
	University degree	15,029	45.9	16,273	50.0	952,535	25.6
	Missing/Unknown	8,611	n/a	n/a	n/a	n/a	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	32.0	13,608	40.8	n/a	n/a
	Employed part-time	2,993	9.0	3,131	9.4	n/a	n/a

		Survey				British Columbia population	
		Un-weighted frequency	Un-weighted % (excl. missing)	Weighted frequency	Weighted %	Population frequency	Population %
	Self-employed	2,704	8.1	3,013	9.0	n/a	n/a
	Unemployed but looking for a job	952	2.9	1,522	4.6	n/a	n/a
	Unemployed and not looking for a job	406	1.2	510	1.5	n/a	n/a
	Full-time parent, homemaker	879	2.6	740	2.2	n/a	n/a
	Retired	12,757	38.3	8,096	24.3	n/a	n/a
	Student/Pupil	566	1.7	1,197	3.6	n/a	n/a
	Long-term sick or disabled	968	2.9	914	2.7	n/a	n/a
	Prefer not to answer	424	1.3	619	1.9	n/a	n/a
	Missing/Unknown	8,072	n/a	n/a	n/a	n/a	n/a
Material Deprivation Index							
	1 (Privileged)	6,407	22.3	6,100	21.8	n/a	n/a
	2	6,475	22.5	5,873	21.1	n/a	n/a
	3	6,972	24.2	6,010	21.6	n/a	n/a
	4	4,822	16.8	5,187	18.7	n/a	n/a
	5 (Deprived)	4,085	14.2	4,656	16.8	n/a	n/a
	Missing	1,2614	n/a	n/a	n/a	n/a	n/a
Follow up consent							
	Yes	20,633	63.8	19,051	58.9	n/a	n/a
	No	11,689	36.2	13,275	41.1	n/a	n/a
	Missing	9,053	n/a	n/a	n/a	n/a	n/a
Data linkage consent							
	Yes	7,290	27.3	7,318	26.4	n/a	n/a
	No	19,467	72.8	20,362	73.6	n/a	n/a
	Missing	14,618	n/a	n/a	n/a	n/a	n/a



Supplementary files

Quantifying contact patterns: development and characteristics of the British Columbia COVID-19 population mixing patterns survey (BC-Mix)

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S1 Table: BC-Mix variable names and definitions

Domain	Variable	Definition	Included in follow up? (Yes/No)
Demographic information			Yes (First name, last name, E-mail only)
	Age, sex, gender, ethnicity, first name, last name, personal health number, postal code, employment status, education, occupation	Age, sex, gender, ethnicity, first name, last name, E-mail, personal health number, postal code, employment status, education, occupation of respondent	
	Number of adults living in respondent's household	How many adults live in your household?	
	Number of children living in respondent's household	How many children (under 18 years) live in your household?	
Perceptions and attitudes around COVID-19			No
	Satisfaction with provincial COVID-19 response	How satisfied are you with how COVID-19 has been managed in the province?	
	Knowledge of COVID-19	How much do you know about COVID-19?	
	Attitude to COVID-19 #1	To what extent do you agree or disagree with the following statements? - 1) COVID-19 would be a serious illness for me if I caught it 2) I think I am likely to catch COVID-19 3) If I don't follow government advice, I might spread COVID-19 to someone who is vulnerable. 4) My boss expects me to work when I am feeling unwell or sick 5) If I could not work because of COVID-19, I would still get paid 6) If I had to isolate myself for 14 days because of COVID-19, I would have enough food and supplies for 14 days 7) If I had to isolate myself for 14 days because of COVID-19... - Someone else would be able to look after my children	
	Attitude to COVID-19 #2	How effective do you think the following are at slowing the spread of COVID-19? -1) Meeting up with fewer people than normal 2) Avoiding crowded spaces 3) Staying at home for 14 days if you have ... - Severe symptoms (e.g., severe cough or high temperature).	
	Attitude to COVID-19 #3	How much, if at all, have you changed the number of face-to-face interactions with other people as a result of the COVID19 pandemic?	
	Attitude to COVID-19 #4	How well do you think you are doing at keeping physically distanced from people outside your home?	
	Attitude to COVID-19 #5	How concerned are you personally about the spread of COVID19?	
Attitude toward COVID-19 vaccine			Yes
	Vaccination status (1st or 2nd shot)	Have you received the COVID-19 vaccine (either 1st or 2nd shot)?	
	Date of 1st shot	When did you receive your 1st COVID-19 vaccine shot?	
	Vaccination status (2nd shot)	Have you received your 2nd COVID-19 vaccine shot?	

	Date of 2nd shot	When did you receive your 2nd COVID-19 vaccine shot?	
	Perceived risk	I believe I am at risk of becoming infected with COVID-19.	
	Perceived susceptibility	With the way my life is, I believe I am at a high risk of getting COVID-19 (e.g., risks at my work, recreational activities, people I live with, etc.)	
	Perceived protection 1	I believe a COVID-19 Vaccine will protect me from getting the virus.	
	Perceived protection 2	I believe a COVID-19 vaccine will decrease my chance of getting seriously ill from COVID-19.	
	Trust	I do not trust the COVID-19 vaccine.	
	Effectiveness	I am concerned about the effectiveness of the COVID-19 vaccination.	
	Safety	I am concerned about the safety of the COVID-19 vaccination.	
	Subjective norm 1	Most of the people I know are getting or have received the COVID-19 vaccine.	
	Subjective norm 2	Most of the people who are important to me (my family, relatives and/or friends) think I should get the COVID-19 vaccine.	
	Access	If I choose to get the COVID-19 vaccine, I believe it will be easy to get it.	
	Intention	I plan to get the COVID-19 vaccine.	
COVID-19 testing and results, symptoms, and health behaviours			Yes
	COVID symptoms	Since, January 2020, have you had any of the following symptoms? Check all that apply: headache, fever, stuffy nose/congestion, loss of smell or taste, new or worsening cough, difficulty breathing/shortness of breath, confusion, vomiting, chills, weakness, muscle pain, fatigue, nausea, diarrhea	
	Date of first symptoms	When did your first symptom start? (date)	
	Action following symptoms	Have you done any of the following for these symptoms? (Please check all that apply). Called family doctor/ GP, visited family doctor's /GP office, visited community/public health clinic, been admitted to hospital etc.	
	Actions before symptoms	Before these symptoms, had you been in close contact with anyone who either: (A) had any of those symptoms [fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting]; OR (B) was diagnosed positive for COVID-19 within 14 days before you felt sick?	
	Isolation before symptoms	Did you isolate, or stay away from your workplace or educational facility?	
	COVID-19 test	Have you been tested for COVID-19?	
	Test results	Did you test positive for COVID-19?	

	Household symptoms	Has anyone in your household either: (A) had any of the following symptoms: fever, new or worsening cough, headache, chills, weakness, muscle pain, stuffy nose/congestion, sore throat, difficulty breathing/shortness of breath, nausea, diarrhea, fatigue, loss of smell or taste, confusion, vomiting; OR (B) tested positive for COVID-19 since January 2020?	
	First symptoms date	When did their first symptom start? If you don't remember, please make your best guess.	
	Household isolation	Has anyone in your household been told to quarantine, isolate, or limit time at their school or workplace since January 2020 because: they were sick or exposed to someone with COVID-19?	
	Adherence	Did they follow the advice and isolate, quarantine, or stay away from their workplace or educational facility?	
Activities and behaviour in and outside of the home			Yes
	Movement out of home	How many times did you leave your home (or property, apartment) yesterday?	
	Place of movement	Where did you go when you left your home? (Check all that apply) - Another person's home, a workplace, a hospital, doctor's office etc.	
	Distance	What is the farthest distance that you went from your home yesterday?	
	Means of transport	How did you travel when you left your home? (Check all that apply) - Selected Choice - I only walked (I did not use other transportation)	
	Face mask use	Did you use a face mask yesterday?	
	Face mask use location	Where did you use your face mask yesterday? (Check all that apply) - Selected Choice - Everywhere outside my house	
	Mask use duration	Take your best guess for the total amount of time you wore a mask yesterday (hours and minutes)?	
	Presence at home	In the last 3 hours, have you been in your home?	
	Handwashing	In the last 3 hours, have many times did you wash your hands with soap?	
	Hand sanitizer	In the last 3 hours, how many times did you use hand sanitizer?	
	Transport type	Yesterday, which type of public transportation did you use? (Please check all that apply) - Selected Choice - Airplane, bus, taxi etc	
	Transport duration	Yesterday, for about how long were you on public transportation?	
	PPE use during transportation	Yesterday, did you wear any of the following while on public transportation? (Please check all that apply) - Selected Choice - A face mask or other covering over your nose and mouth (e.g., face shield, bandana), gloves, etc.	
	Travel outside Canada	Have you travelled outside Canada at all since Jan 2020? And if so, to where? - Selected Choice	

	Number of contacts	Now we would like to ask you some questions about people you had in-person, face-to-face contact with yesterday. By in-person, face-to-face contact, we mean EITHER: A. An in-person two-way conversation with three or more words OR B. Physical skin-to-skin contact (for example, a handshake, hug, kiss, or contact sports). This includes family members, friends, co-workers, people you spoke to in shops, bus drivers, strangers, etc... and people of ALL ages. Please do not count people you contacted only with things like telephone, text, or online. How many people did you have in-person contact with between 5 am yesterday and 5 am today?	
	Contact identifier #1 to #10	Please add a non-identifying "nickname" for each of the people you had face-to-face or physical contact with (e.g., DG, checkout person, bus driver, child #2). This "nickname" will help you to answer questions about this contact. - 1st person label	
	Characteristics of contact #1 (gender, age, relationship to respondent)	For the people you "nicknamed" and had in-person contact with between 5am yesterday and 5am today... - I believe this person identifies as… [indicate gender, age, relationship to you, location of contact,	
	Characteristics of contact #2	Distance during contact, duration of contact, contact prior to COVID-19, PPE use during contact, distance during contact)	
	Location of contact of 10+ contacts	You said you had more than 10 in-person contacts. Where did majority of these contacts take place?	
	Occupational setting of 10+ contact	You said you had more than 10 in-person contacts. Which of these best describes your work/occupation or the other person's workplace where these contacts took place?	
	Age-group of contacts of 10+ contacts	You said you had more than 10 in-person contacts. What was the age-group for most of these contacts you interacted with?	
	Duration of 10+ contact	You said you had more than 10 in-person contacts. For most of these contacts, about how long did each contact last?	
Internet and social media use and other information			No
	Internet use	About how often do you use the internet?	
	Social media use	Thinking about the social media sites that you use; about how often do you visit or use each of the following? - Facebook, Instagram, Twitter, Snapchat, YouTube	
	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent	Survey start date, survey end date, IP address, survey duration, response ID, recorded date, respondent's first and last name, location latitude, location longitude, follow up consent, draw consent	
Derived variables			Yes

	Health Authority	The health authority of respondent. This was derived using respondents postal code or location data.	
	Quebec material index	The material deprivation involves deprivation of the goods and conveniences that are part of modern life, such as adequate housing, possession of a car, access to high-speed internet, or a neighbourhood with recreational areas. This deprivation marks the consequences of lack of material resources associated with low education, insecure job situation and insufficient income (1,2).	
	Quebec social index	Social deprivation refers to a fragile social network, starting with the family and encompassing the community. It is characterized by individuals living alone, being a lone parent and being separated, divorced, or widowed (1,2).	
	Ethnocultural composition	Ethno-cultural composition refers to the community make-up of immigrant populations, and at the British Columbia-level takes into consideration factors such as the proportion of population who self-identify as visible minority, the proportion of population that is foreign-born, the proportion of population with no knowledge of either official language (linguistic isolation), and the proportion of population who are recent immigrants (arrived in five years prior to Census). (1)	
	Situational vulnerability	Situational vulnerability speaks to variations in socio-demographic conditions in the areas of housing and education, while taking into account other demographic characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of population that identifies as Aboriginal, the proportion of population aged 25-64 without a high school diploma, the proportion of dwellings needing major repairs, the proportion of population that is low-income, and the proportion of single parent families (1).	
	Economic dependency	Economic dependency relates to reliance on the workforce, or a dependence on sources of income other than employment income. Indicators included in this dimension at the British Columbia-level measure concepts such as the proportion of population participating in labour force (aged 15 and older), the proportion of population aged 65 and older, the ratio of employment to population, and the dependency ratio (population aged 0-14 and aged 65 and older divided by population aged 15-64)(1).	
	Residential instability	Residential instability speaks to the tendency of neighbourhood inhabitants to fluctuate over time, taking into consideration both housing and familial characteristics. The indicators in this dimension at the British Columbia-level measure concepts such as the proportion of dwellings that are apartment buildings, the proportion of persons living alone,	

		the proportion of dwellings that are owned, and the proportion of the population who moved within the past five years (1).	

References

1. Government of Canada SC. Canadian Index of Multiple Deprivation: Dataset [Internet]. 2019 [cited 2021 Jun 10]. Available from: https://www150.statcan.gc.ca/n1/pub/45-20-0001/452000012019002-eng.htm
2. Bureau d'information et d'études En Santé Des Populations (BIESP). Deprivation Index [Internet]. INSPQ. 2019 [cited 2021 May 27]. Available from: https://www.inspq.qc.ca/en/deprivation/material-and-social-deprivation-index

S2 Table. Comparison of baseline eligible and ineligible participants, frequencies and proportions

		Eligible (n=41,375)			Ineligible (n=15, 702) ‡		
		Frequency	Percent (incl. missing)	Percent (excl. missing)	Frequency	Percent (incl. missing)	Percent (excl. missing)
Sex							
	Male	6,823	16.5	16.5	1,697	10.8	18.6
	Female	34,552	83.5	83.5	7,442	47.4	81.4
	Missing	n/a	n/a	n/a	6,563	41.8	n/a
Age							
	18-34	4,978	12.0	12.0	1,726	11.0	17.7
	35-54	12,110	29.3	29.3	3,039	19.4	31.2
	55+	24,287	58.7	58.7	4,981	31.7	51.1
	Missing	n/a	n/a	n/a	5,956	37.9	n/a
Race/ethnicity							
	Indigenous	1,757	4.3	4.4	666	4.2	7.2
	Chinese	882	2.1	2.2	238	1.5	2.6
	White	35,026	84.7	87.5	7,439	47.4	79.9
	South Asian	606	1.5	1.5	315	2.0	3.4
	Other	1,766	4.3	4.4	649	4.1	7.0
	Missing/Unknown	1,338	3.2	n/a	6,395	40.7	n/a
Health region							
	Fraser Health	8,451	20.4	26.1	1,802	11.5	31.0
	Interior Health	6,143	14.8	19.0	1,061	6.8	18.3
	Northern Island	1,825	4.4	5.6	312	2.0	5.4
	Vancouver Coastal	7,315	17.7	22.6	1,329	8.5	22.9
	Vancouver Island	8,640	20.9	26.7	1,300	8.3	22.4
	Missing	9,001	21.8	n/a	9,898	63.0	n/a
Education							
	Below high school	807	2.0	2.5	41	0.3	7.1
	Below bachelor	16,928	40.9	51.7	245	1.6	42.5
	University degree	15,029	36.3	45.9	290	1.8	50.3
	Missing/Unknown	8,611	20.8	n/a	15,126	96.3	n/a
Employment status							
	Employed full-time (30 hours or more/week)	10,654	25.7	32.0	210	1.2	31.6
	Employed part-time	2,993	7.2	9.0	75	0.4	11.3
	Self-employed	2,704	6.5	8.1	64	0.4	9.6

	Unemployed but looking for a job	952	2.3	2.9	24	0.1	3.6
	Unemployed and not looking for a job	406	1.0	1.2	10	0.1	1.5
	Full-time parent, homemaker	879	2.1	2.6	10	0.1	1.5
	Retired	12,757	30.8	38.3	87	0.5	13.1
	Student/Pupil	566	1.4	1.7	67	0.4	10.1
	Long-term sick or disabled	968	2.3	2.9	31	0.2	4.7
	Prefer not to answer	424	1.0	1.3	87	0.5	13.1
	Missing/Unknown	8,072	19.5	n/a	15,037	84.8	n/a
Quebec Material Deprivation Index							
	1 (Privileged)	6,407	15.5	22.3	690	4.4	13.8
	2	6,475	15.6	22.5	1,041	6.6	20.9
	3	6,972	16.9	24.2	1,538	9.8	30.8
	4	4,822	11.7	16.8	751	4.8	15.1
	5 (Deprived)	4,085	9.9	14.2	969	6.2	19.4
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Quebec Social Deprivation Index							
	1 (Privileged)	4,932	11.9	17.2	1,018	6.5	20.4
	2	4,756	11.5	16.5	696	4.4	14.0
	3	6,311	15.3	21.9	1,275	8.1	25.6
	4	5,932	14.3	20.6	897	5.7	18.0
	5 (Deprived)	6,830	16.5	23.8	1,103	7.0	22.1
	Missing	12,614	30.5	n/a	10,713	68.2	n/a
Follow up consent							
	Yes	20,633	49.9	63.8	245	1.6	39.6
	No	11,689	28.3	36.2	373	2.4	60.4
	Missing	9,053	21.9	n/a	15,084	96.1	n/a
Data linkage consent							
	Yes	7,290	17.6	27.3	95	0.6	17.3
	No	19,467	47.1	72.8	454	2.9	82.7
	Missing	14,618	35.3	n/a	15,153	96.5	n/a

‡Does not include 4,106 duplicates

S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
Complete responses	10619 (96.6)	7935 (97.2)	6265 (98.3)	4906 (98.5)	3836 (98.6)	3137 (98.5)	2397(99.2)	1733 (98.5)
Sex								
Male	1590 (14.5)	1115 (13.7)	843 (13.2)	646 (13.0)	495 (12.7)	404 (12.17)	312 (12.9)	217 (12.3)
Female	9403 (85.5)	7049 (86.3)	5532 (86.8)	4335 (87.0)	3396 (87.3)	2780 (87.3)	2105 (87.1)	1543 (87.7)
Age								
18-34	1128 (10.3)	731 (9.0)	497 (7.8)	363 (7.3)	257 (6.6)	199 (6.3)	152 (6.3)	109 (6.2)
35-54	3013 (27.4)	2105 (25.8)	1533 (24.1)	1127 (22.6)	846 (21.7)	662 (20.8)	495 (20.5)	343 (19.5)
55+	6852 (62.3)	5328 (65.3)	4345 (68.2)	3491 (70.1)	2788 (71.7)	2323 (73.0)	1770 (73.2)	1308 (74.3)
Race/ethnicity								
Indigenous	342 (3.1)	229 (2.8)	162 (2.5)	130 (2.6)	91 (2.3)	71 (2.2)	53 (2.2)	38 (2.2)
Chinese	199 (1.8)	124 (1.5)	98 (1.5)	66 (1.3)	48 (1.2)	39 (1.2)	24 (1.0)	16 (0.9)
White	9870 (89.8)	7415 (90.8)	5833 (91.5)	4586 (92.1)	3602 (92.6)	2959 (92.9)	2254 (93.3)	1642 (93.3)
South Asian	79 (0.7)	39 (0.5)	30 (0.5)	20 (0.4)	15 (0.4)	14 (0.4)	12 (0.5)	12 (0.7)
Other	316 (2.9)	229 (2.8)	154 (2.4)	108 (2.2)	86 (2.2)	63 (2.0)	45 (1.9)	35 (2.0)
Missing/Unknown	187(1.7)	128 (1.6)	98 (1.5)	71 (1.4)	49 (1.3)	38 (1.2)	27 (1.1)	17 (1.0)
Health region								
Fraser Health	2748 (25.0)	2039 (25.0)	1590 (24.9)	1243 (25.0)	964 (24.8)	792 (24.9)	613 (25.4)	462 (26.3)
Interior Health	1926 (17.5)	1435 (17.6)	1156 (18.1)	907 (18.2)	703 (18.1)	579 (18.2)	432 (17.9)	317 (18.0)
Northern Island	506 (4.6)	374 (4.6)	280 (4.4)	212 (4.3)	162 (4.2)	116 (3.4)	87(3.6)	63 (3.6)
Vancouver Coastal	2706 (24.6)	1992 (24.4)	1540 (24.2)	1178 (23.7)	932 (24.0)	758 (23.8)	577 (23.9)	403 (22.9)
Vancouver Island	3059 (27.8)	2303 (28.2)	1794 (28.1)	1430 (28.7)	1122 (28.8)	934 (29.3)	703 (29.1)	513 (29.2)
Missing/Unknown	48 (0.4)	21 (0.3)	15 (0.2)	11 (0.2)	8 (0.2)	5 (0.2)	4 (0.2)	2 (0.1)
Education								
Below high school	173 (1.5)	123 (1.5)	89 (1.4)	68 (1.4)	51 (1.3)	37 (1.2)	26 (1.1)	16 (0.9)
Below bachelor	5236 (47.6)	3835 (47.0)	2979 (46.7)	2303 (46.2)	1771 (45.5)	1453 (45.6)	1108 (45.8)	802 (45.6)

	Follow up#1 (n=10,993)	Follow up #2 (n=8,164)	Follow up #3 (n=6,375)	Follow up #4 (n=4,981)	Follow up #5 (n=3,891)	Follow up #6 (n=3,184)	Follow up #7 (n=2,417)	Follow up #8 (n=1,760)
University degree	5529 (50.3)	4169 (51.1)	3283 (51.5)	2594 (52.1)	2057 (52.9)	1683 (52.9)	1278 (52.9)	939 (53.4)
Missing/Unknown	55 (0.5)	37 (0.5)	24 (0.4)	16 (0.3)	12 (0.3)	11 (0.4)	5 (0.2)	31 (0.2)
Quebec Material Deprivation Index								
1 (Privileged)	1547 (14.1)	1072 (13.75)	896 (14.1)	720 (14.5)	569 (14.6)	435 (13.7)	344 (14.2)	253 (14.4)
2	2078 (18.9)	1547 (19.0)	1198 (18.8)	1008 (20.2)	806 (20.7)	665 (20.9)	501 (20.7)	366 (20.8)
3	2994 (27.3)	2184 (26.8)	1674 (26.3)	1273 (25.6)	973 (25.0)	835 (26.2)	642 (26.6)	450 (25.6)
4	1277 (11.6)	942 (11.64)	748 (11.7)	580 (11.6)	475 (12.2)	379 (11.9)	285 (11.8)	215 (12.2)
5 (Deprived)	1668 (15.2)	1290 (15.8)	1033 (16.2)	728 (15.7)	609 (15.7)	504 (15.8)	375 (15.5)	278 (15.8)
Missing	1429 (13.0)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	366 (11.5)	270 (11.2)	198 (11.3)
Quebec Social Deprivation Index								
1 (Privileged)	2188 (19.9)	1641 (20.1)	1286 (20.2)	1063 (21.3)	830 (20.3)	658 (20.7)	509 (21.1)	368 (20.9)
2	1441 (13.1)	1051 (12.9)	787 (12.4)	603 (12.1)	480 (12.3)	411 (12.9)	314 (13.0)	225 (12.8)
3	2478 (22.5)	1831 (22.4)	1480 (23.2)	1148 (23.1)	922 (23.7)	769 (24.2)	574 (23.8)	419 (23.8)
4	1601 (14.6)	1236 (15.1)	945 (14.8)	743 (14.9)	578 (14.9)	488 (15.3)	370 (15.3)	290 (16.5)
5 (Deprived)	1856 (16.9)	1336 (16.4)	1051 (16.5)	808 (16.2)	622 (16.0)	392 (15.5)	379 (15.7)	260 (14.8)
Missing/Unknown	1429 (13)	1069 (13.1)	826 (13.0)	616 (12.4)	459 (11.8)	492 (11.5)	270 (11.2)	198 (11.3)
Follow up consent								
Yes	10357 (94.2)	7793 (95.5)	6182 (97.0)	4857 (97.5)	3789 (97.4)	3106 (97.6)	2380 (98.5)	1714 (97.4)
No	262 (2.4)	142 (1.7)	83 (1.3)	49 (1.0)	47 (1.2)	31 (1.0)	19 (0.7)	19 (1.1)
Missing	374 (3.4)	229 (2.8)	110 (1.7)	75 (1.5)	55 (1.4)	47 (1.5)	25 (0.8)	27 (1.5)

S3 Table. Participant profile of BC-Mix follow up surveys: frequencies and proportions (%) [continued]

		Follow up#9 (n=1,200)	Follow up #10 (n=488)
Complete responses		1,178 (98.2)	483 (99.0)
Sex			
	Male	136 (11.3)	54 (11.1)
	Female	1064 (88.7)	434 (88.9)
Age			
	18-34	70 (5.8)	30 (6.2)
	35-54	226 (18.8)	87 (17.8)
	55+	904 (75.3)	371 (76.0)
Race/ethnicity			
	Aboriginal	49 (4.1)	18 (3.7)
	Chinese	12 (1.0)	8 (1.6)
	Not a visible minority (White)	1117 (93.1)	453 (92.8)
	South Asian	8 (0.7)	3 (0.6)
	Other	0 (0)	0 (0)
	Missing/Unknown	14 (1.2)	6 (1.2)
Health region			
	Interior Health	223 (18.6)	88 (18.0)
	Fraser Health	319 (26.6)	129 (26.4)
	Vancouver Coastal	268 (22.3)	106 (21.7)
	Vancouver Island	355 (29.6)	152 (31.2)
	Northern Island	33 (2.7)	12 (2.5)
	Missing/Unknown	2 (0.2)	1 (0.2)
Education			
	Below high school	7 (0.6)	3 (0.6)

	Below bachelor	549 (45.7)	205 (42.0)
	University degree	643 (53.6)	279 (57.2)
	Missing/Unknown	1 (0.1)	1 (0.2)
Quebec Material Deprivation Index			
	1 (Privileged)	166 (13.8)	71 (14.6)
	2	257 (21.4)	94 (19.3)
	3	296 (24.7)	125 (25.6)
	4	142 (11.8)	50 (10.3)
	5 (Deprived)	192 (16.0)	85 (17.4)
	Missing	147 (12.3)	63 (12.9)
Quebec Social Deprivation Index			
	1 (Privileged)	253 (21.1)	88 (12.9)
	2	165 (13.8)	63 (12.9)
	3	276 (23.0)	123 (25.2)
	4	192 (16.0)	80 (16.4)
	5 (Deprived)	167 (13.9)	71 (14.6)
	Missing	147 (12.2)	63 (12.9)
Follow up consent			
	Yes	1170 (97.5)	475 (97.3)
	No	8 (0.7)	8 (1.6)
	Missing	22 (1.8)	5 (1.0)

S4 Table. BC-Mix eligible sample (baseline) by month recruited

Month	Number of eligible (n=41,375)	% of sample
September, 2020	6,488	15.68
October, 2020	3,516	8.5
November, 2020	1,653	4
December, 2020	3,335	8.1
January, 2021	2,460	6
February, 2021	994	2.4
March, 2021	1,353	3.3
April, 2021	2,507	6.1
May, 2021	4,696	11.4
June, 2021	8,238	19.9
July, 2021	6,135	14.8

S5 Table. Comparison of participant eligibility across survey rounds

	Baseline survey	Follow up#1	Follow up #2	Follow up #3	Follow up #4	Follow up #5	Follow up#6	Follow up#7	Follow up#8	Follow up#9	Follow up#10
Total (eligible+ineligble)	57,077	11,677	8,624	6,657	5,173	4,037	3,309	2,503	1,815	1,234	513
Eligible	41,375	10,993	8,164	6,375	4,981	3,891	3,184	2,417	1,760	1,200	488
% eligible	72.5	94.1	94.7	95.8	96.3	96.4	96.2	96.6	97.0	97.2	95.1

S6 Table. Participant profile of BC-Mix baseline data (n=33, 650), using at least 67% survey completion threshold

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
Sex					
	Male	5,362	15.9	16680	49.4
	Female	28, 288	84.1	17058	50.6
	Missing				
Age					
	18-34	3,957	11.8	9,063	26.9
	35-54	9,674	28.8	11,111	32.9
	55+	20,019	59.5	13564	40.2
Race/ethnicity					
	Indigenous	1,394	4.1	1,718	5.1
	Chinese	711	2.1	3,601	10.7
	White	28,728	85.4	21,216	62.9
	South Asian	405	1.2	2,478	7.3
	Other	1,385	4.1	3,429	10.2
	Missing/Unknown	1,027	3.1	1300	3.9
Health region					
	Fraser Health	8038	26.1	11327	33.6
	Interior Health	5,806	118.9	5023	14.9
	Northern Island	1735	5.6	1732	5.1

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
	Vancouver Coastal	6993	22.7	7739	22.9
	Vancouver Island	8234	26.7	5308	15.7
	Missing/Unknown	2844	n/a	2610	7.7
Education					
	Below high school	807	2.4	1,096	3.2
	Below bachelor	16,928	50.3	15,176	45.0
	University degree	15,029	44.7	16,273	48.2
	Missing/Unknown	886	2.6	1,193	3.1
Employment status					
	Employed full-time (30 hours or more/week)	10,654	32.0	1308	40.8
	Employed part-time	2,993	9.0	3,131	9.4
	Self-employed	2,704	8.1	3,013	9.0
	Unemployed but looking for a job	952	2.9	1,522	4.6
	Unemployed and not looking for a job	406	1.2	511	1.5
	Full-time parent, homemaker	879	2.6	740	2.2
	Retired	12,757	38.3	8,096	24.3
	Student/Pupil	566	1.7	1,197	3.6

		Survey			
		Un-weighted frequency	Un-weighted %	Weighted frequency	Weighted %
	Long-term sick or disabled	968	2.9	914	2.7
	Prefer not to answer	424	1.3	620	1.9
	Missing/Unknown	347	n/a	n/a	n/a
Material Deprivation Index					
	1 (Privileged)	6,219	22.8	6,106	22.1
	2	6,199	22.6	5,850	21.1
	3	6,565	24.0	5935	21.4
	4	4,616	16.8	5,179	18.7
	5 (Deprived)	3,810	13.9	4,612	16.7
	Missing	6,241	n/a	n/a	n/a
Follow up consent					
	Yes	20,633	68.8	19,051	58.9
	No	11,689	36.1	13,275	41.1
	Missing	1,328	n/a	n/a	n/a
Data linkage consent					
	Yes	7,290	27.3	7,318	20.4
	No	19,467	72.8	20,362	73.6
	Missing	6,893	n/a	n/a	n/a

S7 Table. Comparison of participants with 100% survey completion versus those less than 100% completion (baseline data)

		100% completion (n=26, 757)		< 100% completion (n=14,618)	
		Un-weighted Frequency	Un-weighted %	Un-weighted Frequency	Un-weighted %
Sex					
	Male	4,407	16.5	2,416	16.5
	Female	22,350	83.5	12,202	83.5
Age					
	18-34	3,383	12.6	1,595	10.9
	35-54	8,056	30.1	4,054	27.7
	55+	15,318	57.3	8,969	61.4
Race/ethnicity					
	Indigenous	1,072	4.1	685	4.7
	Chinese	627	2.3	255	1.7
	White	22,842	85.4	12,184	83.4
	South Asian	305	1.1	301	2.1
	Other	1,123	4.2	643	4.4
	Missing/Unknown	788	3.0	550	3.8
Health region					
	Fraser Health	6,928	26.1	1,523	26.3
	Interior Health	4,923	18.5	1,220	21.1
	Northern Island	1,465	5.5	360	6.2
	Vancouver Coastal	6,175	23.2	1,140	19.7
	Vancouver Island	7,095	26.7	1,545	26.7

	Missing/Unknown	171	n/a	8,830	n/a
Education					
	Below high school	585	2.2	222	1.5
	Below bachelor	13,155	49.2	3,773	25.8
	University degree	12,634	47.2	2,395	16.4
	Missing/Unknown	383	1.4	8,228	56.3
Follow up consent					
	Yes	16,404	61.3	4,229	76.0
	No	10,353	38.7	1,336	24.0
	Missing	n/a	n/a	9,053	n/a