COVID-19 Vulnerability Index for Québec (CVIQ) Documentation

Concepts, methodology and data dictionary

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1 Introduction

This document presents the concepts underlying the COVID-19 Vulnerability Index for Quebec (CVIQ) and its methodology. At the end of this document, there is the data dictionary for use with the downloadable Excel files, figures showing the population distribution by vulnerability level and type, a table listing the risk factors and their sources, two tables showing the centile limits between the vulnerability categories and a final table with the correlations between the domains.

This document accompanies the CVIQ's website: vulnerabiliteCOVID.cbcr.me.

2 Context

Since the early months of the COVID-19 pandemic, there were reports of infections, hospitalizations and deaths affecting more heavily specific socioeconomic and ethnic groups (Niedzwiedz et al. 2020; Abedi et al. 2020; 2020; Finch et Hernández Finch 2020; Sundaram et al. 2021), not only in North America but elsewhere in the world (Rocha et al. 2021; Mena et al. 2021; Bajos et al. 2021; Yashadhana et al. 2020; Ali et al. 2020; Mathur et al. 2020; Ehlert 2020; Calderon-Larranaga et al. 2020).

Testimonies from racialized communities report an increase in infections and deaths (Centre de recherche-action sur les relations raciales (CRARR) 2020a; 2020b). In Montreal, more than double the number of cases of COVID-19 have been reported among residents in very disadvantaged areas (Direction de santé publique (DSP) de Montréal 2020a) and with high proportions of visible minorities (Direction de santé publique (DSP) de Montréal 2020b; Cleveland et al. 2020).

In addition, a higher number of cases among health care workers living in neighbourhoods characterized by a high proportion of people from visible minority groups on the Island of Montreal has been observed.

From an equity and social justice perspective, geographic localization of vulnerable population groups is essential to protect these populations, to limit morbidity and mortality, to define criteria for containment and deconfinement, and to monitor the evolution of the pandemic (Canadian Institute for Health Information 2020; Canadian Public Health Association 2021; Anderson et al. 2020).

Significant social inequalities have been identified in numerous studies and the role of social determinants of health as risk factors has been confirmed. In Quebec, health authorities do not collect socio-cultural or economic information during the epidemiological investigation. This makes it impossible to verify whether differences in the rates of infection, hospitalization and death by individual characteristics exist.

However, an ecological approach can be used to assess these differences in health status across social groups and geographic territories. The Canadian Census collects socio-cultural and economic information on a very small geographic scale every five years. The use of these population characteristics as proxies for individual case characteristics through the geolocation of their home address and the matching of information from the

2016 Census assumes of relative social homogeneity of residents in small geographic units. On average, these small geographic areas are home to 600 individuals.

The large number of indicators collected by the census makes it difficult to summarize results from analyses carried out with selected indicators into an overall picture. Several countries use a social vulnerability index that combines different socio-cultural and economic indicators for a more concise interpretation of the association between population characteristics and allocation of resources linked to emergency situations. The COVID-19 Vulnerability Index for Quebec (CVIQ) measures the vulnerability of the population living in each of the small geographic units according to various criteria. It then becomes possible to associate the vulnerability measures of the population residing in the unit with the number of COVID-19 infections, hospitalizations, deaths or vaccinated persons in the same geographical unit.

The CVIQ uses risk factors identified in the scientific literature when data sources on a very small geographic scale were available. Not all known risk factors could be integrated. Those that form the basis of the CVIQ are not a direct measure of a person's vulnerability, but rather characterize the vulnerability of the population residing in the geographic area. Since only risk factors associated with an increased risk of SARS-CoV-2 infection are retained, the CVIQ is calibrated to identify vulnerability related to COVID-19 infections, hospitalization and mortality. It can be used with caution to assess the association between vulnerability and other outcomes than these, for example domestic violence, feelings of isolation or food insecurity. However, keep in mind that the CVIQ was not designed for this purpose.

3 Objectives

The COVID-19 Vulnerability Index for Quebec (SVIQ) was developed with the goal of providing a tool to monitor biological, social, and environmental vulnerabilities related to the COVID-19 pandemic at the local level. It was inspired by the COVID-19 Community Vulnerability Index (CCVI) (Smittenaar et al. 2021) which was modelled after the Social Vulnerability Index (SVI) created by the Centers for Disease Control (CDC Agency for Toxic Substances and Disease Registry (ATSDR) 2020; Flanagan et al. 2011; 2018).

Individuals share exposure at the neighbourhood level. In the absence of information on individual characteristics, area-based measures posit social homogeneity at the small-area level. Neighbourhoods and housing blocks are considered small-area geographic level. When we call a neighbourhood a ‘working class’ or ‘student’ neighbourhood, we refer to a predominant population characteristic that we attribute to all residents of the neighbourhood. An individual living in that neighbourhood may well be retired but the neighbourhood itself will be considered a ‘student’ neighbourhood if this group is the majority. Aggregated data attributed to all individuals in small geographic areas (neighbourhoods and housing blocks) are useful when individual-level data are unavailable, and information needs to be imputed. The Canadian Census disseminates information from all residents in the country at the dissemination area (DA) level. This is considered to be a local geographic area as only approximately 600-800 individuals live in a DA.

The SVIQ is useful for comparing levels and domains of vulnerability at the small-area level in the province of Quebec, within its sociosanitary regions and large municipalities (Montréal, Québec, Laval, Gatineau) and across rural, intermediate, and urban areas. Domains cover risk factors related to biological susceptibility, sociocultural and socioeconomic characteristics as well as environmental exposure.

The index constitutes a multifunctional tool that can support efforts to understand vulnerability and manage issues related to vulnerability by various actors:

- It can guide the planning and decision-making process of public authorities by contributing to the detection, anticipation, and monitoring of “hot spots” (high burden) of vulnerable populations living in specific geographic areas.

- It can be used to monitor the evolution of the pandemic and other health issues in populations groups with varying levels of vulnerability.

- It can be used to compare the effect of interventions between populations groups with varying levels of vulnerability, by vulnerability domain, regionally and across the province.

- It is likely to support social interventions by making it possible to determine highly vulnerable communities and to adapt these interventions according to the targeted domain of vulnerability, to prevent or mitigate negative impacts as well as to promote protective factors.

- It facilitates the study of health inequalities and inequities linked to biological, social and environmental vulnerability.

4 Defining vulnerability

The concept of social vulnerability within a disaster management context centers on risk factors that affect humans and community resilience adding depth to traditional risk assessment of threats to the built environment (Flanagan et al. 2018). In this perspective, social vulnerability is considered to be the **degree to which social conditions affect a community's ability to anticipate, manage, and recover from the effects of a disaste**r we used the prevalent definition of social vulnerability (Flanagan et al. 2011).

In sociology, social vulnerability, referred to as structural health vulnerability, denotes the "increased propensity to incur health risks directly related to social inequalities stemming from the interaction between structural and epistemic injustice that affect an individual or a social group" (Chung 2021). It is the **difficulty or impossibility to control health risks** that makes individuals or social groups more vulnerable than those, incurring the same health risks but who have the possibility and opportunity to seek shelter from risk exposure (Eilstein et al. 2015; DREES 2020).

Blumenshine (2008) developed a conceptual framework sketching out possible sources of disparities during an influenza pandemic. We slightly adapted his figure to illustrate mechanisms that link social inequalities to health disparities associated with infectious diseases (Figure 1).

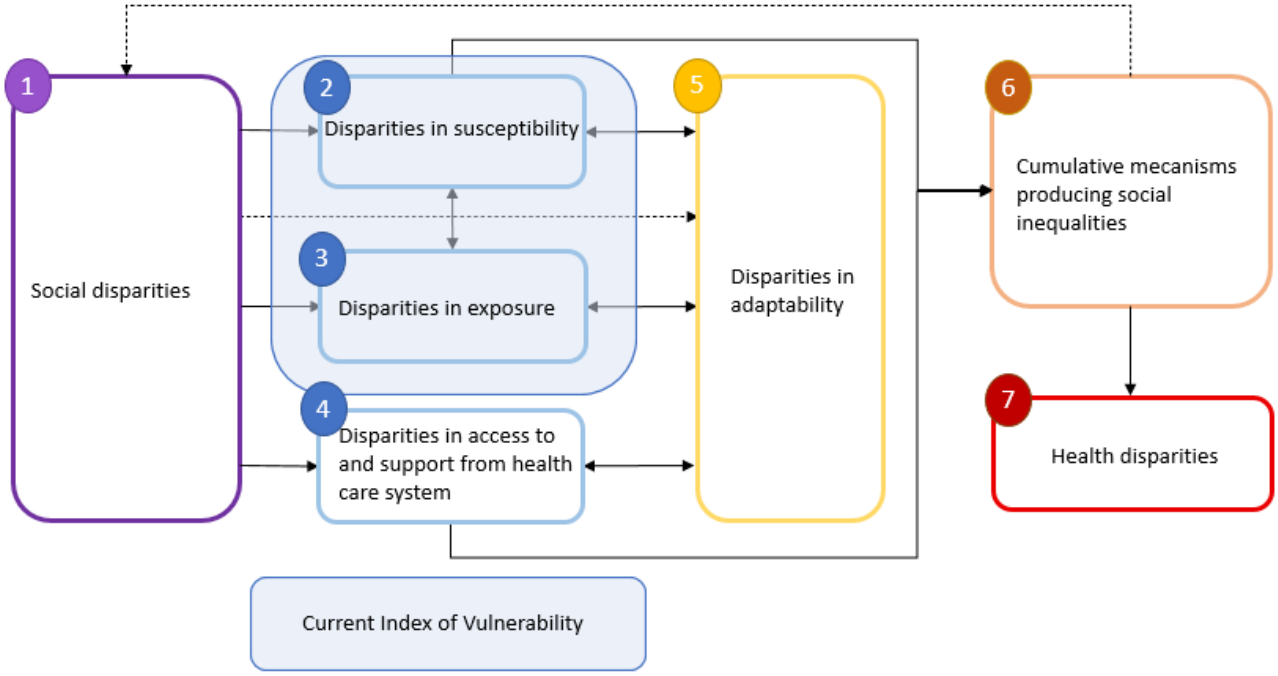

Figure 1. Mechanisms linking social disparities to disparities in health (adapted from DREES 2020, Eilstein et al. 2015 and Public Health England Transmission Group, 2020

Social disparities result in disparities in **susceptibility**, in **exposure**, and in **access to and support received from the health system** that vary by social group. The conceptual framework of social vulnerability (Figure 1) starts with social disparities qui materialize in varying biological susceptibility, exposure as

well as access to and support from health care systems. These mechanisms are in a dynamic relationship with a group's adaptive capacity which, in a looping system, affect susceptibility, exposure and access to and support from health care systems. The accumulation of these different disparities results in social inequalities of health that we can observe at the population level. In more detail,

1) Social vulnerability stems from disparities in social situations. They refer to conditions or events that may lead to social distress (e.g., discrimination), economic distress (e.g., low income), or dependency (e.g., essential workers who are forced to continue working in a high-risk environment). All these situations can lead to an increased risk of exposure to a virus or an increase in susceptibility to risk factors.

2) to 4) Social disparities which are often intangible, create **disparities between population groups** in relation to 2) susceptibility, 3) exposure, and 4) access to and support from the health system. Social groups thus experience varying levels of susceptibility and exposure as well as less access to and support from the health system.

   Susceptibility refers to the overall likelihood of contracting a disease depending on the level of exposure and biological characteristics. The more susceptible an individual, or population, is to a specific exposure, the more likely it is that their health will be affected. Susceptibility also varies over time. The level of susceptibility to exposure can be high at one time but low at other moments.

   Exposure refers to the nature and level of risk factor(s) to which an individual or population may be exposed in their living or working environment. A certain level of exposure exists for everyone. The level varies over time.

   Adaptability is the **ability to exercise control over risks** by a population or an individual and, as such, links susceptibility and vulnerability. Indeed, a population and an individual can increase their exposure or their susceptibility and thus put themselves at an increased risk. They may also try to decrease their exposure and susceptibility to reduce the risk to a lower level. These behaviors therefore make it possible to adapt effectively to an increased risk situation.

5) While it is often possible to control risks, not all social groups have the same **leeway in their ability to adapt to risks**, which influences their risk of being affected by a disease.

   Components 2) to 5) are in a dynamic relationship. Exposure is converted into vulnerability (risk) by susceptibility. Adaptability, which is sensitive to vulnerability, influences both the level of exposure, by allowing preventive actions to be applied, and the susceptibility of individuals or populations.

6) Components 2) to 5) can **cumulate over time and within social groups**. They can also interact and multiply social inequalities.

7) Finally, the combined effect of social disparities, disparities in susceptibility, exposure and access to and support from the health care system combined with disparities in adaptability can result in **health inequalities**.

5 Composition of the CVIQ

The CVIQ has four levels ranging from the most detailed to the most aggregated level (Figure 2):

Level 1 - **Individual risk factors** for infectious diseases as gathered from the scientific literature.

Level 2 – **6 risk domains**, grouping risk factors thematically:

a) **Biological susceptibility domain**: physiological, pathological, and genetic risk factors

b) **Sociocultural domain**

c) **Economic domain**

d) **Sociopolitical domain**: not included as no indicators were available.

e) **Indoor contacts domain**: specific population characteristics act as proxy variables for potentially increased exposure to infection through indoor contacts with infected persons.

f) **Outdoor contacts and air pollution domain**: population density is used as a proxy for potentially increased outdoor exposure to infection. Three measures of air pollution are included as some studies link air pollution to increased susceptibility to infection. Measures of distance to green spaces and leisure facilities are planned to be integrated in a later version as they attract visitors, increasing temporarily local population density thus increasing the risk of outdoor infection.

Level 3 - Two of the three **mechanisms** identified in the conceptual model can be distinguished: biological and social *susceptibility* to infection and *exposure* to infected persons. These mechanisms summarize the underlying domains for a more succinct measure of vulnerability.

Level 4 - The **global measure of vulnerability** summarizes all risk factors and domains.

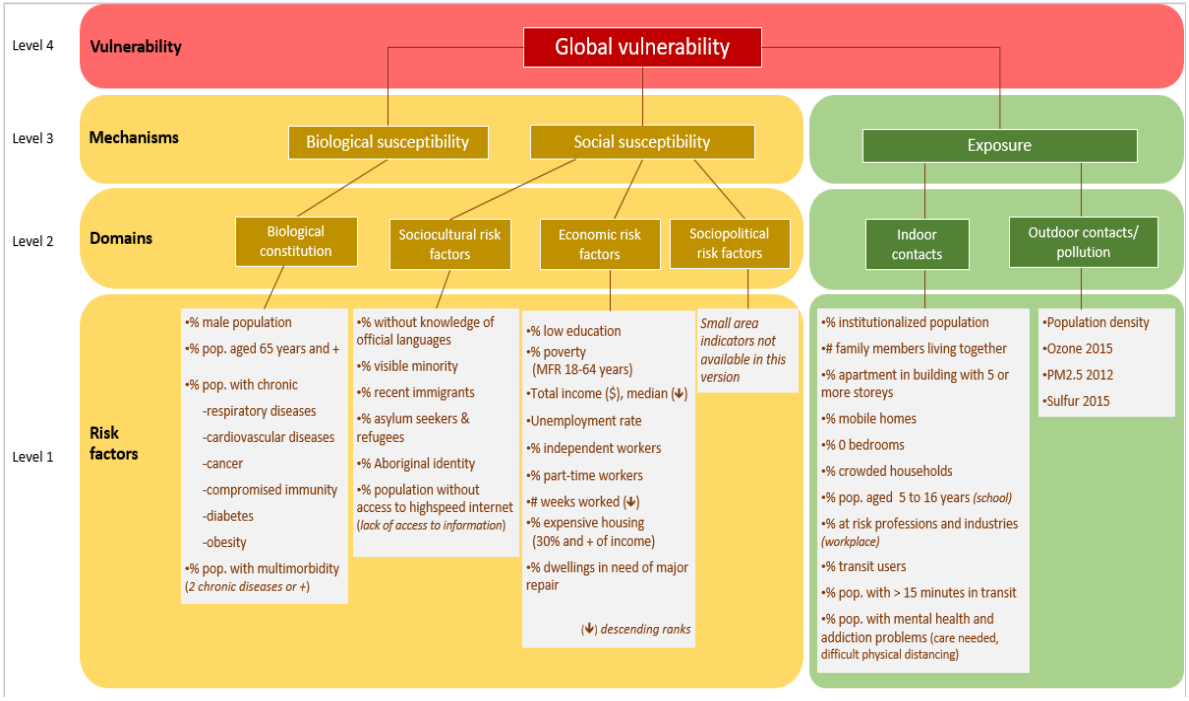

Figure 2. Conceptual framework of the CVIQ with risk factors (level 1), domains (level 2), mechanisms (level 3) and global vulnerability (level 4)

6 Measuring vulnerability

6.1 Indicators and data sources

Predisposing biological risk factors such as male sex, advanced age, and living with a chronic disease have been found to increase the risk of adverse outcomes from COVID-19 infection (Ge et al. 2021; Pijls et al. 2021). Social factors such as unemployment, low educational attainment, residential segregation, and ethnic composition were positively associated with COVID-19 mortality (Paul et al. 2021). Indoor exposure to SARS-CoV-2 related to overcrowding increased risk of mortality independently from poverty (Kamis et al. 2021). Population density and indoor air quality in living and workplace settings are all linked with the likelihood of exposure to SARS-CoV-2 (Weaver et al. 2022). Furthermore, physical proximity during public transportation and at the workplace were found to increase risk of COVID-19 infection (Ellingjord-Dale et al. 2022; Gaffney et al. 2023). Ethnic minority groups and individuals with low socioeconomic position may lack access to information, networks and resources teaching them how to protect themselves from infection (Goldsmith et al. 2022). Furthermore, neighbourhoods are often culturally and socioeconomically patterned sharing exposures related to housing type, transportation and green spaces. Long-term exposure to air pollution was also identified as a risk factor (Wu et al. 2020). Finally, communities with limited internet access had up to 5 times higher mortality rates (Lin et al. 2022). Blaser et al. (2023) put the ISVQ to the test and confirmed the associations observed by other studies.

We identified risk factors used in other social vulnerability indices and reviewed their relevance related to COVID-19 morbidity and mortality in the literature (Appendix 4 and Appendix 5). We also consulted systematic reviews of risk factors for COVID-19 infection, morbidity and mortality (Parohan et al. 2020; Booth et al. 2021; Albitar et al. 2020; Dessie et Zewotir 2021; Noor et Islam 2020; Hashim, Alsuwaidi, et Khan 2020; Li et al. 2021; Zhang et al. 2023; Mhango et al. 2020) and governmental websites (CDC 2020; Gouvernement du Québec 2021; ASPC 2022). We have bolstered the index with additional indicators such as comorbidities, internet access, and air quality. While a few variables present some collinearity, accumulation of risk factors linked to socioeconomic status and sociocultural groups is well known to increase morbidity and mortality (Calderón-Larrañaga et al. 2020).

Several conditions applied to the indicators: 1) they had to be available for all sociosanitary regions of Quebec; 2) they had to cover small geographic areas (dissemination areas); 3) they had to describe the entire population; 4) they had to be publicly and freely available.

We matched the retained risk factors to variables available in Quebec at the dissemination area (DA) level which is the smallest geographic scale for which Statistics Canada publishes aggregated population data. In total, the CVIQ covers 13,182 DA with a nonzero population, covering 97% of Quebec's population.

6.2 Domains

The CVIQ, the SVI and the CCVI are subdivided into domains ('themes') of vulnerability. The SVI has four domains including socioeconomic status (income, poverty, employment, education), household composition and disability (age, single parenting, disability), minority status and language (race, ethnicity, English language proficiency), and housing and transportation (housing structure, crowding, vehicle access).

The more recently developed CCVI has a total of seven themes: three themes cover the social vulnerability domain. Socioeconomic status, minority status and language group the same indicators as the SVI. The household composition and disability domain was merged with the housing type and transportation domain. In addition, the CCVI has four themes in the health vulnerability domain: epidemiological factors, factors related to the healthcare system, high risk environments and population density.

The CVIQ is divided into five domains following the susceptibility and exposure model outline by Blumenshine (2008). Epidemiological factors are captured in the biological susceptibility domain. We distinguish sociocultural and socioeconomic characteristics in the social vulnerability domain, analogous to the socioeconomic status and the minority status and language domains from the SVI. Our exposure domains are divided into a high-risk environment covering indoor exposure and outdoor exposure and air pollution separately. High risk environments refer to living or work settings that place sub-groups of the population at high risk of contracting the virus. During the COVID-19 epidemic these notably included nursing home and assisted living residents, prisoners, and workers in high-risk industries such as food processing, manufacturing, and transportation. Based on literature documenting the increased risk of mortality linked to air pollution, we added indicators to the outdoor exposure domain where we capture population density. Thus, the CVIQ crosses five domains: 1) biological susceptibility (9 variables); 2) sociocultural characteristics (6 variables); 3) socioeconomic characteristics (9 variables); 4) exposure to indoor contacts (11 variables); and 5) exposure to outdoor contacts and air pollution (4 variables) (Table 1). The index covers the main categories identified in a systematic review of social vulnerability associated with the COVID-19 pandemic (Fallah-Aliabadi et al. 2022, tab. 2).

6.3 Indicators

CVIQ			SVI	CCVI
Domain	**Indicator***	**Source**	**Theme**	Theme
Biological susceptibility	% male population % age 65 and over	Census 2016 (Statistics Canada, 2016)	Biological susceptibility	Epidemiological factors
	% population with chronic respiratory disease % population with chronic cardiovascular disease % population with cancer % population with compromised immunity % population with diabetes % population with obesity % population with 2 or more chronic diseases	Quebec Integrated Chronic Disease Surveillance System 2019 (QICDSS) (Blais et al., 2014)	-	-
Sociocultural characteristics	% population without knowledge of official languages % visible minority % recent immigrants % asylum seekers or refugees % population with aboriginal identity	Census 2016 (Statistics Canada, 2016)	Sociocultural characteristics	Minority status & language
	% population without high-speed internet	• National Broadband Data and Pseudo-Household (ISED, 2020) • Demographic Distribution dataset (ISED, 2020)	-	-
Socioeconomic characteristics	% population with low education % age 18-64 living in poverty Median income ($) Unemployment rate % independent workers % part-time workers Number of weeks worked % population living in expensive housing (30% and more of income spent on housing) % dwellings in need of major repair	Census 2016 (Statistics Canada, 2016)	Socioeconomic characteristics	Socioeconomic status
Indoor exposure	% institutionalized population Number family members living together % apartment in buildings with 5 or more stories	Census 2016 (Statistics Canada, 2016)	Indoor exposure	Housing type, transportation, household composition & disability

	% mobile homes % 0 bedrooms % crowded households % population aged 5-16 years			
	% population using public transit % population with over 15 minutes in public transit		Housing & transportation	-
	% population with mental health and addiction problems	Quebec Integrated Chronic Disease Surveillance System (QICDSS) 2019 (Blais et al., 2014)	-	-
	% population working in at risk professions & industries	Census 2016 (Statistics Canada, 2016)	-	High risk environments
Outdoor contacts and air pollution	Population density	Census 2016 (Statistics Canada, 2016)	Outdoor contacts and air pollution	Population density
	Mean annual concentration of ozone (2015) (ppb) Mean annual concentration of PM2.5 (2012) (micrograms per cubic meter (ug/m3)) Mean annual concentration of sulfur (2015) (ppb)	Canadian Urban Environmental Health Research Consortium air pollution dataset (CANUE, 2022)	-	-
-	It was not possible to obtain data related to the healthcare system from Quebec's Ministry of Health and Social Services at the census dissemination area level.	-	-	Healthcare System Factors: • Health System Capacity • Health System Strength • Healthcare Accessibility • Health System Preparedness

*all indicators available at the census dissemination area

Table 1: Risk factors for severe COVID-19 infection grouped by domain of susceptibility

7 Absolute and relative vulnerability

The CVIQ is constructed with 39 risk factors for infection with the Covid-19 virus. All dissemination areas are vulnerable to some extent, more so for some risk factors, less so for others.

When only dissemination areas in which one of the risk factors exceeds a certain threshold are considered to be vulnerable, we adopt a dichotomous approach**.** This view of vulnerability implies that a dissemination area is either vulnerable or it is not. This is an **absolute measure** because a predefined threshold is used rather than a comparison with other dissemination areas. Another point of view is to look at where the level of vulnerability of a dissemination area stands **relative to other dissemination areas** for each of the 39 risk factors. This is a **relative measure**.

- Absolute **vulnerability** is defined by a threshold and designates only the dissemination areas in decile 10 as vulnerable.

- Relative **vulnerability** assigns a higher or lower level of vulnerability to all dissemination areas.

The advantage of having two measures is that you can choose a very restrictive definition of vulnerability or a finely graduated one. The choice of which measure to use relates to the purpose of its use.

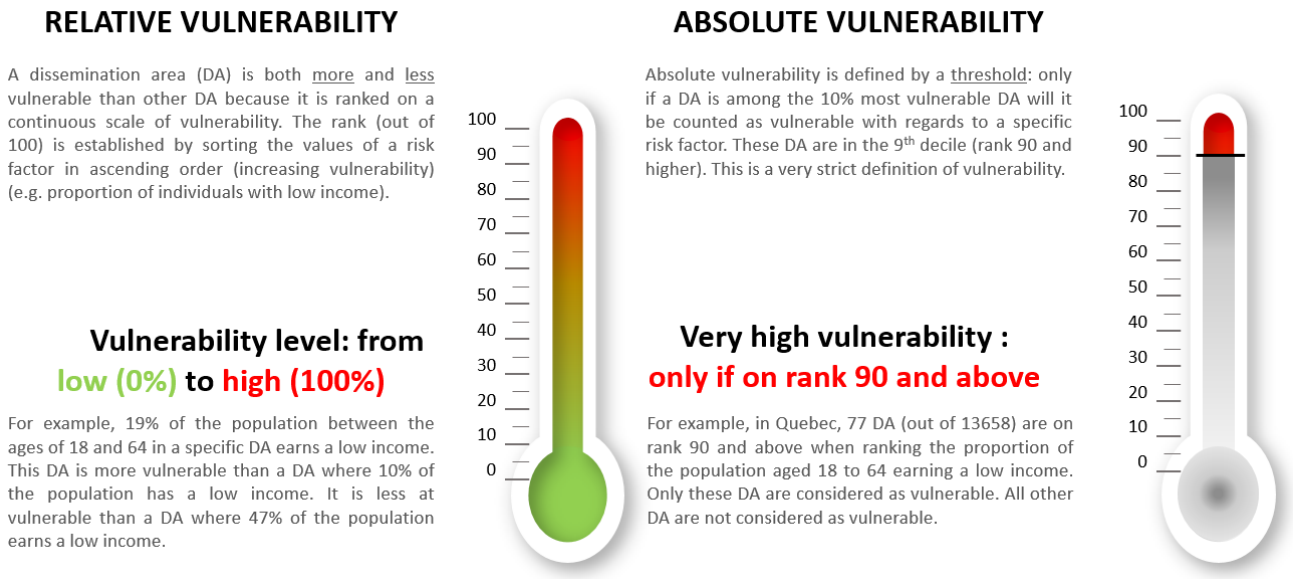

Figure 3. Defining relative and absolute vulnerability

7.1 Transformation of indicators

We followed the method of the CCVI (Smittenaar et al. 2021) and the SVI (CDC Agency for Toxic Substances and Disease Registry (ATSDR) 2021). For each indicator, we calculated the proportion of the population at risk within a dissemination area. For example, we calculated the unemployment rate as the proportion of persons available to work within the labour force. For income, we used the median within the dissemination area. We used frequency counts for the number of weeks worked during the year and number of family members living together. For population density, we used the number of residents per square kilometer (Statistics Canada 2006). For air pollution, we used the mean annual concentration of ozone, sulfur, and fine particulate matter (CANUE 2022). NO_2 was not available at the DA level.

We then ranked DA from highest to lowest for each risk factor, except for income and number of weeks worked, which we ranked from lowest to highest. This ranking was transformed into percentiles ranging from 1 to 100. Some percentiles hold several DA while others are empty.

7.2 Computing vulnerability levels

Relative vulnerability: construction of domains

We summed the percentile ranks of risk factors within a given domain and repeated the ranking process to obtain an overall percentile rank for the domains. A percentile contains 130 DA on average. We proceeded in the same manner for each of the five domains. Thus, the maximum relative vulnerability of a DA, in a domain with nine percentile indicators, is 900 (9 x 100).

- Some DA may not have a value for some of the risk factors. This is why it is necessary to calculate the proportion of relative vulnerability based on the number of indicators with a value. The sum of the indicators (as a percentile) must then be divided by the number of indicators (multiplied by 100) in order to correct for the lack of information in some risk factors.
  Example: When all indicators have a value, in a domain with nine indicators (maximum sum possible relative vulnerability: 900) and a DA has a percentile sum of 300, the relative vulnerability is 0.33 (300 divided by 900). However, when a value is missing in one of the nine indicators (maximum possible relative vulnerability: 800), the vulnerability of the DA in that domain must be calculated on a total of eight indicators (800):

$$Vuln_{rel} = \frac{percentile\ sum}{maximum\ sum\ of\ percentiles} = \frac{300}{800} = 0{,}37$$

Relative vulnerability: construction of mechanisms

We repeated the process of calculating percentiles for each of the three mechanisms in the same way as we constructed the domains: we started by ranking the proportion of vulnerability as calculated above from each domain included in the mechanism (for example sociocultural and socioeconomic characteristics in the social vulnerability domain) and transforming the ranks into percentiles. We then summed the percentile

ranks of the domain value for each DA and ranked the DA from highest to lowest. We then transformed the ranking into percentiles.

Relative vulnerability: construction of the global vulnerability measure
For the global measure, we proceeded in the same was as before by summing the percentile measures of each mechanism for every DA. We then ranked DA from highest to lowest. We then transformed the ranking into percentiles.

Absolute vulnerability: construction of domains
Following the SVI, we classified DA on an absolute scale using the 90th percentile as a threshold in which areas below (or above) are considered equally vulnerable (threshold measure of vulnerability). For each DA, we dichotomized percentile rankings as high (≥ 90th percentile) versus low (< 90th percentile) vulnerability for each indicator. We then computed the proportion of indicators in each DA classified as high vulnerability in each domain.

Absolute vulnerability: construction of mechanisms
Using the dichotomized version of the indicators, we computed the proportion of indicators included in the mechanism in each DA considered as vulnerable.

Absolute vulnerability: construction of the global vulnerability measure
For the global measure, we computed the proportion of all dichotomized indicators for each DA which had a ranking of 90th percentile and above.

7.3 Categorisation of vulnerability levels: from continuous to 5 levels

We produced absolute and relative index measures for all domains, mechanisms and global vulnerability as both a continuous percentile rank and a 5-level category variable to facilitate handling in graphs, tables, and maps. Instead of grouping DA into quintiles which ignore natural clustering, we used the *Fastclus* procedure in SAS to group the percentile ranks for each domain into five categories of vulnerability where 1 indicates the lowest and 5 the highest level of vulnerability. This procedure uses the natural breaks algorithm which creates natural clusters within the data. The categories are created by grouping DA with similar values, while maximizing the difference between DA in different clusters (Jenks 1977; SAS Institute Inc. 2000). Appendix 1 and Appendix 2 show the percentile breaks for each vulnerability measure.

The original values (percentiles) for all vulnerability measures are included in the data file. Using these values, it is possible to create vulnerability groupings based on other criteria.

8 Different versions of the CVIQ

The CVIQ was created at the DA level with data from the 2016 Census, from the SYSMAQ and from CANUE (cf. List of sources), based on the territorial division which was effective in Quebec since 2015.

Three versions of the CVIQ (national, regional and local) are available for Québec, with the exception of health regions 17 and 18.[1] 13,182 eligible DAs[2] were used to establish percentiles (cf. Vulnerability calculations).

8.1 National version

The **national version** includes *all* 13,182 eligible DAs in Quebec. As a result, the most and least vulnerable DAs can be anywhere in the province. For example, it is possible that the majority of DAs in a health region appear to be little vulnerable. This version facilitates the estimation of the extent and geographical distribution of inequalities in vulnerability across Québec. All of Quebec's DAs are compared to each other and the entire province forms the reference territory. This means that it is possible to compare the vulnerability of a group of citizens living in a sociosanitary region with that of another group living elsewhere in Québec.

8.2 Regional version

The **regional version** includes only DAs *in one health region* at a time. The vulnerability of these DAs is calculated separately for each health region. In each region, we identify a DA that is the least vulnerable and the most highly vulnerable. This version can be used to observe the variations in vulnerability inside each health region in Quebec and to compare DAs **within** a region.

8.3 Local version

The **local version** exists for a few major cities (Montreal, Quebec City, Laval, Gatineau) and the entire territory outside the major cities. This version is based on a vulnerability calculation for DAs in each of the major cities separately. It therefore identifies the lowest-vulnerable and high-vulnerable DAs in each of these municipalities. This version identifies variations in vulnerability specific to each municipality and can be used to compare vulnerability within municipalities. To distinguish between DAs outside the four major cities, a typology of rurality has been created. It is inspired, among others, by the classification into core, suburb and rural areas (Statistique Canada 2016a) It groups dissemination blocks (DBs) into population centres by population centre size (Statistique Canada 2016c) and type (Statistique Canada 2016b). DAs were categorized as urban (58% of DAs), rural (17% of DAs) or intermediate (25%), of which 9% were medium-sized DAs in and outside of census metropolitan areas (CMAs) and 16% were small DAs within CMAs (7%) and outside of CMAs (9%).

[1] The 16 dissemination areas of the Terres-Cries-de-la-Baie-James and the 18 DA in Nunavik are excluded from the CVIQ mainly due to missing data (24% of DA) and because the habitat and living conditions are very different in these northern regions.

[2] We did not calculate vulnerability for DA with three or more missing indicators (n=422) nor those with zero population counts (n=16).

9 Comparisons at varying geographical levels

Since social vulnerability is measured at small-area level, levels of vulnerability can be compared between regions. It is important to understand that vulnerability needs to be computed in the same way for DA to be compared. The ranking procedure includes DA either from the same metropolitan area, from the same sociosanitary region or from the entire province. This results in different versions of the vulnerability measure. Imagine a very vulnerable DA in a prosperous municipality. This same DA which is at the top of vulnerability compared to other DA in the same municipality may be in the middle of the ranking when DA from all over Quebec are compared because they may be more vulnerable than the most vulnerable DA in a prosperous metropolitan area.

To improve precision of comparisons, six versions of the CVIQ were developed, each allowing comparison with specific regions, and for relative and absolute vulnerability.

It is important to choose the appropriate version of the CVIQ by asking yourself two questions:

1) National, regional or local version?

- If you are looking to compare DAs within one of the four large municipalities, use the **local version**.
- Be aware that the local version will identify an AD as the most (or least vulnerable) within the four municipalities. This does not mean however that there is not an even more vulnerable DA elsewhere in Quebec or in another health region.
- If you are comparing DAs within a single health region, use the **regional version**.
- Finally, if you are working with DAs from all over Quebec, use the **national version**.

2) Relative or absolute version?

- The **absolute version** of the CVIQ is based on a very strict definition of vulnerability. It applies only to risk factors (level 1), not domains (level 2) or mechanisms (level 3). The DA must be in the top 10% of the most vulnerable DAs to be considered vulnerable. All other DAs are considered non-vulnerable. This measure is ideal for identifying pockets of high social vulnerability.
- The **relative version** of the CVIQ also applies to the risk factors on which the index is based. It includes all vulnerability levels. It is therefore very gradual and better suited to determining a critical degree of vulnerability by the researcher and to considering the entire spectrum.

10 Download the CVIQ

This web page (vulnerabiliteCOVID.cbcr.me) features information on the CVIQ plus Excel files containing the vulnerability measures by DA. The data dictionary can be found in the appendix.

Coverage	Relative vulnerability	Absolute vulnerability
 National version	Comparison of all DA in the province National relative vulnerability	Comparison of all DA in the province National absolute vulnerability
 Regional version	Comparison of DA in the same sociosanitary region Regional relative vulnerability	Comparison of DA in the same sociosanitary region Regional absolute vulnerability
 Municipal version	Comparison of DA in the same metropolitan area (Montréal, Québec, Laval, Gatineau) Local relative vulnerability	Comparison of DA in the same metropolitan area (Montréal, Québec, Laval, Gatineau) Local absolute vulnerability

Table 2: Different versions of the CVIQ available for download

11 Mapping vulnerability

It is possible to show the different vulnerability measures on a zoomable map of Québec on which the domain, the regional comparison and the absolute or relative vulnerability version can be selected which allows a customized view of specific geographic areas.

Quick instructions for mapping

- Go to maps website: https://cartes.inspq.qc.ca/iss/
- Click on the 'burger' at the top left 2.
- Click on the star (Contexts) 3.
- Click on one of the versions of the CVIQ (national, regional or local).
- Choose one of the measures (absolute or relative, a specific domain or mechanism, or the global measure) by clicking on the eye (Map-Layers).
- The tab on the right in this menu (Map-Legend) allows you to view the legend by scrolling down to the selected measurement.
- Move or zoom the map to the region you want to view.
- By clicking on a DA the map, a window displaying the values of the risk factors as well as the detailed and grouped vulnerability measure appears.

The map (Figure 4) shows the Islands of Montreal and Laval as well as parts of the North and South Shore. Poorer neighbourhoods and those with a high proportion of immigrant population appear clearly in Montreal's eastern and southern parts. The map shows the local version of the index with 5 clusters of relative vulnerability levels ranging from light red – very low vulnerability to dark red – very high vulnerability.

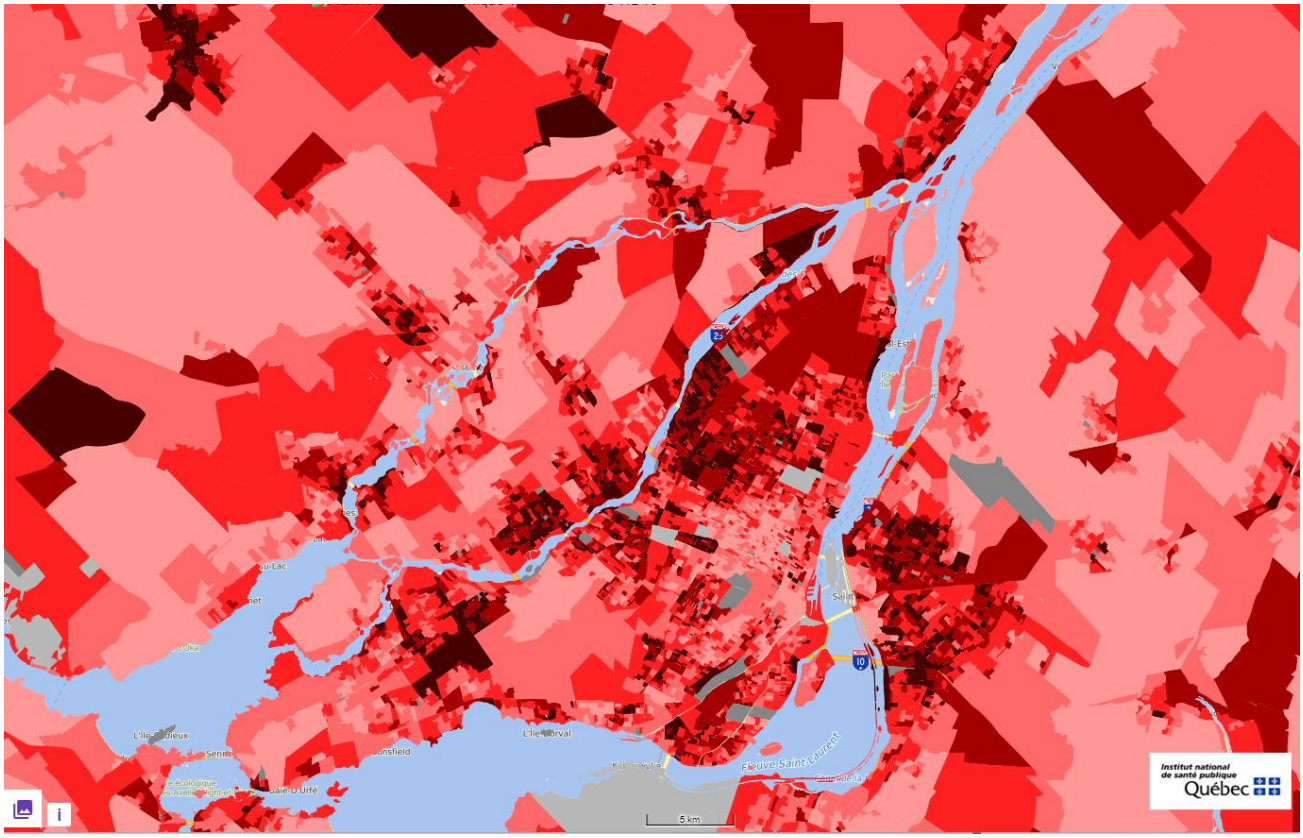

Figure 4. Levels of global relative vulnerability at DA level

Vulnerability level
Very low
Low
Moderate
High
Very high

The map of the Islands of Montreal and Laval as well as parts of the North and South Shore (Figure 5) shows only a few spots of neighbourhoods with very high absolute vulnerability. These are situated within areas with higher relative vulnerability. The index thus identifies small areas where focused interventions such as distribution of face masks or a local mobile vaccination station could take place. The map shows the local version of the index with 5 clusters of absolute vulnerability levels ranging from light yellow – very low vulnerability to brown – very high vulnerability.

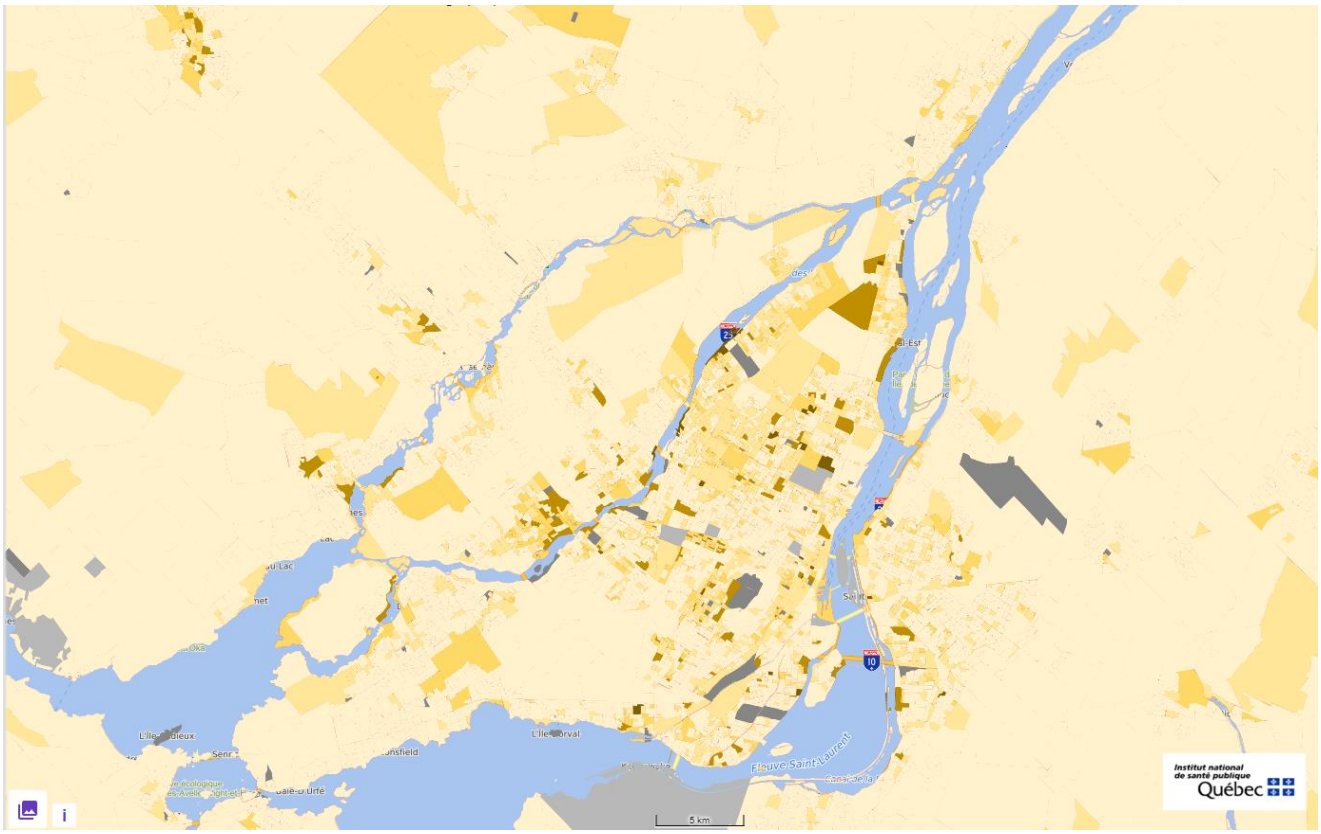

Figure 5. Levels of global absolute vulnerability at DA level

Vulnerability level	
	Very low
	Low
	Moderate
	High
	Very high

12 Data sources

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13 Other COVID-19 vulnerability indices

Similar vulnerability indices were developed for British Columbia, the city of Toronto, the United States and the United Kingdom.

- COVID-19 Risks in British Columbia's Neighbourhoods
- COVID-19 Neighbourhood Vulnerability Index
- COVID-19 Pandemic Vulnerability Index
- COVID-19 Community Vulnerability Index
- British Red Cross COVID-19 Vulnerability Index

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Appendix

Appendix 1 Figures and descriptive tables

Relative vulnerability

1. Global relative vulnerability, national version

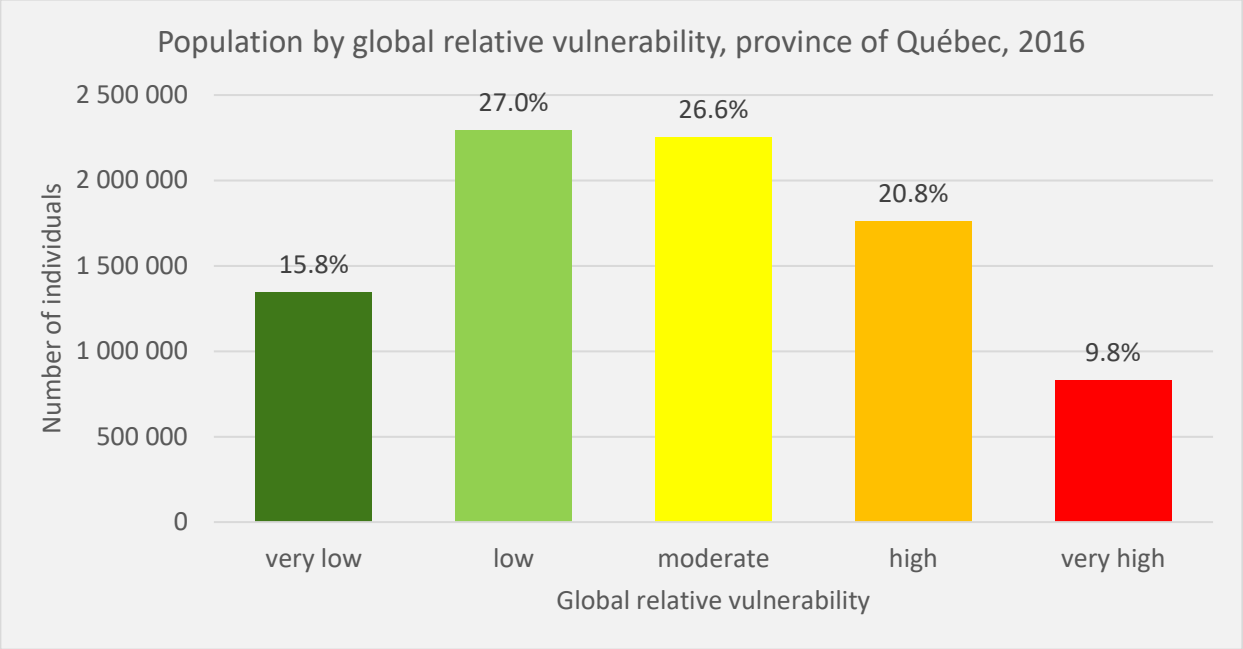

Figure 6. Proportion of population by global relative vulnerability

2. Relative vulnerability associated with biological susceptibility, province of Québec, 2016

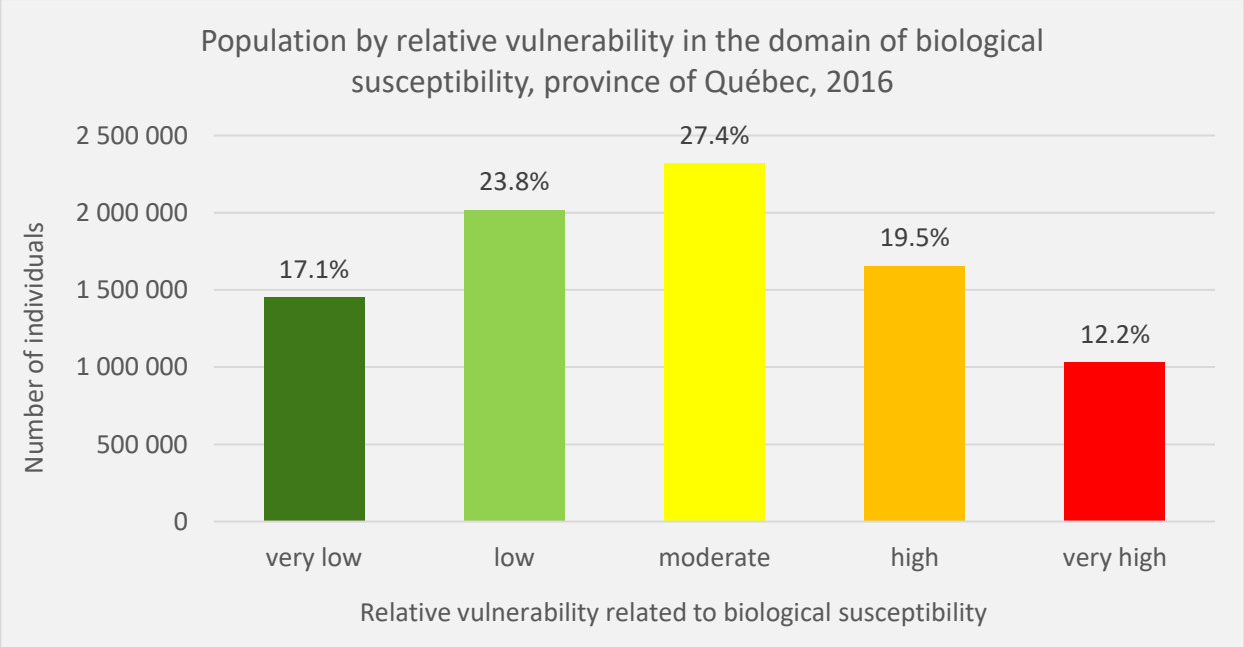

Figure 7. Proportion of population by relative vulnerability in the domain of biological susceptibility

3. Relative vulnerability related to sociocultural characteristics, province of Québec, 2016

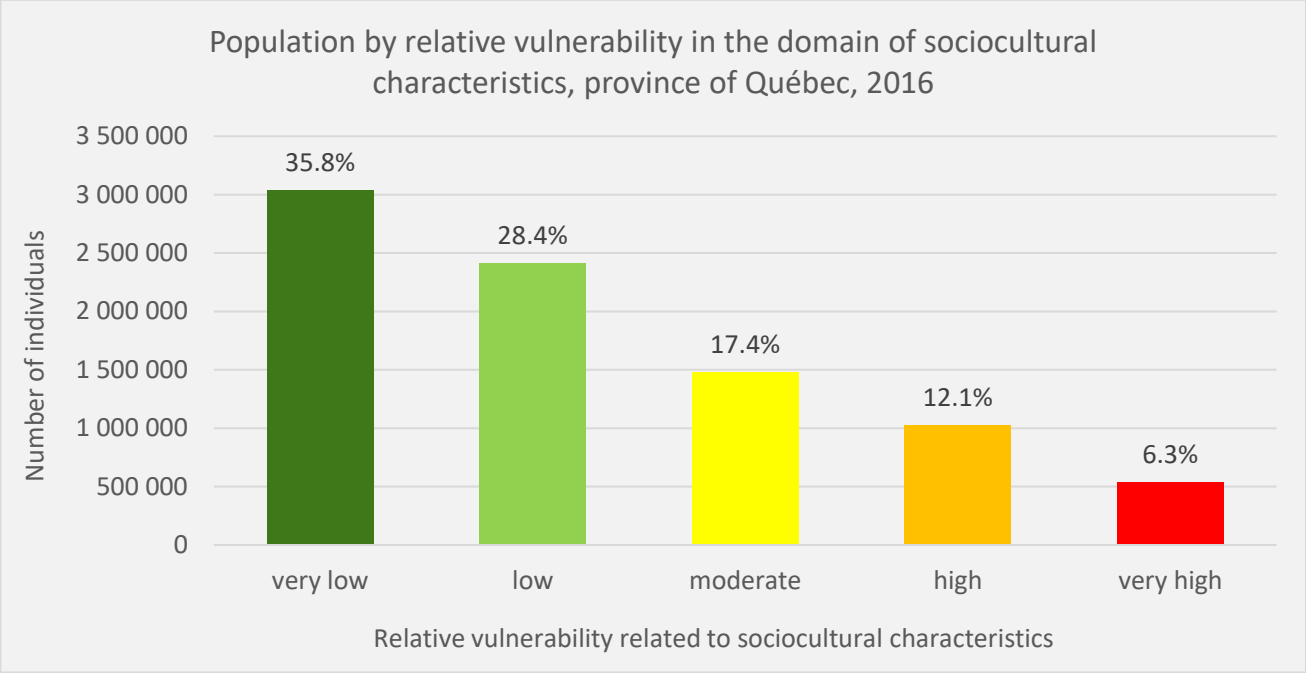

Figure 8. Proportion of population by level of vulnerability related to sociocultural characteristics

4. Relative vulnerability related to socioeconomic characteristics, province of Québec, 2016

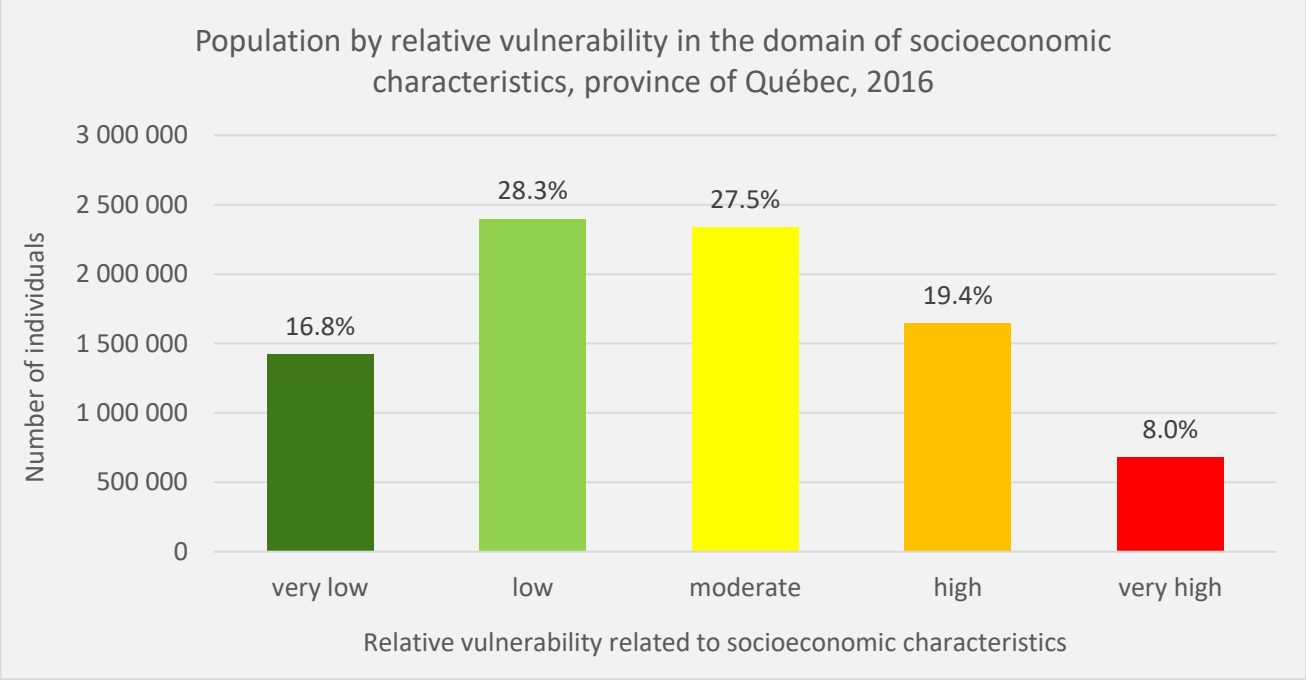

Figure 9. Proportion of population by level of vulnerability related to socioeconomic characteristics

5. Relative vulnerability related to indoor exposure, province of Québec, 2016

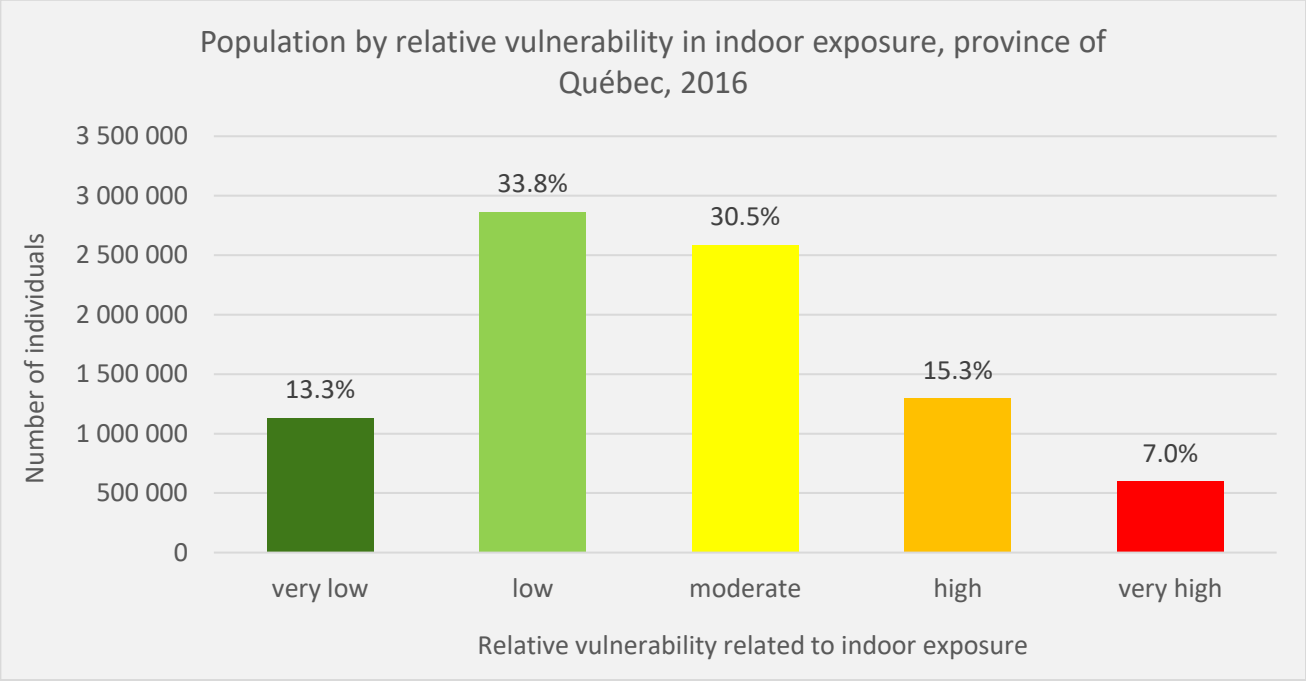

Figure 10. Proportion of population by level of vulnerability related to indoor exposure

6. Relative vulnerability related to outdoor exposure, province of Québec, 2016

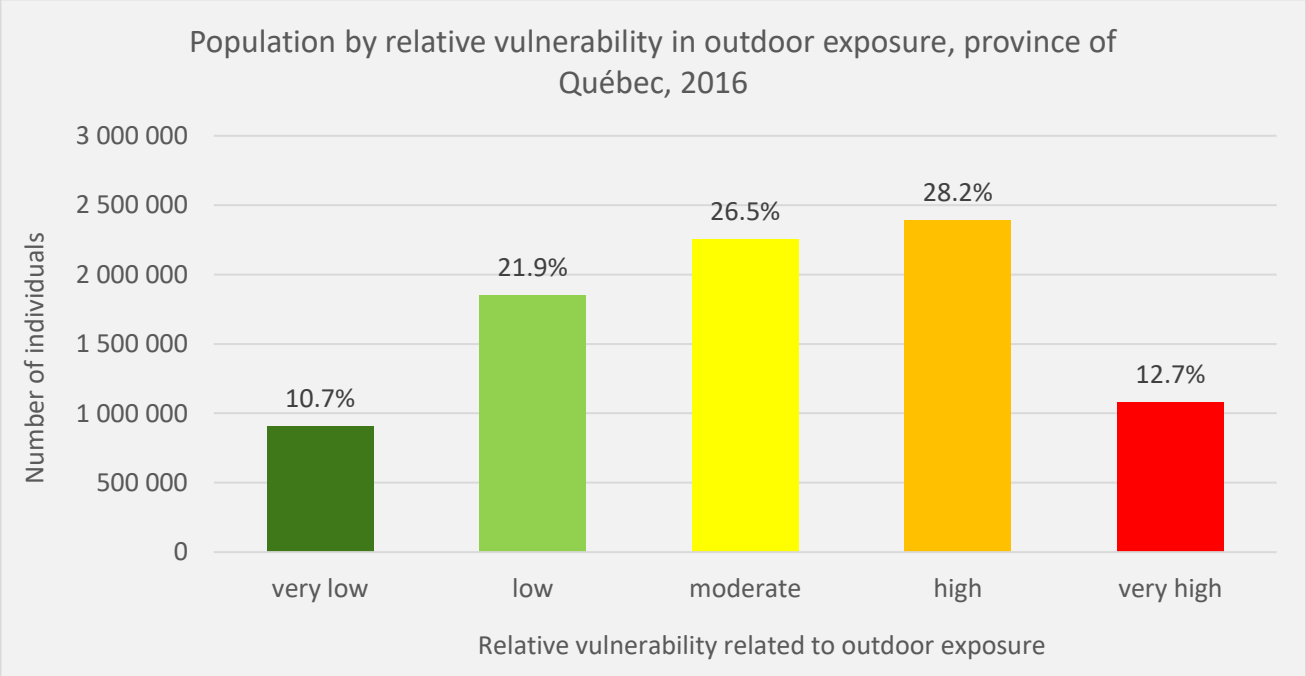

Figure 11. Proportion of population by level of vulnerability related to outdoor exposure

Absolute vulnerability

1. Global absolute vulnerability, province of Québec, 2016

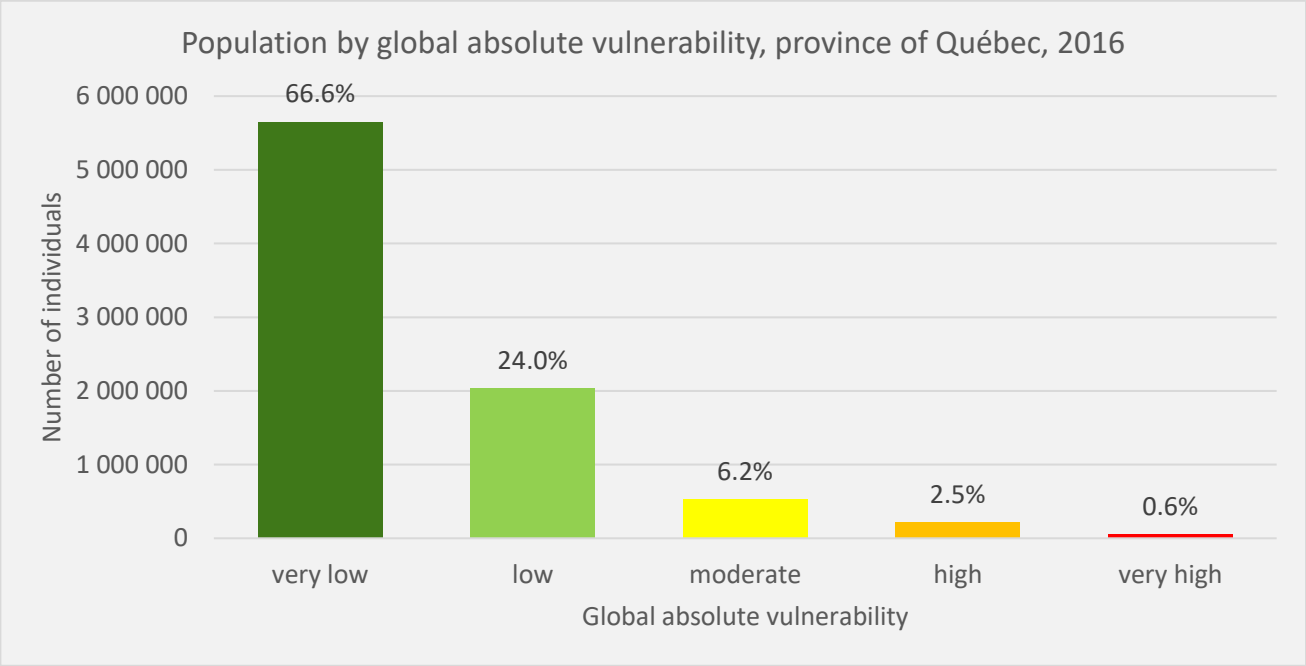

Figure 12. Proportion of population by level of global absolute vulnerability

2. Absolute vulnerability related to biological susceptibility, province of Québec, 2016

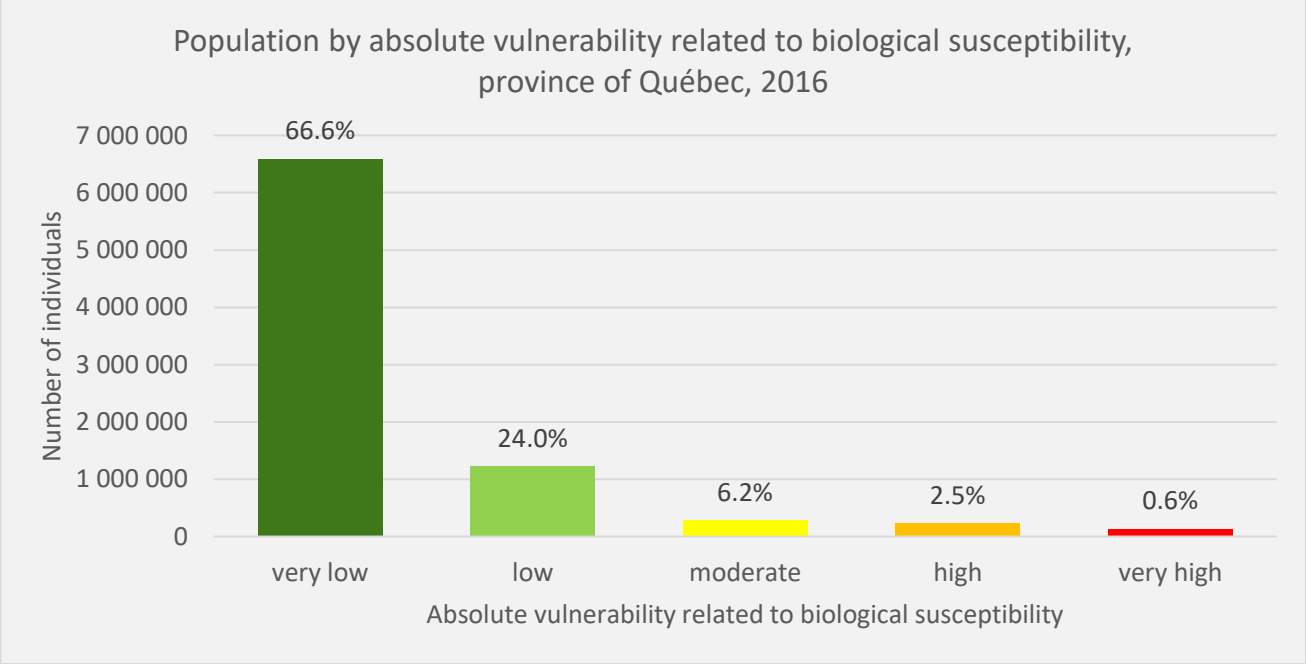

Figure 13. Proportion of population by level of absolute vulnerability related to biological susceptibility

3. Absolute vulnerability related to sociocultural characteristics, province of Québec, 2016

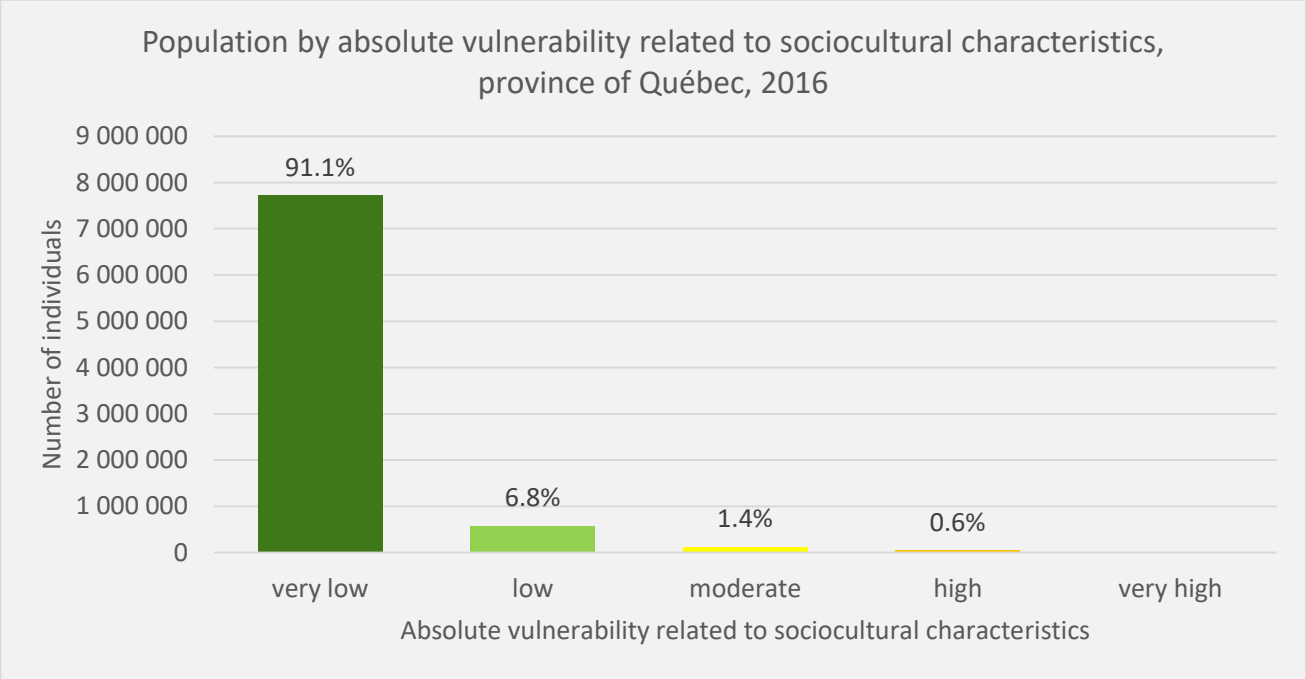

Figure 14. Proportion of individuals by level of vulnerability related to sociocultural characteristics

4. Absolute vulnerability related to socioeconomic characteristics, province of Québec, 2016

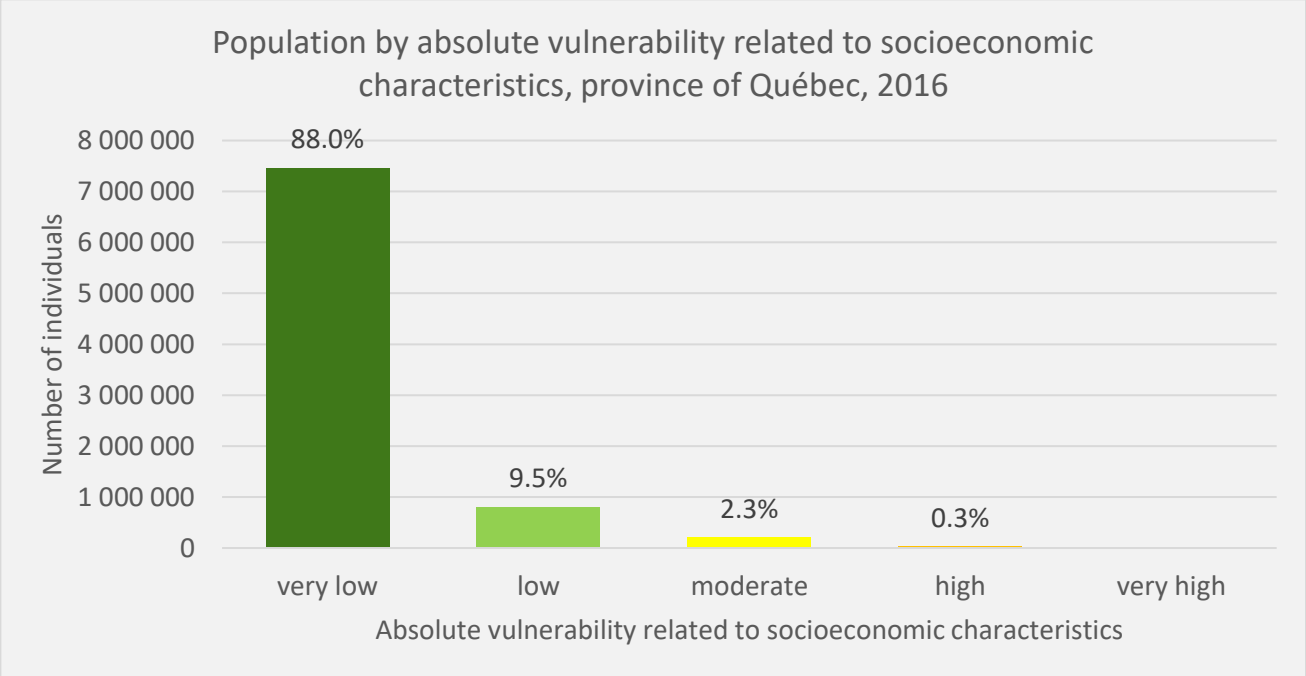

Figure 15. Proportion of individuals by level of vulnerability related to socioeconomic characteristics

5. Absolute vulnerability related to indoor exposure, province of Québec, 2016

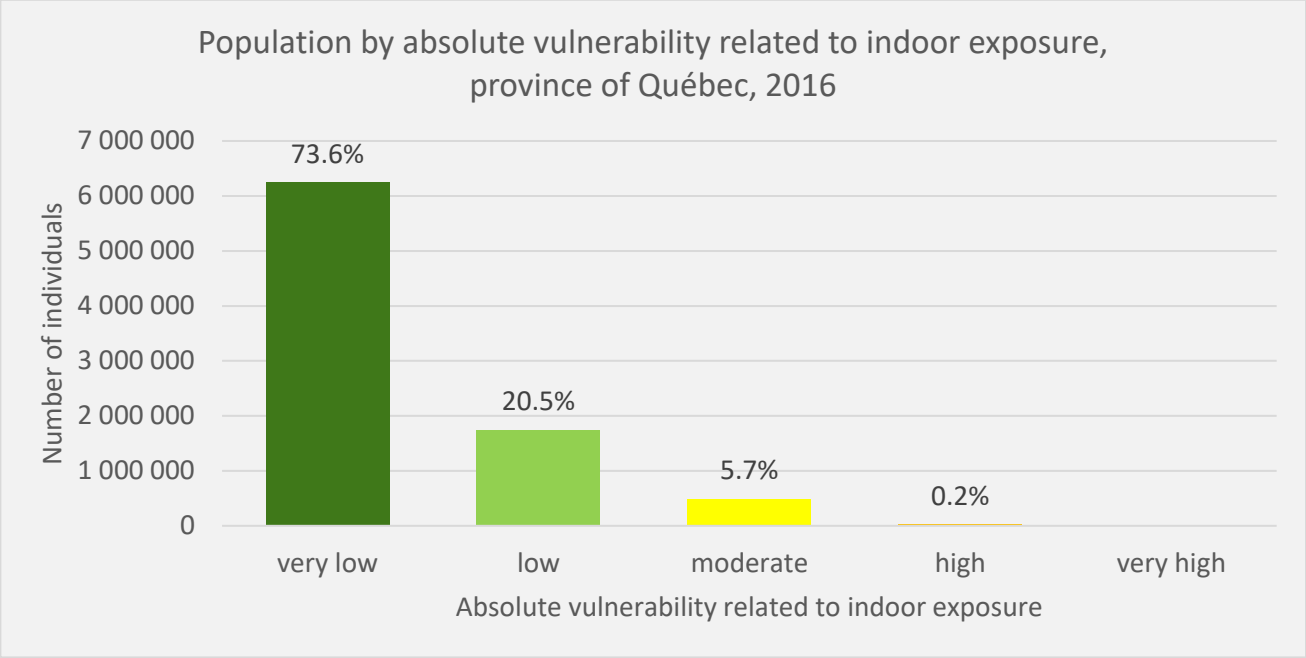

Figure 16. Proportion of individuals by level of vulnerability related to indoor exposure

6. Absolute vulnerability related to outdoor exposure, province of Québec, 2016

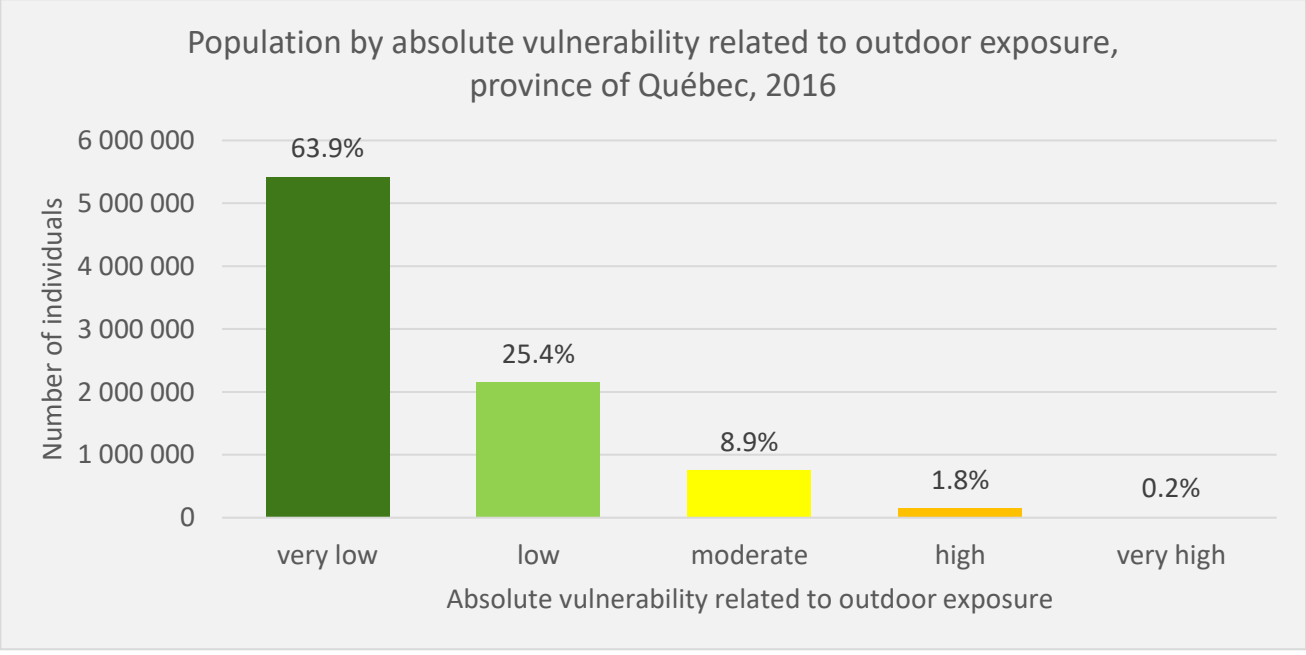

Figure 17. Proportion of individuals by level of vulnerability related to outdoor exposure

The same set of 18 figures can be produced for each sociosanitary region, for each of the four metropolitan areas and for three types of territories along the urban-rural continuum.

Appendix 2 Data dictionary (in alphabetical order)

Variable	Description
Particular codes applying to all variables : -998 – missing information in a DA that has participated in the census -999 – missing information in a DA that has not participated in the census	
AD	Code for the dissemination area (DA), attributed by Statistics Canada
ADPOP2016	Population residing in the DA. When the population residing in the DA did not participate in the census, we attributed codes -998 or -999 (see above).
Vulnerability measures	
Categorical variables	
cl_l_centbio_r2	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (l_centbio_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centsoc_r2	Level of relative vulnerability in the sociocultural domain. Measure grouping the continuous variable (l_centsoc_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centses_r2	Level of relative vulnerability in the socioeconomic domain. Measure grouping the continuous variable (l_centses_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability

Variable	Description
cl_l_centint_r2	Level of relative vulnerability in the indoor exposure domain. Measure grouping the continuous variable (l_centint_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centext_r2	Level of relative vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (l_centext_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centbio_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (l_centbio_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centpop_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (l_centpop_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centenv_r3	Level of relative vulnerability related to exposure. Measure grouping the continuous variable (l_centenv_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The

Variable	Description
	territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_centglob_r4	Level of global relative vulnerability. Measure grouping the continuous variable (l_centglob_r4) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagbio_a2	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (l_flagbio_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagsoc_a2	Level of absolute vulnerability in the sociocultural domain. Measure grouping the continuous variable (l_flagsoc_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagses_a2	Level of absolute vulnerability in the socioeconomic domain. Measure grouping the continuous variable (l_flagses_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability

Variable	Description
cl_l_flagint_a2	Level of absolute vulnerability in the indoor exposure domain. Measure grouping the continuous variable (l_flagint_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagext_a2	Level of absolute vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (l_flagext_r2) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagbio_a3	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (l_flagbio_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagpop_a3	Level of absolute vulnerability related to biological susceptibility. Measure grouping the continuous variable (l_flagpop_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagenv_a3	Level of absolute vulnerability related to exposure. Measure grouping the continuous variable (l_flagenv_r3) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The

Variable	Description
	territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_l_flagglob_a4	Level of global absolute vulnerability. Measure grouping the continuous variable (l_flagglob_r4) into clusters using the Jenks (1967) method. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centbio_r2	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (n_centbio_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centsoc_r2	Level of relative vulnerability in the sociocultural domain. Measure grouping the continuous variable (n_centsoc_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centses_r2	Level of relative vulnerability in the socioeconomic domain. Measure grouping the continuous variable (n_centses_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centint_r2	Level of relative vulnerability in the indoor exposure domain. Measure grouping the continuous variable (n_centint_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs).

Variable	Description
	1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centext_r2	Level of relative vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (n_centext_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centbio_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (n_centbio_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centpop_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (n_centpop_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centenv_r3	Level of relative vulnerability in exposure. Measure grouping the continuous variable (n_centenv_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_centglob_r4	Level of global relative vulnerability. Measure grouping the continuous variable (n_centglob_r4) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagbio_a2	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (n_flagbio_r2) into clusters using the

Variable	Description
	Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagsoc_a2	Level of absolute vulnerability in the sociocultural domain. Measure grouping the continuous variable (n_flagsoc_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagses_a2	Level of absolute vulnerability in the socioeconomic domain. Measure grouping the continuous variable (n_flagses_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagint_a2	Level of absolute vulnerability in the indoor exposure domain. Measure grouping the continuous variable (n_flagint_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagext_a2	Level of absolute vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (n_flagext_r2) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagbio_a3	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (n_flagbio_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 4= High vulnerability 5= Very high vulnerability

Variable	Description
	3= Medium vulnerability
cl_n_flagpop_a3	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (n_flagpop_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagenv_a3	Level of absolute vulnerability in exposure. Measure grouping the continuous variable (n_flagenv_r3) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_n_flagglob_a4	Level of global absolute vulnerability. Measure grouping the continuous variable (n_flagglob_r4) into clusters using the Jenks (1967) method. National version (province-wide calculation including all DAs). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centbio_r2	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (r_centbio_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centsoc_r2	Level of relative vulnerability in the sociocultural domain. Measure grouping the continuous variable (r_centsoc_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centses_r2	Level of relative vulnerability in the socioeconomic domain. Measure grouping the continuous variable (r_centses_r2) into clusters using the

Variable	Description
	Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centint_r2	Level of relative vulnerability in the indoor exposure domain. Measure grouping the continuous variable (r_centint_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centext_r2	Level of relative vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (r_centext_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centbio_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (r_centbio_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centpop_r3	Level of relative vulnerability in biological susceptibility. Measure grouping the continuous variable (r_centpop_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_centenv_r3	Level of relative vulnerability in exposure. Measure grouping the continuous variable (r_centenv_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 4= High vulnerability 5= Very high vulnerability

Variable	Description
	3= Medium vulnerability
cl_r_centglob_r4	Level of global relative vulnerability. Measure grouping the continuous variable (r_centglob_r4) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagbio_a2	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (r_flagbio_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagsoc_a2	Level of absolute vulnerability in the sociocultural domain. Measure grouping the continuous variable (r_flagsoc_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagses_a2	Level of absolute vulnerability in the socioeconomic domain. Measure grouping the continuous variable (r_flagses_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagint_a2	Level of absolute vulnerability in the indoor exposure domain. Measure grouping the continuous variable (r_flagint_r2) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagext_a2	Level of absolute vulnerability in the outdoor exposure domain. Measure grouping the continuous variable (r_flagext_r2) into clusters using the

Variable	Description
	Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagbio_a3	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (r_flagbio_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagpop_a3	Level of absolute vulnerability in biological susceptibility. Measure grouping the continuous variable (r_flagpop_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagenv_a3	Level of absolute vulnerability in exposure. Measure grouping the continuous variable (r_flagenv_r3) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
cl_r_flagglob_a4	Level of global absolute vulnerability. Measure grouping the continuous variable (r_flagglob_r4) into clusters using the Jenks (1967) method. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). 1= Very low vulnerability 2= Low vulnerability 3= Medium vulnerability 4= High vulnerability 5= Very high vulnerability
Measures with continuous variables	
l_flagbio_a2	Absolute vulnerability related to biological constitution. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Local version (calculated separately for each of the selected municipalities including

Variable	Description
	only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagsoc_a2	Absolute vulnerability in the sociocultural domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagint_a2	Absolute vulnerability related to indoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagses_a2	Absolute vulnerability in the socioeconomic domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagext_a2	Absolute vulnerability related to outdoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate regions.). Values range from 0 to 99.
l_flagbio_a3	Absolute vulnerability related to the mechanism of biological sensibility. Gradient measure calculated as the sum of risk factors in the domain of biological susceptibility ordered into centiles and divided by the total of non-missing indicators in the domain multiplied by 100. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.

Variable	Description
l_flagpop_a3	Absolute vulnerability related to the mechanism of sociocultural and socioeconomic susceptibility. Gradient measure calculated as the sum of risk factors in the sociocultural and socioeconomic domains and ranked into centiles. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagenv_a3	Absolute vulnerability related to the mechanism of exposure. Gradient measure calculated as the sum of risk factors in the indoor and outdoor exposure domains and ranked into centiles. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
l_flagglob_a4	Global absolute vulnerability. Gradient measure calculated as the sum of the biological, social susceptibility and exposure mechanisms and ranked into centiles. Local version (calculated separately for each of the selected municipalities including only the DAs of the respective municipality. The territory outside the respective municipality is divided into urban, rural and intermediate areas. Values range from 0 to 99.
n_centbio_r2	Relative vulnerability related to biological susceptibility. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centsoc_r2	Relative vulnerability in the sociocultural domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centint_r2	Relative vulnerability related to indoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centses_r2	Relative vulnerability in the socioeconomic domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centext_r2	Relative vulnerability related to outdoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the

Variable	Description
	total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centbio_r3	Relative vulnerability related to the mechanism of biological susceptibility. Gradient measure calculated as the sum of risk factors in the domain of biological susceptibility ordered into centiles and divided by the total of non-missing indicators in the domain multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centpop_r3	Relative vulnerability related to the mechanism of social (sociocultural and socioeconomic) susceptibility. Gradient measure calculated as the sum of risk factors in the sociocultural and socioeconomic domains and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centenv_r3	Relative vulnerability related to the mechanism of exposure. Gradient measure calculated as the sum of risk factors in the indoor and outdoor exposure domains and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_centglob_r4	Global relative vulnerability. Gradient measure calculated as the sum of the biological, social susceptibility and exposure mechanisms and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagbio_a2	Absolute vulnerability related to biological constitution. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagsoc_a2	Absolute vulnerability in the sociocultural domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagint_a2	Absolute vulnerability related to indoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagses_a2	Absolute vulnerability in the socioeconomic domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.

Variable	Description
n_flagext_a2	Absolute vulnerability related to outdoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagbio_a3	Absolute vulnerability related to the mechanism of biological susceptibility. Gradient measure calculated as the sum of risk factors in the domain of biological susceptibility ordered into centiles and divided by the total of non-missing indicators in the domain multiplied by 100. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagpop_a3	Absolute vulnerability related to the mechanism of social (sociocultural and socioeconomic) susceptibility. Gradient measure calculated as the sum of risk factors in the sociocultural and socioeconomic domains and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagenv_a3	Absolute vulnerability related to the mechanism of exposure. Gradient measure calculated as the sum of risk factors in the indoor and outdoor exposure domains and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
n_flagglob_a4	Global absolute vulnerability. Gradient measure calculated as the sum of the biological, social susceptibility and exposure mechanisms and ranked into centiles. National version (calculated including all DAs in the province). Values range from 0 to 99.
r_centbio_r2	Relative vulnerability related to biological susceptibility. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centsoc_r2	Relative vulnerability in the sociocultural domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centint_r2	Relative vulnerability related to indoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.

Variable	Description
r_centses_r2	Relative vulnerability in the socioeconomic domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centext_r2	Relative vulnerability related to outdoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centbio_r3	Relative vulnerability related to the mechanism of biological susceptibility. Gradient measure calculated as the sum of risk factors in the domain of biological susceptibility ordered into centiles and divided by the total of non-missing indicators in the domain multiplied by 100. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centpop_r3	Relative vulnerability related to the mechanism of social (sociocultural and socioeconomic) susceptibility. Gradient measure calculated as the sum of risk factors in the sociocultural and socioeconomic domains and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centenv_r3	Relative vulnerability related to the mechanism of exposure. Gradient measure calculated as the sum of risk factors in the indoor and outdoor exposure domains and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_centglob_r4	Global relative vulnerability. Gradient measure calculated as the sum of the biological, social susceptibility and exposure mechanisms and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagbio_a2	Absolute vulnerability related to biological constitution. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagsoc_a2	Absolute vulnerability in the sociocultural domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version

Variable	Description
	(calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagint_a2	Absolute vulnerability related to indoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagses_a2	Absolute vulnerability in the socioeconomic domain. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100.Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagext_a2	Absolute vulnerability related to outdoor exposure. Gradient measure calculated as the sum of risk factors ranked into centiles divided by the total of non-missing indicators multiplied by 100. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagbio_a3	Absolute vulnerability related to the mechanism of biological susceptibility. Gradient measure calculated as the sum of risk factors in the domain of biological susceptibility ordered into centiles and divided by the total of non-missing indicators in the domain multiplied by 100. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagpop_a3	Absolute vulnerability related to the mechanism of social (sociocultural and socioeconomic) susceptibility. Gradient measure calculated as the sum of risk factors in the sociocultural and socioeconomic domains and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagenv_a3	Absolute vulnerability related to the mechanism of exposure. Gradient measure calculated as the sum of risk factors in the indoor and outdoor exposure domains and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.
r_flagglob_a4	Global absolute vulnerability. Gradient measure calculated as the sum of the biological, social susceptibility and exposure mechanisms and ranked into centiles. Regional version (calculated separately for each RSS, including only the DAs of the respective RSS). Values range from 0 to 99.

Table 3: Data dictionary

Appendix 3 Colour code for mapping

Relative vulnerability

	Description
	1= Very low vulnerability
	2= Low vulnerability
	3= Medium vulnerability
	4= High vulnerability
	5= Very high vulnerability
	-998 – missing information when a DA participated in the census
	-999 – missing information when a DA did not participate in the census

Table 4: Colour code for relative vulnerability

Absolute vulnerability

	Description
	1= Very low vulnerability
	2= Low vulnerability
	3= Medium vulnerability
	4= High vulnerability
	5= Very high vulnerability
	-998 – missing information when a DA participated in the census
	-999 – missing information when a DA did not participate in the census

Table 5: Colour code for relative vulnerability

Appendix 4 Risk factors included in the SVIQ with link to publications where the risk was documented in 2020

Domain	Indicator	Label	Evidence/reason for inclusion
Biological constitution domain			
	Sex	% male population (2020)	https://bmjopen.bmj.com/content/11/1/e044640 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7577231/
	Age	% age 65 and over (2020)	https://bmjopen.bmj.com/content/11/1/e044640 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7577231/
	Respiratory diseases	% population with chronic respiratory disease (20	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html https://pubmed.ncbi.nlm.nih.gov/32817712/
	Cardiovascular diseases	% population with chronic cardiovascular disease	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html
	Cancer	% population with cancer	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html
	Compromised immunity	% population with compromised immunity	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html https://ard.bmj.com/content/early/2020/10/13/annrheumdis-2020-218946
	Diabetes	% population with diabetes	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Obesity	% population with obesity	https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Multimorbidity	% population with 2 or more chronic diseases	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://pubmed.ncbi.nlm.nih.gov/32817712/ https://www.inspq.qc.ca/sites/default/files/publications/3082-impact-comorbidites-risque-deces-covid19.pdf
Sociocultural risk factors			
	Knowledge of official languages	% population without knowledge of official languages	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Visible minority	% visible minority	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://pubmed.ncbi.nlm.nih.gov/32466757/

			Lien entre min.vis. et trav.essentiel: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7162639/
	Aboriginal identity	% population with aboriginal identity	Discrimination, language, access to networks and information, SDOH
	Recent immigrants	% recent immigrants	Discrimination, language, access to networks and information, SDOH
	Asylum seekers	% asylum seekers or refugees	Lack of access to health services
	Access to high-speed internet	% population without high-speed internet (2020)	https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(20)30085-2/fulltext
Socioeconomic risk factors			
	Education	% population with low education	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext https://pubmed.ncbi.nlm.nih.gov/32466757/
	Poverty	% age 18-64 living in poverty	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext https://pubmed.ncbi.nlm.nih.gov/32466757/
	Income	Median income ($)	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext
	Unemployment	Unemployment rate	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext
	Independent workers	% independent workers	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Part-time workers	% part-time workers	https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext
	Weeks worked	Number of weeks worked	travail saisonnier
	Expensive housing	% population living in expensive housing (30% and more of income spent on housing)	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.scielo.br/scielo.php?pid=S0034-71672020001400158&script=sci_arttext
	Dwellings in need of major repair	% dwellings in need of major repair	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7605696/
Indoor exposure domain			
	Institutionalized population	% institutionalized population	Closed spaces: https://www.canada.ca/fr/sante-publique/services/maladies/2019-nouveau-coronavirus/prevention-risques.html https://www.ecdc.europa.eu/en/COVID-19/latest-evidence/epidemiology https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Family members living together	Number family members living together	

			https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Overcrowding	% overcrowded households	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7605696/
	Apartment buildings	% apartment in buildings with 5 or more stories	
	Mobile homes	% mobile homes	
	Rooms	% 0 bedrooms	
			Closed spaces: https://www.canada.ca/fr/sante-publique/services/maladies/2019-nouveau-coronavirus/prevention-risques.html
	School-aged population	% population aged 5-16 years	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7313894/ https://www.canada.ca/fr/sante-publique/services/maladies/2019-nouveau-coronavirus/prevention-risques.html
	At risk workers	% population working in at risk professions	https://www.ecdc.europa.eu/en/COVID-19/latest-evidence/epidemiology https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.canada.ca/fr/sante-publique/services/maladies/2019-nouveau-coronavirus/prevention-risques.html https://www.ecdc.europa.eu/en/COVID-19/latest-evidence/epidemiology A model of disparities: risk factors associated with COVID-19 infection | International Journal for Equity in Health | Full Text (biomedcentral.com)
	At risk industries	% population working in at risk industries	onlinelibrary.wiley.com/doi/full/10.1111/cars.12288 pubmed.ncbi.nlm.nih.gov/32660216/
	Public transit	% population using public transit	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z
	Time in public transit	% population with over 15 minutes in public transit	Duration of exposure : https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html
	Mental health problems	% population with mental health problems	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html
	Addiction problems	% population with addiction problems	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://www.inspq.qc.ca/espace-itss/itss-covid-19
Outdoor exposure domain			
	Population density	Population density	Contradictory association : https://www.jhsph.edu/news/news-releases/2020/urban-density-not-linked-to-higher-coronavirus-infection-rates-and-is-linked-to-lower-COVID-19-death-rates.html MAIS: https://www.mdpi.com/2220-9964/9/11/624/htm

		https://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/densityhousing_1_arguments_moosmcculleyvinodrai.pdf https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://ghrp.biomedflagral.com/track/pdf/10.1186/s41256-020-00167-y.pdf
Air pollution - ozone	Mean annual concentration of ozone (2015) (ppb)	https://www.mdpi.com/1660-4601/17/12/4487/htm ec.europa.eu/jrc/en/science-update/do-environmental-factors-influence-COVID-19-outbreaks
Air pollution - PM2.5	Mean annual concentration of PM2.5 (2012) (micrograms per cubic meter (ug/m3))	https://equityhealthj.biomedflagral.com/articles/10.1186/s12939-020-01242-z https://ghrp.biomedflagral.com/track/pdf/10.1186/s41256-020-00167-y.pdf https://www.mdpi.com/1660-4601/17/12/4487/htm ec.europa.eu/jrc/en/science-update/do-environmental-factors-influence-COVID-19-outbreaks
Air pollution - Sulfur	Mean annual concentration of sulfur (2015) (ppb)	https://www.mdpi.com/1660-4601/17/12/4487/htm ec.europa.eu/jrc/en/science-update/do-environmental-factors-influence-COVID-19-outbreaks

Table 6: Risk factors included in the SVIQ with link to publication where the risk was documented in 2020

Appendix 5 Risk factors included in other vulnerability indices

Indicators	CVIQ	MDI	SVI	CCVI VI	PVI	British Red Cross COVID-19 VI	COVID-19 risks in BC's neighbourhoods	COVID-19 Neighbourhood VI (Toronto)	Amran et al. 2020[3]	Ong et al. 2020[4]	Khan et al. 2020[5]	Snyder & Parks 2020[6]
	Blaser, 2021	Statistics Canada, 2018	CDC, 2021	Surgo Ventures, 2020	Marvel et al., 2021	British Red Cross, 2020	Crooks, 2020	Yang et al., 2020	Amran et al. 2020	Ong et al. 2020	Khan et al., 2020	Snyder and Parks 2020
Sex	x										x	x
Age	x	x	x	x	x	x		x	x	x	x	x
Respiratory diseases	x	x		x		x		x	x			
Cardiovascular diseases	x	x		x		x		x	x	x	x	x
Cancer	x	x		x		x					x	
Compromised immunity	x	x		x								
Diabetes	x	x		x	x	x		x	x	x		x
Obesity	x			x	x	x				x	x	x
Multimorbidity	x											
Premature death					x							
Smoking					x							
Rate of COVID-19 transmission					x							
Disease spread					x							
Knowledge of official languages	x	x	x	x						x		
Visible minority	x	x	x	x	x			x		x		
Aboriginal identity	x	x			x							
Recent immigrants	x	x										
Asylum seekers	x	x								x		
Access to high-speed internet	x					x				x		

[3] https://www.sciencedirect.com/science/article/abs/pii/S1353829220306298?via%3Dihub

[4] https://www.medrxiv.org/content/10.1101/2020.11.02.20215657v1

[5] https://www.medrxiv.org/content/10.1101/2020.07.04.20146084v1

[6] https://www.sciencedirect.com/science/article/pii/S1353829220306080?via%3Dihub

Education	x			x	x					x			x	x	x
Poverty	x			x	x		x				x		x	x	x
Income	x			x	x			x		x			x	x	
Unemployment	x		x	x	x			x					x	x	
Independent workers	x		x												
Part-time workers	x														
Weeks worked	x		x												
Expensive housing	x		x				x		x						
Dwellings in need of major repair	x		x				x								
Socioeconomic status (SVI)						x									
Institutionalized population	x														
Family members living together	x								x						
Overcrowding	x		x	x			x		x				x	x	
Apartment buildings	x		x	x	x					x			x		
Mobile homes	x			x	x								x		
Rooms	x														
School-aged population	x			x									x		
At risk workers	x		x						x			x			
At risk industries	x		x						x			x			
Public transit	x									x					
Time in public transit	x														
Baseline traffic						x									
Mental health problems	x						x						x		
Addiction problems			x												
Population density	x				x					x	x		x	x	x
Daytime population density						x									
Residential density						x									
Air pollution - Ozone	x						x								x
Air pollution - PM2.5	x					x	x							x	x
Air pollution - Sulfur	x						x								x
Social Distancing						x									

COVID-19 testing	x
Vaccines	x
Uninsured	x
Hospital beds	x
Hospital ventilators	x

Table 7: Risk factors included in other deprivation and vulnerability indices

Also see Wolkin (2022) and Tipirneni (2022) for a comparison of selected indices.

Appendix 6 Cluster limits by domain

Domains	**Biological susceptibility**	**Sociocultural characteristics**	**Socioeconomic characteristics**	**Indoor contacts**	**Outdoor contacts and air pollution**
Low vulnerability	1-25	1-13	1-24	1-24	1-27
Low to moderate	26-42	14-28	25-39	25-38	28-42
Moderate	43-60	29-46	40-54	39-52	43-56
Moderate to high	61-77	47-67	55-70	53-69	57-72
High vulnerability	78-100	68-100	71-100	70-100	73-100

Table 8: Cluster limits by domain

The numbers represent the percentile at which the level of vulnerability changes.

Appendix 7 Cluster limits by mechanism and for global vulnerability

Mechanisms	**Biologic mechanism**	**Social mechanism**	**Environmental mechanism**	**Global vulnerability**
Low vulnerability	1-25	1-22	1-29	1-26
Low to moderate	26-42	23-36	30-42	27-40
Moderate	43-60	37-50	43-54	41-53
Moderate to high	61-77	51-67	55-69	53-67
High vulnerability	78-100	68-100	70-100	68-100

Table 9: Cluster limits for mechanisms and global vulnerability

Appendix 8 Correlations between domains

	Biological susceptibility	Sociocultural characteristics	Socioeconomic characteristics	Indoor contacts	Outdoor contacts and air pollution
Biological susceptibility	-	-0.16814	0.18572	-0.12948	0.12442
Sociocultural characteristics	-0.16814	-	0.43669	0.54095	-0.05545
Socioeconomic characteristics	0.18572	0.43669	-	0.32218	0.14461
Indoor contacts	-0.12948	0.54095	0.32218	-	-0.00896
Outdoor contacts and air pollution	0.12442	-0.05545	0.14461	-0.00896	-

Table 10: Correlation between domains (global relative vulnerability)