Surveillance of SARS-CoV-2 in Asymptomatic Faculty and Staff at the University of Wisconsin-Madison

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ABSTRACT

Introduction: Surveillance of SARS-CoV-2 among university employees is an important part of mitigation strategies to prevent asymptomatic transmission and ensure a safe learning and work environment. Here, we assess the feasibility and performance of a program that relies on monitored self-collected nasal swabs to detect SARS-CoV-2 among asymptomatic faculty and staff.

Methods: We recruited 1,030 faculty and staff via rolling enrollment who completed the required University of Wisconsin-Madison employee COVID-19 training and reported working on campus. Asymptomatic participants visited a designated location during a specified timeframe each week where they self-collected nasal swabs supervised by study staff. Specimens were stored in a cooler between 2 °C and 8 °C, then transported to the Wisconsin Veterinary Diagnostic Laboratory for polymerase chain reaction testing. Symptomatic participants or participants with a known exposure were advised to test elsewhere and follow quarantine guidelines from the Centers for Disease Control and Prevention.

Results: Over the course of 31 weeks, 1,030 participants self-collected 17,323 monitored nasal swabs resulting in high participation (90%). SARS-CoV-2 was detected in 16 specimens. Eight specimens were inconclusive but were treated as positive results because of the implied detection of 1 or more SARS-CoV-2 genes. There were no invalid tests. Weekly SARS-CoV-2 incidence among participants ranged from 0 to 1.54% ($\bar{x}$ = 0.20%). The SARS-CoV-2 incidence among participants was similar to estimated incidence in the greater university employee population.

Conclusion: Weekly SARS-CoV-2 surveillance of asymptomatic faculty and staff on campus allowed for estimation of weekly SARS-CoV-2 incidence among on-campus employees. This surveillance protocol presents a low-cost, effective, and scalable option to identify asymptomatic cases of SARS-CoV-2 among university employees.

INTRODUCTION

In response to the coronavirus disease 2019 (COVID-19) pandemic, the University of Wisconsin–Madison (UW–Madison) joined other institutions of higher education across the United States and quickly transitioned to online instruction starting March 23, 2020, when students were scheduled to return from spring break. Access to campus facilities and in-person activities were limited throughout the summer as leadership discussed how to safely reopen for the fall semester. One of the primary concerns was how to identify and disrupt asymptomatic transmission.

A limited number of essential faculty and staff were allowed to return to the UW–Madison campus during the spring and summer months of 2020. Individuals were required to apply for approval and undergo COVID-19 safety training. By August 2020, approximately 7,000 of 19,225 (36.4%) faculty and staff had returned for work on campus.

Approaches to ensuring safe in-person learning and work environments varied greatly across institutions due to cost, logistics, testing supply shortages, and laboratory capacity.[1] There is a growing body of research dedicated to campus testing strategies,[2-5] primarily aimed at students, but none of the studies focus on faculty and staff. At the UW–Madison, it was necessary to (1) assess whether it was safe for employees to return to campus, and (2) provide early warning should an acceleration in incidence of SARS-CoV-2 be

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detected, particularly in asymptomatic or presymptomatic individuals.[6] Our goal, therefore, was to implement cost-effective SARS-CoV-2 surveillance to detect asymptomatic cases, estimate weekly incidence of SARS-CoV-2, provide reassurance to returning faculty and staff, and support continued university operations. This report reviews the UW–Madison SARS-CoV-2 Incidence Surveillance Program (UWSISP) and evaluates its function over a 31-week period.

METHODS

All surveillance program study participants were UW–Madison employees who reported working on campus in some capacity and had completed the required UW employee COVID-19 training for on-campus workers. The surveillance program was considered a research study. The protocol was reviewed and approved by the UW Health Sciences Minimal Risk Institutional Review Board and was conducted in compliance with human subjects' protection policies.

The target surveillance population was 1,000 individuals based on estimated likelihood of ≥ 95% to detect a weekly incidence of ≥0.3% using calculators from the Influenza Virologic Surveillance Right Size Roadmap.[7] This also allowed for confidence intervals around point estimates of ≤ 0.25%.

Recruitment began with an email notice and invitation to join the study with an embedded link for an online Qualtrics survey (Qualtrics, Provo, Utah) that included questions to ensure eligibility. Contact information of interested, eligible UW–Madison employees was imported into a secure REDCap database, and potential participants were sent a consent form and screening survey.[8]

Upon completion and confirmation, participants were enrolled and assigned to their preferred weekly time slot and campus location. Enrolled subjects received a weekly reminder text message via their mobile phone that included a link to a survey addressing general health, COVID-19 symptoms, expected work attendance, and recent travel. Sending a link either via email or text to a smart phone allowed for encrypted communication. This process was automated through REDCap survey distribution tools. If subjects reported fever, shortness of breath, and/or cough, they were directed to a dedicated COVID-19 test site.

University-owned minivans parked at 3 designated locations served as specimen collection sites. Surveillance staff provided each participant with a collection kit that included a nasal swab, a container filled with phosphate-buffered saline, and an absorbent pad in a biohazard bag. Participants reviewed a video (https://www.youtube.com/watch?v=EnD1SVZc9j4) on how to obtain an anterior nasal swab specimen prior to their first collection; written instructions were available, and staff coached participants as needed. Surveillance staff monitored the collection process. Participants provided weekly monitored nasal swab specimens for SARS-CoV-2 testing.[9] Specimen containers were tightly sealed by participants, placed into a biohazard bag with an absorbent pad, and placed into a cooler between 2 °C and 8 °C. Samples were transported by surveillance staff to the Wisconsin Veterinary Diagnostic Laboratory (WVDL) for testing.

From week 1 through week 9, specimens were tested for SARS-CoV-2 at WVDL using the polymerase chain reaction (PCR) assay developed by the Centers for Disease Control and Prevention (CDC) and the TaqPath COVID-19 ThermoFisher assay.[10] Starting on week 10, WVDL began using a laboratory-developed test (LDT) modeled after the original real-time PCR assay developed by the CDC and used the TaqPath assay for confirmatory testing on inconclusive specimens. On week 18, WVDL switched exclusively to the LDT assay. The TaqPath assay has emergency use authorization from the US Food and Drug Administration. Emergency use authorization for the LDT was submitted on September 4, 2020, and currently is still under review.

Results of each specimen, coded with a unique identifier, were provided to the surveillance team through a secure server, usually within 24 hours from collection time. The data were entered into a password-protected, dual-authenticated REDCap database daily. Negative results were not routinely shared with participants. A positive result prompted an immediate phone call to the participant.

As mandated, identifiable information and data were shared with Public Health Madison and Dane County, the Wisconsin Department of Health Services Division of Public Health, and University Health Services (UHS) for the purposes of contact tracing. UW–Madison campus officials (UHS and Office of Human Resources) also were notified to address public health prevention measures on campus and to ensure appropriate cleaning of work areas. Test results were not recorded in employee personnel files.

Weekly incidence rates and 95% confidence intervals were calculated using standard methods. During the same time period as our surveillance program, UHS operated several locations on campus for drop-in testing of students and employees. Testing for SARS-CoV-2 in symptomatic and asymptomatic faculty and staff provided a background comparator to assess the validity of incidence estimates generated in the surveillance program. We used a denominator of 7,000 faculty and staff for the drop-in testing population based on the approximate number of employees who had received online training for return to campus.

RESULTS

Participants were recruited on a rolling basis to allow for a gradual increase in supply production, time to formulate a system for weekly organization and distribution of kits, and to assess feasibility of the protocol on a small scale before expansion (Figure 1). Recruitment via Qualtrics invitations began on August 10, 2020, and the first group of 48 participants was

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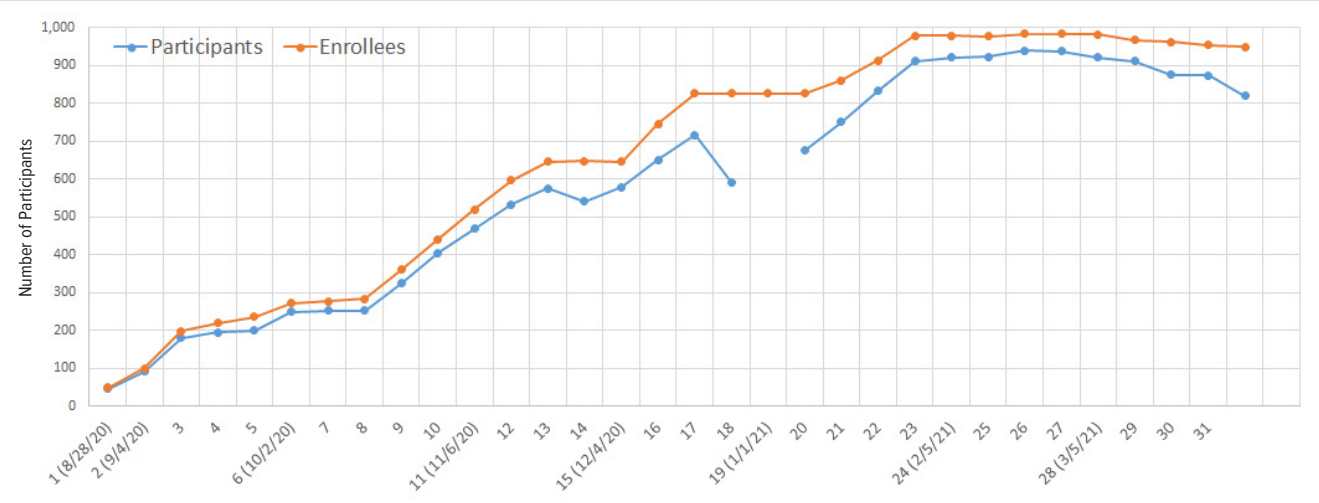
Figure 1. Comparison of Weekly Enrollment Numbers With Weekly Participants Who Collected a Nasal Swab Specimen



Week 19 represents winter break when few faculty and staff were on campus and the surveillance program was suspended.

enrolled to begin surveillance the week of August 24, 2020. Weekly enrollment increased steadily by an average 18% per week until week 23, at which time the university implemented mandatory, campus-wide COVID-19 saliva testing for employees and students during the Spring 2021 semester, and new enrollment in our study was paused (Table 1). Overall compliance of the surveillance participants was 90.0% (95% CI, 89.5-90.4).

Over the course of 31 weeks, 1,030 participants self-collected 17,323 monitored nasal swabs; SARS-CoV-2 was detected in 16 specimens. Eight of these specimens were inconclusive. Inconclusive results, however, were treated as positive results because of the implied detection of 1 or more SARS-CoV-2 genes and to give a conservative estimate of incidence. Positive specimens were indicated by the amplification of 2 or 3 of the 3 gene targets when using the CDC-developed assay during week 1 through week 9 or both SARS-CoV-2 gene targets when using the LDT PCR assay developed by WVDL from week 10 through week 31. Weekly SARS-CoV-2 incidence among participants ranged from 0 to 1.54% ($\bar{x}$ = 0.20%), as shown in Figure 2.

Participants were invited to return for weekly testing 14 days after their initial

Table 1. University of Wisconsin SARS-CoV-2 Incidence Surveillance Program (UWSISP) Weekly Enrollment and Testing Statistics

Study Week (Start Date)	No. Enrolled	Specimens Tested	Attendance Rate	Inconclusive Specimens	SARS-CoV-2 Positive Specimens	UWSISP SARS-CoV-2 Prevalence	New SARS-CoV-2 Cases in Dane County
1 (8/28/20)	48	46	96%	0	0	0.00%	520.000
2 (9/4/20)	99	91	92%	0	0	0.00%	1493.000
3 (9/11/20)	198	180	91%	2	0	1.11%	1143.000
4 (9/18/20)	219	195	89%	2	1	1.54%	895.000
5 (9/25/20)	236	200	85%	0	0	0.00%	867.000
6 (10/2/20)	271	249	92%	0	0	0.00%	843.000
7 (10/9/20)	277	252	91%	0	0	0.00%	1278.000
8 10/16/20)	283	252	89%	0	0	0.00%	1292.000
9 (10/23/20)	361	325	90%	0	0	0.00%	2020.000
10 (10/30/20)	441	404	92%	0	1	0.25%	2451.000
11 (11/6/20)	517	469	91%	2	1	0.64%	3203.000
12 (11/13/20)	596	533	89%	0	1	0.19%	3246.000
13 (11/20/20)	646	576	89%	0	3	0.52%	2162.000
14 (11/27/20)	646	541	84%	0	1	0.18%	1812.000
15 (12/4/20)	646	578	89%	0	2	0.35%	1372.000
16 (12/11/20)	746	650	87%	0	0	0.00%	1221.000
17 (12/18/20)	826	717	87%	0	2	0.28%	1032.000
18 (12/25/20)	826	592	72%	0	1	0.17%	1199.000
19 (1/1/21)							1419.000
20 (1/8/21)	826	675	82%	1	1	0.30%	1170.000
21 (1/15/21)	860	750	87%	0	0	0.00%	856.000
22 (1/22/21)	913	833	91%	0	2	0.24%	837.000
23 (1/29/21)	979	911	93%	0	0	0.00%	819.000
24 (2/5/21)	978	922	94%	1	0	0.11%	624.000
25 (2/12/21)	977	923	94%	0	0	0.00%	654.000
26 (2/19/21)	984	939	95%	0	0	0.00%	496.000
27 (2/26/21)	984	938	95%	0	0	0.00%	465.000
28 (3/5/21)	982	922	94%	0	0	0.00%	383.000
29 (3/12/21)	968	912	94%	0	0	0.00%	325.000
30 (3/19/21)	962	875	91%	0	0	0.00%	332.000
31 (3/26/21)	954	873	92%	0	0	0.00%	381.000

New weekly case counts of SARS-CoV-2 in the surrounding community of Dane County, Wisconsin, included for comparison. Inconclusive and positive specimens were combined to calculate weekly incidence.

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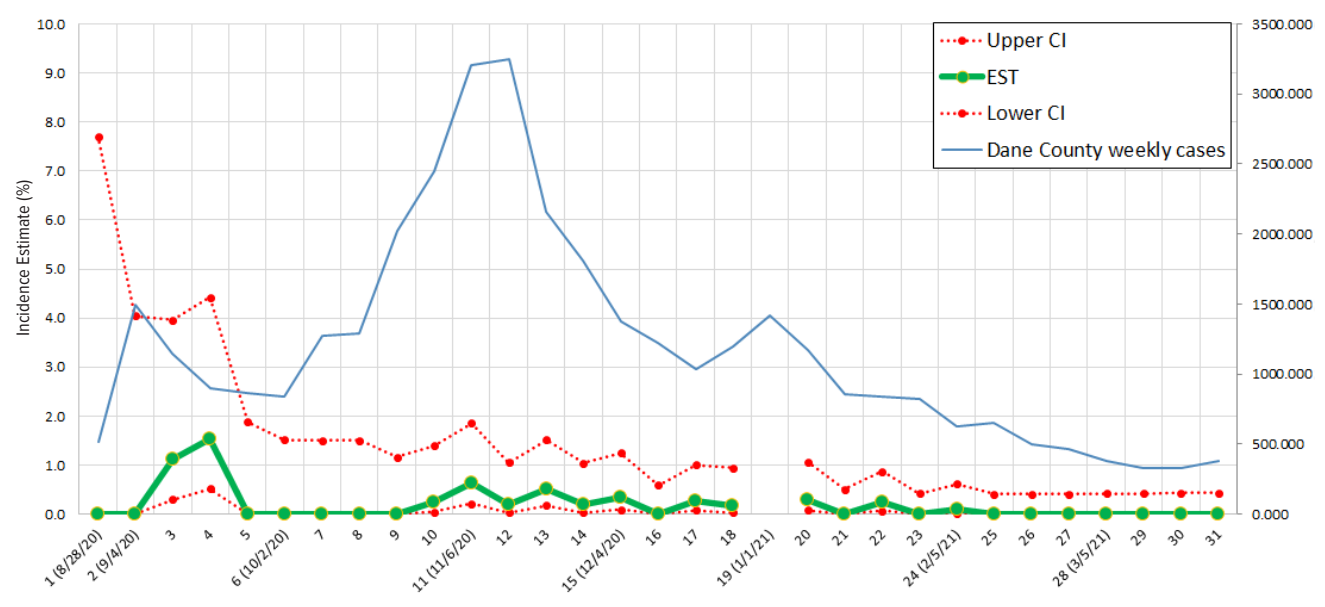
Figure 2. Estimated Incidence of SARS-CoV-2 Among University of Wisconsin-Madison Faculty, Staff, and Graduate Assistants (green line), With 95% CIs (red lines)



New weekly cases in Dane County (blue line) juxtaposed for comparison. Specimens were not collected the week of January 1, 2021 (week 19) due to anticipated diminished number of employees on campus during the holidays.

positive result. Two of the 16 positive specimens were from participants who had previously tested positive for SARS-CoV-2 in our study within 90 days and were likely residual positive results from initial infection. Follow-up surveys were available for 9 of the 14 participants with a SARS-CoV-2 detection. Three participants developed symptoms by the following week and would be considered presymptomatic at the time of specimen collection, while 6 remained asymptomatic. The overall prevalence of SARS-CoV-2 in this asymptomatic cohort was estimated to be 1.4% (95% CI, 0.8-2.3%). The 14 participants who tested positive for SARS-CoV-2 were distributed across 13 departments and 12 work buildings and were unlikely to represent on-campus transmission. Two participants reported working at UW Hospital on different floors and in different departments, and 3 participants cited Wisconsin Institutes for Medical Research as their worksite but reported working on different floors of the facility.

Demographics were evaluated for all participants enrolled at any point in the study and are largely representative of the general employee population at UW–Madison (Table 2). A majority of participants were female (58.4%), White (85.7%), and non-Hispanic (94.0%). Participants ranged in age from 18.9 years to 77.2 years, with a mean age of 40.4 years (SD 13.5). Home addresses from 58 cities and townships were provided, the most common being Madison (69%).

Of UW–Madison's 37 divisions and 521 departments with individuals who completed the UW employee COVID-19 training for on-campus workers, study participation encompassed individuals from 30 (81%) divisions and 221 (42%) departments. Positions held by participants varied widely and included academic staff, graduate students employed as teaching assistants, research assistants and fellows, university staff, faculty, postdoctoral students, and administrative staff.

Table 2. University of Wisconsin SARS-CoV-2 Incidence Surveillance Program Participant Demographics and Characteristics

Characteristic	Total, n (%)
Total participants	1,030
Sex	
Female	602 (58.4)
Male	423 (41.1)
Declined response	5 (0.5)
Age (mean, [range])	40.4 [18.9-77.2]
Race	
Asian	76 (7.4)
Black/African American	15 (1.5)
White	883 (85.7)
American Indian/Alaska Native	2 (0.2)
Unknown/not reported	25 (2.4)
2+ races	29 (2.8)
Ethnicity	
Hispanic/Latino	43 (4.2)
Non-Hispanic or Latino	968 (94.0)
Declined response	19 (1.8)
University position	
Academic staff	338 (32.8)
Administrative staff	24 (2.3)
Faculty	152 (14.8)
Graduate students	266 (25.8)
Postdoctoral students	31 (3.0)
University staff	187 (18.2)
Other	32 (3.1)

Eighty-one participants withdrew from the study at various

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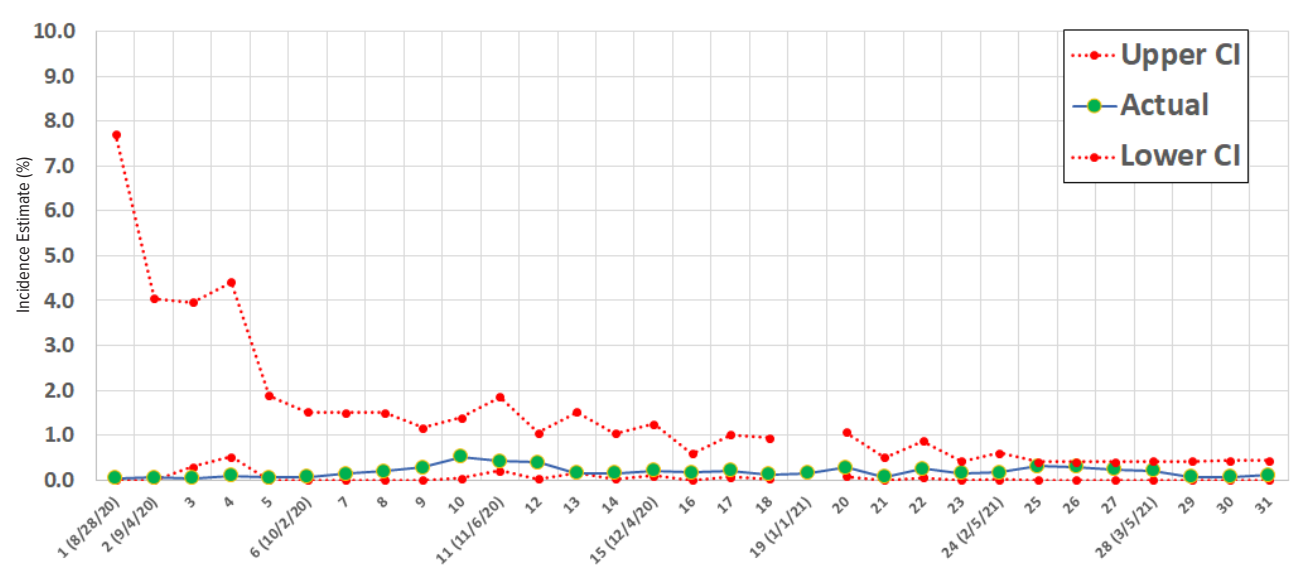
Figure 3. Confidence Intervals Derived From University of Wisconsin SARS-CoV-2 Incidence Surveillance Program Weekly Incidence Data Compared With Actual Incidence Demonstrated by Weekly Cases Detected at University Health Services Among UW–Madison Faculty and Staff



points, some because of retirement or ending employment with UW–Madison (n = 13), a move out of state or change to working off-campus (n = 9), or another reason that made it difficult to get to the collection site on a weekly basis (n = 11). A majority of withdrawals (n = 33) occurred after university officials lifted the mandated weekly testing requirement for vaccinated individuals on week 29.

Weekly incidence of SARS-CoV-2 among UW employees, calculated from available UHS testing data, ranged from 0.043 to 0.529% and remained within the 95% confidence intervals determined using our asymptomatic cohort, except in weeks 3 and 4 (Figure 3). During those weeks, very few faculty and staff presented for specimen collection at the campus drop-in testing centers and WVDL reported 4 inconclusive results in the surveillance population. When counted as positives, these specimens accounted for 80% of positive results for those 2 weeks. Incidence estimates based on drop-in testing cases of staff and faculty peaked on week 10 (0.529%, Figure 3), corresponding well with a peak in incidence estimates within the UWSISP population on week 11 (0.640%, Figure 2).

DISCUSSION

This is one of the first studies to our knowledge that evaluates regular weekly SARS-CoV-2 testing of asymptomatic faculty and staff in an academic setting. Very low weekly incidence rates of SARS-CoV-2 were found in this cohort between August 2020 and March 2021. This is in contrast to high incidence within on-campus and off-campus students and widespread cases of SARS-CoV-2 in the surrounding community of Dane County (Figure 2, Table 1).[11] Our results concur with evidence from several surveillance studies of college students, suggesting transmission among asymptomatic individuals in campus settings is limited.[12,13] The surveillance protocol reported in this paper allowed researchers at UW to efficiently evaluate the weekly incidence of SARS-CoV-2 in asymptomatic employees, thus providing ongoing situational awareness of the potential for on-campus transmission and enabling employees to return to work to perform essential activities during the COVID-19 pandemic. Results were communicated regularly to campus officials, who used the data to update the UW–Madison COVID-19 dashboard and keep employees informed on detection rates and transmission activity. This information provided reassurance for on-campus employees and evidence that mitigation strategies were working to ensure the UW–Madison campus was a safe working environment during the SARS-CoV-2 pandemic.

This surveillance program also demonstrates and fulfills key principles of the CDC Framework for Evaluating Public Health Surveillance Systems, namely those associated with outbreak detection (timeliness and validity) and systems experience (system acceptability, portability, and system costs).[14]

Timeliness

Participant results were available via an online data portal within 24 hours of specimen collection, at which time positive results were reported to the participant with a positive result to UW campus officials to enable appropriate infection control practices, and the Wisconsin Department of Health Services Division of Public Health to facilitate contact tracing and disease monitoring. This expedited timeframe allowed participants with positive test results to rapidly isolate and gave UW officials the chance to quickly enact public health interventions per UW campus pro-

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tocol. As participants were tested on a weekly basis, the interval between an exposure to SARS-CoV-2 and a positive test result was consistently minimized.

Validity

Our program is unique in that complementary testing data from the entire on-campus faculty and staff population were available for comparison from UHS. The SARS-CoV-2 incidence among participants was closely associated with estimated incidence in the greater university employee population reported by UHS, as illustrated in Figure 3. The incidence calculated using UHS testing data remained within the confidence intervals estimated from our asymptomatic cohort, except for 2 weeks early in the program and only when 4 inconclusive results were treated as positive results. Accordingly, UWSISP provided an accurate assessment of SARS-CoV-2 activity on campus among UW faculty and staff through systematic, weekly testing of a representative cohort.

System Acceptability

Five months before the UW mandated weekly testing for all on-campus employees beginning in January 2021, we were able to recruit willing participants at a steady rate, increasing our cohort from 48 in week 1 to 979 in week 23. Although participation was not incentivized and all participants consented to sharing of personal information and results with public health and UW campus officials, 90% of possible specimens were collected. Overall participant retention was 92%, dropping slightly from 96% after the UW dropped the mandated weekly testing requirement for fully vaccinated individuals in week 29. These data, along with strong weekly participation rates and positive anecdotal evidence from participants, support widespread acceptability of our surveillance program.

Portability

This surveillance system was operated with minimal person-dependent steps and relied on the ability of participants to self-collect a simple, front-of-the-nose nasal swab with staff monitoring. We have previously demonstrated the high acceptability of self-collection of anterior nasal swab specimens.[9] The absence of invalid results and any testing-related errors indicates this procedure is easily taught and performed and could be replicated in similar settings. Test results and data imports were managed through a REDCap online database, and survey invitations sent via Qualtrics survey software, platforms which are accessible and configurable for any organization.

System Costs

Because this surveillance program involved a subset of asymptomatic faculty and staff, testing costs were limited to less than 1,000 specimens per week, while still providing an accurate estimate of SARS-CoV-2 incidence among on-campus employees. Staffing and operational costs were limited by offering an inclusive variety of specimen collection timeframes at 3 separate on-campus locations and using university fleet vehicles for specimen and supply transportation.

CONCLUSION

With low average weekly incidence rates (0.20%), high participant retention and participation (92% and 90%, respectively), and no identified clusters of on-campus transmission or outbreaks throughout the study period, this surveillance protocol provided needed situational awareness and high precision estimates of SARS-CoV-2 incidence at a relatively low cost. This approach was an easily scalable, effective alternative to methods involving mandatory testing of all on-campus employees. Furthermore, self-collected nasal swabs monitored by a trained researcher are a reliable collection medium for SARS-CoV-2 testing, with minimal inconclusive results and no invalid results.

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