# Does new onset anosmia predict diagnosis of COVID-19 infection among people accessing outpatient screening in Toronto, Ontario? A retrospective cohort study


## Abstract

### Background

Identifying symptoms predictive of COVID-19 infection could improve decisions to test among community-dwelling individuals. Reports have suggested anosmia is strongly associated with COVID-19 infection, but patients were often asked about this symptom after their diagnosis. This study assessed associations between prospectively collected anosmia and other symptoms related to COVID-19 infection, and SARS-CoV-2 positivity in community testing centres in Toronto, Ontario, Canada.

### Methods

We analyzed routinely collected data from two 'COVID-19 Assessment Centres' in community and academic settings, using generalized estimating equations to describe associations between anosmia and other symptoms and SARS-CoV-2 positivity.

### Results

Between April 5 and September 30, 2020, 83443 SARS-CoV-2 tests were conducted across the two sites. 1640 (1.96%) of all tests were positive; 837 (51%) of positive cases were asymptomatic. The adjusted odds ratio for the association between anosmia and test positivity was 4.93 (95% CI: 4.13 to 5.89), with a sensitivity of 0.138 (95% CI: 0.121 to 0.154), specificity of 0.980 (95% CI: 0.979 to 0.981), positive predictive value 0.120 (95% CI: 0.106 to 0.135), and negative predictive value 0.983 (95% CI: 0.982 to 0.984).

### Interpretation

Anosmia had a high specificity and positive predictive value of 12% for SARS-CoV2 infection in this community population with low prevalence of COVID-19 positivity. The presence of anosmia should increase clinical suspicion of COVID-19 infection and supports the recommendation that people presenting with this symptom should be tested.


Conflicts of interest: Braden O'Neill is an Associate Editor, CMAJ and CMAJ Open. Peter Gill is a member of the CMAJ Editorial Advisory Board. Neither will be at all involved in editorial decisions related to this manuscript. All other authors report no related conflicts of interest.

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## Main manuscript

### Background

COVID-19 infection caused by SARS-CoV-2 has spread rapidly around the world. As of 10 March 2021, there were more than 118 million COVID-19 cases, and almost 2.7 million deaths worldwide (1). There has been a substantial effort to determine specific signs and symptoms predictive of the infection to support screening recommendations or self-isolation to prevent further transmission.(2) Symptoms of COVID-19 infection, such as fever, cough, and shortness of breath are non-specific and common in other respiratory viral infections (3). Furthermore, many people with COVID-19 infection have minimal or no symptoms and are unaware that they may be transmitting the disease (4).

Anosmia (loss of sense of smell) is one symptom that has received substantial interest, starting with case reports, then media coverage, and followed by large-scale observational studies.(5-12) Early in the pandemic the British Rhinological Society suggested that anosmia may be a unique symptom associated with early COVID-19 infection (5), and advised anyone with loss of smell to self-isolate. Subsequently, associations between COVID-19 infection and anosmia were reported across multiple settings, but these studies have been primarily retrospective, asking people if they experienced these symptoms after they knew their test results (7,11), with a high risk of recall bias. A recent systematic review of the diagnostic accuracy of several signs and symptoms including anosmia and COVID-19 diagnosis reported sensitivity of 28.0% (95% CI 17.7% to 41.3%) and a specificity of 93.4% (95% CI 88.3% to 96.4%), but noted a lack of prospective studies on this association.(12) Furthermore, anosmia is common: at any time, 3–20% of the general population (13-14) may develop 'olfactory dysfunction,' of which anosmia is a subset. Up to 40% of anosmia cases are post-viral; and coronaviruses are thought to cause 10–15% of these cases (13).

'Test and trace' approaches have been adopted to control the spread of COVID-19. (15) This is a key pillar of the pandemic response in Toronto, ON, a city of approximately 3 million people. In mid-March 2020, the Ontario government developed 'COVID-19 Assessment Centres' throughout the province to facilitate testing. These assessment centres provide COVID-19 nasopharyngeal swab testing to the public and health care workers based on algorithms that consider symptoms, known or suspected exposure to COVID-19, travel history, and involvement with vulnerable at-risk populations.

We sought to characterize the diagnostic test characteristics (i.e., sensitivity, specificity, and positive and negative predictive values) of 'anosmia' as an early symptom of COVID-19 infection in an outpatient population with varying degrees of risk and symptoms of COVID-19. We also planned to describe the demographic characteristics and clinical presentation of patients positive for COVID-19 infection.


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## Methods

We conducted a retrospective, repeated, cross-sectional (chart review) study including consecutive patients undergoing a SARS-CoV-2 test at two COVID-19 Assessment Centres, located in Toronto, Ontario, between April 5, 2020 to September 30, 2020. We applied the checklist for "*The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement*" (RECORD) guidelines for this observational study (16).

### *Settings*

This study included data from 'COVID-19 Assessment Centres' affiliated with two hospitals in Toronto, Ontario, Canada. The 'community hospital' setting in this study, North York General Hospital, is a medium-sized hospital with 435 inpatient beds serving a socioeconomically diverse population at two locations in northern Toronto.(17) Women's College Hospital is an outpatient hospital in the downtown core, with a focus on women's health, but their COVID-19 assessment centre provides testing to people of all genders and ages. (18)

Access to the centres during the study period (April 5 – September 30, 2020) was either by walk-in or on-line self-assessment with telephone triage and fast track visit for swabbing. Both symptomatic and asymptomatic people were tested based on evolving screening criteria. Individuals accessing the testing sites had varying degrees of risks of contracting COVID-19 infection, ranging from those with a confirmed or suspected close contact with someone infected with COVID-19, to asymptomatic people requesting testing required prior to surgical procedures, visits to relatives in long term care facilities or for reassurance.

The centres operate 7 days per week and tested between 100-2000 patients weekly as the pandemic progressed. Testing was based on evolving screening criteria and recommendations from local public health authorities. Testing for COVID-19 used RT-PCR with gene sequencing for nucleocapsid, envelope and RdRp (enzyme). (19-20)

### *Data Collection*

Clinical data from the COVID-19 Assessment Centres' flowsheets were abstracted from the Cerner and EPIC Electronic Health Records at NYGH and WCH, respectively; and exported into Microsoft Excel spreadsheets. Common data variables collected from both hospitals included age, gender, postal code, exposure history (i.e., travel outside of Canada within 14 days, contact with confirmed or suspected case of COVID-19, health care worker), vital signs (i.e., heart rate, blood pressure, oxygen saturation, temperature); and symptoms (e.g., anosmia, cough and/or shortness of breath, diarrhea and/or abdominal pain, fever). A question about altered or diminished sense of smell was adapted from Hoffman et al (21), as follows: "Have you had a new problem with your ability to smell, such as not being able to smell things or things not smelling the way they are supposed to?" COVID-19 test results were coded as negative or positive. Any subsequent PCR tests done after a positive result, which were conducted early in the pandemic to assess for 'virus clearance,' were excluded, since they would not be new infections and would result in duplicate data for positive cases.

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WCH electronic record data contained other symptoms, including change in taste, cough, difficulty swallowing, fatigue, headache, hoarse voice, myalgia, nasal congestion, nausea, vomiting, respiratory distress, runny nose, sneezing and sore throat; and additional variables, such as length of time since symptom onset.

***Statistical analysis*:**

De-identified data from each institution's Microsoft Excel spreadsheet were combined and exported into SAS version 9.4 (SAS Corp., Cary, NC) for statistical analysis. We conducted primary analyses on the combined data of common variables, as well as secondary analyses within each cohort, including site-specific variables.

*Diagnostic measures*

We calculated diagnostic test characteristics [sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy] for the onset of anosmia in predicting COVID-19 status in patients presenting to the assessment centres. In addition, diagnostic measures were also calculated for common symptoms at both assessment centres, and additional symptoms collected at WCH separately.

*Generalized estimating equations*

Generalized estimating equations with exchangeable correlation structure were used for the binary outcome of COVID-19 results (positive/negative) to capture the patient-level dependence for repeat COVID-19 screening during the study period (22). Generalized estimating equations also adjusted for patient demographics (age, sex, travel history) and common symptoms available at both sites (anosmia, cough and/or shortness of breath, diarrhea and/or abdominal pain, fever, heart rate and body temperature).

***Ethics Review***

This study was approved by NYGH's and WCH's Research Ethics Boards, respectively (Protocol #s: 20-0021 and (2020-0059-E).

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## Results

There were 83443 tests completed: 53479 COVID-19 tests at NYGH (April 12-Sept 30) and 29964 COVID-19 tests at WCH (April 5-Sept 30). Patients' demographic characteristics and reported symptoms are summarized in Tables 1(a) and Table 1(b), respectively. The overall test positivity rate was 2.3%, 1.5% at WCH and 2.0% at NYGH. A higher positivity rate was observed among adults aged 20-29 years (2.25%) as compared to those under age 20 years (1.46%), and older adults aged 60+ years (1.34%).

Patients testing positive for COVID-19 infection reported a higher prevalence of anosmia when compared to those not positive (12.04% vs. 1.73%). Test characteristics for the association between anosmia and SARS-CoV-2 positivity were as follows: sensitivity 0.138 (95% CI 0.121-0.154), specificity 0.98 (95% CI 0.979-0.981), positive predictive value 0.120 (95% CI 0.106-0.135), negative predictive value 0.983 (95% CI 0.982-0.984), accuracy 0.963 (95% CI 0.962-0.965).

Other symptoms that were more common in patients testing positive included fever (6.99% vs. 1.59%), cough and/or shortness of breath (5.11% vs. 1.49%), and diarrhea and/or abdominal pain (2.89% vs. 1.90%).

Low sensitivity and high specificity with low PPV and high NPV were observed for common symptoms recorded at both assessment centres (Figure 1).

At WCH, where additional symptoms were captured (Figure 2), highest sensitivity was observed for cough (0.450 95%: CI: 0.405 to 0.496), headache (0.318, 95% CI: 0.275 to 0.361), and fatigue (0.276, 95%: CI: 0.235 to 0.317), while symptoms with the highest specificity included anosmia (0.987, 95% CI:0.986 to 0.988), change in taste (0.984, 95% CI: 0.983 to 0.986) and difficulty swallowing (0.975, 95% CI: 0.973 to 0.977).

Out of 1640 patients across both sites who had positive COVID tests, 837 (51%) were asymptomatic and reported no anosmia, cough, shortness of breath, fever, diarrhea or abdominal pain.

Figure 3 shows the crude and adjusted odds ratios (aOR) for COVID-19 test positivity with respect to age, sex, common symptoms at both testing sites. With the exception of diarrhea and/or abdominal pain (aOR 0.70; 95% CI: 0.57 to 0.85), patients with any symptoms who presented to the clinic had increased odds of positive COVID-19 test.

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## Discussion

In our retrospective, repeated, cross-sectional study of 83443 SARS-CoV-2 tests in a community-based sample, we identified a moderate association between self-reported anosmia and positive SARS-CoV-2 test results.

Our diagnostic test accuracy study findings are consistent with a meta-analysis of the association between anosmia and COVID-19 test positivity that reported an OR of 14.7 (10). While the adjusted OR reported in our study was lower at 4.9, this may reflect the fact that throughout our study period, there were ongoing changes in testing criteria, and most people who reported COVID-19-like symptoms were from relatively low prevalence areas.

Our identified association between anosmia and SARS-CoV-2 positivity is also lower than what was identified in another study in Toronto where people were retrospectively contacted to ask about the presence of this symptom; we believe our findings more accurately reflect true prevalence of anosmia associated with COVID-19 infection at the time patients present, with a lower risk of recall bias. (11) Anosmia is a common symptom of other conditions, such as allergic rhinitis (21%) (23) and other upper respiratory tract infections (30%) (24). In our study, anosmia was present among 12% of people who tested positive for SARS-CoV-2 and more importantly had very high specificity (98%). However, because of the low prevalence of SARS-CoV-2 in these settings (overall test positivity was 1.96%) the positive predictive value was low (12%). While anosmia had the strongest association with SARS-CoV-2 positivity among people in the sample, the test characteristics make its clinical usefulness limited to raising suspicion of this diagnosis, rather than strongly suggesting it. Since PPV varies by prevalence, small changes in this increase PPV substantially: for example, with a 10% prevalence, the PPV would be 43%. No other symptom was sufficiently associated with SARS-CoV-2 positivity to suggest its presence for 'screening' or for predicting a positive test.

Limitations include the possibility of false negative and positive tests, as well as the heterogenous study population. Testing was conducted for various indications throughout the study period, as knowledge about the disease and testing capacity changed over time. The purpose of tests also varied, from 'screening' asymptomatic people prior to outpatient procedures, to 'diagnostic testing' for people with symptoms thought to be consistent with COVID, or who had a high risk for COVID infection. This study includes data from anyone who was tested, and we were unable to analyze data by testing indication. A recent systematic review identified two studies reporting 20 and 75% prevalence of asymptomatic people among those testing positive (4).

In this study of people attending two community-based COVID assessment centres, presence of anosmia did not reliably identify people with COVID-19. However, anosmia's high specificity and positive predictive value of 12% in this community population with low prevalence of Covid-19 positivity raises the clinical suspicion of infection in individuals with this symptom. This supports the recommendation that people with the symptom, in the context of high SARS-CoV2 virulence and the need to prevent transmission, should be tested for COVID.


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Data access: The data included in this study are not publicly available; analytic code is available on request from the corresponding author. Requests to conduct additional analyses should be directed to the corresponding author.

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Table 1 (a): Patient demographics with respect to COVID-19 swab test at NYGH* and WCH**

| | *COVID-19 swab test* | | | | |
|---|---|---|---|---|---|
| | *Negative* | | *Positive* | | *Total* |
| | *N* | *Row Percent (%)* | *N* | *Row Percent (%)* | *N* |
| *Site* | | | | | |
| *NYGH (site 1)* | 52272 | 97.74% | 1207 | 2.26% | 53479 |
| *WCH (site 2)* | 29531 | 98.55% | 433 | 1.45% | 29964 |
| *Age group (years)* | | | | | |
| *0-9 years* | 4563 | 99.00% | 46 | 1.00% | 4609 |
| *10-19 years* | 5093 | 98.11% | 98 | 1.89% | 5191 |
| *20-29 years* | 18488 | 97.75% | 425 | 2.25% | 18913 |
| *30-39 years* | 16602 | 98.16% | 312 | 1.84% | 16914 |
| *40-49 years* | 11617 | 97.43% | 306 | 2.57% | 11923 |
| *50-59 years* | 11446 | 97.76% | 262 | 2.24% | 11708 |
| *60-69 years* | 8570 | 98.39% | 140 | 1.61% | 8710 |
| *70+ years* | 5419 | 99.07% | 51 | 0.93% | 5470 |
| *Missing* | 5 | 100.00% | . | . | 5 |
| *Sex* | | | | | |
| *Female* | 47646 | 98.11% | 918 | 1.89% | 48564 |
| *Male* | 34157 | 97.93% | 722 | 2.07% | 34879 |
| *Travel* | | | | | |
| *No* | 80090 | 98.06% | 1586 | 1.94% | 81676 |
| *Yes* | 1713 | 96.94% | 54 | 3.06% | 1767 |
| *Total* | 81803 | 98.03% | 1640 | 1.97% | 83443 |

*NYGH= North York General Hospital; **WCH = Women's College Hospital


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Table 1 (b): Patient symptoms with respect to COVID-19 swab test at NYGH* and WCH**

| | *COVID-19 swab test* | | | | |
|---|---|---|---|---|---|
| | *Negative* | | *Positive* | | *Total* |
| | *N* | *Row Percent (%)* | *N* | *Row Percent (%)* | *N* |
| *Cough and/or shortness of breath* | | | | | |
| *No* | 71329 | 98.51% | 1076 | 1.49% | 72405 |
| *Yes* | 10474 | 94.89% | 564 | 5.11% | 11038 |
| *Fever* | | | | | |
| *No* | 76370 | 98.41% | 1232 | 1.59% | 77602 |
| *Yes* | 5433 | 93.01% | 408 | 6.99% | 5841 |
| *Anosmia* | | | | | |
| *No* | 80152 | 98.27% | 1414 | 1.73% | 81566 |
| *Yes* | 1651 | 87.96% | 226 | 12.04% | 1877 |
| *Diarrhea and/or abdominal pain* | | | | | |
| *No* | 76225 | 98.10% | 1474 | 1.90% | 77699 |
| *Yes* | 5578 | 97.11% | 166 | 2.89% | 5744 |
| *Pulse rate (per minute)* | | | | | |
| *Missing* | 56657 | 98.67% | 761 | 1.33% | 57418 |
| *20-60 beats per minute* | 1470 | 97.42% | 39 | 2.58% | 1509 |
| *61-90 beats per minute* | 19006 | 96.85% | 618 | 3.15% | 19624 |
| *91+ beats per minute* | 4670 | 95.46% | 222 | 4.54% | 4892 |
| *Body temperature* | | | | | |
| *Missing* | 51558 | 99.05% | 496 | 0.95% | 52054 |
| *93 - 97.9 Fahrenheit* | 21711 | 96.80% | 717 | 3.20% | 22428 |
| *98 - 98.9 Fahrenheit* | 7474 | 96.05% | 307 | 3.95% | 7781 |
| *>=99 Fahrenheit* | 1060 | 89.83% | 120 | 10.17% | 1180 |
| *Respiratory rate (per minute)* | | | | | |
| *Missing* | 55707 | 98.82% | 666 | 1.18% | 56373 |
| *<= 24 per min* | 25856 | 96.41% | 964 | 3.59% | 26820 |


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| | *COVID-19 swab test* | | | | |
|---|---|---|---|---|---|
| | *Negative* | | *Positive* | | *Total* |
| | *N* | *Row Percent (%)* | *N* | *Row Percent (%)* | *N* |
| *> 24 per min* | 240 | 96.00% | 10 | 4.00% | 250 |
| *Systolic Blood pressure (mmHg)* | | | | | |
| *Missing* | 59368 | 98.96% | 624 | 1.04% | 59992 |
| *<= 110 mmHg* | 2596 | 96.15% | 104 | 3.85% | 2700 |
| *> 110 mmHg* | 19839 | 95.61% | 912 | 4.39% | 20751 |
| *Saturated oxygen (percent)* | | | | | |
| *Missing* | 51204 | 99.04% | 495 | 0.96% | 51699 |
| *<= 92%* | 62 | 89.86% | 7 | 10.14% | 69 |
| *> 92%* | 30537 | 96.41% | 1138 | 3.59% | 31675 |
| *Total* | 81803 | 98.03% | 1640 | 1.97% | 83443 |

*NYGH= North York General Hospital; **WCH = Women's health college

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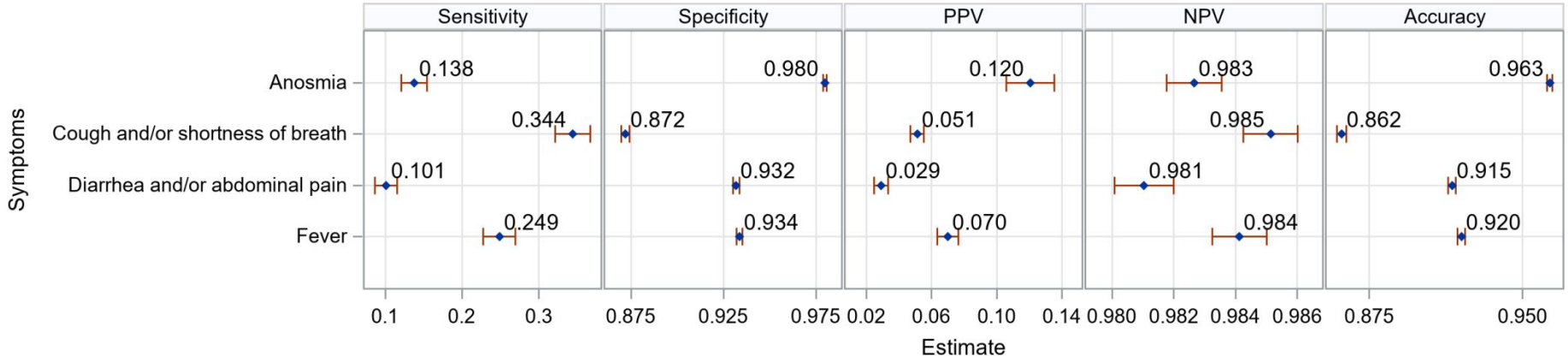
**Figure 1: Diagnostic measures of COVID-19 symptoms***




*Symptoms recorded at North York General Hospital and Women's College Hospital

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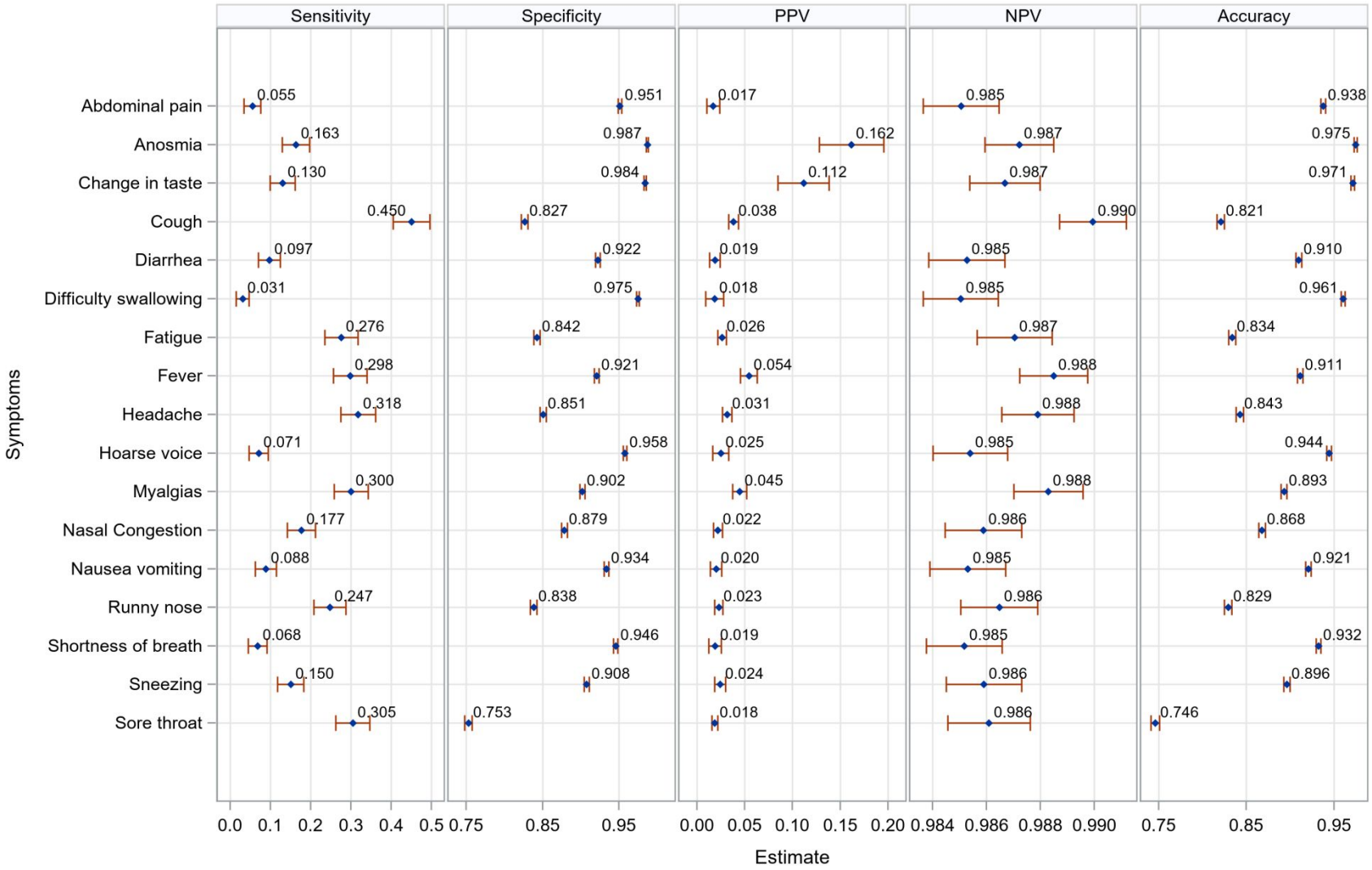
**Figure 2: Diagnostic measures of COVID-19 symptoms***




*Symptoms recorded at Women's College Hospital


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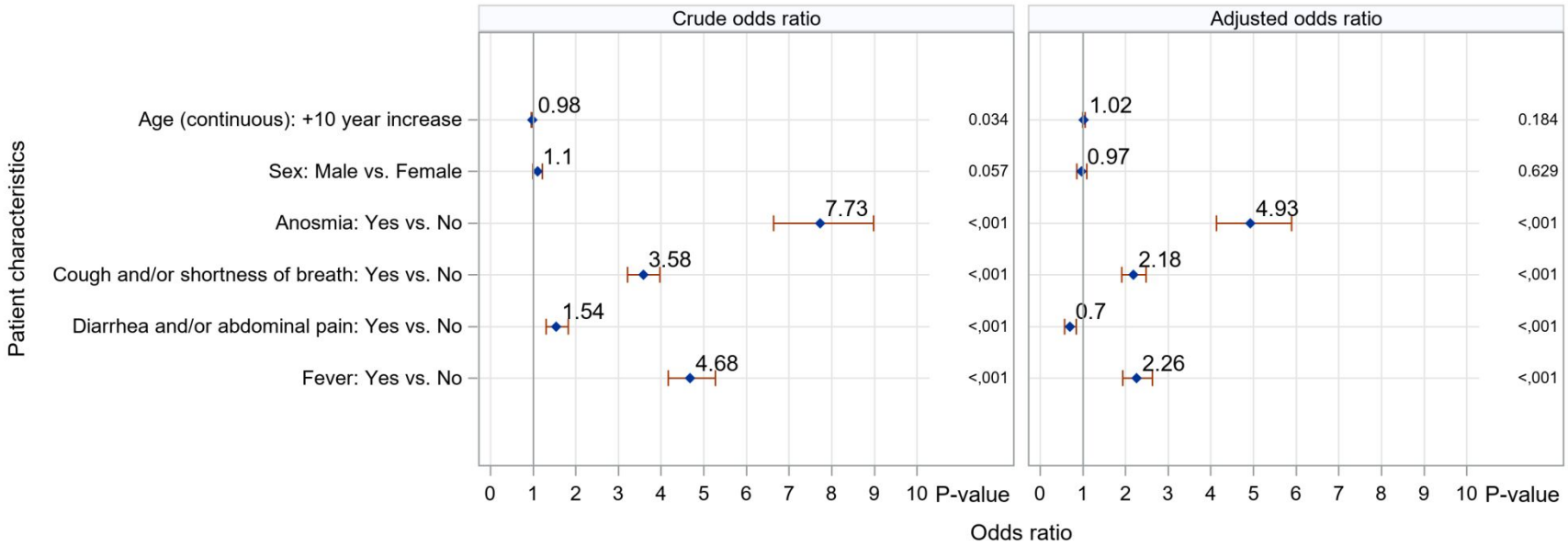
**Figure 3: Odds ratios for positive COVID-19 swab test**





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## Appendix:

**Table S1. Data elements collected at COVID Assessment Centres in Toronto, Ontario**

| WCH (April 5 – Sept 30/20) | NYGH (April 12 - Sept 30/20) |
|---|---|
| Date of swab | Date of swab |
| Age (in years) | Age (in years) |
| Postal code | Postal code |
| Gender | Gender |
| Travel outside Canada in last 14 days (Y/N) | Travel outside Canada in last 14 days (Y/N) |
| Cough (Y/N) | Cough (Y/N) |
| Fever (Y/N) | Fever (Y/N) |
| Shortness of breath (Y/N) | Shortness of breath |
| COVID test result (+/-) | COVID test result (+/-) |
| Anosmia (Y/N) | Anosmia (Y/N) |
| Heart rate | Heart rate (>110 vs </=110) |
| Temperature | Temperature |
| Respiratory rate | Respiratory rate (>24/min vs. </= 24/min) |
| Blood pressure | Blood pressure |
| SaO2 (<92% vs >/=92%) | SaO2 (<92% vs >/=92%) |
| | |
| Sore throat (Y/N) | NA |
| Runny nose (Y/N) | NA |
| Myalgia (Y/N) | NA |
| Date of onset of cough, fever, shortness of breath, anosmia, sore throat, runny nose, myalgia | NA |

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**Table S2. Diagnostic estimates for most common symptoms, both sites combined**

| Symptoms | Label | Estimate | Lower | Upper |
|---|---|---|---|---|
| Anosmia | Sensitivity | 0.138 | 0.121 | 0.154 |
| Anosmia | Specificity | 0.980 | 0.979 | 0.981 |
| Anosmia | PPV | 0.120 | 0.106 | 0.135 |
| Anosmia | NPV | 0.983 | 0.982 | 0.984 |
| Anosmia | Accuracy | 0.963 | 0.962 | 0.965 |
| Fever | Sensitivity | 0.249 | 0.228 | 0.270 |
| Fever | Specificity | 0.934 | 0.932 | 0.935 |
| Fever | PPV | 0.070 | 0.063 | 0.076 |
| Fever | NPV | 0.984 | 0.983 | 0.985 |
| Fever | Accuracy | 0.920 | 0.918 | 0.922 |
| Diarrhea and/or abdominal pain | Sensitivity | 0.101 | 0.087 | 0.116 |
| Diarrhea and/or abdominal pain | Specificity | 0.932 | 0.930 | 0.934 |
| Diarrhea and/or abdominal pain | PPV | 0.029 | 0.025 | 0.033 |
| Diarrhea and/or abdominal pain | NPV | 0.981 | 0.980 | 0.982 |
| Diarrhea and/or abdominal pain | Accuracy | 0.915 | 0.914 | 0.917 |
| Cough and/or shortness of breath | Sensitivity | 0.344 | 0.321 | 0.367 |
| Cough and/or shortness of breath | Specificity | 0.872 | 0.870 | 0.874 |
| Cough and/or shortness of breath | PPV | 0.051 | 0.047 | 0.055 |
| Cough and/or shortness of breath | NPV | 0.985 | 0.984 | 0.986 |
| Cough and/or shortness of breath | Accuracy | 0.862 | 0.859 | 0.864 |

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**Table S3: Diagnostic measures of COVID-19 symptoms at WCH***

| Symptoms | Label | Estimate | Lower | Upper |
|---|---|---|---|---|
| Sore throat | Sensitivity | 0.305 | 0.262 | 0.347 |
| Sore throat | Specificity | 0.753 | 0.748 | 0.758 |
| Sore throat | PPV | 0.018 | 0.015 | 0.022 |
| Sore throat | NPV | 0.986 | 0.985 | 0.988 |
| Sore throat | Accuracy | 0.746 | 0.741 | 0.751 |
| Sneezing | Sensitivity | 0.150 | 0.117 | 0.183 |
| Sneezing | Specificity | 0.908 | 0.904 | 0.911 |
| Sneezing | PPV | 0.024 | 0.019 | 0.030 |
| Sneezing | NPV | 0.986 | 0.985 | 0.987 |
| Sneezing | Accuracy | 0.896 | 0.893 | 0.900 |
| Shortness of breath | Sensitivity | 0.068 | 0.045 | 0.092 |
| Shortness of breath | Specificity | 0.946 | 0.943 | 0.948 |
| Shortness of breath | PPV | 0.019 | 0.012 | 0.025 |
| Shortness of breath | NPV | 0.985 | 0.984 | 0.987 |
| Shortness of breath | Accuracy | 0.932 | 0.930 | 0.935 |
| Runny nose | Sensitivity | 0.247 | 0.208 | 0.287 |
| Runny nose | Specificity | 0.838 | 0.834 | 0.842 |
| Runny nose | PPV | 0.023 | 0.019 | 0.027 |
| Runny nose | NPV | 0.986 | 0.985 | 0.988 |
| Runny nose | Accuracy | 0.829 | 0.825 | 0.834 |
| Nausea vomiting | Sensitivity | 0.088 | 0.062 | 0.114 |
| Nausea vomiting | Specificity | 0.934 | 0.931 | 0.936 |
| Nausea vomiting | PPV | 0.020 | 0.014 | 0.026 |
| Nausea vomiting | NPV | 0.985 | 0.984 | 0.987 |
| Nausea vomiting | Accuracy | 0.921 | 0.918 | 0.924 |
| Nasal Congestion | Sensitivity | 0.177 | 0.141 | 0.212 |
| Nasal Congestion | Specificity | 0.879 | 0.875 | 0.882 |
| Nasal Congestion | PPV | 0.022 | 0.017 | 0.026 |
| Nasal Congestion | NPV | 0.986 | 0.984 | 0.987 |
| Nasal Congestion | Accuracy | 0.868 | 0.864 | 0.872 |
| Myalgias | Sensitivity | 0.300 | 0.258 | 0.342 |
| Myalgias | Specificity | 0.902 | 0.899 | 0.905 |
| Myalgias | PPV | 0.045 | 0.037 | 0.052 |
| Myalgias | NPV | 0.988 | 0.987 | 0.990 |
| Myalgias | Accuracy | 0.893 | 0.889 | 0.896 |
| Hoarse voice | Sensitivity | 0.071 | 0.047 | 0.094 |
| Hoarse voice | Specificity | 0.958 | 0.955 | 0.960 |
| Hoarse voice | PPV | 0.025 | 0.016 | 0.033 |
| Hoarse voice | NPV | 0.985 | 0.984 | 0.987 |
| Hoarse voice | Accuracy | 0.944 | 0.942 | 0.947 |
| Headache | Sensitivity | 0.318 | 0.275 | 0.361 |

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|---|---|---|---|---|
| Headache | Specificity | 0.851 | 0.847 | 0.855 |
| Headache | PPV | 0.031 | 0.026 | 0.037 |
| Headache | NPV | 0.988 | 0.987 | 0.989 |
| Headache | Accuracy | 0.843 | 0.838 | 0.847 |
| Fever | Sensitivity | 0.298 | 0.256 | 0.340 |
| Fever | Specificity | 0.921 | 0.918 | 0.924 |
| Fever | PPV | 0.054 | 0.045 | 0.063 |
| Fever | NPV | 0.988 | 0.987 | 0.990 |
| Fever | Accuracy | 0.911 | 0.908 | 0.915 |
| Fatigue | Sensitivity | 0.276 | 0.235 | 0.317 |
| Fatigue | Specificity | 0.842 | 0.838 | 0.847 |
| Fatigue | PPV | 0.026 | 0.022 | 0.031 |
| Fatigue | NPV | 0.987 | 0.986 | 0.988 |
| Fatigue | Accuracy | 0.834 | 0.830 | 0.838 |
| Difficulty swallowing | Sensitivity | 0.031 | 0.015 | 0.047 |
| Difficulty swallowing | Specificity | 0.975 | 0.973 | 0.977 |
| Difficulty swallowing | PPV | 0.018 | 0.009 | 0.028 |
| Difficulty swallowing | NPV | 0.985 | 0.984 | 0.986 |
| Difficulty swallowing | Accuracy | 0.961 | 0.958 | 0.963 |
| Diarrhea | Sensitivity | 0.097 | 0.070 | 0.124 |
| Diarrhea | Specificity | 0.922 | 0.919 | 0.925 |
| Diarrhea | PPV | 0.019 | 0.013 | 0.024 |
| Diarrhea | NPV | 0.985 | 0.984 | 0.987 |
| Diarrhea | Accuracy | 0.910 | 0.907 | 0.913 |
| Cough | Sensitivity | 0.450 | 0.405 | 0.496 |
| Cough | Specificity | 0.827 | 0.822 | 0.831 |
| Cough | PPV | 0.038 | 0.033 | 0.043 |
| Cough | NPV | 0.990 | 0.989 | 0.991 |
| Cough | Accuracy | 0.821 | 0.817 | 0.825 |
| Change in taste | Sensitivity | 0.130 | 0.099 | 0.161 |
| Change in taste | Specificity | 0.984 | 0.983 | 0.986 |
| Change in taste | PPV | 0.112 | 0.085 | 0.138 |
| Change in taste | NPV | 0.987 | 0.985 | 0.988 |
| Change in taste | Accuracy | 0.971 | 0.969 | 0.973 |
| Anosmia | Sensitivity | 0.163 | 0.129 | 0.197 |
| Anosmia | Specificity | 0.987 | 0.986 | 0.988 |
| Anosmia | PPV | 0.162 | 0.128 | 0.195 |
| Anosmia | NPV | 0.987 | 0.986 | 0.988 |
| Anosmia | Accuracy | 0.975 | 0.973 | 0.976 |
| Abdominal pain | Sensitivity | 0.055 | 0.034 | 0.076 |
| Abdominal pain | Specificity | 0.951 | 0.949 | 0.954 |
| Abdominal pain | PPV | 0.017 | 0.010 | 0.024 |
| Abdominal pain | NPV | 0.985 | 0.984 | 0.986 |
| Abdominal pain | Accuracy | 0.938 | 0.935 | 0.940 |

Unidentified


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**Table S4: Odds ratios for positive COVID-19 swab test**

| Type | Effect | Index group | Reference group | Odds ratio | Lower | Upper | Pr > \|Z\| |
|---|---|---|---|---|---|---|---|
| Crude odds ratio | Age (continuous) | +10 years | | 0.98 | 0.953 | 0.998 | 0.0339 |
| Crude odds ratio | Sex | Male | Female | 1.10 | 0.997 | 1.215 | 0.0572 |
| Crude odds ratio | Anosmia | Yes | No | 7.73 | 6.641 | 8.986 | <.0001 |
| Crude odds ratio | Cough and/or shortness of breath | Yes | No | 3.58 | 3.217 | 3.973 | <.0001 |
| Crude odds ratio | Diarrhea and/or abdominal pain | Yes | No | 1.54 | 1.306 | 1.821 | <.0001 |
| Crude odds ratio | Fever | Yes | No | 4.68 | 4.166 | 5.266 | <.0001 |
| Adjusted odds ratio | Age (continuous) | +10 years | | 1.02 | 0.990 | 1.053 | 0.1838 |
| Adjusted odds ratio | Sex | Male | Female | 0.97 | 0.857 | 1.098 | 0.6295 |
| Adjusted odds ratio | Anosmia | Yes | No | 4.93 | 4.132 | 5.893 | <.0001 |
| Adjusted odds ratio | Cough and/or shortness of breath | Yes | No | 2.18 | 1.909 | 2.484 | <.0001 |
| Adjusted odds ratio | Diarrhea and/or abdominal pain | Yes | No | 0.70 | 0.577 | 0.845 | 0.0002 |
| Adjusted odds ratio | Fever | Yes | No | 2.26 | 1.937 | 2.631 | <.0001 |

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