What factors converged to create a COVID-19 hot-spot? Lessons from the South Asian community in Ontario.

Sonia S Anand MD PhD FRCPC[1,2], Corey Arnold PhD[3], Shrikant Bangdiwala PhD[2,4], Shelly Bolotin PhD[5,6], Dawn Bowdish PhD[1], Rahul Chanchlani MD MSc MBBS[7], Russell de Souza ScD RD[2,4], Dipika Desai MSc[2], Sujane Kandasamy PhD[4], Farah Khan[2], Zainab Khan[2], Marc-André Langlois PhD[3], Jayneel Limbachia[2], Scott Lear PhD[8], Dr. Mark Loeb MD MSc[4,9], Lawrence Loh MD MPH FCFP FRCPC FACPM[6], Baanu Manoharan BSc[4], Kiran Nakka PhD[3], Martin Pelchat PhD[3], Zubin Punthakee MD MSc[1,2], Karleen Schulze MMath[2], Natalie Williams MLIS[1], Gita Wahi MD FRCPC[7]

[1]McMaster University, Department of Medicine
[2]Population Health Research Institute
[3]University of Ottawa, Department of Biochemistry, Microbiology, and Immunology
[4]McMaster University, Department of Health Research Methods, Evidence, and Impact
[5]Public Health Ontario
[6]University of Toronto, Dalla Lana School of Public Health
[7]McMaster University, Department of Pediatrics
[8]Faculty of Health Sciences, Simon Fraser University
[9]Department of Pathology and Molecular Medicine

Address for Correspondence:
Dr. Sonia Anand
Chanchlani Research Centre
Population Health Research Institute
1280 Main St West
McMaster University
anands@mcmaster.ca
905-528-9140 ext 21523

Keywords: South Asian, Ethnicity, COVID-19, Canada

Word Count: 2827

Declaration of competing interests:
M. L. has received vaccine advisory board consulting fees for Seqirus, Pfizer, Merck, Sanofi, Medicago; grant funding for vaccine trial from Seqirus; in-kind vaccine from Sanofi for a trial; and is on the Vaccine Data Safety Monitoring board for Medicago, NIH, CanSino biologics.

Abstract:

Background: South Asians represent the largest non-white ethnic group in Canada. The Greater Toronto Area (GTA), home to a high proportion of South Asians, emerged as a COVID-19 hot spot. Early in the pandemic, the South Asian community was identified as having risk factors for exposure and specific barriers to accessing testing and reliable health information, rendering them uniquely vulnerable to SARS-CoV-2 infection.

Objectives: To investigate the burden of SARS-CoV-2 infection among South Asians in the GTA, and to determine which demographic characteristics were most closely aligned with seropositivity, in this cross-sectional analysis of a prospective cohort study.

Methods: Participants from the GTA were enrolled between April and July 2021. Seropositivity for anti-spike and anti-nucleocapsid antibodies was determined from dried blood spots, and age and sex standardized to the Ontario South Asian population. Demographics, risk perceptions, and sources of COVID-19 information were collected via questionnaire in a subset.

Results: Among the 916 South Asians enrolled, mean age 41 years, the age and sex standardized seropositivity was 23.6% (95% CI: 20.8%-26.4%). Approximately one-third identified as essential workers, and 19% reported living in a multi-generational household. Over half perceived high COVID-19 risk due to their geographic location, and 36% due to their type of employment. The top three most trusted sources of COVID-related information included healthcare providers/public health, traditional media sources, and social media.

Conclusion: By the third wave of the COVID-19 pandemic, approximately one-quarter of a sample of South Asians in Ontario had serologic evidence of prior SARS-CoV-2 infection. Insight into factors that render certain populations at risk can help future pandemic planning and disease control efforts.

Background: The novel SARS-CoV-2 virus was declared a global pandemic in March 2020. Within Canada, COVID-19 hotspots emerged, and attention was drawn to these regions by the high infection and hospitalization rates and need to transfer patients outside of these regions to receive intensive care. South Asians (i.e., people who originate from the Indian subcontinent) are the largest non-white ethnic group in Canada (1) and have been disproportionally affected by COVID-19 (2). More than half of the residents of the Region of Peel, in the Greater Toronto Area (GTA), Ontario identify as South Asian (3).

Peel is divided into three cites - Caledon, Brampton, and Mississauga. Brampton has a population of 600,000; and over one-third of residents are South Asian, rising in some areas to nearly two thirds (4). In the first wave of the COVID-10 pandemic in Ontario [March to September 2020], the SARS-CoV-2 infection rate was almost twice as high in the City of Brampton, compared to the rate in neighbouring Mississauga (711 vs 390 cases per 100,000 people) (2). Peel emerged as a hotspot in Ontario, accounting for 22% of provincial cases during the second wave, beginning in September 2020 (2,5), although making up only 10% of the province's population (Figure 1), with the City of Brampton as the epicentre. Public Health Ontario provided indirect measures of the impact on the South Asian populations, showing the rates of infection, hospitalization, intensive care unit admission and death rates by quintiles of diversity in Ontario. People in the most diverse neighbourhoods were more likely to be new immigrants, younger, living in larger households, and had three times higher infection, four times the hospitalization, four times the intensive care unit admission, and two times the death rate from COVID-19 as compared to less diverse communities (6). Early in the pandemic, there was limited availability of SARS-CoV-2 laboratory

testing throughout Ontario. In hotspot communities, like Peel, this was compounded by other access barriers to health care which pre-dated the pandemic, which resulted in a high burden of infection (2). However, action by local and provincial public health officials, combined with advocacy from community groups and the media (7) resulted in increased resources for testing and prioritization of vaccine roll-out, which commenced in April 2021 (8).

Here we report the seroprevalence of SARS-CoV-2 infection in this ethnic group who were recruited during Wave 3 of the pandemic, [March 2021 to June 2021] and report the factors which correlate with infection.

Design and Methods:

The COVID CommUNITY study is a prospective cohort study focused on South Asian adults living in Canada, in the provinces of Ontario and British Columbia. In this cross-sectional analysis, we present data from the baseline assessment of the Ontario sub-cohort recruited between April 14, to July 28, 2021. All participants provided informed consent and this study was approved by Hamilton Integrated Research Ethics Board (13323 - March 24, 2021).

This study was funded by the COVID-19 Immune Task Force (CITF), and funds distributed from the Public Health Agency of Canada.

Study Population: Adults ≥ 18 years of age and South Asian were eligible. South Asian ethnicity was self-reported and defined by parental South Asian ancestry from the Indian subcontinent, Africa, Caribbean, and Guyana.

Recruitment: Recruitment was predominantly from vaccination centres in Brampton immediately after receiving dose 1 (Pre-vaccination group), or > 24 hours after receiving dose one or two of vaccination (Post vaccination group). A smaller proportion came from places of worship, SARS-CoV-2 testing centre in Brampton, through social media, and by inviting participants of South Asian origin from an existing cohort study (9). At the time of consent, dried blood spots (DBS) were collected along with key sociodemographic information, and vaccination status. Additional information regarding employment type, health history, prior SARS-CoV-2 infection, perception of SARS-CoV-2 infection risk, primary and trusted sources of COVID-19 information was collected on a web-based survey.

Laboratory measurements: DBS were collected in person at recruitment sites, and through the mail for social media and cohort recruitment. For home collection, an instructional video and self-addressed stamped envelope was provided for mail returns. Blood was collected on the WhatmanTM 903® Protein Saver Cards**.** Batched specimens were sent for analysis to the CITF-funded lab of our collaborator (Dr. Langlois) for analysis and were processed and analyzed using a high throughput ELISA assay (10,11). The main assays focused on the parallel detection of immunoglobulin IgG against the spike trimer (S), and the nucleocapsid (N) protein with standardized antigens to S, and N produced by the National Research Council of Canada

laboratory. This method has been used in prior studies (12), and detailed methods are described elsewhere (12,13). The IgG-based ELISAs measure antibody levels in single-point measurements in reference to a standard antibody curve to accurately distinguish individuals with previous infection or vaccination from those who have not been infected or vaccinated (Area Under the Receiver Operating Curve > 0.96 for each assay).

Evidence of previous infection was defined in pre-vaccinated participants (i.e. – those unvaccinated or those submitting samples immediately after receiving vaccine) as individuals with test results having signal to cutoff ratios ≥1 for both anti-S and anti-N IgG, or anti-S≥ 1 and a history of SARS-CoV-2 infection. Evidence of previous infection among vaccinated individuals (i.e. those who submitted a DBS sample >1 day after vaccination) was defined as an anti-N IgG results of ≥ 1. A range of *strict* definition and *lenient* definition in the pre-vaccination group was also examined and defined as a) IgG S and IgG N ≥ 1, and b) IgG S ≥ 1, respectively. The false discovery rate (FDR) was set at 2% for the IgG S, and 3% for IgG to N; These cut-offs have > 98% accuracy when validated by the National Microbiology Laboratory reference panel (11). The background seasonal coronavirus antibody mean titers in the Ottawa region was used as reference (10,13).

Statistical Analysis:

The proportion of participants who had evidence of prior SARS-CoV-2 infection is compared to the infection rate in similar forward sortation areas (FSA). Risk factors for SARS-CoV-2 infection, sources of health information, and perception of SARS-CoV-2 risk are reported as percentages or

means (SD) for the overall cohort, and for comparing seropositive to non-infected participants. Non-responders to the follow-up survey were compared to responders for age, sex, income, location, and seroprevalence. As this sample was not a random sample of the population, the risk of bias was assessed with a modified Joanna Briggs instrument (JBI) Critical Appraisal Checklist for Prevalence Studies (14). This tool evaluates the external and internal validity of the study using the CocoPop mnemonic (Condition, Context, Population) (15). The overall risk of bias was determined based on the criteria met and the impact any criteria that were not met have on the validity and reliability of the prevalence estimate (14). Items include questions on the sampling frame, sampling method, sample size, coverage, validity, and reliability of the condition measured, statistical analysis, and response rate, as shown in Supplementary Table 1.

Results: Recruitment into the COVID CommUNITY study in Ontario began on April 14, 2021, and 939 participants recruited, and a DBS collected up to July 28, 2021. Of 939 participants, 916 participants DBS were analyzed, and 75.7% of these participants completed the follow-up web-survey (Supplementary Figure 1). Participants who did not complete the survey were older, and more likely to be seropositive, although no significant differences in location of recruitment, household income, or sex were observed (Supplementary Table 2).

Demographic Characteristics: Characteristics of the overall cohort are shown in Table 1. The average age of participants was 41.5 years (14.4), and 49% were women. Briefly, over 90% of participants lived in the Peel Region, the majority (82%) from the City of Brampton. About two-thirds of participants were born in Canada or had lived in Canada more than 10 years. Most participants (78%) had completed post-secondary education, and 72% were employed. Almost

33% of participants' jobs were classified as essential work using the Ontario Government classification (i.e., food manufacturing and transportation workers), and an additional 16% of participants preferred not to answer this question. Although multigenerational household data were incomplete, of the 576 participants who completed this section, 19% reported living in a multigenerational household, with an additional 12% who preferred not to answer. The most common mother tongue reported included Punjabi or Urdu, followed by Gujarati, and Hindi. Demographic characteristics by pre- or post vaccination status are found in Supplementary Table 3.

Seropositivity: The proportion of seropositive cases by geographic region (FSA) are shown in comparison to the cumulative incidence of SARS-CoV-2 infection rate (Figure 2). The age-sex standardized seropositivity for previous infection was 23.6% (95% CI: 20.8 to 26.4). Among the 458 participants without a prior vaccination, the seroprevalence was 26.9% (95% CI: 22.8 to 31.0) compared to 21.3% (95% CI: 17.5 to 25.1) in the 458 participants who had received at least one dose of the COVID-19 vaccine (393 received one, 65 had received 2 doses). The seropositivity ranged from 22.7% applying the strict definition of seropositivity, to 27.4% using the lenient definition. The risk of bias assessment was classified as moderate, attributed to the complex, multiprong, non-probability sampling method of recruitment (Supplementary Table 1). The seropositivity was higher in men, older ages, lower education, living in multigenerational households, and from the City of Brampton. Of participants who were seropositive, 53% did not report previous SARS-CoV-2 infection (Table 2).

Risk Perception: Of those who completed the risk perception questionnaire (Table 3), 92% reported COVID-19 posed a major threat to the South Asian community, 51% agreed or strongly agreed that they were at high risk from COVID-19 because of their location, 35% reported being high risk because of their work or profession, 14% because of socializing or lifestyle, and 14% because of their housing situation.

Sources of Health Information: The top ranked health information sources included healthcare providers or provincial public health bodies (52%), traditional media sources (TV news channels, newspapers) (45%), social media (28%), and friends, family or coworkers (26%) (Figure 3).

Discussion:

Among a sample of South Asians recruited primarily from a designated hot spot in the GTA, we report a seroprevalence of SARS-CoV-2 of 23.6% (95% CI: 20.8 to 26.4), which is standardized by age and sex to the Ontario South Asian population. The range in seropositivity using the strict definition to lenient definition was 22% to 27%. The risk of bias assessment was classified as moderate, attributed to the non-probability sampling method. This report confirms other sources of evidence that racialized groups in general, as well as South Asians, specifically in the GTA, represent a high-risk group for SARS-CoV-2 infection (7). Since it utilizes serological testing, it captures infection rate more comprehensively than routine data sources, which rely on SARS-CoV-2 infection PCR testing.

Prior to the COVID-19 pandemic, ethnicity data are not routinely collected or made publicly available in Canada (16). As a surrogate, in areas where a single ethnic group is concentrated, infection and hospitalization rates can be examined by postal code, and then inferred to be representative of high-density ethnic populations (6). However, our data provide direct evidence of the high infection rate suffered by South Asians in the Peel Region. The reasons for this are multiple, and include socio-cultural factors including socioeconomic inequity, multigenerational households, barriers to accessing healthcare including SARS-CoV-2 testing, and the higher percentage of workers who were essential workers in factories, manufacturing, Amazon Inc. centres, and the trucking industry (17-19). Immigrants are overrepresented in meat, food and beverage processing plants, trucking, and in health and long-term care as nurses' aides and orderlies. The reasons for overrepresentation include the low pay and lack of benefits and protections, features not desired by others who can pursue jobs in other sectors (20,21). Almost 33% of participants in our study reported doing essential work, although an additional 12% preferred not to answer this question, and 19% reported living in a multigenerational household, with an additional 12% preferring not to answer. Participants who indicated they "preferred not to answer" may reflect the stigmatization they may have felt during the initial waves of the pandemic. Therefore, the proportion of essential workers and those living in multigenerational households may be underestimates, especially considering our observation that participants who did not complete the follow-up survey where this information was collected, were more likely to be seropositive for SARS-CoV-2 (Supplementary Table 2).

Our seropositivity data mirrors the high infection rate when comparing FSAs in the City of Brampton and Peel Region (Figure 2). The seropositivity rate was higher in men compared to women, those with lower educational attainment, those living in Brampton, and in multigenerational households. Higher seropositivity of 2 to 3-fold has been reported in ethnic minority groups including Black and South Asian people compared to white people living in the United Kingdom (22,23). Compared to population-based seroprevalence studies conducted during the third wave of the pandemic in Canada such as the Canadian Blood Services with a seropositivity for previous infection of 3.95%, we observed a relatively high rate of seropositivity among South Asians in the GTA (23.6%) (24). However, a similarly high rate of seropositivity (22%) was reported among a cross-sectional study of 1,100 incarcerated men in Canada attributed to enhanced daily interactions in a congregate setting (25).

During the initial waves of the pandemic, it was unclear if standard public health messaging by public health officials at the Federal, Provincial, and local levels was reaching communities at high-risk such as South Asians (26). Our data, collected during the third pandemic wave, show that the top sources of information utilized by our cohort included information from healthcare providers or Public Health, traditional media sources, and social media (Figure 3). It is possible that our findings reflect the impact of activities of South Asian advocacy groups to raise awareness of health risks, and testing for SARS-CoV-2 infection, including provision of health information in multiple South Asian languages. For example, at the outset of the second wave of the pandemic, a physician-led group, named the South Asian COVID task force, opened a culturally sensitive testing centre in the Embassy Grand convention centre, with Punjabi signage

and information translated into multiple South Asian languages, which was funded for and supported by Peel Public Health (27,28). Another advocacy group, the South Asian Health Network advocated for isolation centres; sick pay and time off work for testing and vaccination for essential workers, and COVID-19 information sessions regularly (29). Finally, Peel Public Health worked closely with community leaders to provide outreach onsite for essential workers, initiate testing at workplaces, and to develop mass vaccine centres with cultural sensitivity (16).

Finally, over 90% of the South Asian participants reported COVID-19 posed a major threat to the South Asian community, almost half reported their risk of acquiring COVID-19 was high due to their location, and more than 40% reported their risk was high due to their type of employment. In comparison, the minority of participants perceived their risk of COVID to be due to their lifestyle, such as socializing, or to their housing situation.

Limitations of our analysis include recruitment from vaccination centres, which may attract more health-conscious individuals, the selection of whom could lead to an underestimate of the true seroprevalence (Supplementary Table 1). Further, the history of COVID-19 infection was based on self-reporting which is less reliable than laboratory confirmed diagnosis.

Conclusion: The COVID-19 pandemic was particularly devasting for the South Asian community in the GTA, Ontario. In this analysis, we show the seropositivity data confirms a high infection rate of 23.6% from samples collected during the peak of Wave 3. Planning for future COVID-19

waves should incorporate an understanding of socio-cultural determinants of such high-risk communities.

Acknowledgements: We acknowledge the funder of this work COVID-19 Immunity Task Force (CITF), Public Health Agency of Canada. We acknowledge the advocacy support of the South Asian COVID-19 Task Force, and the South Asian Health Network, and Peel Public Health. Dr. Anand holds a Canada Research Chair (Tier 1) Ethnic Diversity and Cardiovascular Disease, and Michael G. DeGroote Heart and Stroke Foundation Chair in Population Health; Dr. Marc-Andre Langlois holds a Canada Research Chair in Molecular Virology and Intrinsic Immunity. Dr. Dawn Bowdish holds a Canada Research Chair in Aging & Immunity.

Study Team:

Principal Investigator: Dr Sonia S Anand

Co-investigators: Dr. Shrikant Bangdiwala; Dr. Shelly Bolotin; Dr. Dawn Bowdish; Dr. Rahul Chanchlani; Dr. Russell de Souza; Dr. Sujane Kadasamy, Dr. Marc Andre Langlois, Dr. Scott Lear; Dr. Mark Loeb; Dr. Lawrence Loh, Dr. Zubin Punthakee; Dr. Gita Wahi

Project Office: Program Manager - Dipika Desai; **Senior Research Coordinator -** Dr. Jodi Miller; **Junior Research Coordinator -** Andrea Rogge, Sherry Zafar; **Statistician -** Karleen Schulze;

Database Management: Marsella Bishop, Natalie Williams

Ontario Recruitment Team: Site Coordinator: Farah Khan; **Research Assistants -** Zainab Khan, Jayneel Limbachia

Student Volunteers: Rabeeyah Ahmed, Archchun Ariyarajah, Riddhi Chabrota, Yajur Iyengar, Lokeesan Kaneshwaran, Elias Larrazabal, Hemantika Mahesh, Baanu Manoharan, Rhea Murti, David Nash, Nisarg Radadia, Khyathi Rao, Anand Sergeant, Rhea Varghese

Dr. Marc-Andre Langlois Serology Lab: Corey Arnold, Martin Pelchat, Kiran Nakka.

References

1. Canada [Country] and Canada [Country] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Statistics Canada. 2017. Available from: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E.

2. Nasser S. Brampton has emerged as one of Ontario's COVID-19 hotspots, but experts urge caution on where to lay blame. CBC News [Internet]. 2020 Sep 14. Available from: https://www.cbc.ca/news/canada/toronto/brampton-coronavirus-covid-19-south-asian-1.5723330.

3. Region of Peel. 2016 Census Bulletin. Immigration and Ethnic Diversity [Internet]. 2017. Available from: https://www.peelregion.ca/planning-maps/CensusBulletins/2016-immigration-ethnic-diversity.pdf.

4. Brampton, CY [Census subdivision], Ontario and Peel, RM [Census division], *Ontario*(table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Statistics Canada. 2017. Available from: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E.

5. Ontario Agency for Health Protection and Promotion (Public Health Ontario). *Weekly epidemiologic summary: COVID-19 in Ontario – focus on September 13, 2020 to September 19, 2020*. Toronto, ON: Queen's Printer for Ontario; 2020. Available from: https://files.ontario.ca/moh-covid-19-weekly-epi-report-en-2020-09-19.pdf.

6. Ontario Agency for Health Protection and Promotion (Public Health Ontario). *COVID-19 in Ontario - A Focus on Diversity: January 15, 2020 to May 14, 2020* Toronto, ON: Queen's Printer for Ontario; 2020. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/epi/2020/06/covid-19-epi-diversity.pdf?la=en.

7. McKenzie K. Socio-demographic data collection and equity in covid-19 in Toronto. *EClinicalMedicine*. 2021;**34**. doi:10.1016/j.eclinm.2021.100812

8. Wilson C. Ont. prioritizing everyone 18+ in hardest hit neighbourhoods as part of Phase 2 of vaccine rollout. CP24 [Internet]. 2021 Apr 7. Available from: https://www.cp24.com/news/ont-prioritizing-everyone-18-in-hardest-hit-neighbourhoods-as-part-of-phase-2-of-vaccine-rollout-1.5378057.

9. Anand SS, Samaan Z, Middleton C, Irvine J, Desai D, Schulze KM, et al. A Digital Health Intervention to Lower Cardiovascular Risk: A Randomized Clinical Trial. *JAMA Cardiol.* 2016;**1**(5):601–606. doi:10.1001/jamacardio.2016.1035

10. Colwill KG, Yannick S, Matthew G, Christian A, Corey R, Bhavisha A, et al. A "Made-in-Canada" serology solution for profiling humoral immune responses to SARS-CoV-2 infection and vaccination [preprint]. *medRxiv*. 2021 Oct. 26. doi: 10.1101/2021.10.25.21265476.

11. Cholette F, Mesa C, Harris A, Ellis H, Cachero K, Lacap P, et al. Dried blood spot specimens for SARS-CoV-2 antibody testing: A multi-site, multi-assay comparison [preprint]. *Research Square.* 2021 Apr. 1. doi: 10.21203/rs.3.rs-366992/v1.

12. Tang X, Sharma A, Pasic M, Brown P, Colwill K, Gelband H, et al. SARS-CoV-2 seroprevalence during the first and second pandemic waves in Canada [preprint]. *SSRN*. 2021.

13. Galipeau Y, Siragam V, Laroche G, Marion E, Greig M, McGuinty M, et al. Relative ratios of human seasonal coronavirus antibodies predict the efficiency of cross-neutralization of SARS-CoV-2 spike binding to ACE2 [preprint]. *medRxiv*. 2021 Jan. 1. doi: 10.1101/2021.07.16.21260079.

14. Bobrovitz N, Arora RK, Cao C, Boucher E, Liu M, Donnici C, et al. Global seroprevalence of SARS-CoV-2 antibodies: A systematic review and meta-analysis. *PLoS One*. 2021;16(6):e0252617. doi:10.1371/journal.pone.0252617

15. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. *Int J Evid Based Healthc*. 2015;**13**(3):147-53.

16. Rocha R, Carman T. How tracking ethnicity and occupation data is helping fight COVID-19. CBC News [Internet] 2021 Jun 14. Available from: https://www.cbc.ca/news/canada/how-tracking-ethnicity-and-occupation-data-is-helping-fight-covid-19-1.6060900.

17. Nagar R. Stop stigmatizing South Asians for high infection rates. CBC News [Internet]. 2020 Dec 8. Available from: https://www.cbc.ca/news/canada/calgary/road-ahead-calgary-south-asian-covid-stigma-1.5831196.

18. Vohra M, Brar A, Banerjee AT. 'It's not Diwali, it's precarious employment and less health care resources.' South Asian medical experts on Brampton's rising COVID-19 cases. Toronto Star [Internet]. 2020 Nov 19. Available from: https://www.thestar.com/opinion/contributors/2020/11/19/its-not-diwali-its-precarious-employment-and-less-health-care-resources-south-asian-medical-experts-on-bramptons-rising-covid-19-cases.html?li_source=LI&li_medium=star_web_ymbii.

19. Weikle B. COVID-19 hotspot Brampton, Ont., chronically underfunded in community health services, local advocate says. CBC Radio [Internet]. 2020 Dec 4. Available from:

https://www.cbc.ca/radio/whitecoat/covid-19-hotspot-brampton-ont-chronically-underfunded-in-community-health-services-local-advocate-says-1.5823815.

20. Region of Peel. COVID-19 and the Social Determinants of Health: Race and Occupation [Internet]. 2020. Available from: https://www.peelregion.ca/coronavirus/_media/COVID-19-race-and-occupation.pdf.

21. The Conference Board of Canada. Essential Work [Internet]. 2021. Available from: https://www.conferenceboard.ca/temp/88efd5a8-c5f7-46dc-9643-fc2c0cf4ee09/11353_summary_for_execs_essential-work_immigrant-talent.pdf.

22. Ward H, Atchison C, Whitaker M, Ainslie KE, Elliott J, Okell L. Antibody prevalence for SARS-CoV-2 following the peak of the pandemic in England: REACT2 study in 100,000 adults [preprint]. *medRxiv.* 2021.

23. Chen X, Chen Z, Azman AS, Deng X, Sun R, Zhao Z, et al. Serological evidence of human infection with SARS-CoV-2: a systematic review and meta-analysis. *Lancet Glob Health*. 2021;**9**(5):E598-#609.

24. O'Brien S. Associate Director of Canadian Blood Services. Personal communication by email. 2021.

25. Kronfi N, Dussault C, Maheu-Giroux M, Halavrezos A, Chalifoux S, Sherman J, et al. Seroprevalence and Risk Factors for SARS-CoV-2 Among Incarcerated Adult Men in Quebec, Canada (2021): A Cross-Sectional Study [preprint]. *SSRN.* 2021.

26. Bangdiwala SI, Gomez A, Monsalves MJ, Palmeiro Y. Statistical considerations when communicating health risks: Experiences from Canada, Chile, Ecuador, and England facing COVID-19. *Social and Health Sciences.* 2021;**19**(1): 52-79.

27. Gamrot S. New COVID-19 testing centre to open in Brampton. Brampton Guardian [Internet]. 2021 Jan 21. Available from: https://www.bramptonguardian.com/news-story/10314339-new-covid-19-testing-centre-to-open-in-brampton/.

28. Cornwell S. Data shows 83 per cent of COVID-19 cases was among racialized communities in Brampton, Caledon and Mississauga. Brampton Guardian [Internet]. 2021 Mar 3. Available from: https://www.thestar.com/local-brampton/news/2021/03/03/data-shows-83-per-cent-of-covid-19-cases-was-among-racialized-communities-in-brampton-caledon-and-mississauga.html.

29. Brar A, Jimenez C. 1 in 4 COVID-19 cases found through contact tracing in Peel were those who went to work sick. Data reveals how Ontario's lack of paid sick legislation fails vulnerable workers. Toronto Star [Internet]. 2021 Feb 3. Available from: https://www.thestar.com/opinion/contributors/2021/02/03/1-in-4-covid-19-cases-

found-through-contact-tracing-in-peel-were-those-went-to-work-sick-data-reveals-how-ontarios-lack-of-paid-sick-legislation-fails-vulnerable-workers.html.

30. Ontario COVID-19 Data Tool [Internet]. Public Health Ontario. 2021. Available from: https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance/covid-19-data-tool?tab=trends.

31. ICES COVID-19 Dashboard [Internet]. Applied Health Research Questions (AHRQ) 2020. Available from: https://www.ices.on.ca/~/media/Files/COVID-19/ICES-COVID19-Vaccination-Data-by-FSA.ashx?la=en-CA.

Table 1: Demographic Characteristics

	Percentage %	Responses
Overall		916
Sex		916
Female	49.2	
Male	50.4	
Self-described	0.3	
Age group		906
18-24	10.5	
25-34	25.7	
35-44	27.3	
45-54	17.3	
55-64	10.4	
65+	8.8	
Vaccinated		916
Yes, 2 doses	7.1	
Yes, 1 dose	42.9	
No	50.0	
Self Reported History of previous COVID-19 infection		699
Yes	12.6	
No	85.8	
Unknown	1.6	
Median Household Income (2015) based on FSA		904
$40-<$60K	1.0	
$60-<$80K	10.7	
$80-<$100K	63.1	
$100K+	25.2	
Prefer not to answer	0.0	
Essential workers #		693
Yes	32.9	
No	50.8	
Prefer not to answer	16.3	
Completed Education		693
High school or less	17.5	

	Percentage %	Responses
College, Trade, Certificate	12.8	
University degree	65.4	
Prefer not to answer	4.3	
Multi-generational Household		654
Yes	19.1	
No	69.0	
Prefer not to answer	11.9	
Years in Canada		717
10 years or less	31.1	
>10 years	53.6	
Born in Canada	11.9	
Prefer not to answer	3.5	
Mother tongue*		732
Punjabi or Urdu	49.6	
Hindi	11.3	
Gujarati	14.5	
Other South Asian Languages	20.8	
English	7.4	
Prefer not to answer	0.5	
Medical history		
CVD (MI/Angioplasty/Stroke)	3.1	679
Chronic Medical condition requiring medication		666
Hypertension	7.2	
Diabetes	8.0	
Arthritis	1.5	
Chronic Lung disease	0.2	
Cancer	0.2	
Smoking Status		641
Never	86.6	
Former	8.3	
Current	5.1	
Location		905
Brampton Resident	82.0	

	Percentage %	Responses
Peel Resident	91.7	

*Multiple answers can be selected. CVD: Cardiovascular Disease
Examples of Essential Work: Food processing, manufacturing, or distribution; transportation; health care; education; utilities

Table 2: Seropositivity by Demographics

	Number of samples tested	Number of positives	Seropositive %	95% CI
Overall	916	212	23.1	22.9 to 23.4
Sex				
Female	451	96	21.3	20.9 to 21.7
Male	462	115	24.9	24.5 to 25.3
Self-described	3	1	33.3	28.0 to 38.7
Age group				
18-24	95	22	23.2	22.3 to 24.0
25-34	233	49	21.0	20.5 to 21.6
35-44	247	54	21.9	21.3 to 22.4
45-54	157	36	22.9	22.3 to 23.6
55-64	94	28	29.8	28.9 to 30.7
65+	80	22	27.5	26.5 to 28.5
Vaccinated*				
Yes	458	107	23.4	23.0 to 23.7
2 doses	65	12	18.5	17.5 to 19.4
1 dose	393	93	23.7	23.2 to 24.1
No	458	105	22.9	22.5 to 23.3
Self-Reported History of previous COVID-19 infection				
Yes	88	69	78.4	77.5 to 79.3
No	600	81	13.5	13.2 to 13.8
Unknown	11	2	18.2	15.9 to 20.5
Median Household Income (2015) based on FSA				
$40-<$60K	9	1	11.1	9.1 to 13.2
$60-<$80K	97	22	22.7	21.8 to 23.5
$80-<$100K	570	130	22.8	22.5 to 23.2
$100K+	228	56	24.6	24.0 to 25.1
Essential workers				
Yes	228	50	21.9	21.4 to 22.5
No	352	73	20.7	20.3 to 21.2

	Number of samples tested	Number of positives	Seropositive %	95% CI
Prefer not to answer	113	21	18.6	17.9 to 19.3
Completed Education				
High school or less	121	31	25.6	24.8 to 26.4
College, Trade, Certificate	89	18	20.2	19.4 to 21.1
University degree	453	89	19.6	19.3 to 20.0
Prefer not to answer	30	6	20.0	18.6 to 21.4
Multi-generational Household				
Yes	125	30	24.0	23.3 to 24.7
No	451	88	19.5	19.1 to 19.9
Prefer not to answer	78	15	19.2	18.4 to 20.1
Location				
Peel Resident	830	194	23.4	23.1 to 23.7
Brampton	742	178	24.0	23.7 to 24.3
Caledon	39	7	17.9	16.7 to 19.2
Mississauga	49	9	18.4	17.3 to 19.5

* Test interpretation for vaccinated individuals differed from non-vaccinated individuals, see Methods section
Essential worker refers to manufacturing, food processing, transportation sector

Table 3: Risk Perception

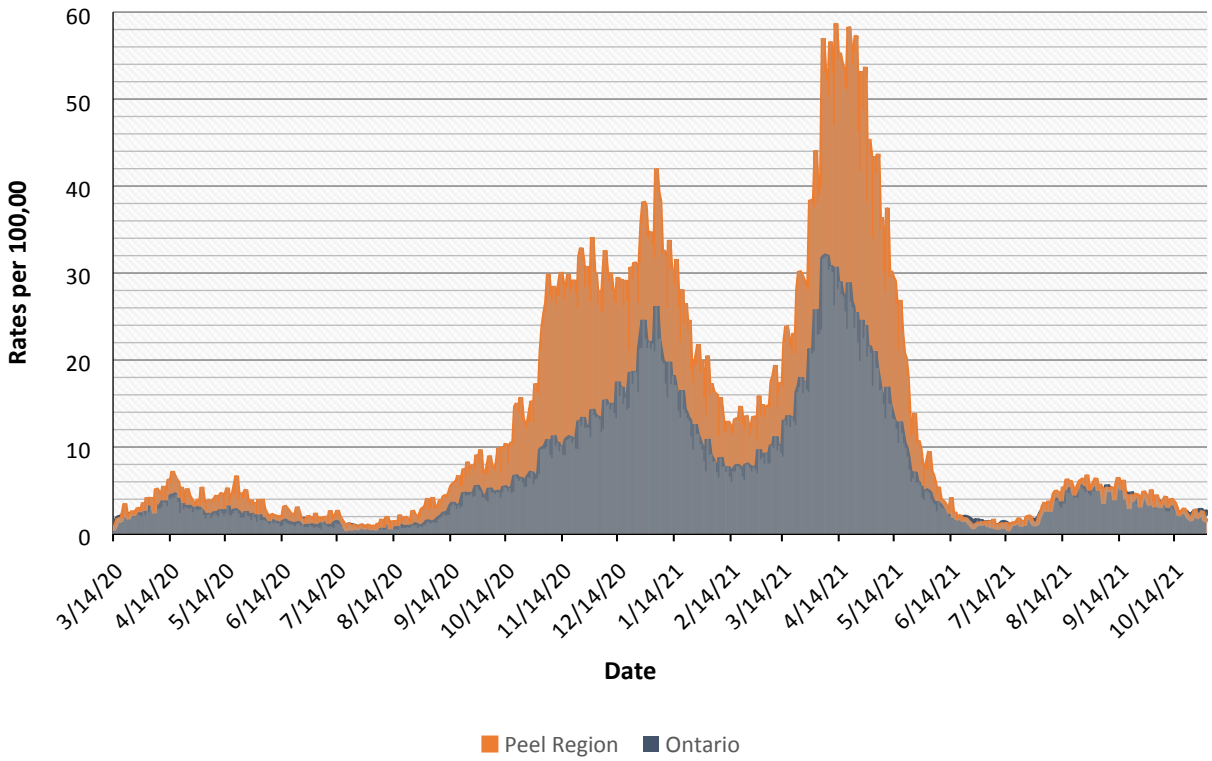
	Proportion Agree#	Score Mean (SD)
Number completed secondary survey	576	
COVID-19 poses a major threat to our community	91.5%	4.5 (0.8)
I am at a high risk from COVID-19 because of my location	51.0%	3.4 (1.2)
I am at a high risk from COVID-19 because of my profession or my work	35.4%	2.8 (1.4)
If I get exposed to/contract COVID-19, I am likely to have serious symptoms because of age, and/or pre-existing conditions	20.2%	2.5 (1.2)
The situation around COVID-19 is over exaggerated/overblown	19.5%	2.4 (1.2)
If I get exposed to/contract COVID-19, I am likely to need hospitalization because of my age, and/or pre-existing conditions	15.2%	2.4 (1.1)
I am at a high risk from COVID-19 because of my lifestyle (socializing or working in a crowded place)	14.2%	2.2 (1.2)
I am at high risk from COVID-19 because of my housing situation	13.9%	2.2 (1.1)

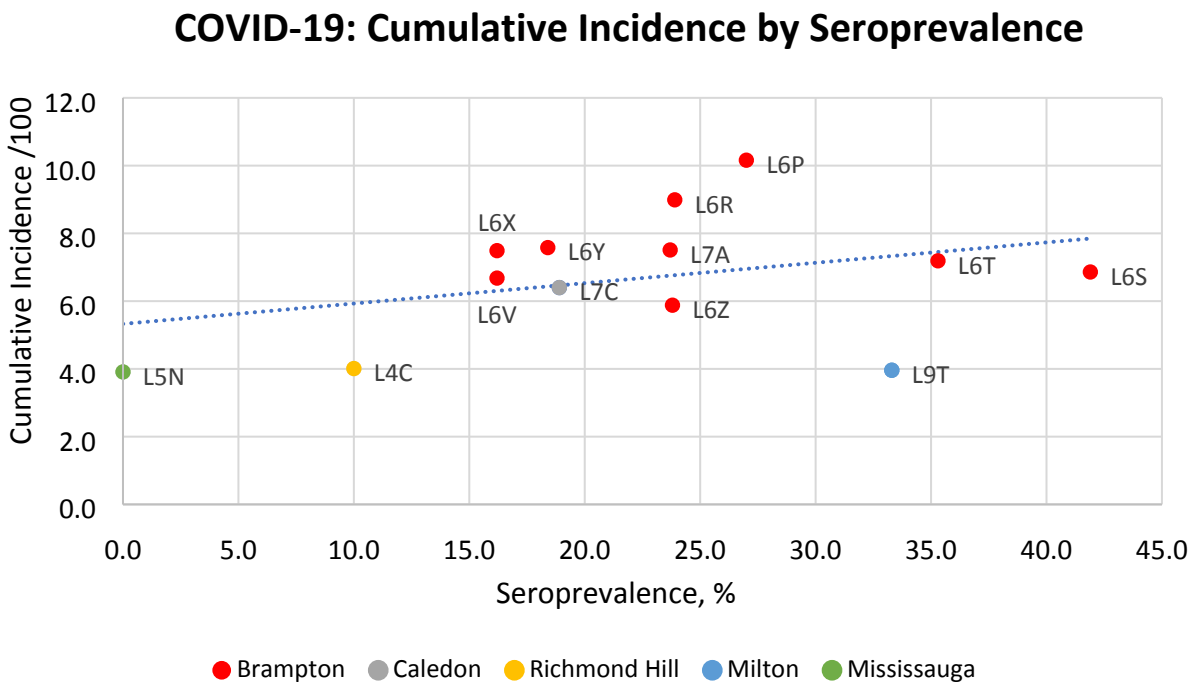
Response captured on 5-point scale of strongly disagree=1, disagree, neutral, agree, or strongly agree=5. #Percent refers to combination of Agree (4) and Strongly Degree (5).

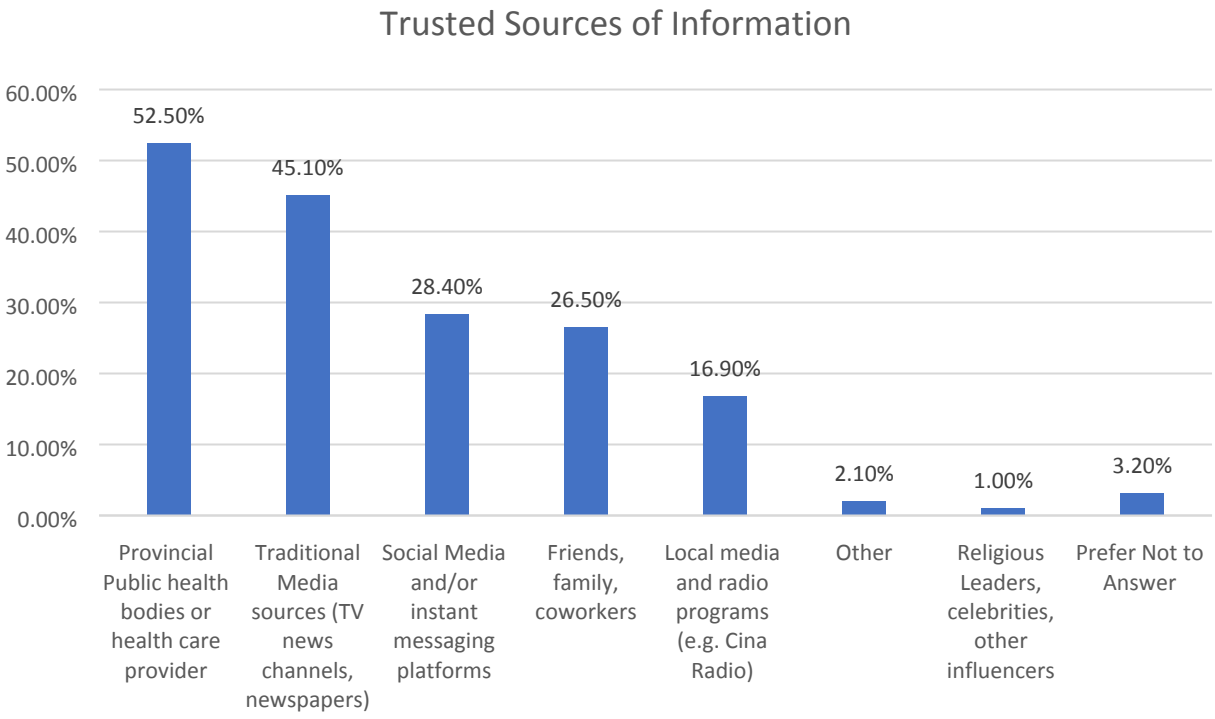
Figure 1: Data from Public Health Ontario: COVID-19 Pandemic Comparing Peel Region to Ontario (30).

Figure 2: Cumulative Incidence of COVID-19 cases (per 100) as of Oct 3, 2021 by Age-Sex Standardized Seroprevalence by FSA. Cumulative Incidence data from Institute of Clinical Evaluative Sciences (31).

Figure 3: Top 3 most Trusted Sources of COVID Health Information Sources according to respondents (N=585 respondents).


COVID-19 Daily Case Rates in Ontario and Peel Region
March 14, 2020 to October 31st, 2021
Rates per 100,00
60
50
40
30
20
10
0
3/14/20
4/14/20
5/14/20
6/14/20
7/14/20
8/14/20
9/14/20
10/14/20
11/14/20
12/14/20
1/14/21
2/14/21
3/14/21
4/14/21
5/14/21
6/14/21
7/14/21
8/14/21
9/14/21
10/14/21
Date
Peel Region
Ontario




Trusted Sources of Information
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
52.50%
45.10%
28.40%
26.50%
16.90%
2.10%
1.00%
3.20%
Provincial Public health bodies or health care provider
Traditional Media sources (TV news channels, newspapers)
Social Media and/or instant messaging platforms
Friends, family, coworkers
Local media and radio programs (e.g. Cina Radio)
Other
Religious Leaders, celebrities, other influencers
Prefer Not to Answer

Supplementary Table 1: Risk of bias assessment

Item 1: Was the sample frame appropriate to address the target population?	
Yes	Sample frame described and it approximated the target population
No	Sample frame did not approximate the target population (e.g., blood donors do not represent general population, doctors do not represent all health care providers)
Exclude	Sample frame not described
*Notes	The term "target population" should not be taken to infer every individual from everywhere or with similar disease or exposure characteristics. Instead, give consideration to specific population characteristics in the study, including age range, gender, morbidities, medications, and other potentially influential factors. For example, a sample frame may not be appropriate to address the target population if a certain group has been used (such as those working for one organisation, or one profession) and the results then inferred to the target population (i.e. working adults). A sample frame may be appropriate when it includes almost all the members of the target population (i.e. a census, or a complete list of participants or complete registry data).
Item 2: Were study participants recruited in an appropriate way?	
Yes	Probability sampling method (simple or stratified random) or entire sample (e.g., an entire town) was used
No	Non-probability sampling
Exclude	Sampling method not reported
Item 3: Was the sample size adequate?	
Yes	≥599
No	<599
Exclude	Sample size not reported
*Notes	To calculate the required sample size we used an assumed prevalence of 2.5%, which was the global average estimated by the WHO in April, 2020.[1] Based on guidance by the Joanna Briggs Institute and published medical statistical recommendations we selected a precision value that was half the assumed prevalence (1.25%) [2,3]. We calculated a minimum sample size of 599 using these inputs: Sample size calculation: $n = \frac{Z^2 P(1-P)}{d^2}$ Where n = sample size; Z = Z statistic for level of confidence (95%); P = expected prevalence (2.5% WHO global estimate); d = precision (1.25%)

	In cases where the sample size calculation was provided and the required sample for 80% power was below our threshold (n<599), this item was marked as yes.
Item 4: Were the study subjects and setting described in detail?	
Yes	Average age and distribution of gender/sex provided
No	Neither age or gender/sex is provided, or only one of age and gender/sex is provided
Item 5: Was data analysis conducted with sufficient coverage of the identified sample?	
Yes	The demographic characteristics (gender/sex, age, and ethnicity) of the sample is at least somewhat representative of the population
No	The demographic characteristics (gender/sex, age, and ethnicity) of the sample is not representative of the population
Unclear	Information is not provided about demographic characteristics of the sample (gender/sex, age, and ethnicity)
Item 6: Were valid methods used for the identification of the condition?	
Yes	The test used met the FDA standards for Emergency Use Authorizations for COVID-19 serological tests: sensitivity minimum 90%, specificity minimum 95%, as reported in the study [4].
No	The test used did not meet the FDA standards for Emergency Use Authorizations for COVID-19 serological tests: sensitivity minimum 90%, specificity minimum 95%.
Exclude	Test sensitivity and specificity not reported
Item 7: Was the condition measured in a standard, reliable way for all participants?	
Yes	The same serology test was used for all participants
No	Different serology tests were used for participants
Unclear	No details were provided about which participants received which serology tests
Item 8: Was there appropriate statistical analysis?	
Yes	Does all of the following: corrects for population characteristics or the sample is somewhat representative of the population (probability sampling), corrects for test characteristics), and provides the information necessary to determine the numerator, denominator, prevalence estimate, and confidence interval.
No	Does not correct for population characteristics and the sample is not likely representative of the population (non-probability sampling), does not correct for test or provide the information necessary to correct for test characteristics, or does not provide the

	information necessary to determine the numerator, denominator, prevalence estimate, and confidence interval.
Item 9: Was the response rate adequate, and if not, was the low response rate managed appropriately?	
Yes	Response rate > 60% or the demographics of the sample were a reasonable match to those of the target population [5]
No	Response rate < 60% and the demographics of the sample were not a reasonable match to those of the target population
Unclear	Response rate not provided and it was unclear if the demographics of the sample differed from the target population
Item 10: Overall risk of bias	
Low	The estimates are very likely correct for the target population. To obtain a low risk of bias classification, all criteria must be met or departures from the criteria must be minimal and unlikely to impact on the validity and reliability of the prevalence estimate. These include sample sizes that are just below the threshold when all other criteria are met, reporting only some of characteristics of the sample, test characteristics below the threshold but corrections for the test performance, and response rates that are just below the threshold in the context of probability-based sampling of an appropriate sampling frame with population weighted seroprevalence estimates.
Moderate	The estimates are likely correct for the target population. To obtain a moderate risk of bias classification, most criteria must be met and departures from the criteria are likely to have only a small impact on the validity and reliability of the prevalence estimates.
High	The estimates are not likely correct for the target population. To obtain a high risk of bias, many criteria must not be met or departures from criteria are likely to have a major impact on the validity and reliability of the prevalence estimates.
Unclear	There was insufficient information to assess the risk of bias.

Supplementary 2: Demographics in Responders versus Non-responders

		Completed Survey	
	Overall	**Yes**	**No**
N		693	223
Female	49.2%	50.2%	46.2%
Age	41.5	40.1	45.7
FSA median household income >=$80,000	88.3%	88.5%	87.5%
Brampton Resident	82.0%	81.6%	83.3%
Peel Resident	91.7%	91.7%	91.7%
Seroprevalence	23.1%	20.8%	30.5%

Note: Those that did not complete the survey were slightly older, while slightly more females completed. Among the non-completers, the seroprevalence was 10% higher.

Supplementary Table 3: Demographics by Vaccination[#] status

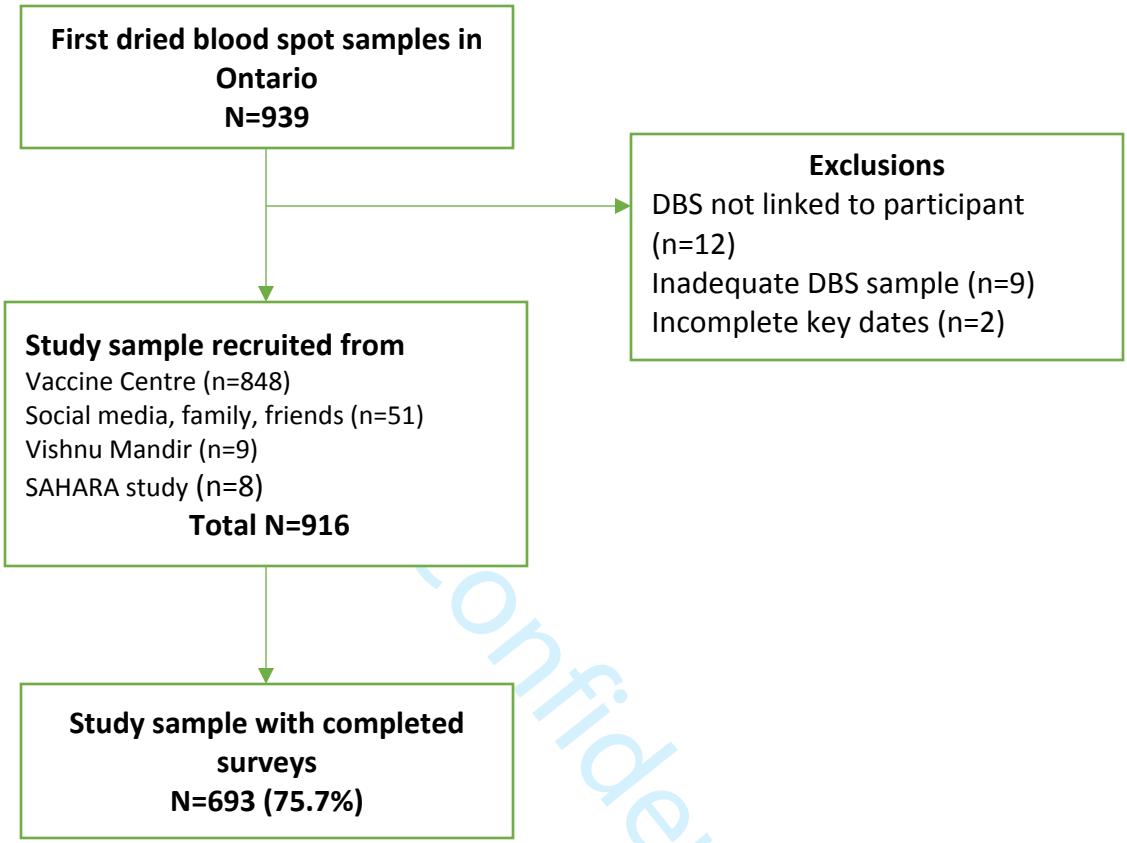
	Percentage Pre-vaccination %	Percentage Vaccinated %	Responses
Overall			916
Sex			916
Female	47.4	51.1	
Male	52.2	48.7	
Self-described	0.4	0.2	
Age group			906
18-24	9.1	11.9	
25-34	15.7	35.7	
35-44	20.6	33.9	
45-54	22.6	12.1	
55-64	15.9	4.8	
65+	16.2	1.5	
Self-Reported History of previous COVID-19 infection			699
Yes	12.0	13.2	
No	87.8	84.0	
Unknown	0.3	2.8	

	Percentage Pre-vaccination %	Percentage Vaccinated %	Responses
Median Household Income (2015) based on FSA			904
$40-<$60K	1.3	0.7	
$60-<$80K	11.8	9.7	
$80-<$100K	57.4	68.7	
$100K+	29.5	21.0	
Prefer not to answer	0.0	0.0	
Essential workers			693
Yes	39.4	27.2	
No	49.1	52.3	
Prefer not to answer	11.5	20.5	
Completed Education			693
High school or less	16.5	18.3	
College, Trade, Certificate	14.3	11.6	
University degree	67.1	63.9	
Prefer not to answer	2.2	6.2	
Multi-generational Household			654
Yes	19.6	18.7	
No	70.9	67.2	
Prefer not to answer	9.5	14.1	
Years in Canada			717
10 years or less	22.7	39.4	
>10 years	64.1	43.1	
Born in Canada	11.5	12.2	
Prefer not to answer	1.7	5.3	
Mother tongue*			732
Punjabi or Urdu	46.8	52.5	
Hindi	12.4	10.2	
Gujarati	16.8	12.2	

	Percentage Pre-vaccination %	Percentage Vaccinated %	Responses
Other South Asian Languages	18.1	23.5	
English	10.8	3.9	
Prefer not to answer	0.0	1.1	
Medical history			
CVD (MI/Angioplasty/Stroke)	6.3	0.3	679
Chronic Medical condition requiring medication			666
Hypertension	10.9	4.0	
Diabetes	12.5	4.0	
Arthritis	1.3	1.7	
Chronic Lung disease	0.3	0.0	
Cancer	0.3	0.0	
Smoking Status			641
Never	85.0	88.0	
Former	9.4	7.2	
Current	5.5	4.8	
Location			905
Brampton Resident	73.5	90.5	
Peel Resident	86.1	97.4	

*Multiple answers can be selected. CVD: Cardiovascular Disease
#Vaccinated group includes 393 (85.8%) with a single dose and 65 (14.2%) with two vaccine doses.

SFigure 1: Consort Diagram



STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2, 6-7
Bias	9	Describe any efforts to address potential sources of bias	7-8, 26-29
Study size	10	Explain how the study size was arrived at	26
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 32
		(b) Give reasons for non-participation at each stage	8, 29
		(c) Consider use of a flow diagram	32
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-10
		(b) Indicate number of participants with missing data for each variable of interest	8, 32
Outcome data	15*	Report numbers of outcome events or summary measures	n/a

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 20-21
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.