Long COVID in young adults on a university campus

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Abstract

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Objective: To determine the prevalence of long COVID in young adults in a university setting and to describe risk factors for long COVID in this population

Methods: This is a prospective cohort study conducted between December 2021 and February 2023 among research study participants in the Husky Coronavirus Testing (HCT) program at the University of Washington (UW). Research study participants who tested positive or inconclusive for SARS-CoV-2 by PCR test or those who reported testing positive by rapid antigen test were invited to participate in a long COVID survey a minimum of 28 days after their test date to collect data regarding current symptom(s), type of clinical care received and impact on daily activities. The primary outcome was presence of long COVID illness. Logistic regression was used to assess for association between risk factors and presence of long COVID.

Results: Overall we received 1764 responses from 1752 unique participants, with 55.0% students and 44.3% staff or faculty. Participants with long COVID were older (median age: 34 years, IQR:

23-48) compared to those without long COVID (median age:27 years, IQR: 21-45). About 15.8% (279/1764) of participants in the survey reported experiencing at least one symptom associated with long COVID. Among participants with long COVID (n=279), the most reported symptoms of long COVID were tiredness (9.9%), followed by brain fog (7.3%), cough (5.6%), anxiety (3.8%) and trouble sleeping (3.6%). After adjusting for presence of sore throat, runny nose, headache and any symptoms at the time of testing positive for SARS-CoV-2, we found that female sex compared to males (adjusted OR (aOR): 1.71; 95% CI: 1.14, 2.60; p-value: 0.011), increase in age by one year (aOR:1.02; 95% CI: 1.00,1.03; p-value: 0.015), cough (aOR: 1.71; 95% CI: 1.09, 2.75; p-value: 0.023) and tiredness (aOR: 2.03; 95% CI:1.32, 3.17; p-value: 0.001) were associated with significantly higher odds of long COVID.

Most participants (65.9%) reported interruption of routine activities due to ongoing symptoms of long COVID. Activities affected included exercise (50.2%), work (29.0%), socializing (26.2%) and school (20.4%). After the end of quarantine period, the average number of days of work or school days missed per person was 3.9 days.

Conclusion: We found a substantial burden of long COVID in a university population, with impact on school and work absenteeism. Knowledge of the risk factors and prevalence of long COVID can help university leadership plan strategies to provide individualized support for students and staff affected by long COVID.

Background and Significance

Surges in COVID-19 cases have been reported that coincide with the re-opening of universities and colleges after scheduled breaks[1–3]. Unique features of university settings such as shared living and dining spaces, crowded lecture halls and high level of engagement in social activities and sporting events provide an ideal setting for increased transmission of COVID-19 among young adults. In-person instruction at universities has also been associated with increased incidence of SARS CoV-2 at the county level[3].

While most people with COVID-19 are expected to fully recover from their acute illness, lingering symptoms and ongoing health issues related to COVID-19 infection have been reported in up to 43% of people globally[4]. Long term effects of COVID-19 are known by various names such as long COVID, long-haul COVID and post-acute sequelae of SARS CoV-2 infection. The World Health Organization (WHO) defines long COVID as new or ongoing symptoms that last 12 weeks or longer after initial infection [5] whereas the Center for Disease Control (CDC) uses a shorter time frame of four weeks [6]. Long COVID can manifest differently in different people, and it can affect multiple organ systems and symptoms can fluctuate over time. More than 50 symptoms associated with long COVID have been described, with the most common being fatigue and headache[7]. Several studies have found that long COVID is significantly associated with increasing age[8–10]. Established clinical risk factors for long COVID include severe illness requiring hospitalization, presence of certain co-morbidities and lack of COVID-19 vaccination[11]. However, it has also been reported in individuals who were asymptomatic or mildly symptomatic and lack risk factors[12].

Currently there is limited published information about the prevalence of long COVID in young healthy adults within a university community. A recent study found the prevalence of long COVID to be 36% in a university setting with a median age of 23[13]. Long COVID is now recognized as a disability under the Americans with Disabilities Act[14]. Students with long COVID are entitled to protections, reasonable modifications and academic accommodations[15]. In order to plan to provide individualized support for students, it is necessary to understand the scale and nature of the problem.

The Husky Coronavirus Testing (HCT) program is a voluntary research study open to individuals affiliated with the University of Washington (UW), a large public university located in Seattle, WA, USA. The objective of this study was to evaluate the risk factors, prevalence, and impact of long COVID among HCT participants including students, staff, and faculty.

Methods

Study design and setting:

This is a prospective cohort study conducted at UW, a large public university in Washington state, with its main campus in Seattle, and two smaller satellite campuses[16]. The university population is composed of approximately 60,000 students and 32,000 faculty and staff[17]. In fall 2020, the Husky Coronavirus Testing (HCT) program was instituted as part of the university's comprehensive plan for prevention and control of COVID-19. The HCT program provides free, voluntary polymerase chain reaction (PCR) testing of SARS-CoV-2 and symptom surveillance for students, faculty and staff affiliated with UW. In this study, individuals were sent daily

messages via text or email to ask about new symptoms, exposures, or high-risk behaviors, which would trigger an invitation to come in for a PCR test. Additionally, once antigen testing became widely available in March 2022, individuals were asked on their daily messages to provide any antigen test results.

Study subjects:

The inclusion criteria for HCT eligibility were: 1) a valid university identification number 2) work or attend classes in-person at the university campus at least once per month 3) live within commuting distance of one of the three campuses, and 4) ability to provide consent in English The exclusion criteria were living outside of the geographic area (living outside the state and working remotely for the university) and age < 13 years. Any individual who met the inclusion criteria could enroll in the parent HCT study, regardless of symptom status and regardless of whether they submitted a sample for testing. Informed consent was signed electronically at the time of enrollment.

For this analysis, we used data collected from December 2021 to February 2023. During this time period, participants who had a positive or inconclusive PCR test or who reported a positive rapid antigen test for SARS-CoV-2 were invited to participate in a follow-up survey to assess for symptoms and presence of long COVID a minimum of four weeks after their positive test.

Data collection:

All data were collected electronically by sending participants an email or text notification with a link to questionnaires. All responses were self-reported. Participants could opt out of email and

text notifications at any time. All study data were collected and managed using REDCap electronic data capture tools. The surveys included:

a) Enrollment questionnaire and quarterly update survey

   The enrollment questionnaire. included demographics, housing status, type of affiliation to the university and COVID-19 vaccination information. Current pre-existing medical conditions were captured by selecting one or more options from the following list: asthma/reactive airway disease, COPD/emphysema, chronic bronchitis, cancer, diabetes, heart disease, high blood pressure, seasonal allergies, immunosuppressed, long COVID or none of the above. A quarterly update survey was used to update eligibility, address, and vaccination status.

b) Daily Attestation Survey and Symptom attestation survey at the time of PCR test for SARS-CoV-2

   All participants were prompted to fill out a survey daily (Daily attestation survey) that collected information on date of known exposures to COVID-19, and date(s), number and results of rapid antigen test(s) performed at home. New or worsening symptoms in the past 24 hours were captured by selecting one or more items from the following list: feeling feverish, headache, cough, chills or shivering, sweats, sore/itchy/scratchy throat, nausea/vomiting, runny/stuffy nose, tired, muscle or body aches, increased trouble breathing, diarrhea, rash, ear pain/discharge, eye pain, loss of smell or taste, other symptoms not listed or no symptoms. Participants who submitted a swab for PCR testing filled out an additional symptom attestation survey that captured new or worsening symptoms in the past 7 days.

c) Long COVID survey

Starting in December 2021, all participants who tested positive or inconclusive for SARS-CoV-2 by PCR testing or those who attested to having had a positive rapid antigen self-test were contacted a minimum of 28 days after their first positive test date and invited to participate in the long COVID survey. Each participant was allowed to fill out the survey only once per academic year.

The long COVID survey collected information on presence of long COVID by asking the question: 'Are you still experiencing symptoms related to your COVID-19 illness? (e.g., brain fog, fatigue, headaches, etc)'. Symptoms of long COVID were collected by selecting one or more choices from the following list: fever, headache, cough, chills/shivering, sweats, sore/itchy/scratchy throat, nausea/vomiting, runny/stuffy nose, feeling more tired than usual, muscle/body aches, increased trouble breathing, diarrhea, rash, ear pain/discharge, eye pain, loss of smell or taste, brain fog, palpitations, sleep disturbances, feeling down/anxious or other symptoms not listed. Other variables collected were type of medical care sought, activities affected by long COVID, and number of days of school or work missed because of long COVID.

Swab collection and laboratory methods for PCR testing for SARS-CoV-2

Swab collection was conducted either via observed self-swab at a staffed kiosk, unobserved self-swab returned to a drop box on university campus, or unobserved self-swab returned to the laboratory via courier, as previously described[18]. Samples were tested for SARS-CoV-2 using a quantitative reverse transcription polymerase chain reaction (RT-qPCR) laboratory-developed test (LDT).

Statistical methods

We performed descriptive statistics of frequency and percentage and mean and standard deviation for categorical and continuous variables, respectively, per unique survey respondent. Sociodemographic characteristics included are age, sex, race, nature of affiliation to the university (student versus faculty/staff) and comorbidities. Additional covariates include type of test used for SARS-CoV-2 (PCR vs rapid antigen), type of symptoms and median symptom count at the time of testing positive for SARS-CoV-2, stratified by presence or absence of long COVID as a binary outcome.

We applied univariate and multivariate logistic regression to assess risk factors predictive of long COVID. The following covariates were selected *a priori*: sex, age, symptom status (at least one symptom versus none) and time difference (in days) between testing positive for SARS-CoV-2 and responding to the long COVID survey as these have been previously known potential risk factors for long COVID[10,13,19,20]. Additionally, we included the top five most frequent symptoms reported at the time of acute COVID illness. Robust standard errors were used for all analysis estimates. All hypothesis tests were 2-sided and Wald test p-values were used to assess statistical significance at an α of 0.05.

Statistical analyses were performed using R Statistical Software (Version 2022.12.0, Foundation for Statistical Computing, Vienna, Austria). All study participants provided informed consent; this study was approved by the Institutional Review Board at UW.

Results

Between December 2021 and January 2023, we sent 4819 invitations to study participants with a request to participate in the long COVID survey. Baseline characteristics of survey invitees stratified by response status is shown in Supplemental Table 1. We received 1769 (36.7%) responses to the survey. Fourteen participants responded to the survey in both academic years of this study period. A total of five responses were not useable due to inability to verify the date of positive COVID test. The final analytic sample consisted of 1764 responses from 1752 unique participants. Of these, 1005 (56.9%) of these had a PCR-positive test, and 759 (43.0%) had a positive antigen test. Survey respondents were older (median age: 28 years) compared to non-respondents (median age: 21 years). The average time to response was 55 days (range, 28 to 220 days) from date of positive COVID test.

Baseline characteristics of survey respondents stratified by long COVID status is shown in **Table 1**. The median age of respondents was 28 years (IQR: 21-45); participants with long COVID were older (median age: 34 years, IQR: 23-48) compared to those without long COVID (median age: 27 years, IQR: 21-45). More than half of the respondents were female (64.0%) and White (61.4%). A higher proportion of respondents were students (55.0%), followed by faculty or staff (44.3%). Most respondents had no underlying conditions (58.5%); the most reported comorbidity was seasonal allergies (29.0%).

Among 1764 responses, 912 (51.7%) reported at least one symptom at the time of testing positive for SARS-CoV-2 **(Table 2)**. Most participants reported upper respiratory symptoms such as sore throat (39.5%), cough (31.4%) and runny nose (31.7%), followed by headache (24.5%) and

tiredness (20.1%). The mean number of symptoms reported was 3.4 (SD: 3.1) per response. 230 (13.0%) were asymptomatic at the time of original SARS-CoV-2 positive test.

About 15.8% (279/1764) of respondents reported experiencing at least one symptom associated with long COVID in the follow-up survey. The most reported symptoms of long COVID were tiredness (9.9%), followed by brain fog (7.3%), cough (5.6%), anxiety (3.8%) and trouble sleeping (3.6%). The mean number of long COVID symptoms per person was 3.1 (SD:2.1). The majority (78.4%) did not seek medical care for long COVID at the time of the survey. Among 230 cases who were asymptomatic at the time of positive SARS-CoV-2 test, 19 (8.3%) reported presence of long COVID, compared to 13.7% long COVID among 913 cases who reported at least one symptom at the time of initial test. Most participants (65.9%) reported interruption of routine activities due to ongoing symptoms of long COVID. Activities affected included exercise (50.2%), work (29.0%), socializing (26.2%) and school (20.4%). After the end of quarantine period, the average number of days of work or school days missed per person was 3.9 days.

In unadjusted analysis we found that female sex compared to males, increase in age by one year, presence of runny nose, cough, headache and tiredness or presence of any symptom at the time of positive SARS-CoV-2 test was strongly associated with development of long COVID **(Table 3)**

In our multivariate model, we found that female sex (adjusted OR (aOR): 1.71; 95% CI: 1.14, 2.60; p-value: 0.011), increase in age by one year (aOR:1.02; 95% CI: 1.00,1.03; p-value:

0.015), cough (aOR: 1.71; 95% CI: 1.09, 2.75; p-value: 0.023) and tiredness (aOR: 2.03; 95% CI:1.32, 3.17; p-value: 0.001) were associated with significantly higher odds of long COVID. **(Table 3)**

Discussion

In this prospective cohort study of 1752 participants representing 1764 SARS-CoV-2 infections between December 2021 and February 2023, we found that the prevalence of long COVID was 16%, and that there were substantial impacts on work and school absenteeism.

This finding is broadly similar to current estimates in the general population in the US[8]; however, it is markedly different from a recent publication by Landry et al[13] that found 36% prevalence of long COVID in a university community, with a median age of 23 years. This disparity could be because our study population had higher vaccination rates. The UW has a COVID-19 vaccine mandate[21] and the vaccination rate is approximately 98.5% in the UW community[22]. It is now known that individuals who are not vaccinated against COVID-19 are at greater risk for developing long COVID, compared to those who are vaccinated[11,19,23].

In both our unadjusted and multivariate models, female sex and increasing age were associated with higher odds of long COVID. It has been well documented that female sex is associated with higher likelihood of long COVID in both hospitalized and non-hospitalized individuals infected with COVID[10,20,24]. The Household Pulse Survey done by the United States Census Bureau in June 2022 found that long COVID was more prevalent in adults aged 50-59 than those aged 80 and older[8]. A survey of households in the UK found that the prevalence of long COVID

was greatest in people aged 35-69 years[25]. Similarly in an analysis of primary care data from the UK, Subramaniam and colleagues found that individuals 70 years and older had a 25% lower risk of long COVID compared to those aged 18-30 years[20]. Our study population is considerably younger with a median age of 28 years. Consistent with other studies, we found that cough and tiredness at time of acute COVID illness was significantly associated with long COVID[10,20]. Additionally, presence of headache and stuffy or runny nose was associated with higher odds of long COVID, but did not reach statistical significance. In our study population, long COVID was predominantly characterized by fatigue, brain fog, cough, anxiety and trouble sleeping. This list is included within the broad range of symptoms associated with long COVID in systematic reviews, surveys and studies utilizing population-level data[7,8,20,26].

Long COVID contributed to about 4 days of absenteeism from work or school in our study participants. This could have important implications on student academic life as well as staff and faculty's ability to fulfill their job responsibilities. According to the US National Center for Education Statistics, 19% of undergraduate students and 12% of graduate students reported having a disability in the 2015-16 academic year[27]. More recently a survey was conducted to assess the impact of the COVID-19 pandemic on students with disabilities. This survey, open to students at 10 large public universities in the United States, found that 28% of graduate and professional students had at least one disability[28]. Learning disabilities make up the vast proportion of student disabilities, increasing from 16% in 1988 to 40% in 2000[29]. US federal law requires institutions to provide accommodations to ensure that qualified students with disabilities have equal access to educational opportunities. Examples of accommodations include adaptive equipment or technology, classroom scribes, sign language interpreters,

alternate exam format or additional exam times[30]. Faculty members are important stakeholders in this decision and universities can support faculty by providing required training sessions and easy access to accommodation options.

With nearly 42% of US adults having had COVID[31], universities must take into account the long-term sequelae of COVID infection. Although the pathophysiology, prognosis, and best treatment options for long COVID are still under investigation, we can use our current understanding of prevalence and risk factors to improve support systems within the community. Better communication and advertising of long COVID clinics that provide multidisciplinary care, reducing administrative barriers for appointments and timely referral for specialist care are important strategies to consider. A recent study from the United Kingdom found that the majority of people with long COVID experienced some form of stigma, and this was especially true for people with a clinical diagnosis of long COVID[32]. Both overt discrimination due to perceived psychosomatization of symptoms and self-stigmatization due to internalized feelings of shame or worthlessness have been described in the literature[32,33]. Therefore, access to mental health practitioners is crucial to empower affected individuals to actively take charge to advocate for their own health.

Limitations of our study include potential selection bias due to use of convenience sampling for recruitment. All questionnaires were administered electronically, and only in English. This may have posed challenges for individuals with limited English proficiency and technology access. Responses to all questionnaires were self-reported and subject to bias. Missingness in data was also a limitation as participants could skip questions at will. Lastly, our survey response was

about 36%; although this is the norm for electronic surveys, our results and conclusions are only representative of those of who responded and not the whole university community.

In conclusion, our study adds to the literature on prevalence and risk factors for long COVID among healthy, young adults in a university community and strategies to help affected students and staff cope with long term effects of COVID.

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Table 11: Baseline characteristics of survey respondents by long COVID status, Seattle, WA, December 2021-February 2023 (N=1752)

	Long COVID (N=278)	No Long COVID (N=1474)	Overall (N=1752)
Age(years)			
Median [IQR]	34.0 [23.0-48.0]	27.0 [21.0-45.0]	28.0 [21.0-45.25]
Sex			
Female	207 (74.5%)	915 (62.1%)	1122 (64.0%)
Male	69 (24.8%)	553 (37.5%)	622 (35.5%)
Missing	2 (0.7%)	6 (0.4%)	8 (0.5%)
Affiliation			
Student	125 (45.0%)	839 (56.9%)	964 (55.0%)
Faculty/Staff	150 (54.0%)	626 (42.5%)	776 (44.3%)
Other	3 (1.1%)	9 (0.6%)	12 (0.7%)
Race			
White	191 (68.7%)	884 (60.0%)	1075 (61.4%)

	Long COVID (N=278)	No Long COVID (N=1474)	Overall (N=1752)
Asian	40 (14.4%)	372 (25.2%)	412 (23.5%)
Black	6 (2.2%)	29 (2.0%)	35 (2.0%)
American Indian/Alaska Native	4 (1.4%)	6 (0.4%)	10 (0.6%)
Native Hawaiian/Pacific Islander	1 (0.4%)	4 (0.3%)	5 (0.3%)
Other	12 (4.3%)	48 (3.3%)	60 (3.4%)
Prefer not to say	7 (2.5%)	29 (2.0%)	36 (2.1%)
Missing	17 (6.1%)	102 (6.9%)	119 (6.8%)
Comorbidities*			
None	130 (46.8%)	895 (60.7%)	1025 (58.5%)
Seasonal allergies	109 (39.2%)	399 (27.1%)	508 (29.0%)
Asthma	42 (15.1%)	125 (8.5%)	167 (9.5%)
High blood pressure	22 (7.9%)	81 (5.5%)	103 (5.9%)
Immunosuppressed	6 (2.2%)	25 (1.7%)	31 (1.8%)
Cancer	2 (0.7%)	4 (0.3%)	6 (0.3%)
Cardiovascular disease	3 (1.1%)	7 (0.5%)	10 (0.6%)

	Long COVID (N=278)	No Long COVID (N=1474)	Overall (N=1752)
Diabetes	7 (2.5%)	19 (1.3%)	26 (1.5%)
Chronic obstructive pulmonary disease	1 (0.4%)	0 (0%)	1 (0.1%)
Bronchitis	1 (0.4%)	1 (0.1%)	2 (0.1%)
Do not know	10 (3.6%)	34 (2.3%)	44 (2.5%)
Prefer not to say	1 (0.4%)	10 (0.7%)	11 (0.6%)

*current comorbidities selected from a list; IQR, interquartile range

Table 2: Frequency and type of acute symptoms at time of SARS-CoV-2 testing by long COVID status, Seattle, WA, December 2021-February 2023 (N=1764)

	Long COVID (N=279)	No Long COVID (N=1485)	Total (N=1764)
Symptom type			
No symptoms	19 (6.8%)	211 (14.2%)	230 (13.0%)
Sore throat	94 (33.7%)	602 (40.5%)	696 (39.5%)
Runny nose	89 (31.9%)	470 (31.6%)	559 (31.7%)
Cough	94 (33.7%)	460 (31.0%)	554 (31.4%)
Headache	74 (26.5%)	358 (24.1%)	432 (24.5%)
Tired	74 (26.5%)	280 (18.9%)	354 (20.1%)
Body aches	63 (22.6%)	235 (15.8%)	298 (16.9%)
Fever	47 (16.8%)	249 (16.8%)	296 (16.8%)
Chills	39 (14.0%)	179 (12.1%)	218 (12.4%)
Sweats	27 (9.7%)	130 (8.8%)	157 (8.9%)
Nausea/vomiting	20 (7.2%)	65 (4.4%)	85 (4.8%)
Breathing trouble	15 (5.4%)	50 (3.4%)	65 (3.7%)

	Long COVID (N=279)	No Long COVID (N=1485)	Total (N=1764)
Diarrhea	9 (3.2%)	43 (2.9%)	52 (2.9%)
Ear ache	15 (5.4%)	34 (2.3%)	49 (2.8%)
Eye pain	8 (2.9%)	35 (2.4%)	43 (2.4%)
Loss of smell/taste	5 (1.8%)	24 (1.6%)	29 (1.6%)
Missing	135 (48.4%)	486 (32.7%)	621 (35.2%)
Symptom count			
Mean (SD)	4.78 (3.21)	3.41 (2.74)	3.58 (2.84)
Missing	135 (48.4%)	486 (32.7%)	621 (35.2%)

Table 3: Univariate and multivariate logistic regression models for risk factors for development of long COVID, Seattle, WA, December 2021-February 2023 (N=1764)

Variable	**Unadjusted OR [95% CI]**	**p-value**	**Adjusted OR* [95% CI]**	**p-value**
Female sex	1.83 [1.38, 2.47]	**< 0.001**	1.71 [1.14, 2.60]	**0.011**
Age	1.01 [1.01, 1.02]	**0.001**	1.02 [1.00, 1.03]	**0.015**
Sore throat	1.24 [0.86, 1.80]	0.249	0.64 [0.39, 1.03]	0.065
Runny nose	1.82 [1.28, 2.62]	**0.001**	1.12 [0.73, 1.73]	0.616
Cough	2.20 [1.54, 3.19]	**< 0.001**	1.71 [1.09, 2.75]	**0.023**
Headache	1.89 [1.33, 2.69]	**< 0.001**	1.20 [0.77, 1.87]	0.426
Tired	2.71 [1.90, 3.88]	**< 0.001**	2.03 [1.32, 3.17]	**0.001**
Symptom count[+]				
≥ 1 symptom	1.66 [1.03, 2.80]	**0.045**	0.78 [0.38, 1.59]	0.487

***** adjusted for all variables in the column and time difference (in days) between testing positive for SARS-CoV-2 and responding to the long COVID survey; OR, odds ratio

+ at time of testing positive for SARS-CoV-2

Supplemental Table 1: Baseline characteristics of survey invitees by response status, Seattle, WA, December 2021-February 2023 (N=4819)

	Non-Respondent (N=3055)	Respondent (N=1764)	Total (N=4819)
Age(years)			
Median [IQR]	21.0 [20.0-25.0]	28.0 [21.0-46.0]	22.0 [20.0-32.0]
Sex			
Female	1811 (59.3%)	1129 (64.0%)	2940 (61.0%)
Male	1226 (40.1%)	627 (35.5%)	1853 (38.5%)
Missing	18 (0.6%)	8 (0.5%)	26 (0.5%)
Affiliation			
Student	2552 (83.5%)	970 (55.0%)	3522 (73.1%)
Staff	341 (11.2%)	558 (31.6%)	899 (18.7%)
Faculty	145 (4.7%)	224 (12.7%)	369 (7.7%)
Other	17 (0.6%)	12 (0.7%)	29 (0.6%)
Race			
White	1454 (47.6%)	1083 (61.4%)	2537 (52.6%)

Supplemental Table 1: Baseline characteristics of survey invitees by response status, Seattle, WA, December 2021-February 2023 (N=4819)

	Non-Respondent (N=3055)	Respondent (N=1764)	Total (N=4819)
Asian	1042 (34.1%)	413 (23.4%)	1455 (30.2%)
Black	86 (2.8%)	35 (2.0%)	121 (2.5%)
American Indian/Alaska Native	16 (0.5%)	10 (0.6%)	26 (0.5%)
Native Hawaiian/Pacific Islander	11 (0.4%)	5 (0.3%)	16 (0.3%)
Other	129 (4.2%)	61 (3.5%)	190 (3.9%)
Prefer not to say	74 (2.4%)	37 (2.1%)	111 (2.3%)
Missing	243 (8.0%)	120 (6.8%)	363 (7.5%)
Comorbidities*			
None	2095 (68.6%)	1030 (58.4%)	3125 (64.8%)
Seasonal allergies	473 (15.5%)	376 (21.3%)	849 (17.6%)
Asthma	135 (4.4%)	54 (3.1%)	189 (3.9%)
High blood pressure	31 (1.0%)	46 (2.6%)	77 (1.6%)

Supplemental Table 1: Baseline characteristics of survey invitees by response status, Seattle, WA, December 2021-February 2023 (N=4819)

	Non-Respondent (N=3055)	Respondent (N=1764)	Total (N=4819)
Immunosuppressed	20 (0.7%)	21 (1.2%)	41 (0.9%)
Diabetes	9 (0.3%)	12 (0.7%)	21 (0.4%)
Cardiovascular disease	3 (0.1%)	3 (0.2%)	6 (0.1%)
Cancer	1 (0.0%)	2 (0.1%)	3 (0.1%)
Do not know	99 (3.2%)	45 (2.6%)	144 (3.0%)
Prefer not to say	31 (1.0%)	12 (0.7%)	43 (0.9%)
Missing	1 (0.0%)	1 (0.1%)	2 (0.0%)

*current comorbidities selected from a drop down list; IQR, interquartile range