

**EVALUATION OF NEW YORK CITY'S  
TEST & TRACE  
PROGRAM  
FOR THE SARS-COV-2 PANDEMIC:**

Lessons Learned to Advance Reach, Equity, and Timeliness

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# EXECUTIVE SUMMARY

At the outset of the SARS-CoV-2 pandemic—from March through May 2020—New York City (NYC) was the epicenter of transmission in the United States. The city was officially placed under a "New York State on PAUSE" executive order on March 22 that lasted through June 24, 2020. On June 1, 2020, NYC Health + Hospitals (H+H), in partnership with the NYC Department of Health and Mental Hygiene, other city agencies, and a large network of community partners, launched one of the country's largest COVID-19 contact tracing programs. The program, known as the NYC Test & Trace (T2) program, had three pillars, each with its own goals:

- ▶ **Test:** Provide NYC residents with free COVID-19 testing at as many accessible locations across NYC as possible.
- ▶ **Trace:** Provide education to New Yorkers who tested positive for COVID-19, assess symptoms, identify close contacts who might have been exposed and venues of potential transmission, help people find testing services, and guide people to supportive services and the best place to safely separate from their loved ones.
- ▶ **Take Care:** Provide direct social services and support to NYC residents under isolation and quarantine, especially members of vulnerable populations.

In this report, we summarize the mobilization required to mount the T2 program and present findings from a mixed-methods evaluation of T2 implementation, with the following goals:

- ▶ Assess implementation of contact tracing systems in terms of reach, timeliness, and equity;
- ▶ Identify factors at the individual, organizational, and contextual levels that contributed to or detracted from optimized and timely implementation of the T2 program;
- ▶ Assess the extent to which populations disproportionately affected by COVID-19 trusted T2 staff and program.

Evaluation data sources included analysis of weekly aggregate T2 data metrics provided by H+H, key informant interviews, brief telephone surveys and review of administrative documents. Methods are summarized in an accompanying technical document.



## Recommendations: Launching the T2 Program

**Early in the pandemic, core decisions were made regarding the leadership and goals of the T2 program. Experiences gained over the course of the protracted pandemic response are important, and lessons learned should be carefully considered, especially for future contact tracing activities.**

- In governmental “after action” assessments of pandemic response, lay out optimal leadership models for standing up future large-scale emergency response programs in NYC, including guidance on legal and technical requirements to share data across relevant agencies and develop integrated data systems.
- Develop preparedness guidelines that make contact tracing goals under different scenarios explicit, and expand awareness of how goals and activities may change over time, depending on knowledge of pathogen characteristics.
- Plan upfront how to align surge capacity strategies for staffing with language and cultural needs of communities.
- Because any major crisis will require a diverse, flexible workforce, identify mechanisms to rapidly

hire a diverse workforce of individuals from vulnerable communities, particularly from communities where underlying trust in government is often low.

- ◇ *Provide opportunities to elicit feedback for staff to improve their job satisfaction, and prevent burnout.*
- ◇ *Promote arrangements that achieve better parity of compensation, support, and opportunity between agency and contacted staff who perform the same responsibilities.*

### Test Pillar

- Establish working relationships with potential private sector vendors and contractors to rapidly procure and manufacture necessary supplies locally, before future crises and in early response efforts.
- Conduct periodic assessments of potential supply chain gaps in core testing materials and identify alternative methods of filling supplies other than through the Federal Government: for example, by manufacturing materials independently or through local means.
- Sustain and build out capacity to provide mobile testing services, which can be set up rapidly and are flexible, instead of relying too heavily on brick-and-mortar testing sites.

### Trace Pillar

- Develop or identify an end-to-end case management and data system that is flexible to adaptation and meets back-end epidemiologic analysis needs of a large-scale public health program.
  - ◇ *Validate capability to change call scripts to streamline them, address essential questions, and incorporate new information as it arises.*
  - ◇ *Use text messaging, instead of daily calls, to push notifications to the public for monitoring purposes during isolation and quarantine periods, particularly as recipients often screen calls and opt not to respond.*
  - ◇ *Ensure capabilities to directly transfer individuals to staff who speak the appropriate language.*
- Conduct a thorough impact evaluation to examine the extent to which universal contact tracing mitigated the disease's spread.

### Take Care Pillar

- Develop and maintain strategic and explicit cross-agency collaboration during non-crisis periods that can facilitate provision of a wide array of services to a highly diverse population when crises hit.

### Community Engagement

**Forming and maintaining a Community Advisory Board (CAB) throughout the T2 program greatly facilitated community engagement. T2 leadership and multiple CBOs all recommended creating a model to facilitate dialogue between government, CBOs, and communities on an ongoing basis, which can then be activated in times of crisis.**

- Create more enduring community engagement infrastructures before more emergencies occur.
- During crises, consider the following:
  - ◇ *Facilitate opportunities for direct communication between key leaders from core city agencies and CBO leaders to build trust and foster partnerships during crisis response.*
  - ◇ *Leverage the trusted status of CBOs in communities to improve trust in testing services by engaging them to assist with or engage in testing efforts.*
  - ◇ *Create decentralized workgroup structures, organized topically by community partners, to more effectively obtain and incorporate feedback.*
  - ◇ *Allow flexibility in CBO contracts that permit each organization to tailor outreach and education and communicate through media channels specific to their communities.*

◇ *Engage CBOs in development of job description and qualifications; leverage CBOs' knowledge of local individuals with appropriate cultural and linguistic qualifications for hiring and filling staff capacity.*

**Trust and Communication**

- Build capacity to actively document and address misinformation through education campaigns, staying at the forefront of communications and working to dispel myths before they become established.
- Conduct early media campaigns targeting communities where distrust may be more entrenched to educate the public about the purpose of contact tracing and the use of the resulting information.
- Sustain efforts to build relationships with CBOs working in communities to ensure that networks are readily available in advance of future pandemics.
- Engage celebrities and CBOs in setting the tone for tweets on test and trace programs to increase the likelihood of user engagement and help generate social media positive responses.

**Test & Trace Program Timeline**  
*May 2020 - December 2021*

**2020**

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|---|---|
| <p><b>May 8</b> ● NYC Mayor Bill de Blasio announces Test and Trace (T2) Program led by Health + Hospitals (H+H)</p> <p><b>May</b> ● T2 Community Advisory Board formed with over 50 CBOs</p> <p><b>May 27</b> ● "Take Care Initiative" announced to help all COVID-positive NYers safely separate</p> <p><b>Jun 1</b> ● Test &amp; Trace Corps launched with universal COVID-19 testing announced</p> <p><b>Jun 17</b> ● Mobile testing units launched</p> <p><b>Jul 10</b> ● Hyper-local strategy announced to deploy resources to neighborhoods with low testing rates and high percentage of positive tests</p> <p><b>Jul 27</b> ● \$7.8M in grant funding provided for CBOs to promote testing and tracing awareness</p> | <p><b>Aug 7</b> ● Launch of "Take Care" packages (masks, thermometer, wipes, etc.) for positive cases</p> <p><b>Sep 17</b> ● Pandemic Response Lab, dedicated COVID test lab, opens with aim to process H+H tests in 24-48 hours</p> <p><b>Oct 1</b> ● Take Care launches phone distribution program for cases and contacts in need</p> <p><b>Oct 2</b> ● Take Care launches cash assistance program</p> <p><b>Nov 5</b> ● T2 introduces rapid testing at COVID-19 testing sites</p> <p><b>Nov 20</b> ● T2 launches "Validate My Tracer" tool for NYers to verify contact tracer's identity</p> <p><b>Dec 10</b> ● Launch of rapid testing at transportation hubs</p> |
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**2021**

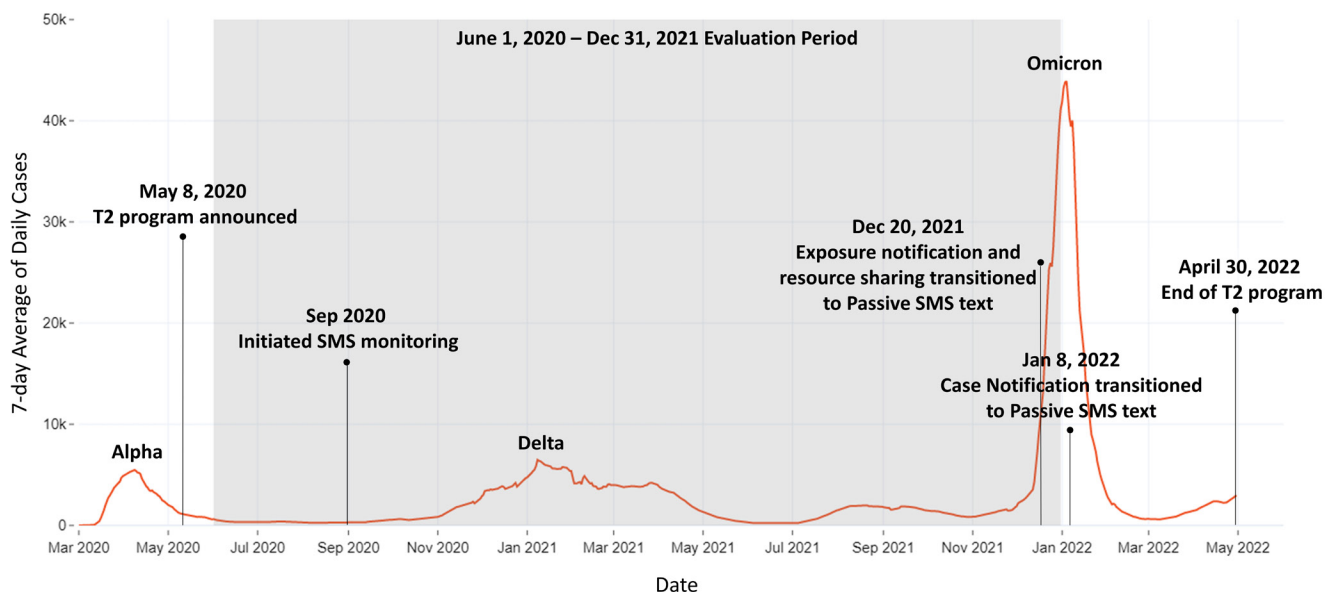
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| <p><b>Jan 12</b> ● Mayor announces 24/7 Mega Vaccination Site at Citi Field</p> <p><b>Jan 15</b> ● Trace team hires 500 additional tracers for winter case surge</p> <p><b>Mar 1</b> ● T2 launches program to provide free at-home testing to NYC COVID contacts in high-need zip codes</p> <p><b>Apr 15</b> ● Test expands program to provide free at-home testing to all NYC COVID contacts</p> | <p><b>Apr 29</b> ● Street Homelessness Outreach and Wellness launches mobile units to provide health and social resources to people experiencing homelessness</p> <p><b>Aug 10</b> ● Expansion of at-home testing to all immunocompromised and 65+ NYers</p> <p><b>Sep 13</b> ● Simultaneous influenza and COVID testing added to mobile testing units</p> <p><b>Dec</b> ● T2, with CBOs, adjusts messaging to reflect importance of booster; T2 commits to continue CAB meetings throughout 2022</p> |
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# INTRODUCTION

At the outset of the SARS-CoV-2 pandemic, NYC was the epicenter of transmission in the United States. According to official NYC Department of Health and Mental Hygiene (DOHMH) data sources, during the first three months of the pandemic, March–May 2020, approximately 203,000 laboratory-confirmed cases of SARS-CoV-2 were reported to the DOHMH<sup>[1]</sup>, and many more went undiagnosed due to lack of testing. On March 22, 2020, the city was officially placed under a stay-at-home order that lasted through June 24, 2020. Its hospitals met or exceeded their intake capacity to treat COVID-19 patients during that period. NYC Health + Hospitals (H+H) facilities were particularly hard hit. From March through May of 2020, NYC H+H admitted 10,437 patients with confirmed or suspected COVID-19, including more than 2,000 patients to the ICU<sup>[2]</sup>.

Three months into the pandemic, on June 1, 2020—during the final month of the city’s stay-at-home order—H+H, in partnership with the DOHMH, other city agencies, and a large network of community partners, launched one of the country’s largest COVID-19 contact tracing programs, known as the NYC Test & Trace (T2) program<sup>1</sup>. Rapidly standing up any large public health program is inherently challenging. This was particularly true for NYC’s COVID-19 contact tracing programs given the short time period in which the program needed to be stood up and the city’s size, density, and diversity. In the context of the high transmissibility of the SARS CoV-2 virus, initial lack of vaccine and effective treatment, and severe health implications of infection, the program was launched with urgency to achieve three objectives: (1) identify and isolate cases (Test); (2) reduce transmission through contact tracing (Trace); and (3) provide resources to residents in need of support during their isolation/quarantine periods (Take Care). The T2 program remained in operation through April 30, 2022 (**Fig. 1**).

**Figure 1. Trend in the SARS-CoV-2 Pandemic and Key Moments of the T2 Program, March 2020 – May 2022**

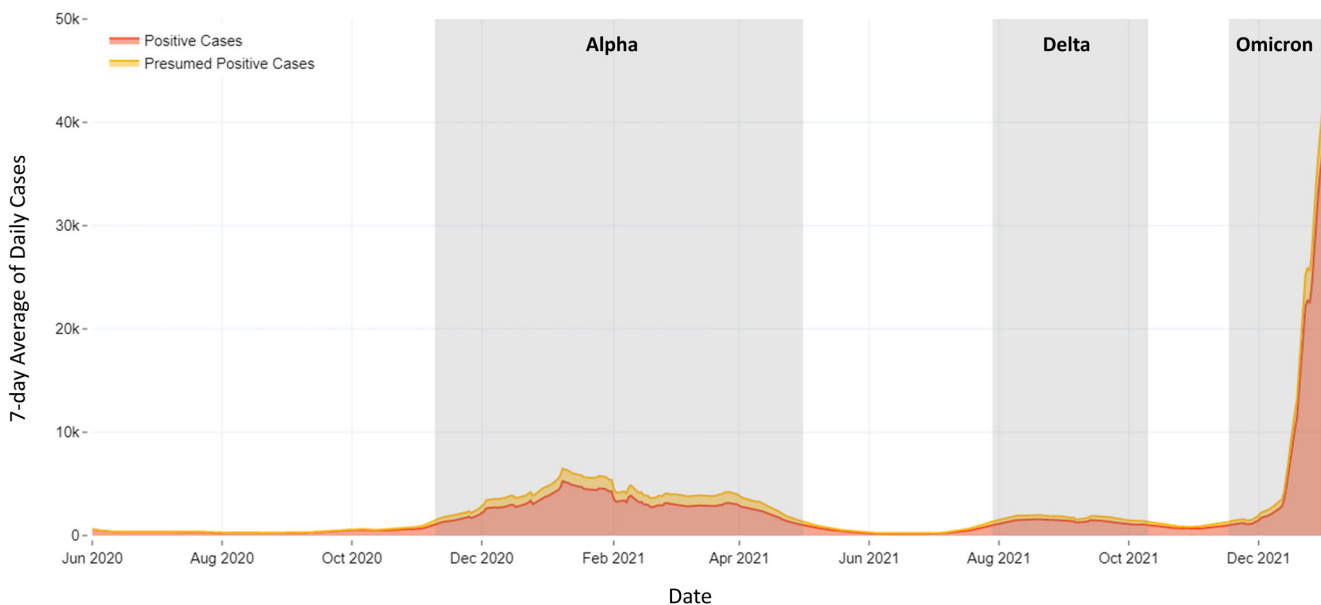


**Data source:** 7-day average (averaging values over the most recent day and the previous six days of data) of all cases citywide from the NYC DOHMH NYC Coronavirus Disease 2019 (COVID-19) Data Repository<sup>[3]</sup>.

<sup>1</sup>Re-named Test & Treat in August 2022 when the program pivoted to connecting positive cases with outpatient antiviral medications.

In fall 2021, a team at the Department of Population Health of NYU Grossman School of Medicine (NYU GSoM) received funding from H+H to conduct a rigorous mixed-methods evaluation of the T2 program implementation. This report summarizes main findings from that evaluation, with a focus on providing actionable information to improve future responses to public health emergency, particularly those involving infectious diseases. The evaluation centered around the core period of T2 activity, June 1, 2020–December 31, 2021. After this period, case investigation continued through April 2022, but tracing contacts ceased to be a primary mitigation strategy due to extensive Omicron variant transmission, widespread vaccination, and the concurrent rise in widespread use of at-home SARS-CoV-2 test kits. During the 19 months of the evaluation period, 1,256,586 cases of SARS-CoV-2 infection in NYC were reported to the DOHMH. **Figure 2** shows the number of reported cases over this period and highlights (in gray) peaks associated with major variant waves.

**Figure 2. Number of Reported SARS-CoV-2 Infections, June 2020 – December 2021**



**Data source:** 7-day average (averaging values over the most recent day and the previous six days of data) of all cases citywide from the NYC DOHMH NYC Coronavirus Disease 2019 (COVID-19) Data Repository<sup>[3]</sup>. Positive cases defined as those that were confirmed through molecular laboratory results (e.g., PCR). Presumed positive cases calculated by subtracting positive cases from the total number of cases. Presumed positive cases will include those with positive antigen test results, those with symptoms and exposure to a confirmed case, and those with a cause of death on the death certificate is COVID-19 or similar.

By December 31, nearly three years after SARS-CoV-2 was first detected locally, more than 37,000<sup>[4]</sup> NYC residents had died from COVID-19 illness, over 2.5 million had received at least one positive molecular (nucleic acid–based) test for SARS-CoV-2 infection<sup>[5]</sup>, and 90% had received at least one dose of the primary series of a COVID-19 vaccine<sup>[6]</sup>. In preparation for future infectious disease epidemics, and for the eventuality of a more severe vaccine-evading SARS-CoV-2 variant that might again substantially disrupt daily life, lessons learned from the T2 program’s experience can provide valuable input into future public health emergency response efforts.

## Evaluation Aims

This scope of this evaluation, designed in partnership with H+H leadership, was as follows:

- Assess implementation of contact tracing systems in terms of reach, timeliness, and equity;
- Identify factors at the individual, organizational, and contextual levels that contributed to or detracted from optimized and timely implementation of the T2 program;
- Assess the extent to which populations disproportionately affected by COVID-19 trusted T2 frontline staff (primarily contact tracers, but also other Take Care and testing site staff) and institutions over time.

Per H+H leadership request, the report scope did not include any of the following aspects:

- Critical assessment of municipal leadership decision-making prior to launch of the T2 program
- Evaluation or modeling of the impact of the T2 program (or contact tracing specifically) on SARS-CoV-2 transmission;
- T2 testing and contact tracing activities in the NYC school system;
- Contact tracing in congregate settings.

## Methodological Approach

We applied a mixed-methods approach to conduct this evaluation, which included qualitative analysis of programmatic documents and key informant (KI) interviews, as well as quantitative analysis of weekly aggregate data on T2 program metrics at a geographically granular level. Additional information was obtained from primary data collected via a telephone survey of T2 staff and NYC residents who were notified as cases or contacts during the study period and secondary data sources, including DOHMH-reported SARS-CoV-2 cases. See the **Technical Appendix A** for additional information on methods used for the evaluation.

### *Data sources:*

1. T2 programmatic documents;
2. H+H Test & Trace data on testing, case notification, and contact tracing;
3. 74 KI interviews with H+H, DOHMH, City Hall, and CBO leadership and T2 staff, supervisors, contacts, and cases;
4. Four interviews with pandemic response leaders in other jurisdictions (NY State, Chicago, Los Angeles, San Francisco);
5. Quantitative surveys of T2 staff and confirmed cases; and
6. Social media analysis.

## Report Structure

We have integrated findings from data sources and structured this report into five main sections (with a final summary), designed to maximize the report's utility as a means both to evaluate the launch, structure, and performance of the T2 program during the study period and to serve as a guide or "playbook" for future use:

- 1. Pandemic onset in NYC and the city's initial response prior to the launch of T2**
- 2. Implementation outcomes, based on epidemiologic data**
- 3. Community engagement**
- 4. The role of trust and communication**
- 5. Social media analysis**
- 6. A summary of our key findings**





## SECTION 1 EARLY PANDEMIC RESPONSE AND LAUNCH OF TEST & TRACE

### COVID-19 Arrives in NYC

The COVID-19 response in NYC began in January 2020, and the DOHMH activated its emergency response infrastructure, known as the Incident Command System (ICS), on January 30, 2020. There was early agreement among city agency leadership, including leaders at the two core health agencies (DOHMH and H+H), that the virus had most likely already reached the city at that time, but severe restrictions on who could be tested by the U.S. Centers for Disease Control and Prevention (CDC) limited the city's capacity to proactively test suspected cases. Testing began in February 2020 using a limited supply of CDC test kits<sup>[7]</sup>. The first case of COVID-19 in NYC was confirmed on March 1, 2020<sup>[8]</sup>.

On March 15, 2020, NYC mayor Bill de Blasio announced that NYC schools would shift to remote learning, and on March 20, the Office of the Governor of the State of New York issued an executive order ("PAUSE Order") that closed all non-essential businesses in the city to reduce transmission. Face masks were mandated in public areas on April 5, 2020. The city attempted to blunt the impact of closing schools, businesses, public and private gathering places, and community resources by providing in-home alternatives such as the GetFoodNYC program; this early collection of services was the first iteration of what would later become the Take Care pillar of the T2 program. Cases and hospitalizations continued to grow rapidly. By March 29, more than 30,000 cases had been reported, and NYC had become the worst-affected area in the United States. In April 2020, the Mayor appointed a dedicated Senior Advisor for Public Health to guide the city's COVID response strategy as Senior Advisor for Public Health to the Mayor.

From mid-January through April 2020, city officials were aware of rising cases in the city; however, testing capacity was still severely limited and so only those with specific symptoms qualified for testing. During March and April, H+H partnered with the New York City Economic Development Corporation (EDC) to rapidly develop local solutions to global supply chain issues that delayed the production of needed supplies for testing (e.g., nasal swabs). The Mayor's Office and city agencies also jointly developed a broader SARS-CoV-2 testing strategy and advocated for federal and other assistance to support these efforts. Specifically, H+H worked closely with the DOHMH to identify existing laboratory testing facilities across the city and assess volume capacity for running tests. The Mayor's Office worked with H+H to negotiate bulk-buy supply orders with vendors to increase testing to 5,000 tests per day and set a goal to develop capacity to perform 100,000 tests per day, managing acute shortfalls of equipment through negotiations with lab companies. H+H began testing in tents set up outside their facilities, which served as a precursor to the large scale-up of testing services. Negotiations began with CityMD (a large provider of urgent care in New York and New Jersey) to offer free testing. Overall, the strategic focus during this time was on developing capacity to perform as much testing in as many locations as possible, even if some locations could only perform limited testing.

## Establishing Program Goals

The Mayor's Office established and announced programmatic goals for T2 with H+H leadership on May 8, 2020, stating that H+H would lead the pandemic response efforts and stand up the program by the beginning of June, which they did on June 1. From the outset, the Mayor's Office emphasized two goals with respect to contact tracing and resource navigation: to (1) to elicit contact information from all newly infected individuals for rapid contact tracing ("Trace") and (2) to assess their social needs ("Take Care"). Two respondents from DOHMH indicated that due to capacity, the approach they would have developed for DOHMH would have focused on enhanced communication strategies for contact tracing (i.e., calls vs text messages or website navigation only for the broader population) and resource navigation for more vulnerable population subgroups as they were most likely to need additional resources. Another DOHMH respondent also indicated that she believed the approach DOHMH would have taken would have focused much more on collecting risk factor and exposure data to track shifts in the epidemiology of the pandemic. Numerous respondents across the board indicated that the universal approach was a communicated priority for the Mayor's Office.

Although the CDC offered no official guidance during this period, this was the prevailing model under discussion across much of the United States and in New York State. In our interviews with Mayor de Blasio, he expressed concern about allowing only certain subgroups to access resources, as it might have decreased community support for the program and even led to stigma against using its services. Alternate triage models similar to what some DOHMH staff advocated for were used in other large U.S. cities, including Los Angeles and San Francisco. The Los Angeles County Department of Public Health targeted their telephonic and in-person contact tracing resources toward those in high-risk jobs and/or living in high-risk communities according to the Healthy Places Index (HPI®)<sup>[9]</sup>, which takes into account social conditions that drive health, while other community members received an automated text message when they tested positive for COVID-19. Similarly, the priority for the San Francisco contact tracing program was to reach underserved populations, including non-English speakers and those living in low-income zip codes, while those in higher-income zip codes received an automated message.

In the absence of clear federal guidance, the prevailing approach of most jurisdictions nationally at that time was to attempt a universal notification and contact tracing program. The scope of our evaluation does not include an outcomes assessment of whether contact tracing was effective at reducing transmission, but we acknowledge that some KI respondents with expertise in epidemiology and disease control believed from the outset that universal tracing would not greatly reduce transmission, and we note that the city did not have *a priori* guidelines on when to scale up or down universal contact tracing as knowledge about transmission evolved.

From the program's inception, T2 leadership placed a strong emphasis on health equity and community engagement. The T2 program exclusively hired NYC residents as frontline staff, and made a strong effort to hire from neighborhoods hardest hit by the virus. In late May, Mayor de Blasio appointed a T2 Lead Equity Officer to focus on reducing disparities among communities disproportionately affected by the virus. On May 27, the program announced<sup>[10]</sup> that T2 Corps members hired to date were racially/ethnically diverse and spoke 40 different languages. The DOHMH formed a Community Advisory Board (CAB) in May 2020 comprising over 50 community-based organizations (CBOs) that spanned all 5 boroughs to ensure an

equitable implementation. Beginning in May, the CAB met weekly and served as a guide for T2 messaging and community engagement. Informed by CAB recommendations, in July 2020 the city announced a \$7.8 million funding opportunity for CBOs to promote COVID-19 testing and tracing in communities hardest hit by the virus. A total of 38 CBOs were funded to conduct community outreach activities that aimed to increase trust in the T2 program (see Section 5: Community Engagement).

Several legal and technical complications arose from the decision to have H+H lead the T2 program. The core issue was that legal and regulatory authority to collect test results and perform case notification and contact tracing rests with local public health departments. The DOHMH and H+H had to establish a detailed data-sharing Memorandum of Understanding to allow the sharing of testing data between the DOHMH and H+H. This process was complex and resulted in data transfer delays. In addition, more technical difficulties emerged with integrating data systems and transferring data. Technical integration and deduplication issues proved challenging throughout the tenure of the T2 program.

## Programmatic Pillars and Organizational Structure

Despite its name, T2 included three core components (“pillars”) from its inception: Test, Trace, and Take Care.

The goals of each pillar were:

- **Test:** Provide NYC residents with free COVID-19 testing at as many accessible locations across NYC as possible;
- **Trace:** Provide education to New Yorkers who tested positive for COVID-19, assess symptoms, identify close contacts who might have been exposed and venues of potential transmission, help people find testing services, and guide people to supportive services and the best place to safely separate from their loved ones.
- **Take Care:** Provide direct social services and support to NYC residents under isolation and quarantine, especially members of vulnerable populations.

The organizational structure, and the approach to and scale of staffing, varied by pillar. Although resource demands were most intensive for the Trace pillar due to the need to contact all cases and contacts, each pillar faced the challenge of needing to engender trust throughout all of NYC’s diverse neighborhoods.

### Test

Testing staff were assigned from within H+H, where clinical staff shifted from usual job duties to testing functions; thus, this pillar involved less hiring than the other two. External contracts were established with testing sites at CityMD locations and Federally Qualified Health Centers (FQHCs), and T2 provided them with essential testing equipment to boost citywide testing capacity beyond H+H-run testing sites. Over time, a growing cadre of mobile testing units using vehicles borrowed from other city agencies (e.g., Departments of Parks & Recreation and Corrections) and re-outfitted for testing capability were also mobilized to supplement capacity in neighborhoods where brick-and-mortar testing sites were lacking or were underutilized by the local community. Mobile units were staffed by a contracted agency and H+H staff.

## ***Trace***

As the lead agency for the T2 effort, H+H was initially charged with hiring 2,500 people in 28 days for the Trace pillar alone to launch the program by June 1, 2020. The agency contracted with two hiring organizations to achieve this. Case investigators (CIs) were all new hires in the H+H system beginning June 1, 2020. CIs were fully remote workers who performed all tracing telephonically. Some CIs were trained to perform specialized duties, including the Situation Room staff that focused on contact tracing for schools, Out-of-jurisdiction team members that handled contact tracing for non-NYC residents who were exposed to or tested positive for COVID-19 in NYC, and facility investigators that covered contact tracing for healthcare facilities. Another group of Trace staff, known as the Information Gatherers (IGs) were responsible for finding phone numbers and addresses for cases and contacts whose information was missing or found to be incorrect. Community Engagement Specialists (CES) were responsible for going door to door to connect hard-to-reach individuals with the program. Monitors were hired and supervised by an outside hiring organization's employees and were responsible for follow-up with cases and contacts after their initial intake calls to check how they were doing during their isolation or quarantine period. Some Monitors were eventually cross-trained to also perform CI duties.

## ***Take Care***

Take Care was initially managed by the NYC Mayor's Office of Housing Recovery Operations (HRO). This city agency was responsible for managing two models of staffing. H+H employees were hired to staff the Take Care pillar, but the bulk of Take Care services were coordinated by CBOs contracted to perform resource navigation and service provision. All CBO staff hired by Take Care required approval by the HRO, even when existing staff were being used to fill roles. The program employed hundreds of community-based Resource Navigators through these CBO partners over the course of the program and at its peak had close to 400 active navigators in place.

## ***Community Advisory Board***

The COVID-19 Test and Trace Corps CAB comprised over 50 CBOs to ensure an equitable implementation of the T2 program. The CAB was led by senior leadership from the DOHMH and two Co-Chairs from H+H senior leadership. CAB members convened virtually at weekly meetings to guide T2 messaging and community engagement work in order to increase trustworthiness of the program for the public. The CAB regularly made recommendations to the T2 leadership, who made decisions on which to enact. Within the CAB, five workgroups were launched that also met separately from the weekly CAB meeting: 1) T2 assessment; 2) CAB Evaluation; 3) CBO Involvement; 4) Messaging; 4) Workforce and Training; and 6) Data and Privacy.

## ***Barriers and Facilitators to the Launch of Test & Trace***

### ***Barriers***

Although contacting with hiring organizations facilitated rapid hiring to implement T2 quickly, there was widespread agreement among supervisors and staff that quality control for new hires was lacking during the ramp-up phase. Some staff interviewed reported that the hiring process was extremely brief and superficial and that positions were not accurately described

to them in interviews. Additionally, less than half of front-line staff survey respondents (42%) reported that they agreed “very much” that their job responsibilities were clearly articulated during the hiring process. The stated goal was to match CES staff to their own communities, and CES staff desired this; however, this did not always happen, with CES frequently asked to travel to other parts of the city based on need (e.g., language concordance). CBOs engaged in the Take Care pillar reported that the HRO could be overly stringent about hiring decisions.

### Facilitators

For testing, H+H was able to rely on its existing neighborhood health centers, which were well located within low-income communities throughout the city, in addressing pandemic response in these high-risk areas. The EDC was effectively enlisted to help Test pillar leaders partner with private companies to obtain or locally manufacture testing supplies and expand laboratory capacity. Contacting with hiring organizations was a strong facilitator to successfully hire rapidly, allowing for a dramatic scale-up of T2 services in a short period.



### Recommendations: Launching Contact Tracing

**The experiences gained over the course of the sustained COVID-19 pandemic response are important and should be documented and lessons carefully considered, especially for future contract tracing activities.**

#### PLANNING

- In ongoing governmental “after action” assessments, lay out optimal leadership models for standing up future large-scale emergency response programs in NYC, including guidance to avoid legal and technical challenges of sharing data across relevant agencies and steps towards potentially integrating data systems.
- In addition to working out the legal aspects of data sharing, identify and address the technical challenges of sharing data across relevant agencies and take steps towards potentially integrating data systems.
- Develop preparedness guidelines that make contact tracing goals under different scenarios explicit, and expand awareness of how goals and activities may change over time, depending on knowledge of pathogen characteristics.
  - ◊ *Clinical versus public health goals should be clearly distinguished. For example, case notification can have strong benefits for infected individuals, including opportunities to link them to care and address social and economic needs, whereas contact tracing can be scaled to address a variety of goals, ranging from a more limited goal of linking individuals to testing services (potentially achievable through low-touch technologies) to a more expanded public health goal of curtailing transmission through timely, active tracing.*
  - ◊ *Municipal emergency planning playbooks should include guidance on when and how to scale up contact tracing from targeted vulnerable subgroups to universal tracing, and when it might be appropriate to scale down.*
- Plan upfront to determine how to align surge capacity strategies for staffing with language and cultural needs of communities.
- Develop specific hiring guidelines for consultants to follow in an emergency response effort to help the lead agency, consultant agencies, and new hires feel confident in hiring decisions. Potential hires should be thoroughly vetted and accurately informed about the nature of the work, hours, and expectations.

## RESPONSE

- Future contact tracing efforts should make public and explicit the rationale behind the selected approach (e.g., targeted or universal) to increase support at every level. As knowledge evolves, the strategies selected may also need to evolve, and this, too, should be communicated.
- Engaging and prioritizing communication with community leaders from the outset of a response is key to developing responses to public health crises that are attuned to equity and the needs of vulnerable communities. Forming and maintaining a Community Advisory Board (CAB) throughout T2 greatly facilitated community engagement.
- Conduct a thorough impact evaluation to examine the extent to which universal contact tracing mitigated the disease's spread. The COVID-19 pandemic also offers an opportunity to understand additional benefits beside reducing transmission, such as connecting patients to testing facilities, healthcare services, and social service benefits.

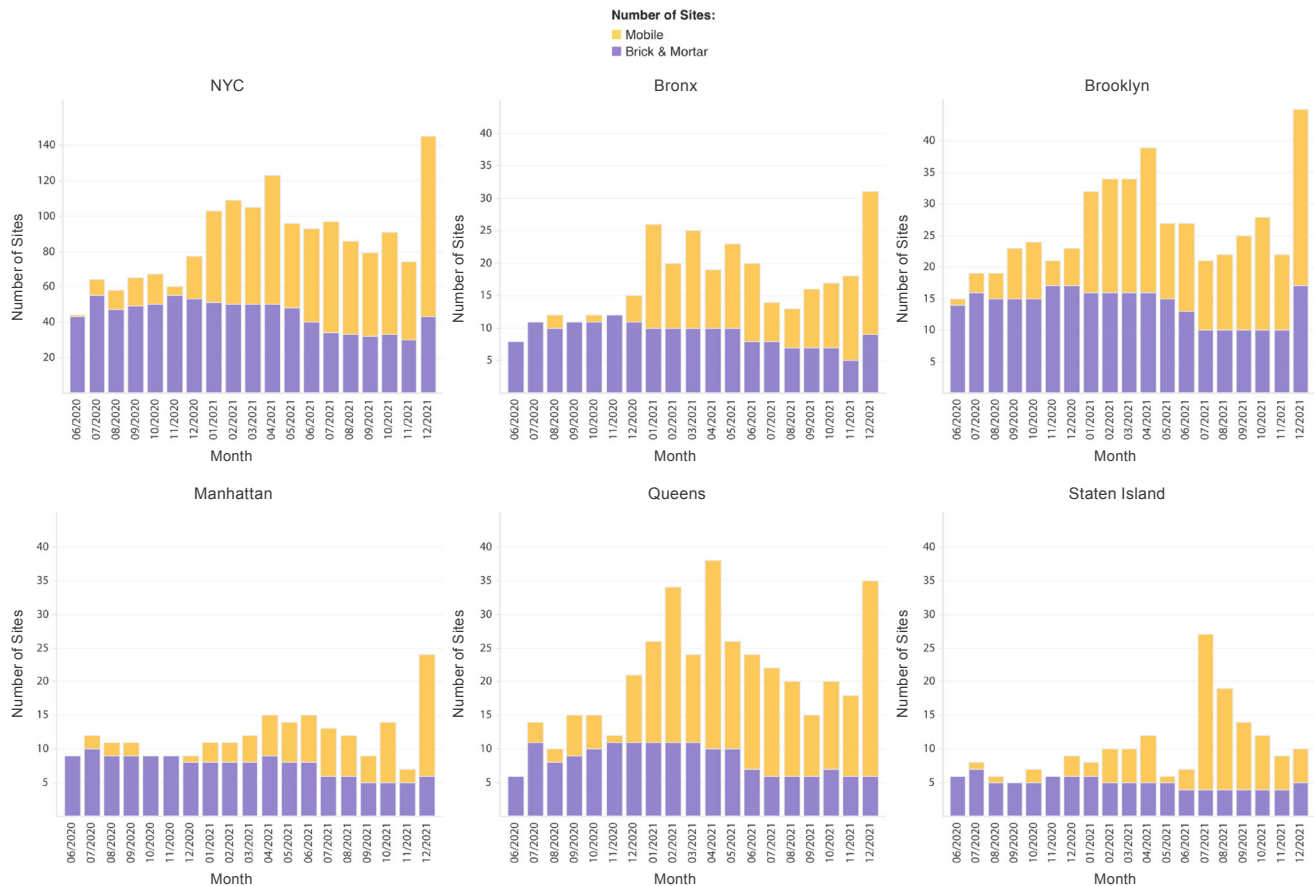


## Test Pillar: Scale-Up of Testing Services

A primary T2 strategy was to expand access to SARS-CoV-2 testing to identify cases, support access to care, and mitigate virus spread. During the T2 evaluation period, H+H was the largest provider of SARS-CoV-2 testing services in NYC. This was a major success of the T2 program. As mentioned earlier, early testing relied on H+H sites as well as urgent care partners (e.g., CityMD), and later mobile units, to conduct widespread testing throughout NYC. A review of historical pages of the T2 website (see **Appendix A** for methods) indicated that the program operated or directly supported 586 different SARS-CoV-2 testing sites across NYC, including a combination of fixed (brick-and-mortar) sites and mobile clinics. H+H also supported SARS-CoV-2 testing in NYC public schools. We were unable to calculate the exact proportion of all testing in NYC that was conducted by H+H through T2-supported testing services due to inconsistencies between the DOHMH and H+H in how data were collected. However, at our request, senior H+H officials prepared their own rough estimate, indicating that T2 conducted approximately 24% of all testing in NYC (9,257,167 of the 37,931,010 citywide tests reported by the DOHMH<sup>[11]</sup>) during the evaluation period. The school testing program accounted for 25% of T2 testing (2,274,123 tests); with those excluded, T2 was responsible for 18% of NYC tests (6,486,645 tests) during the evaluation period (H+H personal communication, 8/19/2022). Other sources largely included private hospitals, commercial urgent care establishments, and state-run testing sites.

After the launch of T2, testing services were rapidly scaled up through a combination of redirecting of existing H+H staff and services to support testing operations, contracts with third-party laboratory and testing vendors, and new hiring. In September 2020, the Pandemic Response Lab (PRL) was opened in the Alexandria Center for Life Science in Manhattan—a result of a partnership between H+H, DOHMH and the EDC on the municipal side, together with OpenTron and NYU Langone Health scientists—with the goal to serve the T2 program’s needs by exclusively processing COVID-19 tests within 24–48 hours with a capacity of 20,000 tests per day. The number of testing sites grew over the duration of the T2 program, starting with 43 brick-and-mortar sites and one mobile clinic in June 2020 (**Fig. 3**) and subsequently rising and falling in response to pandemic waves. The number peaked during the Omicron variant wave in December 2021, with 143 total sites across NYC. A smaller peak was observed during the Alpha variant wave, reaching up to 120 sites in April 2021. These peaks and valleys were largely driven by the deployment of mobile testing, while the number of brick-and-mortar sites remained steady until June 2021 and then declined most markedly in Brooklyn and Queens. By January 2021, half of all test sites were mobile, and by December 2021, 70% were mobile. On average, brick-and-mortar sites were open 59 hours per week while mobile sites were open 53 hours per week. The monthly trend in total hours of operation tracked closely with the number of available sites across all boroughs.

**Figure 3. Trends in Number of H+H Testing Sites and Hours of Operation by Borough and Site Type, June 2020 – December 2021**



**Data source:** NYC Health + Hospitals (H+H) [Test and Trace website](#) using the [Wayback Machine](#)<sup>[12]</sup>.

### Geographic Distribution of Testing Sites

A key program goal was to ensure equitable access to SARS-CoV-2 testing services, and this was reflected in the placement of test sites. Location selection was based on population size, availability of suitable sites or buildings, and transmission patterns determined by tracking the proportion of positive SARS-CoV-2 test results by neighborhood. Over the program’s course, density of H+H testing locations per 100,000 population was highest in Staten Island and lowest in Manhattan (**Table 1**). Despite a roughly three-fold difference in total population sizes, Manhattan and Staten Island had nearly the same number of test sites (approximately 1.6 million vs. 0.5 million population and 75 vs. 66 sites, respectively), in response to the high percentage of residents ever testing positive (23.6%) and low site accessibility (due to lower population density) in Staten Island (an average travel time of 24.1 minutes and distance of 2.58 miles to the closest testing site by census tract).



Table 1. Density of Testing and Testing Sites by Borough and Time Period

Test Site Locations	Number of Testing Sites <sup>a</sup>	Population <sup>b</sup>	Sites per 100K Population	Cumulative % Ever Testing Positive for SARS-CoV-2 <sup>c</sup>	Average Travel Time to a Site (min) <sup>d</sup>	
<i>Total Study Period</i>	All NYC	586	8,411,554	6.93	16.9	18.4
	Bronx	114	1,441,455	7.91	18.4	17.2
	Brooklyn	158	2,600,747	6.08	17.3	15.8
	Manhattan	75	1,621,771	4.62	12.6	15.8
	Queens	170	2,273,480	7.48	17.9	22.0
	Staten Island	66	474,101	13.92	23.6	24.1
<i>Before Mobile Testing Site Ramp-Up (06/2020–12/2020)</i>	All NYC	141	8,377,444	1.68	2.9	21.8
	Bronx	23	1,424,948	1.61	3.3	19.3
	Brooklyn	46	2,576,771	1.79	3.0	17.5
	Manhattan	18	1,629,153	1.10	1.8	19.0
	Queens	39	2,270,976	1.72	3.4	23.8
	Staten Island	15	475,596	3.15	4.8	27.3
<i>After Mobile Testing Site Ramp-Up (01/2021–12/2021)</i>	All NYC	504	8,377,444	6.02	4.7	17.9
	Bronx	104	1,424,948	7.30	5.1	16.0
	Brooklyn	131	2,576,771	5.08	4.8	15.8
	Manhattan	66	1,629,153	4.05	3.5	16.3
	Queens	144	2,270,976	6.34	5.5	19.4
	Staten Island	59	475,596	12.41	6.2	22.2

<sup>a</sup> Test & Trace website: <https://www.nychealthandhospitals.org/covid-19-testing-sites/>, Jun 2020–Dec 2021 data. Last updated July 29, 2022. Accessed June 1, 2022.

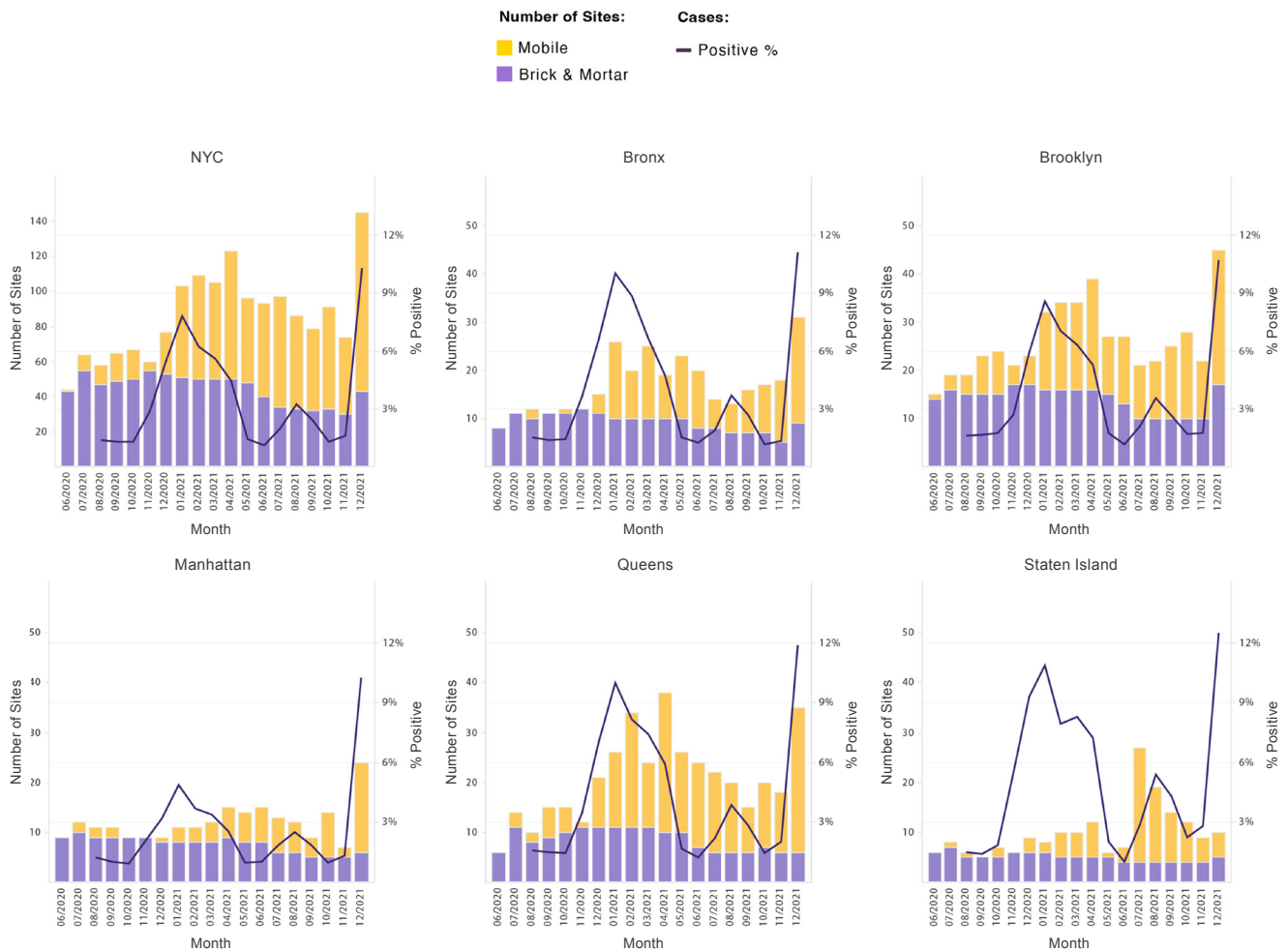
<sup>b</sup> Data Commons Place Explorer Website: <https://datacommons.org/place/geoid/36005>. Last updated June 30, 2022. Accessed August 1, 2022.

<sup>c</sup> Data obtained from the New York City Department of Health and Mental Hygiene NYC Coronavirus Disease 2019 (COVID-19) Data Repository: <https://github.com/nychealth/coronavirus-data>. Accessed January 3, 2022.

<sup>d</sup> Average travel time calculated to the closest site for each census tract via Google map API using public transportation on Wednesday at noon.

Location availability and hours of service varied across the evaluation period. Testing availability during the first spring wave was limited, and transmission was relatively low during the months that followed, July–September 2020. From October 2020 to April 2021, however, the number of testing sites and site hours in the Bronx, Brooklyn, and Queens ramped up substantially (**Fig. 4**), roughly in proportion to the rise in percent positivity. In contrast, Staten Island did not see a significant ramp-up until July 2021, despite having a high percent positivity from October 2020 to April 2021. Another 20 mobile testing sites were deployed in Staten Island in June 2021. In December 2021, all boroughs experienced dramatic increases in percent positivity during the Omicron wave, and many additional testing sites, mostly mobile, were deployed in all boroughs but Staten Island. The average travel time to testing sites for neighborhoods with the highest percent positivity was relatively short (**Fig. 5**), suggesting that the placement of testing services was largely well managed.

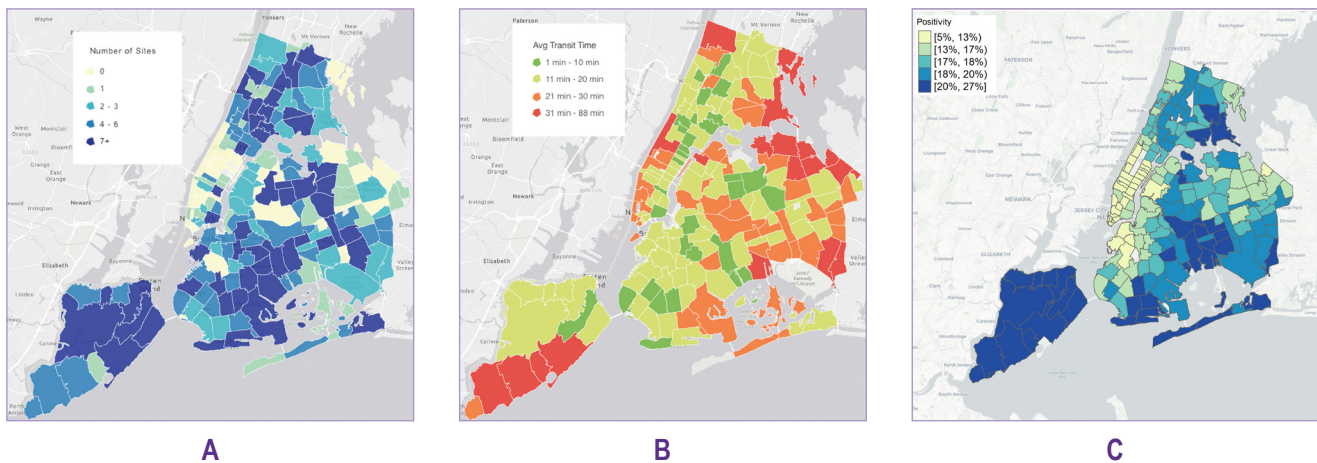
**Figure 4. Trend in Number of H+H Testing Sites and Percent Positivity by Borough, June 2020 – December 2021**



\*Hours of operation for 06/2022 and 07/2022 are suppressed due to high levels of missing data (>10%).

**Data source:** NYC Health + Hospitals (H+H) [Test and Trace website](#) using the [Wayback Machine](#)<sup>[12]</sup>.

**Figure 5. Cumulative Number of H+H Testing Sites (A), Average Travel Time (B), and Cumulative Percent of Residents Ever Tested Positive (C) by Modified ZCTA During the T2 Evaluation Period, June 2020 – December 2021**



**Data sources:** Percent positivity data (panel C) obtained from the New York City Department of Health and Mental Hygiene NYC Coronavirus Disease 2019 (COVID-19) Data Repository: <https://github.com/nychealth/coronavirus-data>. Accessed January 3, 2022. ZCTA (zip-code-defined tracing area). Modified ZCTAs combine census blocks with small populations to allow for more stable estimation<sup>[3]</sup>.

## Barriers and Facilitators to Scaling Up Testing Services

### Barriers

Barriers faced by the Test pillar varied as the pandemic unfolded. One KI reported that strategies to scale up testing citywide had not been developed before April 2020. As testing scale-up began in April 2020, the primary barrier was a lack of needed materials, including swabs and reagents, due to national and international shortages. To address this, H+H worked with the EDC to identify local manufacturers to produce swabs and viral transport media. To expand testing services, the Test pillar partnered with private external testing sites, including CityMD and FQHCs, and provided them with essential testing equipment to boost testing capacity across the city beyond H+H-run testing sites.

Although mobile testing vans were key to expanding access to testing, the use of an external vendor introduced some challenges. T2 interviewees from H+H and CBOs noted that language barriers were a common issue between mobile test staff and community members. Thus, the T2 mobile testing program relied heavily on community organizations to assist communication with the public in these instances. KI respondents from both H+H and CBOs also reported that contracted mobile test staff were often late or unprofessional in the early months. Test leadership reported that this community feedback was crucial, as it enabled them to make improvements to the program.

A combination of barriers led to the decision to create the new PRL in partnership with the EDC in September 2020. The Test pillar had partnered with multiple reference laboratories, but eventually the volume of COVID-19 testing reportedly overwhelmed them. In addition, there were reported delays in patients receiving test results, “sometimes 10 days and I daresay even longer,” according to one interviewee. Test pillar leadership therefore decided to stand up their own lab at PRL that they could control and shape for their specific needs.

### Facilitators

Interviewees identified multiple facilitators that helped make the NYC T2 testing initiative successful. First, many commented that because the Mayor’s Office of Operations (MOO) was heavily involved in coordinating testing strategy and operation, resources were successfully leveraged from various city agencies to set up testing sites and to forge partnerships with the private sector. Interviewees stressed that partnerships with CityMD and EDC were particularly important and boosted the city’s testing capacity significantly.

“...I'll say this recommendation for the city, you can't ignore the private sector or the community.... I believe we have the largest testing function of any city in the United States for a while. And that's because we didn't rely on just what the city could do, we went out to cut deals with private partners to partner with us to give us the resources. CityMD, we went from, I don't know, 20 testing sites to over 80 by adding CityMD.... Of course, they don't have the same interest as we do sometimes. So, find the middle ground. Get in there and figure out what can be done.”

— Mayor’s Office of Operations staff

The PRL formed through the partnership with EDC was described by more than one interviewee as “one of the best things that we did here in New York City.”

A second major facilitator in the scale-up of testing services and subsequent ability to reach diverse communities with testing services was the widespread use of mobile testing vans. In summer 2020, H+H began to scale up the use of rapid testing equipment for use in mobile test units. The Test pillar began with two mobile test units, and relied on community partners to point them to high-visibility spots in their neighborhoods for parking the testing vans, conduct community-based education and outreach on testing, and publicize scheduled mobile van locations and events to community members. The early success of the mobile unit testing strategy led the Test pillar to ultimately build out a mobile fleet of over 100 testing units.

As the mobile testing program grew, H+H contracted with an external vendor to run mobile testing under its own direction and staffing, with H+H-provided protocols. T2 leadership emphasized that this greatly facilitated expansion of testing sites to many high-need areas where it might otherwise have been unavailable. Although H+H testing made up approximately 24% of the city's testing for COVID-19, the placement of these services was deliberately targeted to areas where private services were less available. T2 leadership also highlighted the importance of adaptability to the Test pillar, in that they were able to scale up quickly to meet the demand of various surges, including Omicron, during which they reported opening 150 testing sites in three weeks.

Finally, the efforts of the Trace pillar facilitated testing education. During conversations with contacts who had been exposed to COVID-19, Trace staff were able to recommend testing and provide information about where individuals could get tested. Towards the end of the program, they offered at-home specimen collection kits or at-home tests.



### Recommendations: Test Pillar

#### PLANNING

- Establish working relationships with potential private sector vendors and contractors to rapidly procure and manufacture necessary supplies locally, before future crises and in early response efforts.
- Conduct periodic assessments of potential supply chain gaps in core testing materials and identify alternative methods of filling supplies other than through the Federal Government: for example, by manufacturing materials independently or through local means.

#### RESPONSE

- Partner across agencies and with the private sector to leverage needed resources and boost capacity.
- Sustain and build out mobile testing services, which are highly flexible and can be set up rapidly, early in any future health crisis instead of relying too heavily on brick-and-mortar testing sites.

## Trace Pillar: Case and Contact Notification

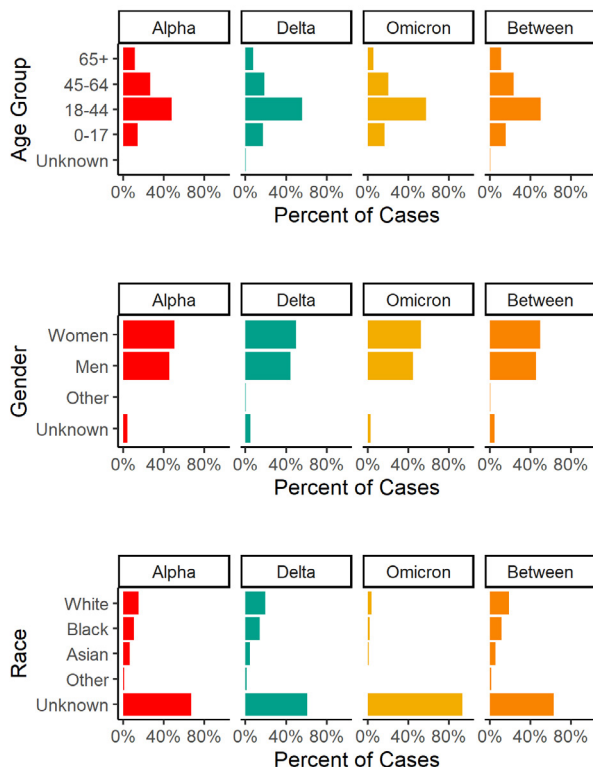
Prior to the widespread availability of at-home testing, most individuals who tested positive for SARS-CoV-2 in NYC, or were presumed positive based on documented recent contact with a confirmed-positive individual and symptoms, were reported to the T2 program for case investigation and contact tracing. Cases occurring in congregate settings were retained at the

DOHMH for longstanding contact tracing staff to manage. Cases identified as residents of other jurisdictions were referred to other jurisdictions. DOHMH officials estimate that 96% of cases were sent to the T2 program.

While prior studies have defined variant waves based on predominant viral genomic sequencing results, this report used a novel definition of variant waves to better understand the impact of case surge on T2 programmatic activities<sup>[13 14]</sup>. Alpha, Delta, and Omicron waves were defined for time periods where the total case count exceed 1,000 per day, as per the DOHMH Coronavirus Disease 2019 (COVID-19) Data Repository<sup>[3]</sup>. The between wave period aggregates all times between these three waves, when case counts were below 1,000 per day.

Over the period under evaluation, 1,276,530 individuals who tested positive for SARS-CoV-2 were referred to the T2 program. Demographic profiles of those testing positive remained similar over the period of evaluation (**Fig. 6**), with a slight shift toward younger age groups in later waves. Those aged 18–44 years comprised the majority of cases testing positive (52%) and had the highest rate of infection (19.3 per 100 population). Those aged 65 years or older made up the smallest proportion of the positive cases (9%), with a case rate of 9.3 per 100 population (**Table 2**). Half of cases were women (51%), 45% were men, fewer than 1% belonged to other gender categories (transgender, gender nonbinary, or other gender), and 4% had gender information missing. Importantly, race/ethnicity information was unavailable in 75% of cases.

**Figure 6. Proportion of Cases Testing Positive and Referred to the T2 Program by Demographics and Time, May 31, 2020 – January 1, 2022**



**Data source:** T2 Trace Data on confirmed cases.

**Table 2. Total Number of SARS-CoV-2-Positive Cases and Rate of Infections per 100 Population Referred from DOHMH to the T2 Program by Age and Gender, May 31, 2020 – January 1, 2022**

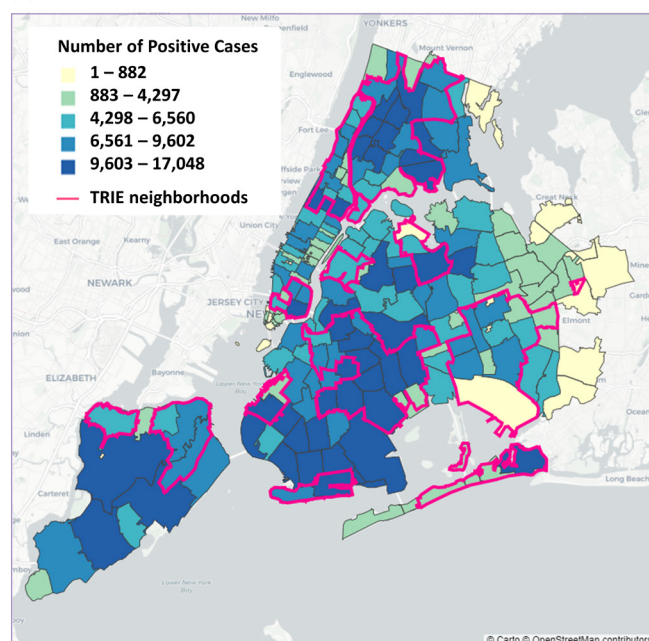
Strata		Confirmed Cases	Rate per 100 Population
Age Group	0–17	196,322 (15%)	11.1
	18–44	663,089 (52%)	19.3
	45–64	297,628 (23%)	14.2
	65+	118,032 (9%)	9.3
	Missing	1,459 (0%)	
Gender	Man	574,238 (45%)	14.0
	Woman	653,359 (51%)	14.6
	Other	2,068 (0%)	
	Missing	46,865 (4%)	

**Data source:** T2 Trace Data on confirmed cases, restricted to cases who were geocoded to NYC census tracts. Rates calculated using the 2020 American Community Survey 5-year NYC population totals.

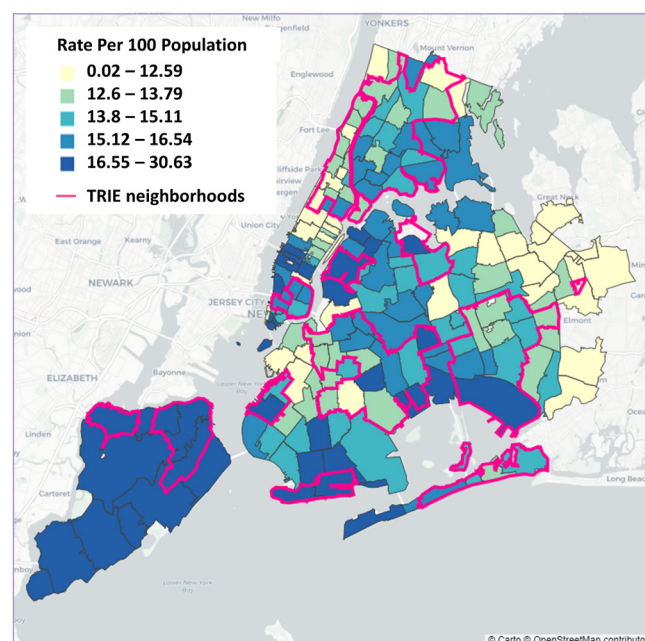
During the evaluation period, there were large geographic disparities in the total burden of cases reported to the T2 program, reflecting both the variable sizes of neighborhood populations and inequities in transmission (**Fig. 7**). Neighborhoods in southern Brooklyn (e.g., Sheepshead Bay, Midwood, Bensonhurst, Gravesend) and Staten Island (e.g., Mid-Island, Great Kills Park–Fort Wadsworth), as well as other neighborhoods identified by the city’s Taskforce on Racial Inclusion and Equity (TRIE) as vulnerable based on COVID cases, deaths, and other health and socioeconomic indicators (Sunset Park, Brownsville, and Coney Island), had both the

**Figure 7. Total Number of SARS-CoV-2-Positive Cases (A) and Rate of Infections Per 100 Population (B) Referred to the T2 Program by Neighborhood (ZCTA), May 31, 2020 – January 1, 2022**

(A) Total Number of SARS-COV-2 Positive Cases



(B) Rate Per 100 Population

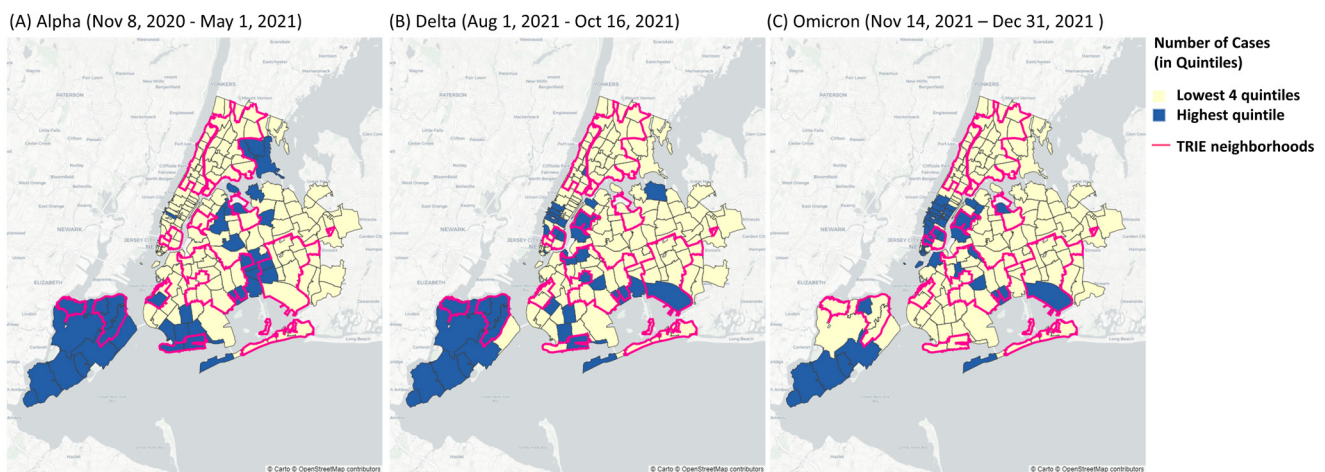


**Data source:** T2 Trace Data on confirmed cases. Rates calculated using the 2020 American Community Survey 5-year NYC ZCTA population totals.

highest numbers and highest rates of SARS-CoV-2 infections. Although parts of the Bronx (e.g., Morris Park, Allerton, Morrisania), central Queens (e.g., Ridgewood–Maspeth–Middle Village, Corona, Elmhurst), and central Brooklyn (e.g., Bedford-Stuyvesant, Bushwick, Crown Heights) had high numbers of positive cases, rates were moderate in relation to the sizes of the neighborhood populations. The TRIE-identified neighborhoods of East New York–Starrett City (Brooklyn), St. George–Stapleton–Port Richmond (Staten Island), and Queensbridge–Astoria, Jackson Heights, and Woodhaven (Queens) had low absolute burdens of positive cases but high rates of infection given their population sizes.

Although the total number of cases varied by variant wave, most of the same neighborhoods were at disproportionate risk in each wave (**Fig. 8**).

**Figure 8. Neighborhoods with Highest Number of SARS-CoV-2 Cases by Variant Wave, May 31, 2020 – January 1, 2022**



**Data source:** T2 Trace Data on confirmed cases.

A core aspect of the Trace pillar was focused on notifying cases about the need to isolate, identifying close contacts, notifying contacts about the need to quarantine, and referring people to Take Care services (the third program pillar) if they needed support to isolate/quarantine. We evaluated these outcomes for (1) completeness of coverage and points of attrition (the “tracing cascade”) and (2) timeliness of tracing relative to the case’s first positive specimen (i.e., inclusive of laboratory delays) and to when T2 was informed of the positive case (i.e., not inclusive of laboratory delays).

Popularized in the global fight against HIV/AIDS, a “cascade of care” model examines attrition at different points in a health care process, showing how each stage of attrition affects the number of people who ultimately achieve a desired outcome. For the Trace pillar, we conducted a tracing cascade analysis to compare the number of individuals lost at each point in the process and determined their multiplicative effect on the number of people who successfully received the service of interest. Because both cases and contacts were eligible to receive T2 services, we divided the analysis into separate case and contact cascades. **Table 3** provides definitions of each step of the cascade for cases and contacts. We then compared cascade metrics over time (weekly and by wave), by demographics, and by NYC neighborhood.

**Table 3. Definitions Used for T2 Cascade of Care Analysis**

Step of Cascade	Definition for Cases	Definition for Contacts
<b>Total</b>	Number of cases reported to T2	Number of exposed contacts elicited by cases during case interviews or from bulk uploads from facilities like schools
<b>Attempted</b>	Individuals for which the T2 tracer made at least 1 telephone attempt, including call dispositions of “busy/no answer”, “incorrect or inactive number”, “left voicemail”, “three failed attempts”, “unable to locate final”, “call back requested”, “call dropped”, “call back scheduled”, “duplicate/already completed”, “emergency”, “in progress”, “language barrier”, “refused, call completed”, “incapable of responding/no proxy”, “out of jurisdiction”, “potentially deceased”, “referred to NYC Health Department Congregate Settings Team”, “refused – reports vaccination”, and “vaccine immune”.	
<b>Reached</b>	Subset of individuals attempted whom the T2 tracer reached, with call disposition of “call back requested”, “call dropped”, “call back scheduled”, “duplicate/already completed”, “emergency”, “in progress”, “language barrier”, “refused, call completed”, “incapable of responding/no proxy”, “out of jurisdiction”, “potentially deceased”, “referred to NYC Health Department Congregate Settings Team”, “refused – reports vaccination”, and “vaccine immune”.	
<b>Completed</b>	Subset of individuals reached who completed the intake interview, with call dispositions “call completed,” “incapable of responding/no proxy,” “out of jurisdiction,” “potentially deceased,” “referred to NYC DOHMH Congregate Settings Team,” “refused - reports vaccination,” and “vaccine immune”	
<b>Eligible monitored</b>	Subset of individuals with completed intake who had >0 days of monitoring left	
<b>Success monitored</b>	Proportion of individuals eligible for monitoring with at least 1 complete monitoring interaction with ≤3 monitoring days or at least 2 complete monitoring interactions with >4 monitoring days	
<b>Provided contacts</b>	Proportion of individuals who provided name and contact information for at least 1 contact	Not Applicable

Modeling studies have shown that the impact of contact tracing on transmission is intimately linked to how rapidly cases are identified and isolated and how rapidly contacts who may be incubating disease are quarantined. We also conducted a T2 tracing timeliness analysis to estimate the overall delays (1) attributable to factors external to the T2 program (e.g., timeliness of lab results) and (2) attributable to factors related to the T2 tracing program (e.g., timeliness of



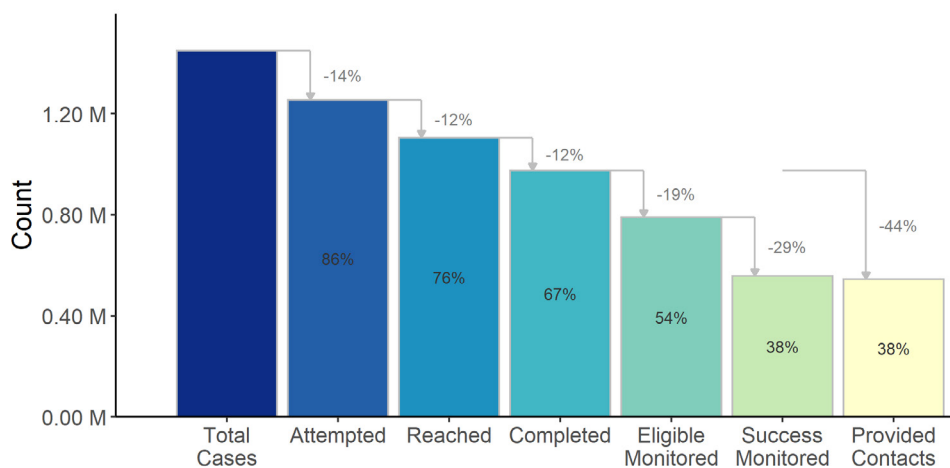
case or contact notification). Timeliness metrics were compared over time (quarterly, monthly, and by wave) and by NYC neighborhood.

## Test & Trace Cascade of Care and Timeliness Results

For all NYC cases between June 2020 and December 2021, the overall case tracing cascade is shown in **Fig. 9**. Of the 1.45 million cases reported to T2 during this period, two-thirds completed tracing interviews (roughly 980,000, or 67% of total), with drop-offs occurring evenly across each step of attempting, reaching, and completing the tracing process. Considerably fewer completed monitoring (roughly 560,000, or 38% of total and 71% of those eligible for monitoring) or provided contacts (roughly 540,000, 38% of total). Approximately 56% of cases who completed intake provided information for at least one contact (roughly 540,000, or 38% of total). Completion of tracing interviews was more successful prior to the start of the Omicron variant wave (November 14, 2021), with 79% of cases completing intake pre-Omicron compared to 41% during Omicron (**Fig. 10**). However, once cases had completed intake, the proportion providing contacts was relatively stable, with 56% providing at least one contact pre-Omicron compared to 55% during Omicron. These findings are largely consistent with results published by H+H, which were limited to the period of June 1, 2020–October 31, 2021<sup>[15]</sup>.

For the duration of the evaluation period, considerably fewer cases completed monitoring (roughly 560,000, or 38% of total and 71% of those eligible for monitoring). This aggregate cascade does not take into account changes in the modality or duration of monitoring over time. For example, monitoring was initially conducted through phone calls, but passive monitoring through SMS texting became available in September 2020. This was increasingly utilized over the course of the evaluation period. Also, the duration of monitoring decreased from 14 to 10 days in December 2020. Overall, notification of case status was prompt, with median times of 1 day from specimen collection to upload into the T2 system and 2 days from upload to first notification attempt. These findings suggest that, for a majority of positive cases, T2 served as a timely notification of the need to isolate, but was less successful at eliciting exposed contacts or monitoring notified cases.

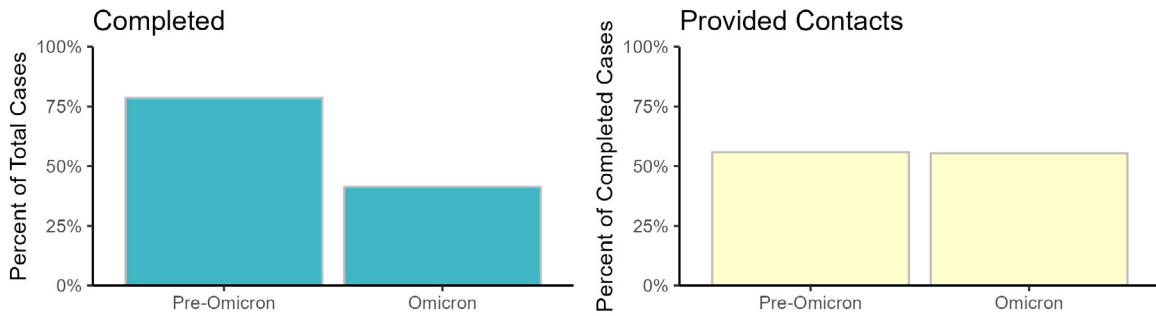
**Figure 9. Case Investigation Cascade, Aggregated over Time (May 31, 2020 – January 1, 2022), NYC**



**Data source:** T2 Trace Data.

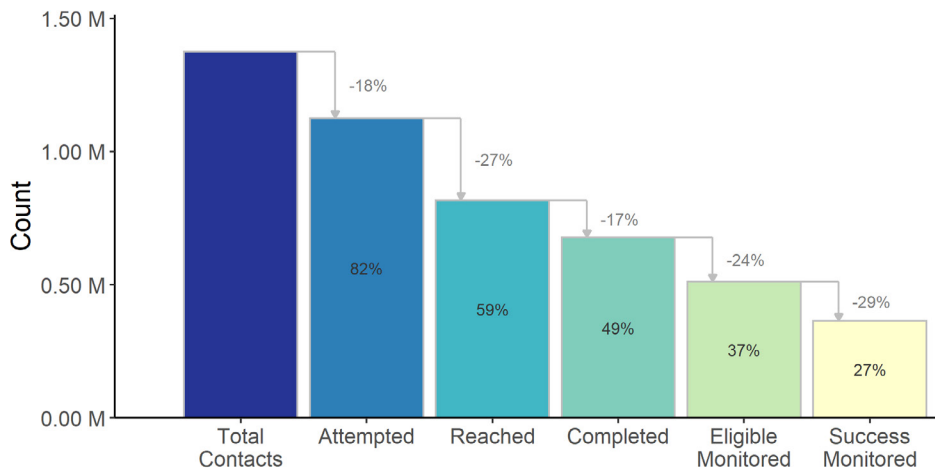
Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

**Figure 10. Key Case Investigation Cascade Metrics Pre-Omicron (May 31, 2020–November 13, 2021) vs. Omicron (November 14, 2021 – January 1, 2022)**



The overall tracing cascade for contacts, aggregated over time and geography, is shown in **Fig. 11**. Of the 1.38 million contacts reported to T2 during this period, half completed tracing (0.68 million, 49% of total), with the largest drop-off between those attempted and those reached. Significantly fewer contacts completed monitoring (0.36 million, 27% of total, and 71% of those eligible for monitoring). These data suggest that engagement in tracing was much lower for contacts than for cases, particularly in the early stages of attempting, reaching, and completing tracing. However, notification of contact status was prompt among those who were attempted, with a median of 0.24 days from contact elicitation to first notification attempt.

**Figure 11. Contact Intake Cascade, Aggregated over Time (May 31, 2020 – January 1, 2022), NYC**

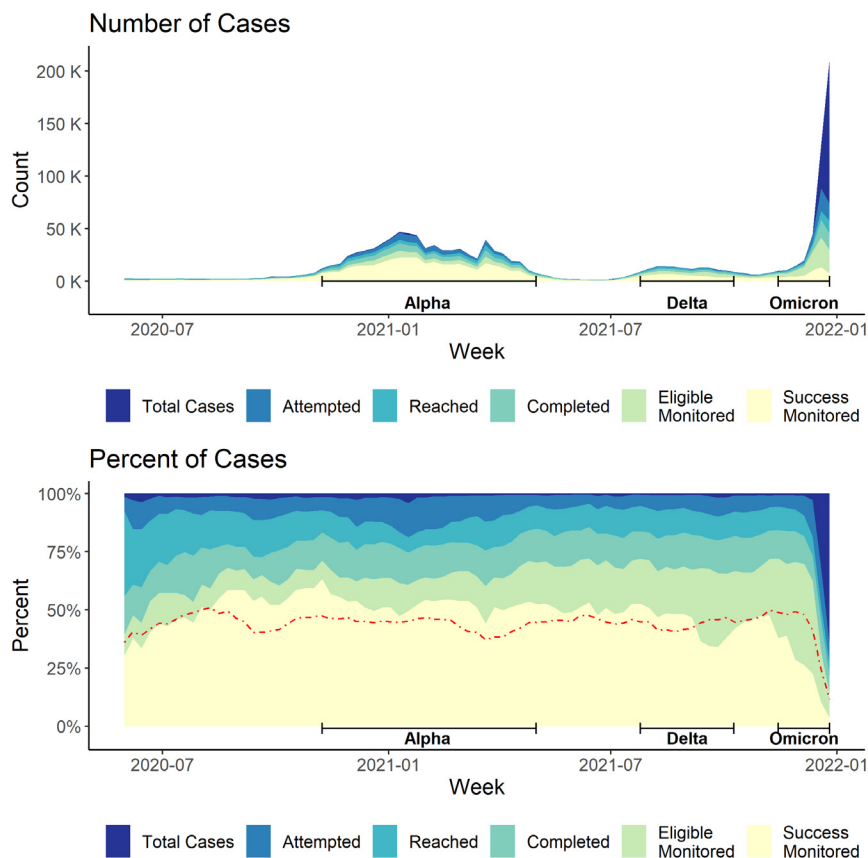


**Data source:** T2 Trace Data.  
 Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

Measured by week, the case tracing cascade did not change substantially over time (**Fig. 12**) except for modest shifts in the program’s early weeks and a dramatic shift during the Omicron wave. At program launch, a substantial proportion (92%) of cases were reached, but 44% of cases did not complete tracing. This proportion declined steadily over the first few months of the program, falling to approximately 20% of cases from January to November 2021, before rising again during the Omicron wave. The corresponding proportion who completed tracing increased from 62% in the first month of the program to approximately 80% over January–November 2021. This improvement may reflect adjustments to the tracing protocol to encourage completion. Prior to the Delta wave, approximately 80% of cases were successfully monitored.

Successful case monitoring began to fall during the Delta wave, when 65% of eligible cases were successfully monitored, and declined further during the Omicron wave, when only 35% of eligible cases were successfully monitored. This trend may reflect changes to monitoring protocols, as a greater proportion of cases opted into text messaging (SMS) monitoring during these waves (64% during Delta and 74% during Omicron). The proportion who provided contacts over time did not change significantly from program launch until the Omicron wave, when it dropped precipitously, reflecting reductions as a result of overwhelming call volumes and shifts in public attitude about reporting contacts.

**Figure 12. Case Investigation Cascade by Week, May 31, 2020 – January 1, 2022**

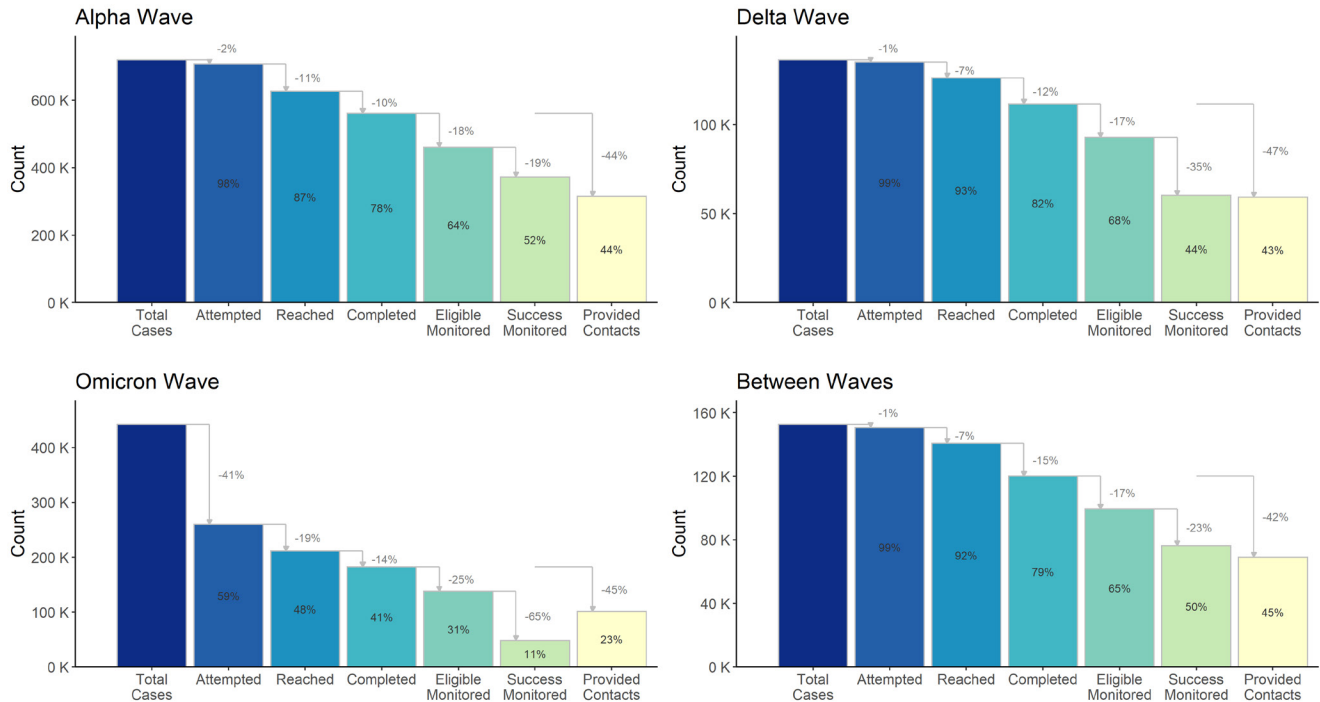


**Data source:** T2 Trace Data.

Red dashed line represents the percentage of total cases who provided contacts.

The Alpha and Delta waves had little impact on case completion when compared to between-wave time periods (**Fig. 13**). During the Omicron wave, the proportion of cases attempted dropped precipitously, reflecting a surge in cases that exceeded the program's capacity. However, of cases who were attempted, the proportions reached, completed, and providing contacts remained similar to those in earlier waves and in between-wave time periods. After initial lab delays at the start of the response, timeliness of lab results did not differ substantially by variant wave, with a median of 1 day from specimen collection to upload into the T2 system. However, timeliness of the first notification attempt worsened during the Omicron wave, when the median time from upload into the T2 system to first call attempt was 4 days (**Fig. 14**).

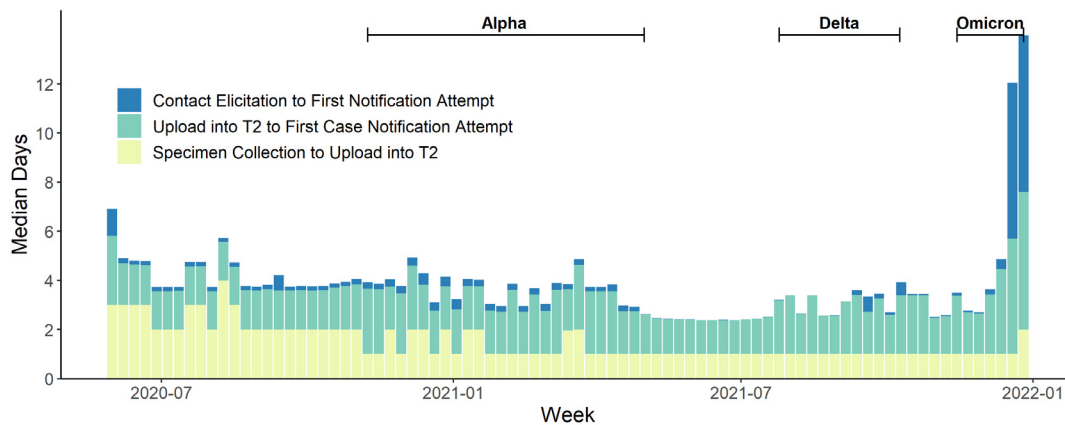
**Figure 13. Case Investigation Cascade by Variant Wave, May 31, 2020 – January 1, 2022**



**Data source:** T2 Trace Data.

Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

**Figure 14. Timeliness of Case and Contact Notification, May 31, 2020 – January 1, 2022**

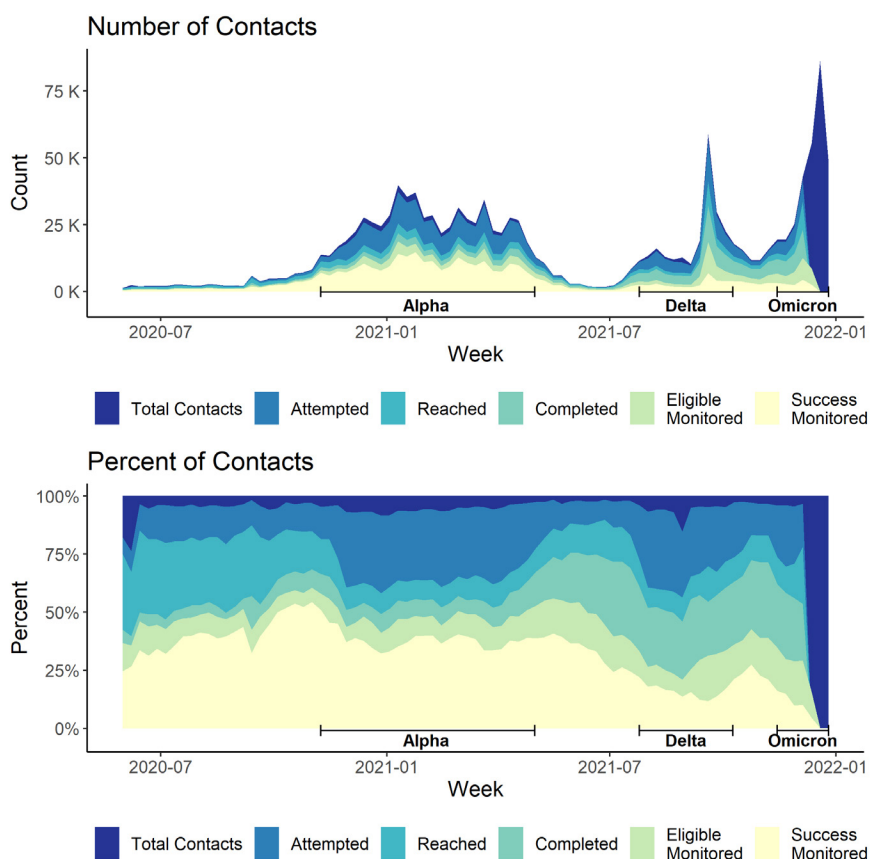


**Data source:** T2 Trace Data.

A review of the contact tracing cascade (**Fig. 15**) showed that, at program launch, approximately one-quarter of contacts were not attempted, and another quarter were reached but did not complete tracing. Within a few weeks, the program attempted to reach over 95% of contacts, and the proportion who completed tracing grew steadily over the next 4–5 months, rising to 66% of contacts at the onset of the Alpha wave. These gains were erased during the Alpha wave, rebounded during the inter-wave period, and fell again during the Delta wave. Attempts to reach contacts abated during the Omicron wave, despite record numbers of contacts being reported to T2, reflecting a shift in strategy toward automated notifications via SMS. As with the case tracing cascade, the proportion of contacts who were successfully monitored declined during the Delta wave, when 51% of eligible contacts were successfully monitored. It declined further

during the Omicron wave, where only 37% of eligible contacts were successfully monitored. During all waves, the proportion of contacts who opted into text monitoring was relatively stable at approximately 60%.

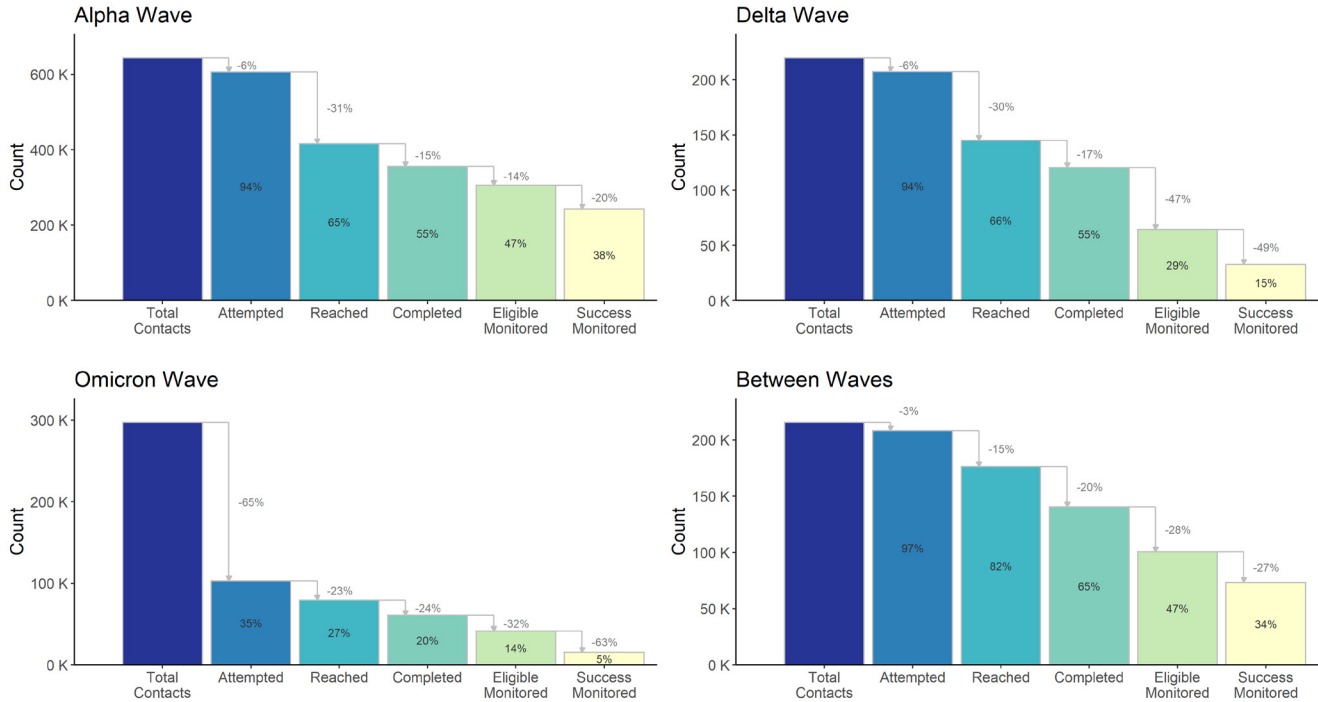
**Figure 15. Contact Intake Cascade by Week, May 31, 2020 – January 1, 2022**



**Data source:** T2 Trace Data.

Stratified by epidemic wave (**Fig. 16**), the contact cascade was more successful in between-wave periods than during periods of increased transmission. For example, the proportion of contacts attempted but not reached was twice as high during the Alpha and Delta waves (~30%) as between waves (15%). The Omicron wave included a smaller proportion of contacts attempted, reflecting the above-mentioned mid-wave shift in policy toward automated SMS notification. There was also more attrition of reached contacts not completing tracing during the Omicron wave (24%) compared to the Alpha (15%) and Delta (17%) waves, a trend that led up to the decision to use automated digital notification strategies as the Omicron wave grew. Among contacts attempted, initial notification attempts were timely until mid-December 2021, with a median of less than 1 day from contact elicitation to first call attempt. After this point, the median time from contact elicitation to first notification attempt rose quickly to more than 6 days (**Fig. 14**).

Figure 16. Contact Intake Cascade by Variant Wave, May 31, 2020 – January 1, 2022

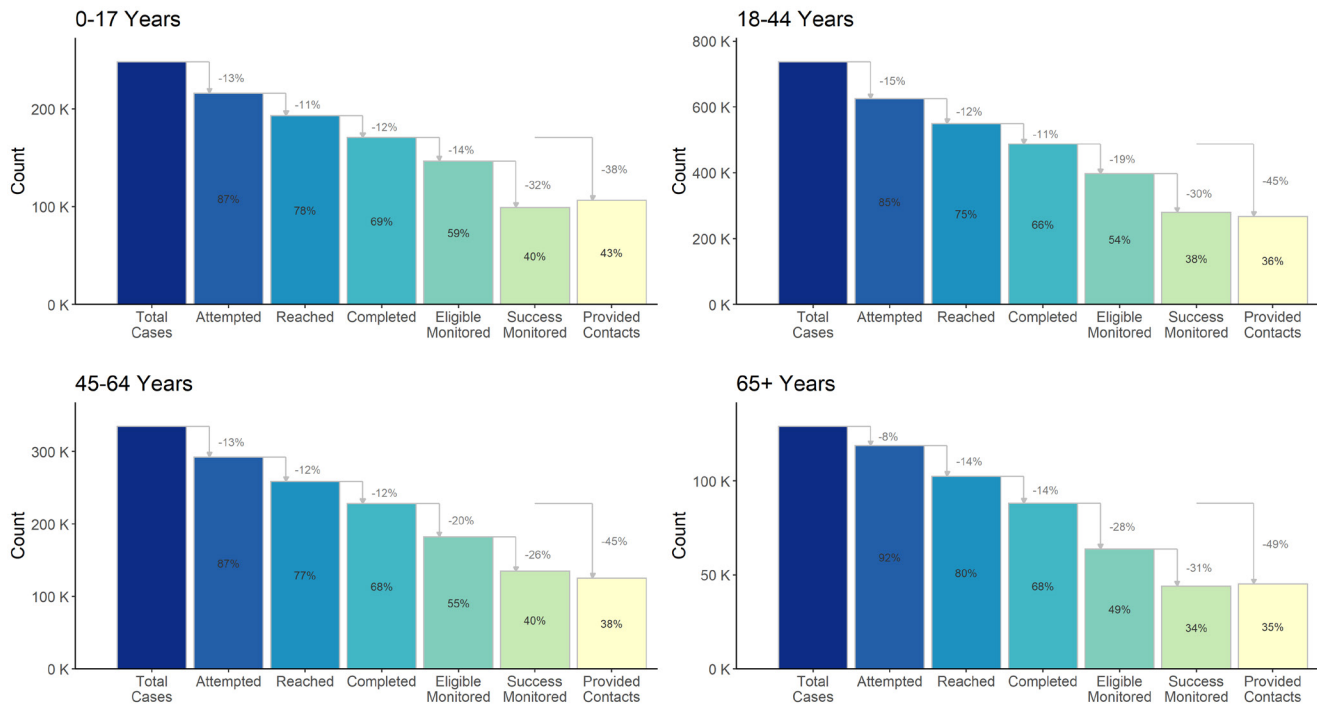


**Data source:** T2 Trace Data.

Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

Case tracing cascades differed moderately by age and gender. A greater proportion of cases aged 65 years or older were ever attempted to be notified (92%), though the proportion of cases with completed intake was relatively consistent across age groups (~68%) (Fig. 17). Cases who were aged 0–17 years and cases who were women (Fig. 18) were more likely to provide contacts (43% and 39%, respectively). Contact demographics could not be ascertained reliably due to large amounts of unknown data (>30%).

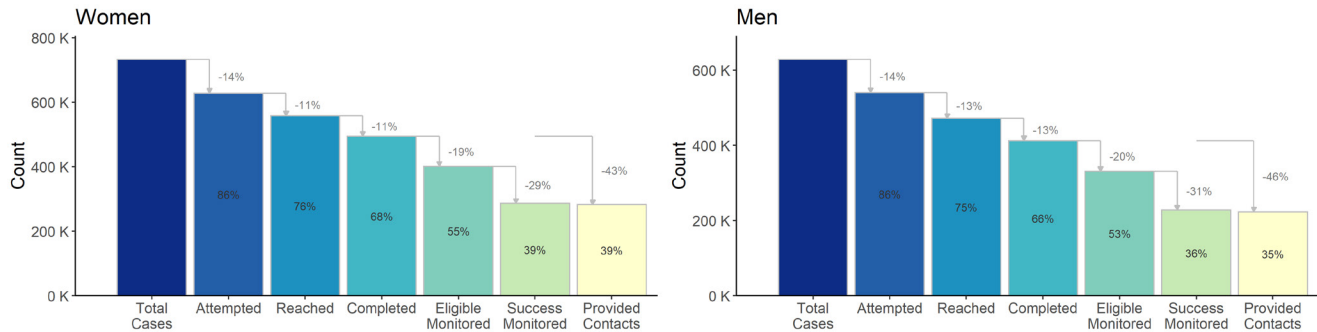
**Figure 17. Case Investigation Cascade by Age Group, Aggregated over Time (May 31, 2020 – January 1, 2022)**



**Data source:** T2 Trace Data.

Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

**Figure 18. Case Investigation Cascade by Gender, Aggregated over Time (May 31, 2020 – January 1, 2022)**



**Data source:** T2 Trace Data.

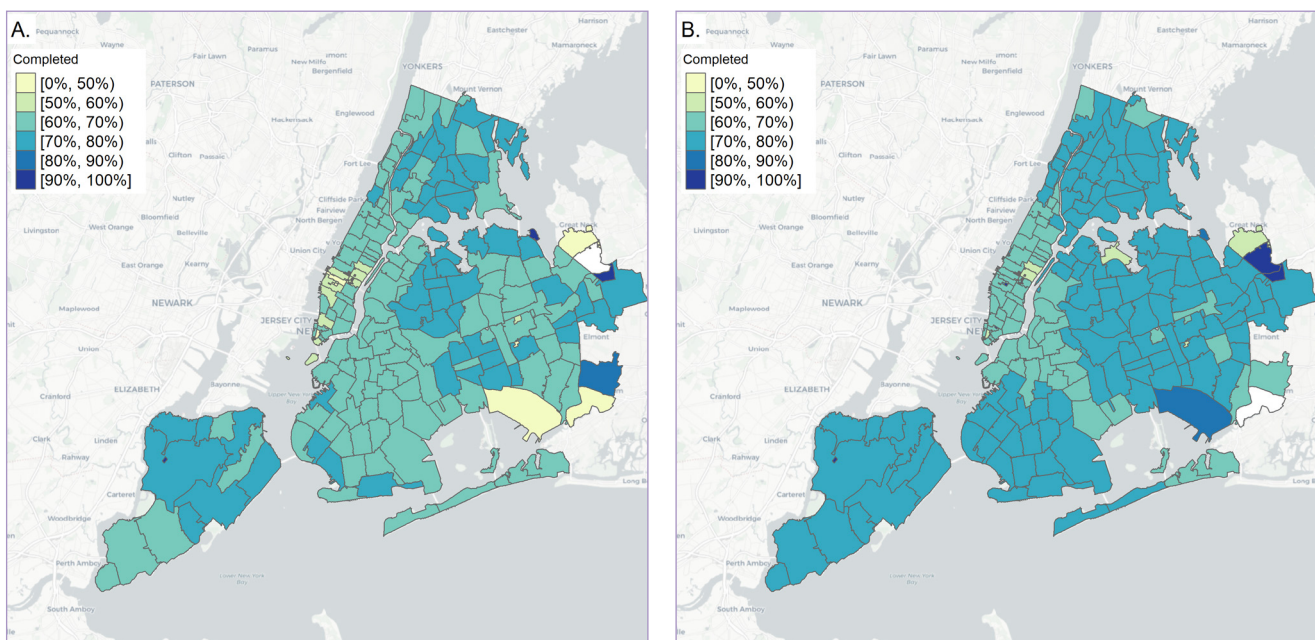
Percentages outside the bars represent the percent decrease from the reference group displayed by the arrow; percentages inside the bars represent the percent of total cases that reached the cascade category.

Tracing cascades also did not differ substantially by neighborhood (**Fig. 19**). The median proportion of individuals residing within ZCTA (zip-code-defined tracing area) neighborhoods with completed intake was 68% for cases and 71% for contacts. Over the study period, neighborhoods within Manhattan had slightly lower proportions of both cases and contacts with completed intake and lower proportions of cases who provided contacts (**Fig. 20**), perhaps reflecting tourists or other temporary NYC residents who were less likely to complete follow-up. This reflected drop-offs at each stage in the tracing cascade, including individuals providing accurate phone numbers, T2 tracing staff making call attempts, and individuals being reached during a call attempt. While neighborhoods within Staten Island

and Southern Brooklyn had higher levels of completion for cases and contacts, they had low proportions of cases providing at least one exposed contact.

As reflected in the citywide tracing cascades, NYC neighborhoods showed substantial reductions in cases and contacts with completed intake and cases providing contacts during the Omicron variant wave. Spatial patterns in cases with completed intake varied by wave. Neighborhoods in the Bronx generally had the highest proportion of cases completing intake until the Omicron wave, when they became relatively low compared to those for other NYC neighborhoods. Spatial patterns in contacts with completed intake and cases providing contacts were slightly more stable, with neighborhoods in Manhattan consistently displaying low proportions relative to other NYC neighborhoods across waves.

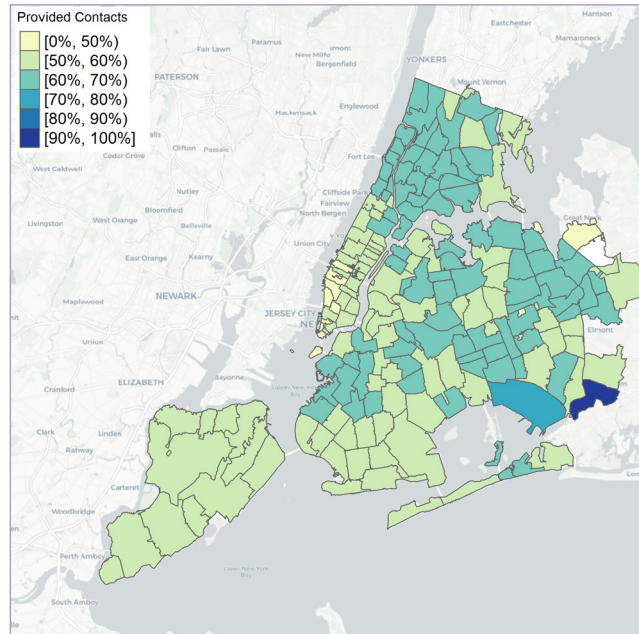
**Figure 19. Percent of Cases (Panel A) and Contacts (Panel B) with Completed Intake by ZCTA, May 31, 2020 – January 1, 2022**



**Data source:** T2 Trace Data.



Figure 20. Percent of Cases Providing Contact(s) by ZCTA, May 31, 2020 – January 1, 2022



Data source: T2 Trace Data.

Neighborhood-level percentages of cases and contacts attempted and subsequent percent completion of notification were not strongly correlated with total numbers of cases/contacts. This suggests that the T2 program's efforts to explicitly target high-burden neighborhoods in their case or contact notification efforts did not necessarily yield large improvements in case and contact completion levels compared to those in other neighborhoods over the duration of the program, but it is unclear how much it improved efforts over the counterfactual of no outreach in those neighborhoods.

### Neighborhood Determinants of Risk

Neighborhood characteristics may have influenced outcomes for the T2 metrics of case completion and cases providing contacts. To examine this, we assessed neighborhoods with low case completion or low proportion of cases providing contacts (defined as the lowest quartile). **Figure 21** shows that neighborhoods with higher median household income, lower median social vulnerability index (SVI), lower proportion with limited English proficiency, and lower proportion Hispanic or Black race/ethnicity had worse case completion and likelihood of providing contacts than other neighborhoods. We also found that, despite heavy targeting for testing and outreach services, a substantially higher proportion of neighborhoods with at least one public housing development had low case completion (21% vs. 12%) or low cases providing contacts (16% vs. 13%).

**Figure 21. High vs. Low Case Completion and Proportion of Cases Providing Contact Information by Neighborhood Characteristics<sup>1</sup>, May 31, 2020 – January 1, 2022**



**Data sources:** T2 outcome status defined using T2 Trace Data. Neighborhood determinants defined using 2020 American Community Survey 5-year NYC Census Tract data and public housing data using the NYC Housing Authority's housing development shapefile, accessed from NYC Open Data. <sup>1</sup>Low outcome neighborhoods: lowest quartile neighborhoods (Census Tracts) for proportion of cases with completed intake (case completion) and proportion of cases providing at least one contact (cases providing contacts). High outcome neighborhoods: Higher 3 quartiles. \*For all neighborhood characteristics except for public housing, points represent median value and bars represent 25<sup>th</sup> and 75<sup>th</sup> percentiles across Census Tracts. For public housing, points represent the proportion of Census Tracts with public housing and bars represent the 95% confidence interval.

Because many of these characteristics cluster together, we examined which characteristics were associated with low performance after adjusting for other neighborhood determinants in a multi-level logistic regression model (**Table 4**). As neighborhoods increased in percent of the population that was Hispanic, percent Black, or median age, odds of low case completion or low cases providing contacts were lower (**Table 4**). This finding was consistent with an earlier analysis published as a conference abstract by H+H, where neighborhoods with a higher percentage of residents of color were observed to have higher case completion<sup>[15]</sup>. Neighborhood with public housing developments were significantly associated with greater likelihood of low T2 outcomes, with approximately three times greater odds of low case completion and two times the odds of low cases providing contacts compared to neighborhoods without public housing. These results emphasize the importance of targeting vulnerable communities and neighborhoods and highlight the unique challenges of engaging public housing residents in the Trace efforts.

**Table 4. Neighborhood Determinants Associated with Odds of Low Case Completion or Cases Providing Contacts<sup>1</sup>, May 31, 2020 – January 1, 2022**

Neighborhood Determinant	Low Case Completion OR (95% CI)	Low Cases Providing Contacts OR (95% CI)
Median Income ( <i>\$1 K increase</i> )	1.02 (0.98–1.07)	0.97 (0.92–1.03)
Median Age ( <i>1 year increase</i> )	0.95 (0.94–0.97)*	0.96 (0.95–0.98)*
SVI ( <i>1 unit increase</i> )	0.50 (0.20–1.22)	0.84 (0.33–2.15)
Unemployment ( <i>1% increase</i> )	17.59 (1.38–223.52)*	2.97 (0.21–40.73)
Limited English ( <i>1% increase</i> )	0.71 (0.19–2.56)	0.40 (0.10–1.51)
Hispanic ( <i>1% increase</i> )	0.06 (0.03–0.15)*	0.002 (0.0005–0.005)*
Black ( <i>1% increase</i> )	0.63 (0.38–1.05)*	0.21 (0.12–0.36)*
Public Housing ( <i>Yes vs. No</i> )	3.31 (2.24–4.90)*	2.00 (1.26–3.20)*

<sup>1</sup>Multilevel logistic regression models for low case completion or low cases providing contacts with random intercepts for county.

\*Statistically significant at the 0.05 level.

**Data sources:** T2 outcome status defined using T2 Trace Data. Neighborhood determinants defined using 2020 American Community Survey 5-year NYC Census Tract data and public housing data using the NYC Housing Authority’s housing development shapefile, accessed from NYC Open Data.

## Barriers and Facilitators of Case and Contact Notification

### Barriers

The Trace pillar was arguably the most challenging and resource-intensive program component to staff and implement. We highlight barriers around data systems, staffing, and the quality of interactions with cases and contacts.

**Data Systems.** The first barrier, already discussed, was obtaining testing data from the state and local health departments. The Senior Advisor of Public Health to the Mayor worked closely with Department of Information Technology and Telecommunications (DoITT) leadership to quickly determine the most suitable pre-existing information technology (IT) system to track all positive cases and contacts, track numbers of call attempts. DoITT leaders felt that that Maven, the data system used by the DOHMH for epidemiological tracking, was insufficiently flexible to serve as the IT system for Trace, and moreover it did not include case management capabilities to track interactions with cases and contacts from first attempt to end. DoITT therefore selected Salesforce as the data platform. The great majority of staff survey respondents (82%) reported that they “somewhat” or “very much” agreed the Salesforce platform worked well. In interviews, most respondents agreed that Salesforce worked fine for front-end data entry and could handle extremely large caseloads and frequent surges, but it was not well designed for back-end data analysis (i.e., epidemiologic) purposes. Multiple Trace pillar leaders also reported that the inability to make programming changes to Salesforce themselves was problematic. Instead, DoITT leadership had to be consulted, resulting in delays each time platform changes were needed—which happened frequently given the need to update the system to meet the

demands of the unfolding pandemic. Similarly, scripts for frontline staff (CIs, Monitors, CES) needed to be changed frequently. Staff reported that since these changes could not be made quickly in Salesforce, they had to use “work-arounds” and open the updated scripts in different applications, requiring them to switch back and forth between applications during a call; this was more challenging for some staff than others. Another challenge consistently mentioned by interviewees was duplication of cases and contacts in the Salesforce data, which led to people being called multiple times by T2 staff, often in one day. There also was initially no method to identify members of the same household in the system, again meaning that families might receive several calls about one exposure in one day. No interviewee identified any existing alternative data platform superior to Salesforce.

CES staff and supervisors also reported numerous challenges, including inaccurate or missing name and address information for cases and contacts they were assigned to visit, redundancy in being assigned people already contacted by CIs/Monitors, being assigned to neighborhoods that did not match their language or cultural backgrounds, experiencing racism and general threats to their safety in the field, and having to implement frequent program changes immediately without warning.

*It took us a while, even on Salesforce, to be able to have each other's notes be visible—which was kind of a mess. Because there would be whole conversations that the case investigators would be having with people that we would be calling, and there was a lot of redundancy in that... [I]f they didn't even complete anything and said this person was in France, you know—they may have reported that note, or something. But we wouldn't see that, so we would call them again.*

— Community Engagement Specialist

**Staffing.** Staff appropriately with respect to linguistic and cultural needs in a city with hundreds of spoken languages was challenging as it was not feasible to hire and maintain staff to speak so many languages. T2 addressed this challenge by maintaining staff speaking approximately 50 different languages and hiring speakers of additional languages when focal outbreaks occurred in communities outside those 50 languages.

*....[B]ack in September, August and September of 2020 we started to see an uptick of cases in some communities across New York City, in particular our Orthodox Jewish communities. And at that time, we had only a handful of contact tracers... that spoke Yiddish. We had a fair number that spoke Russian, which is relevant for those communities too, um, but we had to very quickly find people from those communities that spoke the language of those communities, and I remember that that was definitely a challenge at the time.*

— T2 Leader

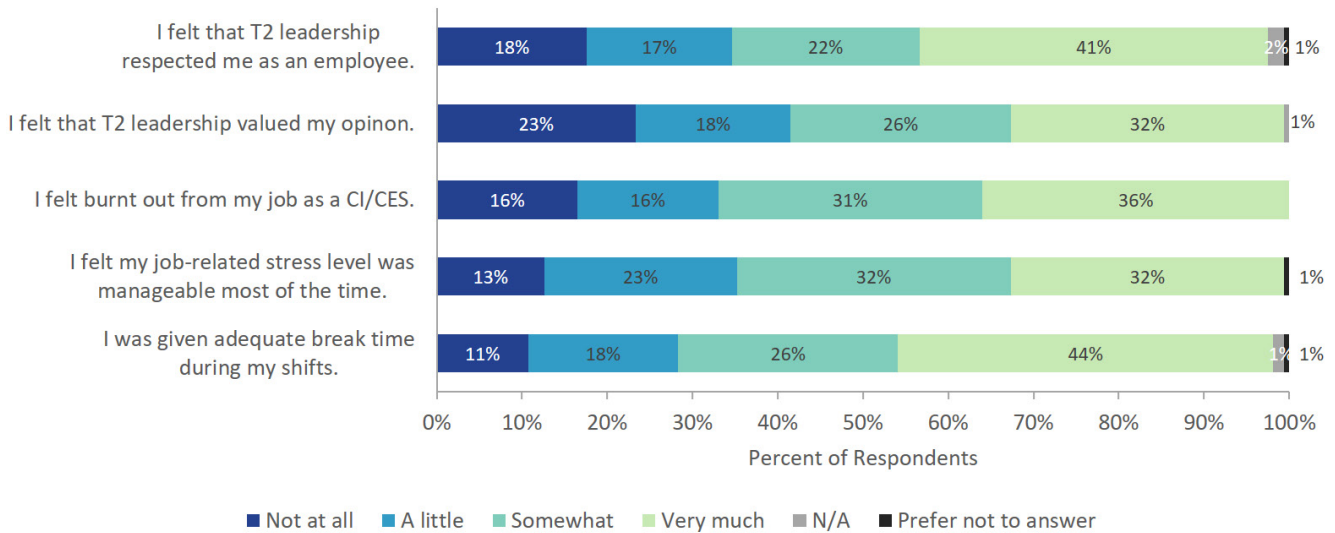
Interviews with frontline Trace staff identified various challenges around working conditions not reported for the Test or Take Care pillars. Frontline and supervisor interviewees reported that working conditions were undesirable and ultimately unsustainable, and described performance evaluation metrics as unfair. CIs and Monitors reported inadequate break times during the work day (two 15-minute breaks and one 30-minute lunch break).

*" You will literally just be making calls back-to-back-to-back. And I think at one point, they were saying you could only take 30 seconds between each call. And you would be on the queue from 10:00 [a.m.] to 7:00 p.m. It just became unbearable at a certain time. "*

*— Case Investigator*

Frontline staff survey respondents also reported on various aspects of the working conditions during their employment with T2 (Fig. 22).

**Figure 22. Frontline T2 Staff Survey Responses: Working Conditions**



Job performance for CIs and Monitors was evaluated using a point system totaling 100 points for a “perfect” call. Calls with cases or contacts were recorded, and point values were allocated for accurately following the call script and collecting certain pieces of information; for example, eliciting at least one close contact from a case was worth approximately 30 points. Staff were ranked internally among teammates based on their scores. Many staff interviewees felt the evaluation metrics were overly stringent and did not emphasize quality interactions with cases and contacts. Supervisors focused on the metrics with varying levels of intensity. Interviewees also noted that management did not preemptively staff up for surges, even when waves were predictable (e.g., after holidays), making the job more stressful for frontline staff dealing with increased volume.

*" It did change the focus from really trying to provide people with quality care, and to really care about the people that you're contacting when you're worried about metrics, and you're worried about someone reaching out to you and telling you, 'You didn't spend enough time on this call. You missed this word.' I think it took a little bit away from the actual work. It was difficult to do both, to be qualitative and quantitative. "*

*— Case Investigator*

Relatedly, it was common for frontline staff to report having multiple supervisors during their time at T2, and job satisfaction varied greatly between supervisors.

*...I had many supervisors. I think I had maybe four or five.... [T]he first supervisor left in October of 2020. And then, the second supervisor came in, in October 2020. I had her for most of my time with Test & Trace. She was lovely. She helped me a lot. She was very patient. And the third supervisor, we didn't get along, and she made the job very—I don't know how to put this. She made the job very difficult and unenjoyable. And then, the last supervisor, we really didn't have any communication. It was just strictly for monitoring us. We didn't talk at all.*

— Cross-Trained Monitor

One issue raised in interviews with Monitors employed by the outside hiring organization was that they were aware of a pay discrepancy between themselves and CIs employed by H+H. Cross-trained Monitors were essentially performing the same job of case notification as CIs, who were paid more, which led to animosity.

A final staffing challenge related to inter-agency coordination. DOHMH staff were seconded to H+H to assist in program operations, but not all seconded staff were in fact experts in contact tracing. Some reported that this placed them in a very difficult position, as they felt “stuck in the middle” between the DOHMH and H+H while not receiving adequate support from either side.

**Quality of Case and Contact Interactions.** Several barriers to successful completion of Trace calls were identified by interviewees. These included the heavy volume of calls to families, lack of flexibility to reduce calls when asked by families, a lengthy telephone script, and language barriers.

CIs and Monitors noted that cases and contacts frequently expressed frustration with the number of calls they received from the T2 program. Multiple case and contact KI respondents noted that they preferred the switch to daily monitoring text messages when those became available. CIs and Monitors were not allowed to remove cases or contacts from the call queue unless they explicitly stated that they refused to participate in the program; therefore, people who hung up or were verbally hostile to the staff, short of explicitly refusing to participate, remained in the call queue.

*Technically, unless I heard the person say, it was a specific sentence that they had to say, something about, ‘Do not call me anymore.’ I don't remember the exact verbiage, but unless they told me that, I could not mark them as ‘refused.’ So, technically, I should've thrown them back in the queue, but I would mark them as ‘refused,’ yeah.*

— Case Investigator

One interviewee shared that an acquaintance become paranoid and fearful after receiving many calls from T2 and eventually a home visit because she did not wish to participate. Multiple interviewees also commented that the telephone script was lengthy and burdensome for CIs and Monitors, and that the length discouraged participation from the public.

*The script was far too long. For people who could not get through spelling their name out without having to cough, this was the last thing they needed, was to be on the phone for 45 minutes to an hour. It did get reworked several times, but even then, once I was familiar with the script, I would cut it down to the bare necessity, and just give them what they needed and nothing more. It wasn't repetitive, it did offer useful information, but a lot of it explained too much.*

— Case Investigator

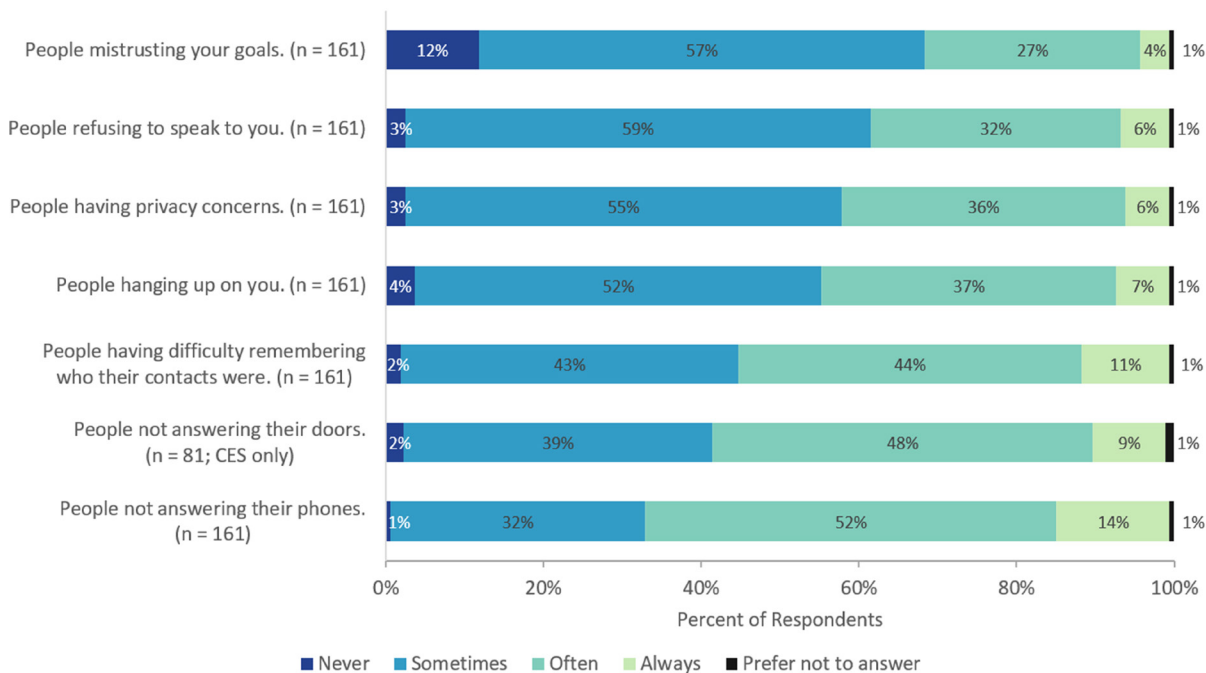
Calls with cases and contacts were conducted only in either English or Spanish. Over half of staff survey respondents (57%) reported that they “sometimes” were not able to speak to people due to language barriers. If cases or contacts spoke another language, CIs and Monitors had to utilize a language interpretation service over the phone, which multiple staff described as time consuming. Additionally, although there was a Spanish queue, staff who spoke only English still often had to complete calls with Spanish-speaking cases and contacts and did not have a mechanism to directly transfer them into the Spanish queue.

“ ...[W]e had Spanish-speaking representatives, but I would still get countless Spanish calls. And they'd ask me to speak to somebody in Spanish, but I'd still have to do it myself knowing that there's somebody else who could have done it.... But for the main languages, there should be at least a few representatives to talk with them. We should be able to transfer them into that queue and just say, 'They'll call you back whenever they're available.' It's going to save a lot of time, but they didn't allow us to do that.

— Case Investigator and Monitor

In addition, according to survey data, frontline staff identified which challenges they encountered most frequently during contact tracing efforts (Fig. 23).

**Figure 23. Frontline T2 Staff Survey Responses: Contact Tracing Challenges**



### Facilitators

An oft-mentioned rationale for selecting H+H as the operational lead was its capacity to hire and onboard staff quickly, including ready capacity to contract with vendors for this purpose. This rationale was well supported during the rapid stand-up of the program, particularly for the Trace pillar, which required substantial staff hiring. The ability to contract quickly with vendors that were in turn able to recruit and hire Trace staff very quickly proved to be a significant facilitator.

Concerted efforts to hire a diverse workforce of NYC residents facilitated buy-in among staff and the ability of CES staff, in particular, to engage with their communities. With respect to the CIs and Monitors, the decision to use telephonic translation services ensured that all language needs were met in real time; most interview respondents spoke quite positively about the translation services. Similarly, the vast majority of staff survey respondents (86%) agreed “somewhat” or “very much” that language interpretation services worked well.

*“ The language line, never had an issue with, always had really great interpreters. The process to call them was pretty easy. Yeah, I didn't have many issues with that, other than just having to use it, in general. ”*

— Case Investigator

Late-stage programmatic adaptations addressed some problems noted by interviewees. Cases and contacts noted that after the initial case or contact interview phone call, they preferred to receive monitoring text messages rather than daily phone calls during the isolation/quarantine period. This change was made in late 2021. In addition, the call scripts were changed and shortened to facilitate shorter calls in response to surging call numbers during the Omicron wave. This adaptation in particular was applauded by CIs and Monitors.

*“ At one point during the last big surge, they shortened the script because we couldn't afford to spend 25 minutes and up on a single case. So, they shortened the script and made it about 5–10 minutes. So, that was key. And that should have been done from the beginning to be honest with you because a lot of the questions were redundant. And that's not coming from me, that's coming from the actual cases. They themselves would say, 'You already asked me that question.' ”*

— Community Engagement Specialist





## Recommendations: Trace Pillar

**Any major crisis will require a diverse, flexible workforce that can be scaled up and down, as well as flexible data systems to address myriad logistical challenges associated with high-volume case management systems.**

### PLANNING

- Identify mechanisms to rapidly hire a diverse workforce of individuals from vulnerable communities where underlying trust in government is often low.
  - ◇ *Provide opportunities to elicit feedback and support flexible arrangements for all frontline staff (monitors, CIs, CES and other Trace programmatic staff) to improve their job satisfaction, and prevent burnout.*
  - ◇ *Promote arrangements that achieve better parity of compensation, support and opportunity between agency and contracted staff for performing the same responsibilities.*
  - ◇ *Develop communication opportunities that enable frontline staff to voice concerns directly to leadership.*
- Identify or develop an end-to-end case management and data system that is flexible to adaptation and meets back-end epidemiologic analysis needs of a large-scale public health program.
  - ◇ *Validate capability to change call scripts to streamline them, address essential questions, and incorporate new information as it arises.*
  - ◇ *Ensure capabilities to directly transfer individuals to staff who speak the appropriate language.*
  - ◇ *Use text messaging, instead of daily calls, to push notifications to the public for monitoring purposes during isolation and quarantine periods, particularly as recipients often screen calls and opt not to respond.*

### RESPONSE

- Limit the number of contacts attempted, both overall and in a given day, before individuals are removed from the list of cases and contacts to be contacted, and there should be mechanisms for individuals to opt out of the program more easily, to prevent wasted effort and burnout among staff and unnecessary stress among cases and contacts.

## Take Care Pillar: Provision of Services

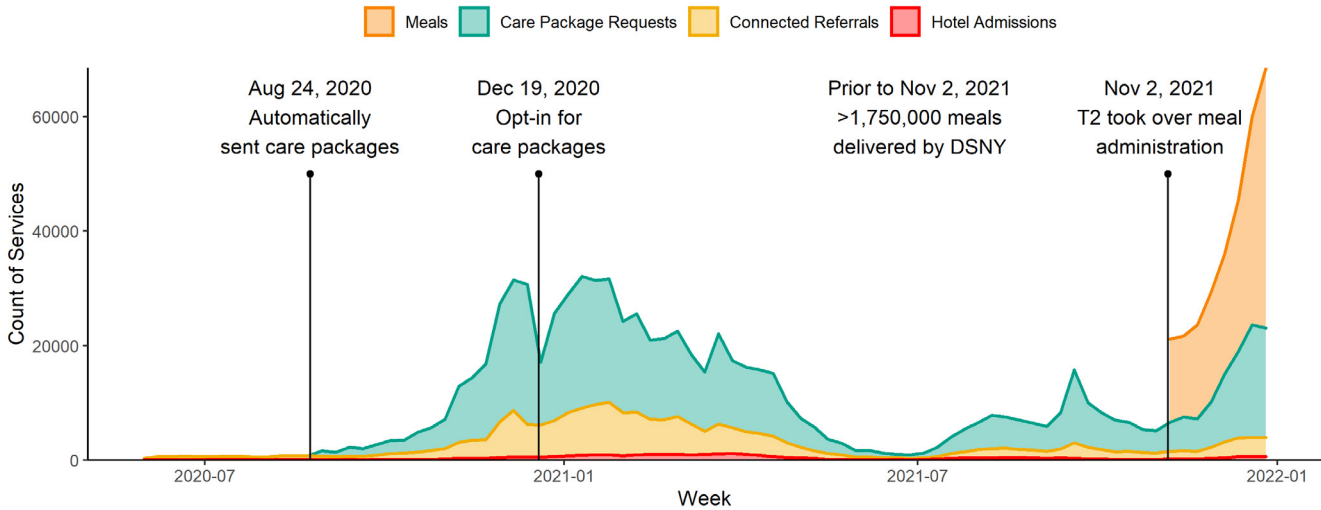
The Take Care pillar was designed to provide direct outreach and support to NYC residents affected by the pandemic (**Table 5**). The Take Care pillar was established by building on a hotel isolation program early in the pandemic, in which H+H managed over 1,200 hotel rooms. Take Care operated through CBOs, which were responsible for resource navigation to serve cases and contacts in their homes during isolation and quarantine periods. It evolved significantly over time to meet community needs, ultimately including everything from emergency food delivery (a program housed in the NYC Department of Sanitation until November 2021) to at-home care packages to dog-walking services. Take Care also granted residents access to other resources such as legal assistance, paid sick leave, and even a grant to support cash assistance and food delivery to individuals who were ineligible or did not feel they could access paid sick leave. The program also included the AfterCare sub-program focused on providing resources and support for those struggling with Post-Acute Sequelae of SARS-CoV-2 (PASC or “long COVID”). Initially, six or seven CBOs were contracted to provide services, but over time several CBO contracts were not renewed, and by 2021 three large CBOs spanning multiple geographic locations were the sole operators for Take Care services.

**Table 5. Description of Take Care Service Metrics**

Take Care Service	Description
Hotel admissions	Hotel admissions for isolation/quarantine of cases and exposed contacts.
Meals	Meals provided once T2 took over program operations on November 2, 2021. A total of 6 meals were included in each delivery.
Care package requests	Provided to individuals who requested care packages, which included face masks, hand sanitizer, thermometers, educational materials, and a pulse oximeter (for those who tested positive). Starting August 24, 2020, cases and contacts who completed intake were mailed 1 or 2 Take Care packages depending on household size. Starting December 19, 2020, a question was added to make this an opt-in program rather than a default.
Referrals requested	Referral requests for wrap-around services (food, health insurance, medications, methadone delivery, assistance applying for government benefits [e.g., SNAP], housing, eviction or other tenant issues, legal assistance, other); individuals were then expected to receive a follow-up call from a resource navigator.
Completed referrals	Subset of referral requests that were operationally completed, including combined resource service status of “Completed Client Connected to Resources,” “Completed Resources Declined,” “Completed Did Not Reach after Three Attempts,” “Completed Invalid Phone Number,” “Completed Unable to Reach Client,” and “Completed.”
Connected referrals	Subset of referral requests that were successfully connected to the wrap-around service, including combined resource service status of “Completed Client Connected to Resource.”

During the study period, over 30,000 individuals (1.1% of all cases and contacts who interacted with T2) were housed in hotel rooms. Granular data on the GetFoodNYC program are available only for after T2 took over its administration on November 2, 2020 (**Fig. 24**). In total, over 2 million emergency meals (71 meals per 100 cases and contacts) were delivered to T2 clients through GetFoodNYC. Starting in August 2020, all cases and contacts who completed intake interviews were automatically sent Take Care support packages that included face masks, hand sanitizer, thermometers, educational materials, and a pulse oximeter (for those who tested positive). On December 19, 2020, this was converted to an opt-in program to better target care packages to those in need. After this point, care packages were provided to approximately 50% of cases (roughly 330,000) and 37% of contacts (roughly 150,000) with completed intake and at least 1 day left in monitoring (**Fig. 24**).

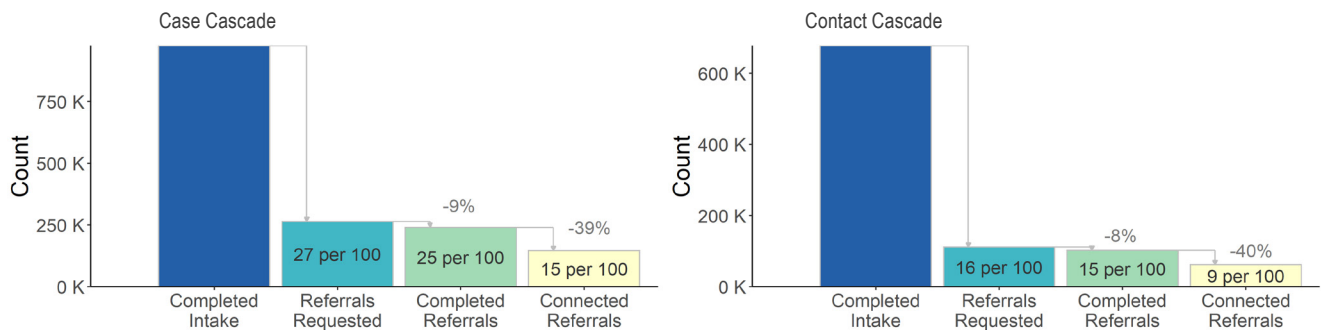
**Figure 24. Timeline of Take Care Services Provided to Cases and Contacts Through Test & Trace, May 31, 2020 – January 1, 2022**



Data source: T2 Take Care Data.

Cases and contacts were also offered the opportunity to connect with wrap-around services for basic necessities, such as food, health insurance, medications, assistance applying for government benefits, housing, or legal assistance. Such referrals were requested at a rate of approximately 27 per 100 cases (roughly 260,000) and 16 per 100 contacts (roughly 110,000) who completed intake. Almost all referrals were completed by a Resource Navigator (91% for cases and 92% for contacts), but only 55% of requested referrals were successfully connected to a Take Care service (**Fig. 25**). This drop from completed to connected referrals reflects both individuals who could not be reached and those who were reached but declined the service.

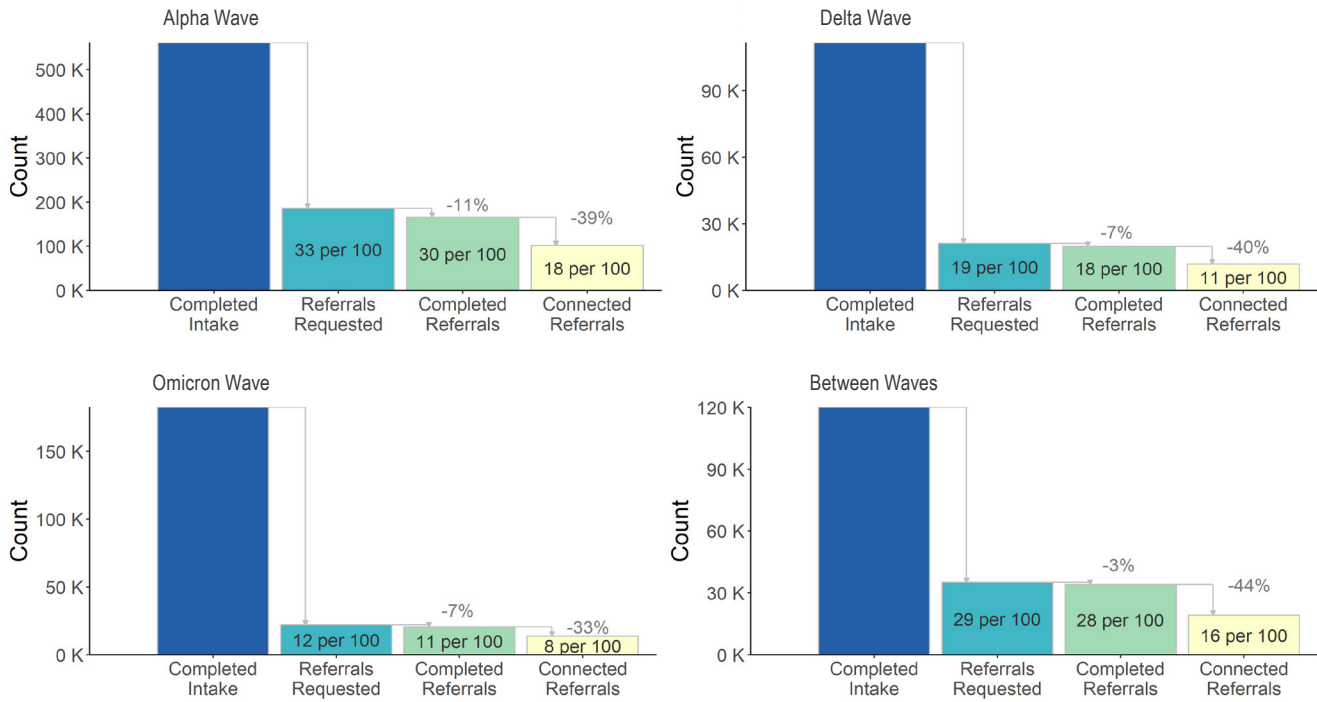
**Figure 25. Cascade of Care for Take Care Services, May 31, 2020 – January 1, 2022**



Data source: T2 Take Care Data.

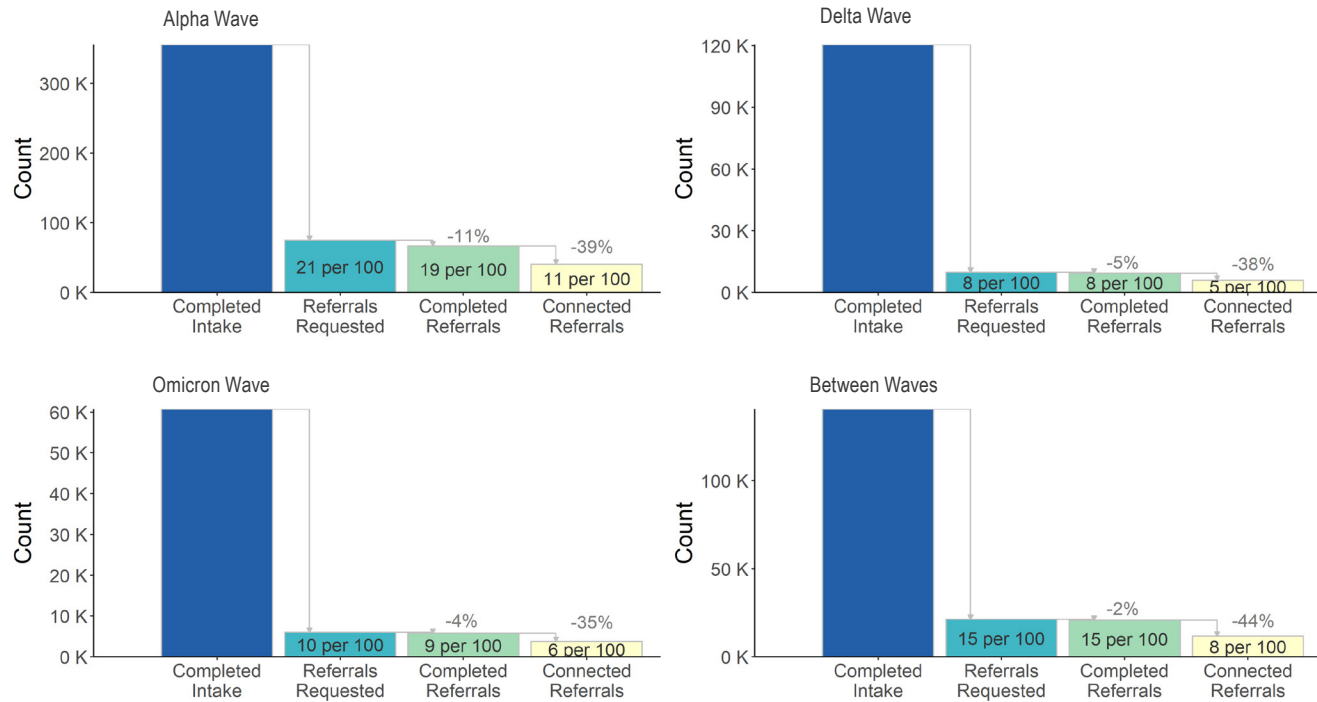
For both cases and contacts, referral requests for wrap-around services were much more common during the Alpha wave than during the Delta and Omicron waves and between-wave periods (**Figs. 26 and 27**). This may reflect the greater need for these services during periods of more stringent restrictions, such as school and business closures. Drops in referral completions and connections were relatively stable across variant waves, with minor improvements over time as the number of referral requests decreased.

**Figure 26. Case Cascade of Care for Take Care Services by Variant Wave, May 31, 2020 – January 1, 2022**



Data source: T2 Take Care Data.

**Figure 27. Contact Cascade of Care for Take Care Services by Variant Wave, May 31, 2020 – January 1, 2022**



Data source: T2 Take Care Data.

The demographic profile of cases requesting referral for wrap-around services generally reflected the underlying profile of those with completed intake (**Table 6**). Those aged 18–44 years were slightly less likely to request referrals, with approximately 22 referral requests per 100 cases. The connection of referrals to wrap-around services did not differ by demographics, indicating equitable distribution of resources among those who requested these services. The demographics of contacts could not be ascertained reliably due to large amounts of unknown data.

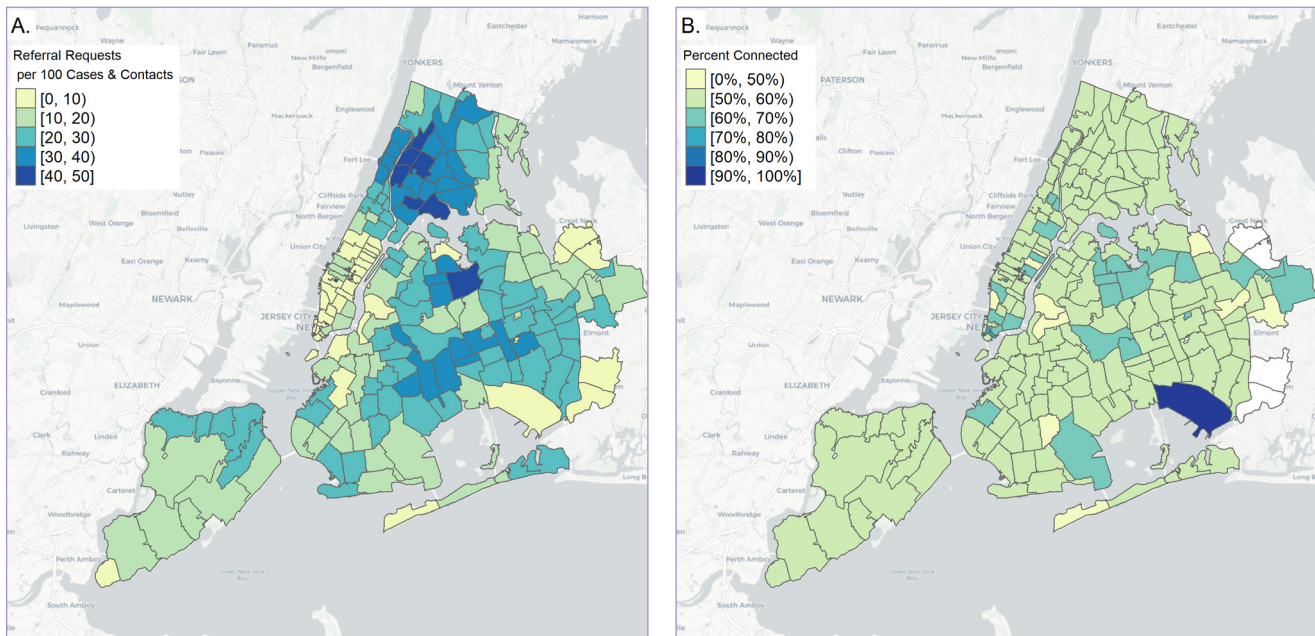
**Table 6. Demographic Profile of Take Care Referral Requests by Connection Status among Cases, May 31, 2020 – January 1, 2022**

		Completed Eligible Cases	Requested Referrals (per Eligible Cases)	Connected (% of Total Requested)	Not Connected (% of Total Requested)
Gender	Men	412,625	94,634 (23 per 100)	52,060 (55%)	42,574 (45%)
	Women	494,926	143,092 (29 per 100)	80,205 (56%)	62,887 (44%)
	Other	2,511	606 (24 per 100)	326 (54%)	280 (46%)
	Unknown	65,264	25,682 (39 per 100)	13,667 (53%)	12,015 (47%)
Age	0–17	170,730	57,349 (34 per 100)	30,131 (53%)	27,218 (47%)
	18–44	487,638	105,919 (22 per 100)	59,075 (56%)	46,844 (44%)
	45–64	228,295	76,134 (33 per 100)	43,751 (57%)	32,383 (43%)
	65+	88,200	24,387 (28 per 100)	13,193 (54%)	11,194 (46%)
	Unknown	463	225 (49 per 100)	108 (48%)	117 (52%)

**Data source:** T2 Take Care Data.

Frequency of requests for referrals for wrap-around services varied substantially by neighborhood (**Fig. 28**). Residents within neighborhoods in the Bronx and portions of Brooklyn and Queens requested more referrals for wrap-around services, with over 20 referral requests per 100 cases and contacts with completed intake. This demand likely reflects underlying social needs within these neighborhoods. The proportion of referral requests that led to connection to services was largely stable across neighborhoods at 50–60%, reflecting equitable distribution of resources among those requesting these services.

**Figure 28. Rate of Referral Requests for Wrap-Around Services Among Cases and Contacts (Panel A) and Percent of Referrals Connected to Wrap-Around Services (Panel B) by ZCTA, May 31, 2020 – January 1, 2022**



**Data source:** T2 Take Care Data.

## Barriers and Facilitators to Provision of Take Care Services

### Barriers

The decision by H+H to rely on CBOs for resource navigation was designed to make the program more community based; initially, ten CBOs were funded to support resource navigation. However, once the Take Care Resource Navigation program was centralized within a small number of CBOs, it ceased to be a locally tailored intervention. While administratively easier, this situation excluded a number of small local community-engaged organizations from the pool of service providers.

”

*So, it was supposed to be a localized community-based model. I can't speak to whether or not that was effective when it was first rolled out. I will say now that we only have three CBOs, one based in the Bronx, one based in Chinatown, and one based across the city, it's not a community-focused program. Additionally, the resources that we give are relatively standardized.... At the same time, I think that there is a lot of value that can come from being connected to a local community organization, so there's a missed opportunity there, potentially. So, I have mixed feelings about it.*

”

— Take Care staff

Take Care and all CBO contracts, administration, and budgeting were initially managed by the HRO until H+H assumed this role in early 2022. The HRO was assigned this role because it had already invested in CBO relationships as part of recovery work after Hurricane Sandy, and it contracted with CBOs under an existing emergency contracting provision. With this system, there was a high variability in budget size between CBOs; both CBO staff and H+H staff were aware of this and felt that it was not fair or reflective of the work being done.

*Because HRO basically treated these CBOs as though there is like a bottomless well of funding, and gave these incredibly high 'Not to Exceed' contracts, these NTEs, that were millions of dollars large, and were not standardized across CBOs. So, one CBO could ask for this much money and have extra supportive staff and pay for accountants and this and that, and another CBO have like only bare-bones, and their salaries were lower, and it was approved. Like there was zero standardization.*

— Take Care staff

As noted in other sections, control over the Salesforce data system occurred at a high level programmatically, through DoITT. As in the Trace pillar, Take Care interview respondents noted this lack of control as a barrier. They also wanted flexibility to make changes and improvements and add more data points, and found that doing this through the approval hierarchy could not keep pace with the pandemic. Dealing with the politics of working with DoITT and competing with other agencies for IT time was frustrating and a barrier to adaptive response to the evolving needs of the population.

*We wanted to be able to offer a new resource. We want to add that resource in Salesforce. Couldn't even add a new checkbox. Or change the language, 'This is a confusing word, let's change the word in Salesforce.' 'Nope, can't do that.' Can't get rid of fields, can't make fields optional, can't make fields required. It had to be on their set schedule, which happens maybe once every four months. And they lock it in and if your business need changes, because we're in a pandemic, and things are rapidly changing every two months, doesn't matter, because DoITT operates on a four-month cycle and there's no off-cycle support.*

— Take Care staff

## Facilitators

Engagement of local CBOs and their ties to their local communities greatly facilitated the provision of Take Care services to the diverse population of NYC. The Take Care pillar also featured a high degree of collaboration across multiple city agencies, including EDC, which helped broker some hotel relationships; DSNY, which ran the GetFoodNYC program until November 2021; and the Administration for Children's Services (ACS), which was consulted about issues related to how best serve their clients and H+H.

H+H outsourced staffing to Right Source, which facilitated fast hiring, as for the other pillars. With the exception of Resource Navigators (who were hired through CBOs), some Take Care staff were contracted through and paid by Right Source, but otherwise operated like any other T2 employee.

The Take Care Resource Navigation program switched from using Smartsheet to Salesforce software in November 2020, which gave Take Care leadership greater insight into the operations of contracted CBOs, enabling them to compare performance across Resource Navigators and CBOs and to readily identify sources of problems (e.g., performance or technical issues) that could then be addressed.

A workgroup was established to assess data by race/ethnicity, identify structural barriers, prioritize community testing, and support isolation and quarantine by providing other resources needed, e.g., dog walking or food. Once H+H analysts could analyze the data directly and set up Dashboards to monitor success, staff were able to work towards eliminating barriers more systematically.

Additionally, the Take Care program found that people who had been exposed to COVID-19 but were

waiting for their test results, which could take days to arrive in the period before widespread availability of rapid testing—did not want to go to a hotel to quarantine until they knew whether they tested positive. To address this issue, Take Care launched a campaign with the slogan “Don’t Wait, Separate” to encourage people to quarantine in hotels right away when exposed. Take Care leadership tried to eliminate barriers to people using the hotel service by positioning Resource Navigators at rapid testing sites to connect people with resources as soon as they knew their results, and by providing a number of perks, including on-site PCR testing, family-friendly adjoining rooms with separate bathrooms, personal protective equipment, food, Wi-Fi, television, and comfortable beds. Social media testimonials recommending hotel services also led to greater uptake of the program.



### **Recommendations:**

#### *Take Care Pillar*

- Develop and maintain strategic and explicit cross-agency collaboration during non-crisis periods that can facilitate provision of a wide array of services to a highly diverse population when crises hit.
- Contracted CBOs should be allowed to staff their programs and make independent hiring decisions about positions such as Resource Navigators that fall within their expertise, with appropriate guidance from the lead agency but without a requirement for approval from the agency on a granular level.





Community engagement—including partnership with community organizations and stakeholders and mechanisms to support bidirectional communication and input between communities and city agencies—was envisioned as a key feature of the T2 program from the outset of the pandemic. City Hall and T2 leadership recognized the critical role of collaborative engagement with community leaders, organizations, and individuals with deep knowledge of, and connections to, diverse communities and neighborhoods in ensuring the program’s successful implementation across the city. **Appendix B** includes a list of organizational partners within each structure. In addition, H+H developed a separate T2 outreach canvassing program to encourage testing and vaccination across the city, hiring vendors and contracted individuals to participate in canvassing efforts.

Equity was centered as a key approach to T2’s community engagement outreach strategy. Given NYC’s diversity, it was critical that community-based engagement efforts reach individuals across all demographic and linguistic groups. Across T2 partnerships, leadership sought to include community leaders and organizations representing diverse racial and ethnic groups who could communicate in concordant languages and culturally competent ways. Initially, the program ensured community outreach across all zip codes in the city. As the pandemic progressed, the program’s community engagement efforts were strategically focused on prioritizing high-need neighborhoods identified by TRIE based on COVID cases, deaths, and other health and socioeconomic indicators. The list initially included 27 neighborhoods and expanded to 33 in January 2021.

### Community Advisory Board

Building upon a history of established relationships with CBOs across the city, DOHMH leadership began efforts in late spring 2020 to create a CAB to provide needed guidance on messaging, engagement, and operations for T2 efforts within neighborhoods. The CAB was convened by the DOHMH Equity Officer and co-led by senior leaders at H+H and the DOHMH. CAB members were selected based on CDC Public Health Emergency Preparedness guidelines and represented more than 50 CBOs. Broadly, the CAB’s mission was to ensure an equitable implementation of the T2 program by incorporating feedback and soliciting recommendations from community leaders. Specific goals were to (1) inform T2 leadership of community concerns and equity issues with COVID-19 testing, tracing, and Take Care efforts; (2) provide equity-focused feedback to T2 leadership on topics brought to the CAB’s attention; and (3) propose recommendations supported by a majority of CAB members for improving T2’s impact on marginalized populations.

T2 CAB meetings were held virtually with key H+H and DOHMH leaders present. At the meetings, T2 leadership communicated the latest pandemic data and provided updates on the T2 program, such as new testing guidance, services, or resources; presented ideas for feedback; and responded to CAB inquiries. Initially, meetings were held twice a week to keep pace with the pandemic and growing T2 program; they were later reduced to weekly meetings. CAB members reported that the meetings were valuable and enabled them to get the latest information on the T2 program and on COVID-19 from leaders close to federal and local sources. Those interviewed reported high levels of commitment to the CAB.

Smaller workgroups (**Table 7**) were convened to develop recommendations for the T2 program.

Members self-selected into workgroups and reached decisions by majority vote. Workgroup leaders chose recommendations to present to leadership, and implementation decisions were communicated at the general weekly meetings. Interviewees reported the CAB provided useful feedback and recommendations for the program.

**Table 7. CAB Workgroups**

Workgroup	Goal	Selected Program Recommendation/Achievement
T2 Assessment	Develop program objectives and measuring and reporting system	Created metrics for funded CBO outreach
CAB Evaluation	Assess whether the CAB was meeting its objectives and conduct a CAB evaluation	Designed and implemented partnership assessment of CAB
CBO Involvement	Facilitate community responses prior to implementation of T2 program elements	Engage with smaller CBOs to reach immigrant communities
Messaging	Ensure linguistically and culturally appropriate messaging	Create videos in different languages with diverse occupations
Workforce and Training	Ensure that T2 members reflected the communities they served	Expand testing sites to essential worker locations and congregate settings such as schools.
Data Privacy and Collection	Ensure that data collection met data privacy standards	Improve public COVID data availability: add zip-code-level data; make raw data publicly available.

## Test & Trace–Funded CBOs

Informed by the CAB and DOHMH’s recognition of the need to support CBOs in engagement efforts, the Test & Trace pillars funded CBOs to conduct outreach and education on COVID-19 prevention, testing, and the value of contact tracing, as they were best suited to offer culturally and linguistically tailored communications to their communities. The DOHMH led the process of releasing a Request for Proposals in July 2020 and, along with H+H, selected CBOs through a competitive process based on their geographic coverage, racial/ethnic/linguistic coverage, and ability to culturally tailor health education materials. At its height, Test & Trace funded 41 CBOs from across NYC. The T2 CAB recommended that both small and large CBO partners should be engaged in the program to reach diverse populations; funding thus was allocated to three “tiers” of CBOs. In contrast to some of the discrepancies and inconsistencies in funding allocation experienced by CBOs funded for Take Care components of T2 (highlighted above), Test & Trace CBO tiers were set up with clear differentiation of funding levels, staffing requirements, and minimum required levels of deliverables for outreach, education, and message and service delivery. Those with more funding were required to hire more staff and reach larger numbers of people with their outreach, education, and message and service delivery. Tier 1 members, which received the most funding, were also allowed to subcontract with other organizations. Other than deliverable requirements, the funded CBOs were given latitude to decide how to conduct their outreach and education.

Test & Trace CBOs were funded and contracted through H+H but then managed by the DOHMH,

which provided guidance on policy changes, conducted training and capacity building, and furnished PPE, literature, and materials for outreach. Test & Trace–funded CBOs met biweekly, i.e., every two weeks, with T2 leadership to receive updates on the program and on COVID-19. The program also organized borough meetings for CBOs to discuss topics relevant to their individual boroughs.

Responsibilities of Test & Trace–funded CBOs included hosting activities to promote COVID-19 prevention and improve program implementation by increasing awareness of Test & Trace and encouraging testing and responsiveness to contact tracing efforts. CBOs created, promoted, and/or distributed messages and materials in person and virtually. In-person activities included leafleting through street distribution, event outreach, and testing events. CBOs were required to hold virtual town halls and meetings, conduct phone/text banking to community member, and provide updates about the program via email and social media posts. For testing, the funded CBOs' main roles were to direct community members to testing sites, attend events with mobile testing vans, and advise on where to set up testing sites. Early in the program, Test & Trace had problems attracting community members to certain pop-up testing sites. However, T2 leadership noted that once funded CBOs endorsed testing sites and events, they became successful. Funded CBOs had a more limited role in contact tracing: they provided the “COVID contact line” and increased community awareness of contact tracing. When COVID-19 vaccines became available, funded CBOs promoted uptake during outreach. They were initially allowed to select neighborhoods to target for outreach and education; later, Test & Trace shifted focus to the 33 TRIE-identified neighborhoods that accounted for over 50% of NYC’s COVID cases.

Funded CBOs were required to report information daily and weekly to the T2 program using the Salesforce system, including the number of events, people reached, PPE distributed, and other key measures, and could also report more qualitative information. Most CBO staff interviewed found the process non-burdensome and straightforward.

## **Take Care–Funded CBOs**

Take Care CBOs were funded by the program to provide resource navigation to cases and contacts who requested services for safe quarantine and isolation within assigned zip codes. They were also responsible for keeping service provider lists up to date. Once COVID-19 vaccinations became available, these CBOs promoted vaccines and contacted community members to encourage vaccination. Take Care CBOs were initially managed by the HRO under an emergency contracting provision and later by H+H from December 2021 until the program ended.

Take Care CBOs hired Resource Navigators who made phone calls to positive cases and to contacts requesting Take Care referrals during their initial contact tracing calls. Resource Navigators were assigned shifts to take calls during specific hours. Working remotely, they used phone call scripts with prompts to identify the resources that cases/contacts needed. Later in the program’s course, Resource Navigators were also placed at COVID testing sites to facilitate resource navigation at points of care.

As previously mentioned, Take Care partners initially managed resource navigation services using Smartsheet and then transitioned to Salesforce. Through Salesforce, Take Care CBO partners received client referrals from H+H. Clients were randomly assigned to a Resource Navigator, with targeted assignments for those with specific language needs. Once navigators contacted clients, the system tracked the resources provided to them.

Take Care leadership felt that Salesforce created greater accountability and oversight to help manage each CBO effectively, compare individual and CBO performances, and identify sources of emerging problems. CBOs had some difficulties with the software due to outdated systems and varying technological skill levels.

## **Test & Trace Campaign Team**

The T2 program included a Campaign team assigned to support community outreach through canvassing and by managing community partnerships. The Campaign team was tasked with developing relationships with local organizations across the five boroughs, including tenant associations and community, faith-based, and civics organizations, that could be called upon to support T2 events and activities. The Campaign team also managed a canvassing team staffed through vendors. Beginning in June 2020, the T2 program hired external canvassing teams to conduct outreach and education and increase awareness of COVID-related services citywide. Because of the urgency of these outreach efforts, T2 hired experienced canvassing vendors with staff immediately available. Teams were directed to visit the TRIE-identified neighborhoods to encourage COVID-19 prevention measures, such as PPE use, and testing. Canvassers attended “Day of Action” events, accompanied mobile testing vans, and were located at testing sites. Canvassers also engaged in conversations with community members about testing. Once vaccines became available, canvassers focused efforts on vaccination uptake. The Campaign team also ran a separate “Vax 4 All” initiative to promote vaccinations throughout the city once they became available.

## **Unfunded CBOs**

Community-based and local organizations not funded by the T2 program also played roles in the program. Leaders from some unfunded CBOs that were CAB members participated in the general T2 communications meetings at which COVID information was disseminated. Other CBOs and entities (e.g., faith-based organizations, public school parent associations) partnered with the T2 Campaign team as external partners. CBOs co-sponsored T2 events, distributed COVID test kits, and referred people for vaccines. For the unfunded CBOs we interviewed, the pandemic was a priority, and they conducted COVID education, outreach, and PPE distribution as part of their own work, sometimes securing outside funding for these activities.

### ***Barriers to and Facilitators of Community Engagement***

#### ***Barriers: Community Advisory Boards***

CAB members felt the bureaucratic approval processes limited their efficiency and were inappropriate for the pace needed during the pandemic. One CAB member noted that T2 needed to approve all materials created by the workgroups, including CAB minutes, which slowed down the CAB recommendation process. Others noted that the decision-making process and the rationale for programmatic decisions were not transparent. It was unclear to CAB members which agency, H+H or DOHMH, had the authority to make decisions. CAB members noted that at times it wasn't clear that their input was being considered, and that even when recommendations were accepted by the T2 program, it was not always apparent how they were implemented.

*“ [If we had [CAB proposed] recommendations, we had to wait to get on the schedule before the recommendations can move which may mean another month later. ”*

*— CBO Leader*

### **Barriers: Test & Trace–Funded CBOs**

In regard to the funded CBOs, several interviewees discussed frustrations with T2 contracts. First, contracts were time limited and unpredictable, expiring every few months and needing to be renewed, which made it difficult for CBOs to plan and manage staffing. Several CBOs also mentioned inadequate levels of funding to cover costs such as printing materials and competitive wages for staff.

CBOs reported requesting COVID-19 and vaccination data at smaller geographic levels and disaggregated by subgroups (e.g., race/ethnicity) to more strategically target outreach and education efforts to specific communities within neighborhoods, but never got them. Later on, CBOs were directed to work in the TRIE-identified zip codes and thus could not choose the neighborhoods where they worked. For several CBOs, these zip codes overlapped with their catchment areas, but others found it problematic that neighborhoods where they had relationships and that would greatly benefit from outreach efforts were not included among the TRIE neighborhoods.

*“ [T]here are some unique populations within those zip codes that are important to target. If you just take out a zip code completely, you're really leaving out a whole population of people that won't know that they should get vaccinated unless you actually reach out to them. ”*

*— CBO Leader*

CBOs reported lack of language capacity and cultural competence at in-person events, mobile vans, and testing sites within the T2 program. There were reports of lack of sensitivity and poor bedside manner when responding to questions among COVID testing staff. Additionally, CBOs felt that Test & Trace could have better utilized CBOs in community messaging efforts, rather than hiring private contractors through the canvassing program. One CBO highlighted that translating information is not enough to effectively communicate health messaging. Rather, those developing outreach materials also need to understand cultures and how to communicate messages appropriately. CBOs, as trusted messengers, can play essential roles in this regard.

CBOs also cited problems with the accessibility of COVID-19 testing and vaccination services. CBOs reported a lack of testing sites in specific neighborhoods, noting that many community members were unwilling to travel outside their own neighborhoods. When testing sites were available, there were occasionally other barriers. Not all testing sites were free—some required health insurance and identification cards. Other CBOs reported complaints about site hours of operation: testing sites were not open at night or on weekends to accommodate essential workers' schedules. And lastly, accessing service often required technical competence that some community members lacked. For example, some sites required the use of QR codes and smartphones to register for services, creating additional service hurdles for those with low digital literacy.

### **Barriers: Take Care CBOs**

CBOs felt the hiring process for Resource Navigators was difficult due to the Take Care and HRO's requirement for specific credentials. The resulting process, including identification of appropriate candidates and onboarding, was burdensome and time consuming. Additionally, a specific ratio of supervisors to supervisees was required, which felt onerous.

CBOs had varying feelings about their role in the Take Care program. Select CBOs welcomed the opportunity and felt well-equipped for the role, having existing staff capacity that were experienced in calling clients. These CBOs expressed that providing Take Care services enabled them to maintain staff who would have otherwise been displaced. In contrast, one Take Care CBO felt the Resource Navigator positions should have been handled by the city. They felt that the role specifications (e.g., hours and staffing requirements) were restrictive and the funding did not cover the cost of the work. The same CBO felt the model didn't leverage the strengths of the CBOs, in that the Resource Navigation role didn't create meaningful engagement with the community because their staff did not necessarily have relationships with the communities they were calling. However, the Take Care leadership felt that Resource Navigators were effective in helping to build trust with the community.

*" I think the Resource Navigators are the best embodiment of it, and they're... gonna land with people better than the one that we would have picked if we were just going through... the global registry.... There's just so much information that they're getting from clients and that they're able to represent and use in their advocacy, and I don't think that you would have gotten that if we had structured the resource navigation program in a different way. "*

— Take Care leadership

Take Care CBOs were not consistently able to reach clients or ensure service uptake. CBOs reported that people sometimes responded negatively to the services. Other cases/contacts did not want the added attention, were worried about immigration status, or were not comfortable with their COVID-19 positivity status potentially being discovered by others.

### **Facilitators: Community Advisory Board**

CAB members reported that having key T2 leaders, such as Dr. Ted Long, attending meetings facilitated the CAB's effectiveness and fostered trust between community and city agencies. CAB members felt well respected and felt that the program recognized the value of community input. Leadership showed commitment to communities by being responsive to questions and requests on urgent matters, which built trust and feelings of being heard among CAB members. Having leadership "at the table" also made the process more efficient as community partners felt the main decision-makers were present.

CAB members reported having good access to the latest COVID information and resources through the meetings and communication channels made available to them. Having CAB workgroups made developing recommendations easier. Many KI interview respondents noted that the overall CAB meetings were not suitable for engagement or general discussion, whereas the workgroups were better suited for deeper engagement and more productive for getting CBO input.

### *Facilitators: Test & Trace – Funded CBOs*

Holding regular H+H and DOHMH meetings to disseminate information and have leadership available for questions was useful for the CBOs. CBOs felt adequately informed of the program and COVID information, though some noted problems with insufficient granularity of data on specific subgroups. The program also set up a dedicated phone number for funded CBOs working on Test & Trace to facilitate problem-solving, which some found useful.

CBOs' experience in outreach and education made them well equipped for Test & Trace–funded responsibilities. All had experience with outreach and education; COVID-19 outreach just involved conveying new information, along with adapting strategies for a pandemic. Similarly, CBOs had experience training staff to conduct these activities. One CBO leader discussed how, with proper training, those who lacked outreach experience but were comfortable talking to people could prove well suited for outreach roles. Moreover, the funded CBOs appreciated the flexibility in the contracts that allowed them to choose how to conduct outreach. Each used various combinations of methods to accomplish outreach and leverage their organizations' strengths.

Hiring staff with diverse cultural and linguistic capacities was an asset for the outreach and education role. Being able to speak the same language, and having an understanding of or being a member of the same culture, was important for connecting with people. In cases where they lacked these assets, CBOs partnered with other local organizations during outreach to complement cultural and linguistic capabilities.

A particularly effective strategy for CBOs included the use of ethnic-specific media outlets, including radio and neighborhood newspapers in different languages. Social media platforms were also used to distribute information, including WhatsApp, Facebook, Instagram, Twitter, Discord, and WeChat. Working in neighborhoods where CBOs had an established presence was a key facilitator of outreach and education. Partnering with local neighborhood organizations, such as local CBOs, faith-based organizations, and businesses, helped in less familiar areas, promoting access to community members and resources. For example, co-sponsoring events, including with non-funded CBOs and H+H, increased their reach. Several CBOs also noted that staying in one geographic location for long periods of time to establish a presence in the neighborhood helped to establish trust. Many found that having items to distribute, such as PPE, hand sanitizer, and test kits, was key to starting conversations with community members.

### *Facilitators: Take Care–Funded CBOs*

Take Care leadership worked with the Data, Analytics, and Product team and workgroups in the centralized offices to examine T2 case data to optimize services. The group examined the data by race/ethnicity to identify structural barriers, prioritize community testing, and support isolation and quarantine by providing other resources as needs were identified. Further, they developed risk models to better target cases who might need more services.

Take Care partners that felt trainings and written call scripts sufficiently prepared staff to handle the Resource Navigator calls and address individuals' hesitations about receiving services (e.g., fears regarding immigration status). Once Take Care partners began placing calls to encourage vaccinations, training in motivational interviewing and de-escalation were useful for holding effective discussions.

" Naturally, if you're receiving phone calls, and then some people are probably scared about their (immigration) status... we try to make it clear with the [call] scripts that your status doesn't matter for these services. "

— CBO Leader

Take Care CBOs reported that hiring multilingual staff augmented their ability to handle the linguistic demands of resource navigation calls. In cases where the caller did not speak call recipient's language, the language translation line provided by T2 worked well.

Take Care CBOs who felt well equipped for the responsibilities assigned staff already accustomed to making phone calls to the resource navigation calls. Those with less experience had more difficulty managing the call volume and demands.



### Recommendations: Community Engagement

**For the T2 program, DOHMH and H+H leadership communicated regularly with the T2 CAB. Much of the trust leveraged in the program was built upon relationships that were built prior to pandemic. This form of direct communication between agency and community leaders is critically important in future crises.**

- Prioritize direct communication between key leaders from core city agencies and CBO leaders to build trust and foster partnerships during crisis response.
- Create more enduring community engagement infrastructures before emergencies occur. T2 leadership and multiple CBOs all recommended creating a model to facilitate dialogue between government, CBOs, and communities on an ongoing basis, which can then be activated in times of crisis.
- During crises, consider the following:
  - ◇ Create decentralized workgroup structures, organized topically by community partners to more effectively obtain and incorporate feedback than large group meetings.
  - ◇ Allow flexibility in CBO contracts that permit each organization to tailor outreach and education and communicate through media channels specific to their communities.
  - ◇ Leverage CBOs' knowledge of local individuals with appropriate cultural and linguistic qualifications for hiring and filling staff capacity; engage CBOs in development of job description and qualifications.
  - ◇ Engage CBOs in efforts beyond outreach and education. For example, engage CBO staff and/or hiring staff at CBOs to assist with or engage in testing efforts to leverage their trusted status in communities to improve trust in the testing process and services.
- Increase transparency of the T2 program's agencies' roles and decision-making processes to manage expectations of CBOs. Future efforts should offer more participatory, democratic approaches to facilitating discussions and decision-making, rather than top-down approaches, which can foster lack of engagement from community partners.
- Increase training in cultural humility for all frontline staff, including vendors. This training can occur during non-pandemic times and should provide opportunities for continual learning on cultural and social dynamics of diverse communities.





## SECTION 4 The Role of Trust and Communication

Earning the trust of NYC residents was vital for the T2 program—specifically, fostering the belief that services and organizations are honest, competent, good communicators, and maintain confidentiality. T2 leaders described several strategies they used to gain community trust in testing services, contact tracing, and later vaccinations. These included creating paid media for the T2 program and engaging with elected officials and community leaders who “vouched for” and promoted their services. The program’s primary strategy CBO staff as trusted messengers to communicate the value of and promote testing and contact tracing and direct people to the T2 services. Many of these CBOs had longstanding programs and relationships with their communities and the DOHMH prior to the COVID-19 pandemic, including the funded Test & Trace CBOs in addition to other local organizations. In addition, the T2 Campaign team built connections and generated a roster of potential partner organizations to attract community members and endorse local T2 events.

Public trusts in the three T2 program pillars (Test, Trace, and Take Care) varied. Interviewees reported that testing sites and vans, although initially met with some suspicion in some communities, became a generally trusted component of T2 services. CBO leaders who led the outreach efforts reported that most community members trusted the testing process and results but were hesitant to get tested due to nasal swabbing discomfort. Few barriers to trust in the Take Care pillar were reported in key informant interviews; however, mistrust was reported with greater frequency for the Trace pillar compared to other pillars: in particular, contacted individuals often did not trust that contact tracing calls were from legitimate sources. Additionally, cases who completed calls did not always feel comfortable providing information about their contacts. One Case Investigator noted they felt like trust with contact tracing improved over time.

### ***Barriers to and Facilitators of Trust***

#### ***Barriers: Summary***

Despite the community-engaged measures the T2 program put in place to enhance trust in the program, the rapid spread of misinformation, particularly about COVID-19 illness and vaccination, reduced trust in the T2 program. T2 leadership reported encountering misinformation in early 2020 while setting up testing sites, and T2 campaign staff, CBO outreach staff, and contact tracers reported encountering misinformation during education, outreach, and contact tracing calls throughout the duration of the program. CBO and outreach staff reported sources of misinformation included national news outlets, social media, and politicians, and that the pace of dissemination through these channels was difficult to combat compared to more time-intensive community engagement and outreach efforts. Examples of misinformation included not believing that COVID-19 was a real or valid threat or believing that one could contract COVID-19 from testing. Even more frequent was misinformation about vaccine development, ingredients, and effects on the body. One CBO respondent noted that misinformation was the “biggest challenge” for outreach throughout the pandemic but reached new heights after vaccines were developed.

Distrust in government as an entity and governmental services was another barrier to enhancing trust in the T2 program. For some residents, distrust of government was more entrenched due

to longstanding perceptions of unfairness, racism, or political opposition. For other residents, distrust stemmed directly from their perceptions that the pandemic was being mishandled, with mixed messages and guidance from government officials and politicians. As a result, some residents were hesitant or unwilling to trust evolving COVID-19 guidance.

Distrust created challenges for T2 programmatic activities and events. Issues of safety, low testing, and non-compliance were encountered in specific neighborhoods and demographic groups across the city, including along racial/ethnic and religious lines. Specific examples of communities with entrenched distrust included predominantly black communities, where mobile testing and vaccination vans were not initially welcomed. Multiple challenges associated with trust were also reported in Staten Island, where staff encountered instances of hostility to T2 program activities and outreach due to political beliefs. Entrenched distrust was also high in some predominantly Orthodox Jewish communities, which impeded T2 contact tracing efforts.

### **Barriers: Testing**

As noted in the Community Engagement section, the T2 program had early difficulties attracting local residents to testing sites. Some resistance stemmed from misinformation about COVID-19 transmission, longstanding mistrust of the health system due to a history of negative experiences, and political beliefs that led to lack of interest in being tested. Also, some people feared contracting COVID-19 through exposure to other people at testing sites.

*" We set up this is amazing free testing resource and people didn't come out, so I ended up having my team go into the community, and I said, can you ask why people aren't coming? And I'll never forget the reasons why: the people in that community ... said, 'Oh, if we go to your tents we're going to get COVID,' it was like, no, no, no, no um, but it was a lot of misinformation and a lot of fear. "*

— T2 leadership

It is likely that a combination of the factors—including historical legacies, misinformation, and fear of transmission—drove barriers to testing.

### **Barriers: Contact Tracing**

Frontline staff and supervisors noted that a primary barrier to completing contact tracing calls was establishing initial trust. Due to call privacy protocols established at program launch, T2 staff could not identify themselves as contact tracers before confirming a case/contact's personal information. As a result, some people thought the calls were spam and were unwilling to proceed. Staff cited that the public lacked knowledge about the T2 program and the purposes of contact tracing, mistrusted call goals, and expressed privacy concerns, including questioning how the information would be used by the government. Several staff felt that more could have been done to publicize contact tracing.

*" I would say people were not trustful of it being a support service. They felt like it was an invasive government [program] getting information, keeping you at home, sending the police to you. People did not trust the nature of the call. And so they avoided speaking to us and became very angry, because the first thing you have to do is identify their birth date. And that's a pretty critical piece of information. So, we lost a lot of people right at that juncture. "*

— Case investigator

Among cases and contacts who cooperated with contact tracing calls, most provided information about their own illness or circumstance. However, there were still challenges to collecting information during calls. The main challenge for frontline staff and supervisors was eliciting information about contacts. In our survey of T2 staff (n = 168), 66% of respondents cited mistrust in how information would be used as a major reason why people did not want to speak with tracers. Thirty-six percent of staff reported that cases “often” or “always” refused to share their contacts. Fifty-eight percent of staff reported that mistrust in how information would be used was a common cause cited for not wanting to share information about contacts. Case investigators reported that individuals did not want, or feel they had permission, to provide the personal information of their friends and family. Similarly, our survey found 62% of staff said that cases often did not feel they had permission to share information about contacts. Additionally, only about half of staff felt they “very much” had effective strategies to address this reluctance (57%) and to address mistrust (55%). Cases and contacts interviewed confirmed this sentiment and expressed discomfort with providing contacts. Some felt uncomfortable answering certain questions and reported declining to do so. Repeat phone calls from different staff were reported by staff and supervisors as a barrier to establishing trust. Additionally, the protocol of having T2 CES staff visit homes in person if people could not be reached via phone was perceived as uncomfortable and intrusive, making some less willing to share information.

*“Some people were more than willing to provide contacts. Other people were a little reluctant to provide contacts. They found it an invasion of their privacy, no matter how much you told them it was confidential and, ‘We will never share your information.’ People were reluctant and found it a little invasive.”*

— Case investigator

### **Facilitators: Summary**

A key facilitator of trust was the brand recognition of H+H and CBOs within communities. H+H was cited by CBOs as a familiar health care provider with clinical sites in at-risk communities. One CBO reported often referring their clients, including undocumented immigrants, to H+H for medical care, so that referral to testing services felt familiar to community members. Similarly, partnering with CBOs that were well-known was a key facilitator to enhancing trust in the T2 program. The CBOs engaged in T2 had longstanding community programs and leveraged their pre-existing reputations and trusted relationships. T2 leaders reported that engaging with trusted community organizations and leaders for testing outreach and education were key to validating the program in specific communities. They found the program to be more effective at disseminating information and directing people to services when working with embedded community organizations. Both T2 leadership and CBOs funded by T2 reported that working in unfamiliar territories was more difficult and they had to work to build trust through expanding their networks. This included networking with local trusted organizations and making efforts to build trust themselves by creating a constant, physical presence and having repeated interactions to increase their recognition within communities.

Another key facilitator identified was being able to communicate in the same language and understand the cultures of recipients of T2 program messaging and services. According to our survey, the large majority of staff cited the following as being “helpful” or “very helpful” in

gaining case/contact trust: ability to speak the same language (92%), being from the same community (79%), and being of the same race/ethnicity (75%). Across T2 programmatic areas, T2 leadership, staff, and CBOs interviewed noted that when community members communicated with staff who spoke the same language or were from the same culture, it engendered greater trust in the goals and messages of the T2 program, as did utilizing in-language media outlets and print materials. All of these efforts enabled the T2 program to extend their reach. CBO leaders discussed accomplishing this by hiring within the communities where they worked to ensure outreach workers had similar backgrounds and understood the neighborhood concerns. Similarly, the T2 program hired CES staff from communities who could conduct services in culturally appropriate ways.

*One of the things that was very crucial, at least within the [...] community is the fact that they don't trust anyone who don't [sic] speak their language. And that's true to any ethnicity.*

— CBO leader

### **Facilitators: Testing**

A key facilitator to enhancing trust in testing was working with CBOs to promote the use of testing sites in communities. Prior to engaging local organizations, T2 leaders acknowledged it was difficult to attract community members to sites. H+H leaders reported utilizing this strategy to encourage greater testing when COVID rates were high and testing was low in specific areas or among specific demographic groups. This involved event partnerships and seeking out community partners from target populations who would disseminate the key messages of T2. Examples provided by our key informants included collaborating with women's organizations and synagogues to improve testing among Bengali women and the Orthodox Jewish community, respectively.

### **Facilitators: Take Care Services**

A number of factors enhanced trust in and appreciation of the Take Care program. A major facilitator was providing Take Care services and resources at no cost, including hotel stays, care packages, and food delivery. Additionally, T2 leadership and staff thought that trust was built through program responsiveness and adapting services according to community members' needs. Changes they made to the program included making hotel services more family-friendly and offering more diverse, culturally-appropriate food options. Take Care leaders discussed identifying new areas of need through resource navigation activities; for example, providing dog-walking services. Another facilitator to trust was positive testimonials of Take Care services on social media. T2 leadership found these testimonials, particularly from celebrities with wide reach, enhanced trust and made people more comfortable with using the services.

### **Facilitators: Contact Tracing**

To enhance trust in contact tracing calls, the T2 program took measures to establish the authenticity of calls. The program set calls from contact tracers to show on caller ID as NYC Test and Trace so calls were immediately recognizable to those being contacted. The program

also instituted a validation system, the “Validate my Tracer” tool, that would allow individuals to verify that they were speaking to a legitimate contact tracer.

Frontline staff and supervisors felt that soft skills for building rapport with callers were key to gaining trust on calls. Examples included active listening, sharing commonalities, empathy, and allowing people to vent to build trust. A total of 98% of survey respondents said showing empathy was “helpful” or “very helpful” for gaining trust of cases/contacts. Of the CIs and Monitors interviewed who felt they were successful, most leveraged previous work experiences or had supervisors who supported building these skills. Other successful strategies CIs and Monitors used to promote trust included emphasis on privacy, security, and voluntary participation in phone calls. 68% of T2 staff survey respondents reported “very much” being able to gain confidence and trust.



### Recommendations: Trust and Communication

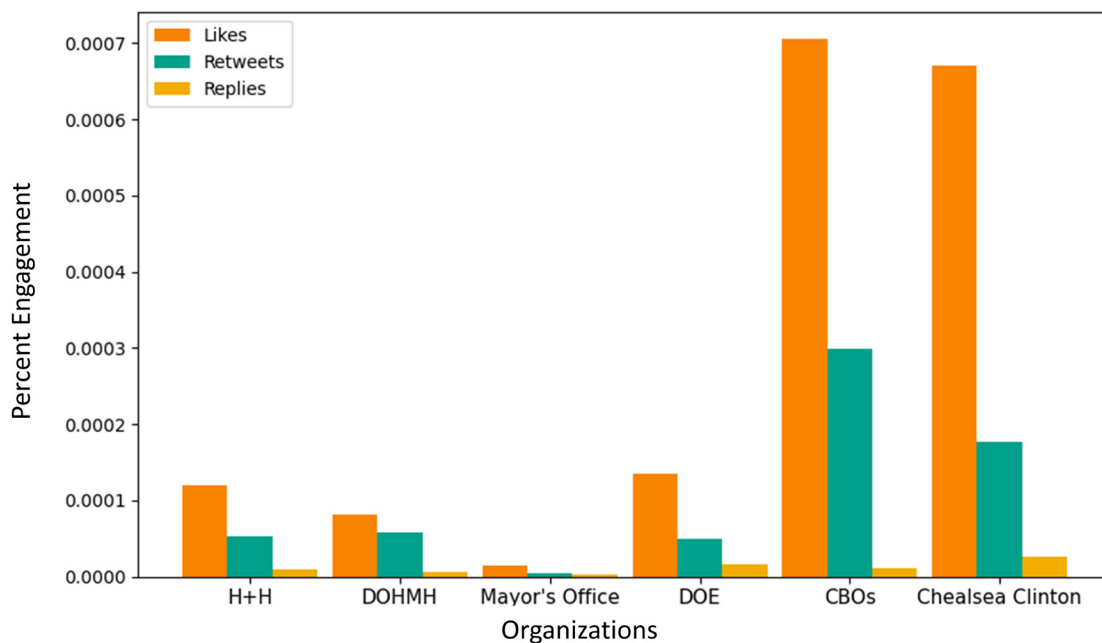
- Build capacity to actively document and address misinformation through education campaigns, staying at the forefront of communications and working to dispel myths before they become established.
- Conduct early media campaigns targeting communities where distrust may be more entrenched to educate the public about the purpose of contact tracing and the use of the resulting information.
  - ◇ *Future efforts should recognize that mistrust from communities occurs at the nexus of the historical context of biomedical research and health services delivery across communities, misinformation disseminated through a number of outlets, and fear of transmission. Media campaigns to mitigate mistrust in communities should address these multiple contexts to maximize success.*
- Sustain efforts to build relationships with CBOs working in communities to ensure that networks are readily available in advance of future pandemics.
- Create consistent trainings on developing skills to relate to clients and develop rapport on phone calls for the contact tracer workforce.



## Quantify the Reach and Engagement of Tweets That Discussed Test & Trace Programs

Our goal in analyzing social media and its effects was to evaluate how organizations—including H+H, government agencies, and community partners—communicated information about T2 on Twitter. We examined tweets sent during the Alpha (November 1, 2020–April 30, 2021), Delta (August 1, 2021–November 1, 2021), and Omicron (December 1–31, 2021) variant waves to understand how social media users engaged with Twitter posts related to the program. We demonstrate that celebrities and CBOs (**Fig. 29**) generated more engagement than government agencies (e.g., H+H, DOHMH, and the Mayor’s Office). These data reinforce the value of engaging with CBOs and with celebrities to promote public health priorities.

**Figure 29. Percent Engagement with Tweets, as Defined by the Percentage of Followers Who Liked, Replied to, and Retweeted Posts, for Government Agencies, CBOs, and Chelsea Clinton During the Alpha Wave**



## Sample of Tweets and Overview of Analyses

To collect tweets, we utilized a Twitter API full-archive search endpoint to fetch data with #nycTestandTrace hashtags from 16 agencies, city organizations, and CBOs (**Table 8**), enabling us to download thousands of tweets, replies, and comments. We collected data for any post during Alpha, Delta, and Omicron from those organizations and identified 3,540 posts, 18,782 “likes,” 8,793 retweets, and 2,650 replies/comments. We then isolated tweets that mentioned T2 programs (i.e., testing, tracing, or Take Care services).

**Table 8. Agencies, City Organizations, and CBOs Included in Sample**

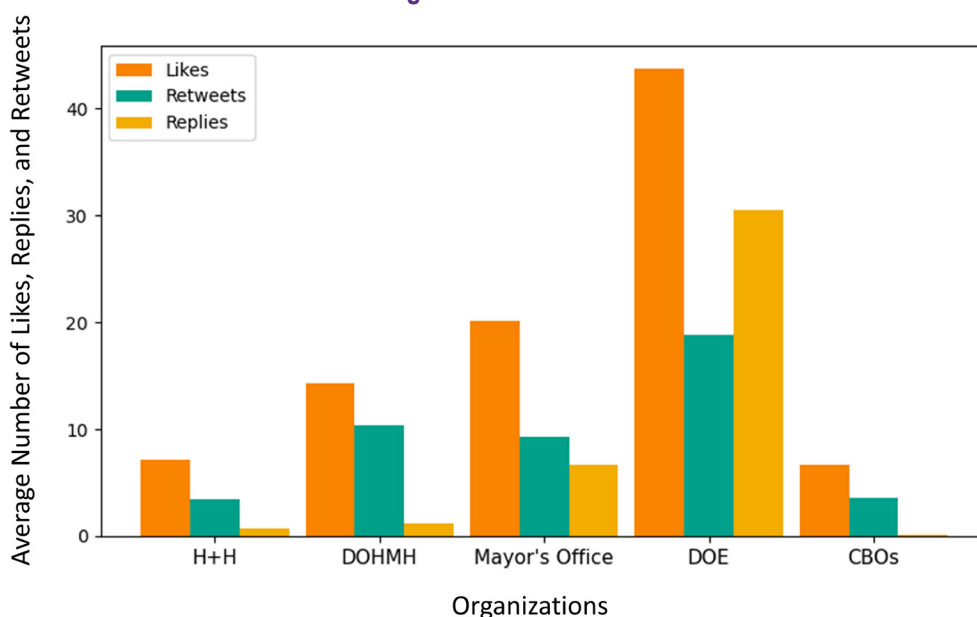
Agencies	City Organizations	Community-Based Organizations
NYC Health + Hospitals (H+H)	NYC Department of Education (DOE) NYC Department of Health and Mental Hygiene (DOHMH) Mayor's Office	Make the Road New York Brooklyn Public Library The New York Immigration Coalition Housing Works The Fortune Society The Door Chinese-American Planning Council National Black Leadership Commission on AIDS YAI Inc. The Child Center of NY Inc. Bronx Works Jewish Community Center of Staten Island

### Comparison of Tweets from Celebrities vs. Government Agencies and CBOs

H+H had the most posts with T2 content (n = 1,490), followed by the DOHMH (n = 141). Of the government agencies we analyzed (H+H, DOHMH, NYC Mayor's Office, and NYC Department of Education), H+H had the highest collective number of likes (n = 8,371), followed by the Mayor's Office (n = 2,013). H+H also had the highest collective number of retweets (n = 3,841), followed by the DOHMH (n = 926). We also examined engagement with posts, defined as the percentage of followers who "liked" a T2 post. Among the government agencies and CBOs, the Child Center New York had the highest engagement with T2 posts in our sample—on average, 0.26% of their 1,980 followers liked such posts. The Mayor's Office had the lowest engagement, with 0.0019% of their 1 million followers on average liking these T2 posts. Overall, less than 1% of followers liked the T2 posts. **Figure 29** shows the breakdown of engagement for the Alpha wave; the pattern was similar for government agencies and CBOs across the Delta and Omicron waves.

We also examined social media users' engagement with one celebrity—Chelsea Clinton—who tweeted about test and trace programs as an example of the wide reach and engagement that can be generated by a celebrity. We chose Chelsea Clinton because T2 staff interviewees mentioned how much visibility she created for national test and trace programs through her tweets. Her tweets praising contact tracing on average generated 1,876.6 likes, 496.1 retweets, and 75.3 replies. In comparison, H+H tweets on average generated only 6.3 likes, 3.0 retweets, and 0.6 replies, and NYC Mayor's Office's tweets on average generated 19.2 likes, 8.3 retweets, and 6.2 replies per tweet (**Fig. 30**). On average, 0.07% of Chelsea Clinton's 2.8 million followers liked her contact tracing posts (**Fig. 29**).

**Figure 30. Average Engagement with Tweets, as Defined by the Average Number of Likes, Replies, and Retweets, for Government Agencies and CBOs Across All Waves**



Because government agencies typically have fewer followers and reach than celebrities, future test and trace campaigns should proactively engage with local celebrities or local influencers who have tweeted about test and trace programs and ask them to post additional content. Celebrities have large numbers of followers relative to government agencies and CBOs, suggesting that future campaigns requiring a public health response would benefit from additional partnerships with celebrities to amplify messaging. Likewise, despite having fewer followers than government organizations, some CBOs had high levels of social media engagement by those followers. Because many CBOs focus on specific communities, their hyperlocal focus may enable them to generate trust in test and trace programs. The T2 program likely benefitted from proactively partnering with CBOs to amplify campaign messages via social media, though, as we note in Section 4, it is important to allow CBOs flexibility to tailor their own messaging.

## Using Sentiment Analysis to Explore Social Media Users' Perception of Test & Trace

### *Sample of Tweets and Overview of Analyses*

To estimate the sentiment of NYC residents' response to the T2 program, we collected tweets using the same method described above and searched for all users who had posted tweets containing the contact tracing keywords and hashtags and who did not have a verified "blue check mark" (used by Twitter to mark accounts of politicians, celebrities, activists, or agencies), so as to capture users who were NYC residents rather than celebrities or agencies. Because government agencies and community organizations tended to include "NYC" in their Test and Trace hashtags, we included only tweets with Test and Trace hashtags that did not specify NYC (e.g., "#TestandTrace"). We therefore excluded tweets with the hashtag "#NYCTestandTrace," which we observed were mostly automated tweets (promoted by government agencies and community organizations but not everyday users). Those automated tweets were used solely to promote the T2 program and therefore may not have captured the sentiments of NYC residents.



Through this search mechanism, we collected 85,536 posts that mentioned the Test & Trace program between June 2020 and December 2021. Among these, 1,675 also mentioned NYC or NYC boroughs in the main text of the tweet (e.g., “Here’s the **NYC** gov #COVIDtesting site finder. Just pop in your zip code.”; “Another one no line no wait #CovidTesting #COVID19 #nyc”). We used this more granular, NYC-focused data as the sentiment analysis data.

We conducted sentiment analysis of tweet content (see **Appendix A** for methods) that uses a list of words with predetermined sentiment scores. This model was created to process shorter text, making it suitable for our use in a social media setting. Based on the sentiment of the input tweet, the model returns three values—positive, negative, and neutral—as well as a compound value that summarizes all three sentiments into a value that ranges from -1 to 1, with -1 being negative and 1 being positive. Values below -0.05 are then classified as negative and those above 0.05 as positive. We used an ordinary least squares regression model to evaluate the relationship between sentiment and numbers of likes.

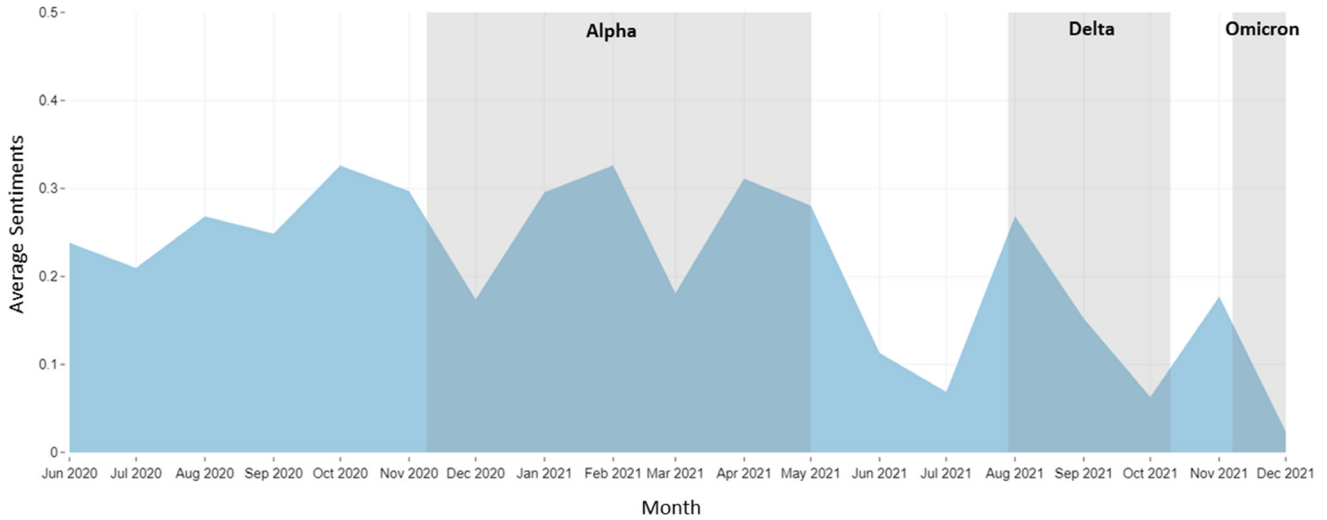
### **Comparison of Tweet Sentiment and User Engagement**

Between June 2020 and December 2021, there were 310 negative sentiment tweets and 778 positive sentiment tweets in our sample of 1,674 tweets containing contact tracing keywords and mentioning NYC. The average monthly sentiment score of T2 tweets was 0.273 during the Alpha wave, 0.138 during the Delta wave, and 0.1 during the Omicron wave (**Fig. 31**). In regard to positive, negative, and neutral tweets (**Fig. 32**), the first month of the Omicron wave—December 2021—had the highest number of T2-related tweets per month in our sample ( $n = 379$ ), with almost equal numbers of positive and negative tweets ( $n = 116$  [30.6%] vs  $n = 115$  [30.3%], respectively). Both the Alpha (November 1, 2020–April 30, 2021) and Delta (August 1–November 1, 2021) waves had more positive ( $n = 324$  [1.4%],  $n = 60$  [39.2%], respectively) than negative tweets ( $n = 81$  [12.9%],  $n = 32$  [20.9%], respectively). Although there was a slight decrease in sentiment value from June 2020 to December 2021, we did not find any clear pattern of changes in sentiment in our sample.

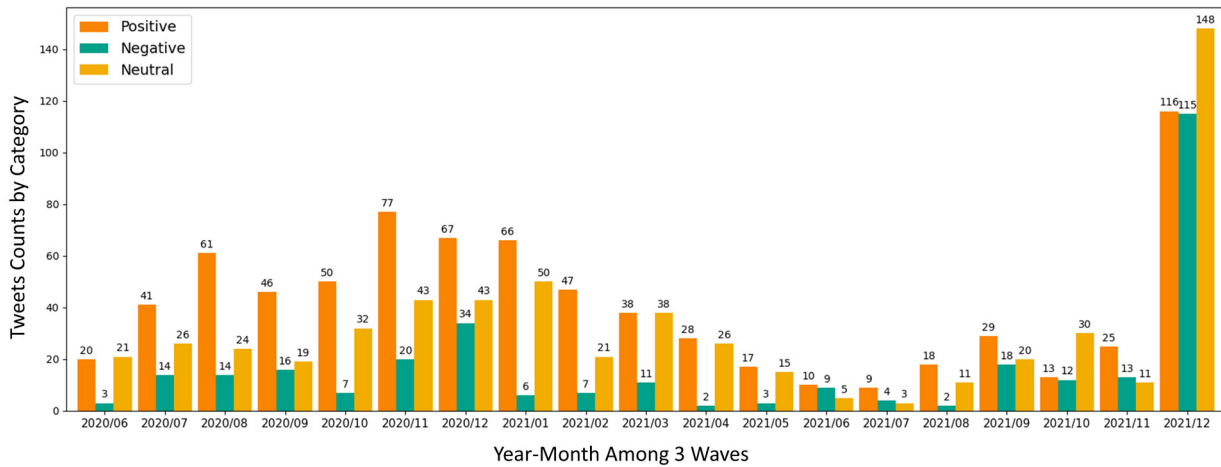
The relationship between user engagement and sentiment showed a weak positive relationship between sentiment score and number of likes ( $R^2 = .095$ ,  $p < .01$ ), suggesting that positive tweets often increased user engagement (**Fig. 33**). One limitation of our data is that, compared to those of other platforms (e.g., Instagram, TikTok), Twitter API data are more robust and flexible and Twitter’s demographic base is older—meaning that we cannot draw conclusions about levels of social media engagement through other platforms.

Sentiment analyses suggested that social media users on Twitter had mixed feelings—mostly positive and neutral—about the NYC T2 program. During the first wave, the number of positive and negative tweets was similar, whereas the other two waves revealed more positive (51.4% for Delta and 39.2% for Omicron) than negative tweets (less than 20% for each wave). Positive tweets had higher user engagement than negative tweets, reinforcing the value of celebrities and CBOs in setting the tone for tweets on test and trace programs. When celebrities and CBOs post positive tweets about test and trace programs to their followers, it may increase the likelihood of user engagement and help generate positive responses.

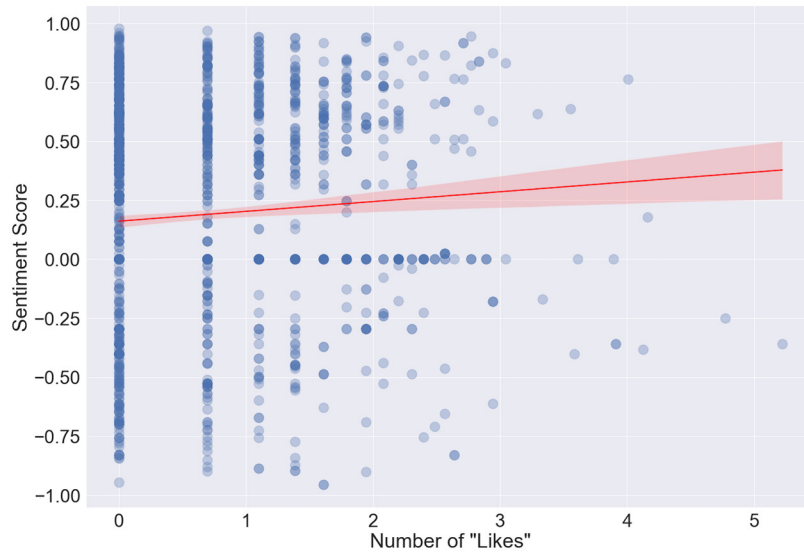
**Figure 31. Average Sentiment Scores of 85,536 Tweets Referencing Test & Trace by NYC Unverified Accounts Between June 2020 and December 2021**



**Figure 32. Count of Positive, Negative, and Neutral Tweets Referencing Test & Trace by NYC Unverified Accounts Between June 2020 and December 2021**



**Figure 33. Relationship Between Sentiment Score and Engagement Level**





## **Recommendations:** *Social Media*

- Engage celebrities and CBOs in setting the tone for tweets on test and trace programs to increase the likelihood of user engagement and help generate social media positive responses.

# CONCLUSION

The experiences gained over the course of the sustained COVID-19 pandemic response are important. They should be documented and lessons carefully considered, especially for future contact tracing activities. Our mixed-methods evaluation of the T2 program, one of the country’s largest COVID-19 contact tracing programs, representing a multi-sector partnership between H+H, the DOHMH, other city agencies, and a large network of community partners, uncovered a number of important strengths of the program and opportunities for improving future response efforts to public health pandemic and emergencies. We offer a series of recommendations to guide program launch, and considerations for community engagement and facilitating trust and communication across communities that can serve as a “playbook” for action. T2 created a tremendous infrastructure that can be leveraged for future response efforts. It will be critical for city agencies to disseminate and consider recommendations in partnership with stakeholders to ensure sustainability of efforts and optimize the reach, equity, and timeliness of pandemic response in the future.

# APPENDICES

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## Appendix A. Technical Appendix

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## Data Sources

### NYC Coronavirus Disease 2019 (COVID-19) Data Repository

Testing metrics were pulled from the NYC Coronavirus Disease 2019 (COVID-19) Data Repository created by the New York City Department of Health and Mental Hygiene (NYC DOHMH) on April 27, 2022. Data and full documentation can be found on the [GitHub repository](#).<sup>[11]</sup>

### T2 Testing Sites

T2 testing site data were pulled from the NYC Health + Hospitals (H+H) [Test and Trace website](#) in June of 2022 using the [Wayback Machine](#)<sup>[12]</sup> and a WebCrawler designed by Analytics Intel (**Table 1A**). Testing sites were uniquely coded to identify test site type (brick and mortar v. mobile), location, and operating hours. The guidelines for the data pull included: (1) Time period: June 2020 through December 2021; (2) Data pulled monthly on the second to last day that data was available for each month and at the latest time; and (3) All test sites that were included in the website and were brick and mortar or mobile sites, regardless of administrating entity.

**Table 1A. Logic for WebCrawler, Separated by Structure Type.**

Logic for WebCrawler	Structure 1 (Data Updates)	Structure 1 (Data Updates)
WebCrawler identified the Borough, as rendered within an h4 HTML tag	Step 1	Step 1
Each location was grouped by type, as identified by the WebCrawler based on the H3 HTML tag	NA	Step 2
A loop searched for all p HTML tag elements of class "m-b-20" as that identified the site's data	Step 2	Step 3
Each element was saved in a generic field column, which increases the flexibility of data handling	Step 3	Step 4

### T2 Trace Data

Cascade of care metrics from the Trace database were provided by the NYC H+H Data, Analytics, and Product Team (DAP) as aggregate counts by time period (week or month), geography (2020 Census Tract or Zip Code Tabulation Area - ZCTA), age group (0-17, 18-44, 45-64, 65+, or Unknown/No Response), gender (Women; Men; Transgender, Non-Binary, or Other Gender; Unknown), and race (Black, including African American or Afro-Caribbean; White; Other (PI, Indigenous, Multiracial); Asian, including South Asian; Unknown). Data were provided for all T2 cases and contacts from May 31, 2020 to January 1, 2022. Cases that were identified from congregate settings, were residents of other jurisdictions, were identified due to death records without an antigen result, or were identified too late/outside of the period of diagnosis and would no longer have been eligible for follow up were not referred to the T2 program and are not reflected in these metrics. Timeliness metrics from the Trace database were provided as median values by time period (cumulative, variant wave, week, or month) and geographic (citywide, 2020 Census Tract or ZCTA). Variant wave defined as: Alpha = 11/8/20-4/25/21; Delta = 7/25/21-10/3/21; Omicron = 11/14/21-12/26/21; All else = Between Waves. Data were

1

provided for all T2 cases and contacts from May 31, 2020 to January 1, 2022.

### ***T2 Take Care Data***

Referrals to wraparound services metrics from the Trace database were provided by the H+H DAP team as aggregate counts by time period (week), geography (2020 Census Tract or ZCTA), age group (0-17, 18-44, 45-64, 65+, or Unknown/No Response), gender (Women; Men; Transgender, Non-Binary, or Other Gender; Unknown), and race (Black, including African American or Afro-Caribbean; White; Other (PI, Indigenous, Multiracial); Asian, including South Asian; Unknown). Data were provided for all T2 cases and contacts from May 31, 2020 to January 1, 2022.

Take care package metrics from the DAP database were provided by the DAP team as aggregate counts by time period (week), geography (2020 Census Tract or ZCTA), age group (0-17, 18-44, 45-64, 65+, or Unknown/No Response), gender (Women; Men; Transgender, Non-Binary, or Other Gender; Unknown), and race (Black, including African American or Afro-Caribbean; White; Other (PI, Indigenous, Multiracial); Asian, including South Asian; Unknown). Data were provided for all care package requests from August 24, 2020 to January 1, 2022.

Hotel guest metrics from the Epic database were provided by the DAP team as aggregate counts by time period (week), ZCTA, (0-17, 18-44, 45-64, 65+), sex (Female; Male; Unknown), and race (Black, including African American or Afro-Caribbean; White; Other (PI, Indigenous, Multiracial); Asian, including South Asian; Unknown).

Meals metrics from the DAP database were provided by the DAP team as aggregate counts by time period (week) and geography (Zip Code). Zip Codes were translated to 2020 ZCTAs using the 2021 Zip Code to ZCTA crosswalk published [online](#) by the Uniform Data System Mapper.<sup>[16]</sup> Data on meals delivered were only available starting on 11/2/21 when T2 took over administration of the GetFood program from the Department of Sanitation. A rough approximation of the total number of meals provided for the study period through the GetFood program was provided by the DAP team.

### ***Neighborhood Determinants***

Population totals were obtained from the 2016-2020 American Community Survey (ACS) 5-year data. Population totals were defined by geography (citywide, 2020 Census Tract and ZCTA), age group (0-17, 18-44, 45-64, 65+), and gender (Women; Men).

The following demographic and socioeconomic variables were additionally obtained from the 2016-2020 ACS 5-year data at the Census Tract level: median household income for past 12 months, median age, ethnicity breakdown, race breakdown, percent of limited English speaking households, and unemployment rate for the civilian labor force.

Public housing data for New York City were drawn from the New York City Housing Authority's housing development shapefile, accessed from [NYC Open Data](#).<sup>[17]</sup>

Social Vulnerability Index (SVI) data for 2020 were taken from the Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry's [Geospatial Research, Analysis, and Services Program database for New York](#).

### ***Key Informant Interviews***

Key informant interviews were conducted with T2 leadership and front-line staff, staff from community-based organizations, and cases and contacts. All interviews were recorded and transcribed with permission from the interviewee. The study team selected potential leadership interviewees after reviewing the T2 organizational chart and receiving a list of recommended interviewees from H+H. In addition, during interviews we asked participants to recommend other potential interviewees they felt would help to further strengthen our understanding of the program. We continued to conduct

leadership interviews until we reached saturation and a strong understanding of the T2 program as a whole, as well as within each sub-team. In total, we conducted 34 leadership interviews.

Interviews with T2 front-line staff included Supervisors, Case Investigators, Community Engagement Specialists, and Monitors. H+H provided the study team with a short list of Supervisors of Case Investigators and Community Engagement Specialists, from which we recruited interviewees. During interviews with supervisors, we requested that participants ask their supervisees for permission to be contacted by our team regarding participating in an interview about their experience working for T2. The study team then recruited Case Investigators and Community Engagement Specialists who agreed to be contacted. To recruit Monitors and Monitor Supervisors, H+H posted a message on LinkedIn explaining the study and requesting that former Monitors and Monitor Supervisors contact the study team if they were interested in participating in an interview; we used this recruiting method as contact information for Monitors and Monitor Supervisors was not available through H+H as they were contract workers. The study team then scheduled and conducted interviews with Monitors and Monitor Supervisors on a first-come first-serve basis. We conducted 18 interviews with front-line staff in total.

The community-based organizations from which we interviewed were selected based on the Test and Trace and Take Care partners listed on the H+H website and partner information provided by H+H. We asked our Community Advisory Board to provide feedback on which organizations to include; those that received 2 or more recommendations from CAB members were selected for interviews. Our study team then selected additional CBOs for interviewing, prioritizing those with a recommendation from the CAB but also ensuring diverse representation across funding status (unfunded, funding Tier, current/previous funding), and geographic and demographic catchments of the organizations. Fourteen CBO leaders from different organizations participated in interviews with the study team.

Finally, we interviewed 4 cases and 4 contacts who had previously been contacted by the T2 Trace team due to COVID-19 infection or exposure, respectively. The cases and contacts were recruited from the Case and Contacts survey administered by the study team. Survey participants were asked at the end of the questionnaire if they were willing to be contacted by the study team about participating in an interview regarding their experience with COVID-19 and interaction with the T2 Trace team. The study team then reached out to those who agreed to be contacted to explain the study further and schedule an interview. Interviews were scheduled and conducted on a first-come first-serve basis.

### **Surveys**

Online surveys were conducted with T2 Case Investigators and Community Engagement Specialists, cases, and contacts. The NYU study team requested from H+H a list of 300 randomly sampled Case Investigators and Community Engagement Specialists from which survey participants were recruited. The study team sent invitations to participate in the survey to staff members by email and participants completed the survey online via REDCap. The survey assessed staff members' experiences and opinions regarding their training, supervision, job performance, challenges, facilitators, and general attitudes towards the job. Participants received a \$25 gift card incentive for their time and effort. 168 staff members provided responses to the survey.

To recruit cases for participation in the survey, H+H provided the study team with a list of purposefully sampled cases (n=750) who had been contacted by the T2 Trace team due to COVID-19 infection and agreed to be contacted for research purposes during testing. We received a sample of 200 cases who lived across NYC, excluding the two lowest response communities as documented by the H+H DAP team, and who provided contacts to the T2 Trace team by phone; 150 cases from the two lowest response communities who provided contacts to the T2 Trace team by phone; 300 cases who were contacted by Community Engagement Specialists and provided contacts to the T2 Trace team; and



100 cases who refused to provide contacts to the T2 trace team. The study team called eligible survey participants to invite them to participate in the survey, and if they consented, administered the survey to participants over the phone. Eligible participants were also texted an invitation to participate in the survey and could complete the survey online using REDCap. 92 cases provided responses to the survey.

H+H provided the study team with a list of purposefully sampled contacts (n=425) who had been contacted by the T2 Trace team due to exposure to COVID-19 from which we recruited survey participants. We received a sample of 175 contacts who were contacted by phone, agreed to quarantine and completed at least 2 follow-up calls with the Trace team; 150 contacts who were contacted by Community Engagement Specialists, agreed to quarantine, and completed at least 2 follow-up calls; 50 contacts who did not agree to quarantine and/or did not complete follow-up calls; and 50 contacts who were contacted by Community Engagement Specialists and were contacted for a follow-up call at least once. The study team called eligible survey participants to invite them to participate in the survey, and if they consented, administered the survey to participants over the phone. Eligible participants were also texted an invitation to participate in the survey and could complete the survey online using REDCap. 39 contacts provided responses to the survey.

The cases and contacts surveys assessed services offered, comfort with contact tracing, trust in various institutions (e.g., government, healthcare), general health, experiences with COVID-19, isolation barriers, and health information sources. Surveys were available in English, Spanish, and Chinese. Participants received \$25 gift card incentives for their time and effort.

Due to very low response rates, data from the cases and contacts surveys were not substantially utilized in this report.

#### ***Social Media Data***

Tweets were pulled from a Twitter API full-archive search endpoint to fetch data with #nycTestandTrace hashtags from 16 agencies, city organizations, and CBOs (Table 7 of main report) for any time during the Alpha, Delta, and Omicron variant waves. Tweets were limited to those that mentioned T2 programs (e.g., testing, tracing, take care services).

#### ***Shapefiles***

Maps in this report use the 2020 TIGER ZCTA520 shapefile, available on through the [Census Bureau](#).<sup>[18]</sup> Taskforce on Racial Inclusion & Equity (TRIE) neighborhoods were classified using the NYC [published list](#) of modified ZCTAs.<sup>[19]</sup> TRIE neighborhoods were mapped using the NYC DOHMH MODZCTA shapefile, available on [NYC OpenData](#).<sup>[17]</sup>

## Metrics

### NYC Coronavirus Disease 2019 (COVID-19) Data Repository (NYC DOHMH)

Metrics	Description
<b>Total Cases</b>	7-day average of count of all cases (confirmed positive and presumed positive) citywide obtained from the “trends/cases-by-day.csv” table on the <a href="#">GitHub repository</a> . <sup>[11]</sup>
<b>Positive Cases</b>	<p>“A case is classified as confirmed after a positive result from a molecular test, such as a PCR test.” 7-day average count of confirmed positive cases citywide obtained from the “trends/cases-by-day.csv” table on the <a href="#">GitHub repository</a>.<sup>[11]</sup></p> <p>Rates of positive cases calculated as the number of positive cases divided by the population total and expressed per 100 population.</p>
<b>Presumed Positive Cases</b>	<p>“A case is classified as probable after any of the following:</p> <ol style="list-style-type: none"> <li>(1) Positive antigen test result</li> <li>(2) Person has symptoms and was exposed to a confirmed case</li> <li>(3) Person died and their cause of death on the death certificate is COVID-19 or similar, but a positive molecular test is not on record”</li> </ol> <p>7-day average count of presumed positive cases citywide obtained from the “trends/cases-by-day.csv” table on the <a href="#">GitHub repository</a>.<sup>[11]</sup></p>
<b>Percent Positivity</b>	<p>“Among people who were tested, the percent of people who tested positive. Percent positivity defined using a numerator including all people with positive results and a denominator including all people who received a test. If a person is tested more than one time, they are only counted once. If a person tests both positive and negative, the positive result is counted.” Obtained from the “totals/data-by-modzcta.csv” file on the <a href="#">GitHub repository</a>.</p>

### T2 Testing Sites

Metrics	Description
<b>Total Testing Sites</b>	Total number of H+H mobile and brick & mortar testing sites by month.
<b>Mobile Testing Sites</b>	Total number of H+H mobile testing sites by month.
<b>Brick &amp; Mortar Testing Sites</b>	Total number of H+H brick & mortar testing sites by month.
<b>Total Hours Open per Week</b>	Average number of hours open per week for mobile and brick & mortar testing sites. Operating hours data have been excluded completely from June-July 2020 due to missingness in the data.
<b>Average Travel Time</b>	Average number of minutes from the centroid of the neighborhood to the closest testing site via public transportation.
<b>Average Travel Distance</b>	Average number of miles from the centroid of the neighborhood to the closest testing site via public transportation.

## T2 Trace Metrics - Cases

Metrics	Definition for Cases
<b>Confirmed Positive Cases</b>	<p>Total number of disease events with positive PCR or antigen test in Trace database. All positive molecular and antigen tests were reported to the Department of Health and Mental Hygiene (DOHMH) and then added to the Trace database.</p> <p>Cases that were identified from congregate settings, were residents of other jurisdictions, were identified due to death records without an antigen result, or were identified too late/outside of the period of diagnosis and would no longer have been eligible for follow up were not included as cases in the T2 data.</p> <p>Confirmed positive cases were de-duplicated following DOHMH guidelines - if the person had positive COVID-19 results with collection dates at least one year (before June 9, 2021) or at least 90 days (after June 9, 2021) apart, then the data would include multiple disease events for the same person. Confirmed positive cases were also de-duplicated during case investigator workflows based on first/last name, address, and phone number, but the time period for deduplication was not known.</p>
<b>Presumed Positive Cases</b>	<p>Total number of events of individuals who were reported as a close contact of confirmed positive case and who met the clinical criteria for COVID, but who did not have laboratory evidence of positivity (including a molecular or antigen test). From the start of Trace until April 2021, any contact with one symptom was queued for case investigation; after April 2021, only contacts meeting CSTE criteria were queued.</p> <p>Following Council of State and Territorial Epidemiologists (CSTE) criteria, cases are presumed positive if they meet the following:</p> <ul style="list-style-type: none"> <li>Two of the following symptoms: Fever, chills, muscle aches, headache, sore throat, vomiting, diarrhea, fatigue, congestion, OR</li> <li>- One of the following symptoms: Cough, shortness of breath, new loss of smell or taste</li> </ul> <p>Presumed positive cases were de-duplicated during case investigator workflows based on first/last name, address, and phone number, but the time period for deduplication was not known.</p>
<b>Total Cases</b>	Sum of confirmed and presumed positive cases reported to T2.
<b>Attempted</b>	<p>Cases that were attempted were defined as those where the T2 tracer made at least 1 telephone attempt, including all call dispositions <u>except</u> “no phone number,” “no validation date of birth/address,” or “call scheduled” (the default disposition prior to any call attempt). Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of cases attempted was calculated at the number attempted divided by the total cases. The drop-off from total cases to attempted was calculated as the percent difference from total cases to cases attempted.</p>
<b>Reached</b>	<p>Cases that were reached were defined as those whom the T2 tracer reached, with any call disposition <u>except</u> “busy/no answer,” “incorrect or inactive number,” “left voicemail,” “3 failed attempts,” “unable to</p>

	<p>locate”, “no phone number,” “no validation date of birth/address,” or “call scheduled”. Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of cases reached was calculated at the number reached divided by the total cases. The drop-off from attempts to reached was calculated as the percent difference from cases attempted to cases reached.</p>
<b>Completed</b>	<p>Cases that were completed were defined as those who completed the intake interview, with call dispositions “call completed,” “incapable of responding/no proxy,” “out of jurisdiction,” “potentially deceased,” and “referred to NYC DOHMH Congregate Settings Team”. Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of cases completed was calculated at the number completed divided by the total cases. The drop-off from reached to completed was calculated as the percent difference from cases reached to cases completed.</p>
<b>Eligible monitored</b>	<p>Cases that were eligible for monitoring were defined as those with completed intake and &gt;0 days of monitoring left. The monitoring period was originally specified as 14 days but was changed to 10 days in December 2020.</p> <p>The proportion of cases eligible for monitoring was calculated at the number eligible divided by the total cases. The drop-off from completed to eligible was calculated as the percent difference from completed to eligible for monitoring.</p>
<b>Success monitored</b>	<p>Cases that were successfully monitored were defined as those with either at least 1 complete monitoring interaction with ≤3 or monitoring days or at least 2 complete monitoring interactions with &gt;4 monitoring days.</p> <p>The proportion of cases successfully monitored was calculated as the number successfully monitored divided by the total eligible for monitoring. The drop-off from eligible to successful monitoring was calculated as the percent difference from eligible to successfully monitored.</p>
<b>Provided contacts</b>	<p>Cases that provided contacts were defined as those who provided name and contact information for at least 1 contact.</p> <p>The proportion of cases who provided contacts was calculated as the number provided contacts divided by the total cases. The drop-off from completed to provided contacts was calculated as the percent difference from completed to provided contacts.</p>
<b>Timeliness of lab result</b>	<p>Median number of days from specimen collection to upload into the T2 Salesforce instance (when they would appear in the call queues) among confirmed positive cases.</p>
<b>Timeliness of case notification</b>	<p>Median number of days from Maven upload into the T2 Salesforce instance (when they would appear in the call queues) to first case notification attempt among confirmed positive cases.</p>

## T2 Trace Metrics - Contacts

Metrics	Definition for Contacts
<b>Total Contacts</b>	<p>Contacts were defined as those who were less than 6 feet away from the confirmed or presumed positive case for a total of 15 or more minutes over a 24-hour period during the case's infectious period (2 days before symptoms for symptomatic case, 2 days before positive molecular or antigen test for asymptomatic cases).</p> <p>Contacts are found through:</p> <ul style="list-style-type: none"> <li>- Interviews with confirmed cases who provide their contacts to Trace staff</li> <li>- Bulk uploads from facilities like schools (such as the classmates of a student who is a confirmed case).</li> </ul> <p>All contacts collected through case interviews were included, regardless of vaccination status. Certain school-based contacts were excluded based on CDC criteria. School-based contacts were only included if they are students within 3 ft of a case (or 3-6 ft without a face covering, or staff within 6 ft of a case). Vaccinated, asymptomatic school contacts were not included in total contacts, but were included in other bulk uploaded facilities or through contact collection via case interviews.</p>
<b>Attempted</b>	<p>Contacts that were attempted were defined as those where the T2 tracer made at least 1 telephone attempt, including all call dispositions except "no phone number," "no validation date of birth/address," or "call scheduled" (the default disposition prior to any call attempt). Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of contacts attempted was calculated at the number attempted divided by the total contacts. The drop-off from total contacts to attempted was calculated as the percent difference from total contacts to contacts attempted.</p>
<b>Reached</b>	<p>Contacts that were reached were defined as those whom the T2 tracer reached, with any call disposition except "busy/no answer," "incorrect or inactive number," "left voicemail," "3 failed attempts," "unable to locate," "no phone number," "no validation date of birth/address," or "call scheduled". Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of contacts reached was calculated at the number reached divided by the total contacts. The drop-off from attempts to reached was calculated as the percent difference from contacts attempted to contacts reached.</p>
<b>Completed</b>	<p>Contacts that were completed were defined as those who completed the intake interview, with call dispositions "call completed," "incapable of responding/no proxy," "out of jurisdiction," "potentially deceased," "referred to NYC DOHMH Congregate Settings Team," "refused - reports vaccination," and "vaccine immune". Call disposition definitions are provided at the end of the technical appendix.</p> <p>The proportion of contacts completed was calculated at the number completed divided by the total contacts. The drop-off from reached to completed was calculated as the percent difference from contacts reached to contacts completed.</p>

<b>Eligible monitored</b>	<p>Contacts that were eligible for monitoring were defined as those with completed intake who had &gt;0 days of monitoring left. The monitoring period was originally specified as 14 days but was changed to 10 days in December 2020.</p> <p>The proportion of contacts eligible for monitoring was calculated at the number eligible divided by the total contacts. The drop-off from completed to eligible was calculated as the percent difference from completed to eligible for monitoring.</p>
<b>Success monitored</b>	<p>Contacts that were successfully monitored were defined as those with either at least 1 complete monitoring interaction with <math>\leq 3</math> monitoring days or at least 2 complete monitoring interactions with &gt;4 monitoring days.</p> <p>The proportion of contacts successfully monitored was calculated as the number successfully monitored divided by the total eligible for monitoring. The drop-off from eligible to successful monitoring was calculated as the percent difference from eligible to successfully monitored.</p>
<b>Timeliness of contact notification</b>	<p>Median number of days from contact elicitation to first contact notification attempt. For non-bulk uploads, contact elicitation happened during case investigation interviews.</p>

### T2 Take Care Metrics

<b>Metrics</b>	<b>Description</b>
<b>Hotel admissions</b>	<p>Hotel admissions defined as cases and exposed contacts who were housed in hotel rooms for isolation/quarantine.</p> <p>The proportion housed in hotel rooms was calculated as the total number of hotel admissions divided by the total number of cases and contacts.</p>
<b>Meals</b>	<p>Meals defined as meal deliveries that were provided through the GetFood program once T2 took over program operations on November 2, 2021. Cases and contacts could request multiple meal deliveries. A total of 6 meals were included in each delivery.</p> <p>The rate of meals provided was calculated as the number of meal deliveries divided by the total number of cases and contacts.</p>
<b>Care package requests</b>	<p>Care package requests defined as cases and contacts who requested care packages, which included face masks, hand sanitizer, thermometers, educational materials, and a pulse oximeter (for those who tested positive).</p> <p>Starting August 24, 2020, cases and contacts who completed intake were mailed 1 or 2 Take Care packages depending on household size. Starting December 19, 2020, a question was added to make this an opt-in program rather than a default.</p> <p>The proportion requesting a care package was calculated as the</p>

	<p>number of care package requests divided by the total number of cases and/or contacts who were eligible for monitoring after December 19, 2020.</p>
<b>Referrals requested</b>	<p>Referrals requested defined as requests for wrap-around services (food, health insurance, medications, methadone delivery, assistance applying for government benefits [e.g., SNAP], housing, eviction or other tenant issues, legal assistance, other). Referral requests were then expected to receive a follow-up call from a T2 resource navigator. Cases and contacts could request multiple referrals for wrap-around services.</p> <p>The rate of referrals requested was calculated as the number of referrals requested divided by the total number of cases and/or contacts.</p>
<b>Completed referrals</b>	<p>Completed referrals defined as the subset of referral requests that were operationally completed, including combined resource service status of “Completed Client Connected to Resources,” “Completed Resources Declined,” “Completed Did Not Reach after Three Attempts,” “Completed Invalid Phone Number,” “Completed Unable to Reach Client,” and “Completed.”</p> <p>The rate of completed referrals was calculated as the number of completed referrals divided by the total number of cases and/or contacts. The proportion of completed referrals was calculated as the number of completed referrals divided by the number of referrals requested. The drop-off from requested to completed was calculated as the percent difference from requested to completed.</p>
<b>Connected referrals</b>	<p>Connected referrals defined as the subset of referral requests that were successfully connected to the wrap-around service, including combined resource service status of “Completed Client Connected to Resource.”</p> <p>The rate of connected referrals was calculated as the number of connected referrals divided by the total number of cases and/or contacts. The proportion of connected referrals was calculated as the number of connected referrals divided by the number of referrals requested. The drop-off from completed to connected was calculated as the percent difference from completed to connected.</p>

### Neighborhood Determinants

Metrics	Description
<b>Median Income</b>	Estimated median household income in the past 12 months
<b>Median Age</b>	Estimated median age
<b>SVI</b>	The CDC’s <a href="#">Social Vulnerability Index (SVI)</a> is a summary index designed to reflect each Census Tract’s relative vulnerability on a variety of social, as a way to identify communities most likely to need support. Each Census Tract is ranked on factors constituting four themes: socioeconomic status, household composition & disability,

	minority status & language, and housing type & transportation. An overall ranking is then assigned; this composite index was used in the present analysis.
<b>Limited English Proficiency</b>	Estimated percent of limited English-speaking households
<b>Hispanic</b>	Estimated population of Hispanic or Latino origin as a percent of total population
<b>Black</b>	Estimated population identifying as Black or African American alone as a percent of total population
<b>Unemployment</b>	Estimated percent of the civilian labor force that is unemployed. Civilian labor force denotes persons 16 years of age and older who are not inmates of institutions and are not on active duty in the Armed Forces.
<b>Public Housing</b>	Boolean indicator of whether each Census Tract contains at least one New York City Housing Authority (NYCHA) development. NYCHA lot footprints were spatially joined with Census Tracts using shapefiles. If at least one NYCHA lot intersected with a Census Tract, that Tract was assigned a value of 1; otherwise, it was assigned 0.

### Social Media Metrics

Metrics	Description
<b>Likes</b>	Indicated by a heart icon that Twitter users click to show appreciation for a Tweet.
<b>Retweets</b>	A re-posting of a Tweet that allows users to quickly share that Tweet with all of their followers
<b>Replies</b>	A Twitter user's response to another person's Tweet. Replies can be viewed under the original Tweet.
<b>Sentiment Score</b>	A compounded value ranging between -1 to 1 that reflects the overall sentiment of a Tweet's content. This score is computed by VADER Sentiment Analyzer, using a lexical approach. Sentiment scores are classified as positive (greater than 0.05), negative (less than -0.05), or neutral (between -0.05 and 0.05).
<b>Positive Tweets</b>	Defined as Tweets with a sentiment score values above 0.05.
<b>Negative Tweets</b>	Defined as Tweets with a sentiment score values below -0.05.
<b>Neutral Tweets</b>	Defined as Tweets with a sentiment score values between -0.05 – 0.05.
<b>Engagement Level</b>	Defined as the total number of likes by a Twitter account's followers on their T2-related Tweets.



## Methods

### **Scale-Up of Testing Services**

For locations that were missing a borough, a uniquely-created python code leveraged Google API to assign the missing data borough to the location's longitude and latitude. More than 10% of locations in June 2020 and July 2020 (11% and 39% respectively) were missing hours of operations. The operating hours data were excluded completely for this period (June-July 2020).

Distance to test sites was calculated using tract information for people's home locations and the site addresses for the site locations. Tracts information was obtained from the 2020 Census through the [NYC OpenData website](#).<sup>[17]</sup> Tracts are polygons and the mathematical distance was calculated from the coordinates of the center point of the tract to the coordinates of the site location. This calculation considered only brick and mortar and mobile testing sites. The average time reported to get from a tract to a test site is based on Google map's API using public transportation in the middle of the week (Wednesday at noon).

### **Neighborhood Determinants of Risk**

Census tracts with low case completion were defined as those within the lowest quartile of case completion, and census tracts with high case completion were defined as those within the top three quartiles of case completion. Census tracts with low cases providing contacts were defined as those within the lowest quartile of cases providing contacts, and census tracts with high case completion were defined as those within the top three quartiles of cases providing contacts. We calculate the descriptive statistics of the 25th, 50th (median), and 75th percentiles for the census tract neighborhood determinants of SVI, median household income, median age, Hispanic race/ethnicity, limited English proficiency, unemployment, and Black race/ethnicity, as well as the proportion (and 95% confidence interval) of census tracts with at least one public housing development, by high vs. low case completion and high vs. low cases providing contacts.

Because many of these neighborhood characteristics cluster together, we examined which characteristics were associated with low performance after adjusting for other neighborhood determinants in a multi-level logistic regression model. Median household income was scaled by dividing by 100,000 and median age was scaled by dividing by 100. Models included all neighborhood predictors and a random intercept for county. Coefficients were exponentiated to report odds ratios for low case completion or low cases providing contacts, and Wald 95% confidence intervals were calculated. Coefficients for median household income and median age were rescaled to report odds ratios for \$1,000 increase in median household income and a 1-year increase in age. Odds ratios for unemployment, limited English proficiency, Hispanic race/ethnicity, limited English proficiency, and Black race/ethnicity were reported for 1% increases and odds ratios for SVI were reported for 1-unit increases in these determinants. Odds ratios for public housing were reported using the referent group of no public housing.

### **Key Informant Interviews**

We used rapid qualitative methods to analyze the key informant interview data. The study team chose 17 thematic domains which were derived from interview protocol questions and developed an interview summary template as a systematic way of extracting and condensing data from each interview transcript. The study team used the summary templates to outline the main points related to each domain and to capture corresponding illustrative quotes. The interview team tested the summary template using three interview transcripts. Groups of 3-4 study team members reviewed each transcript and completed the summary template independently. Side-by-side comparison was made of information extracted from the transcripts including the amount of data extracted and attribution to specific domains. Modifications were then made to the summary template to ensure ease of use and to enhance comparability among study team members. Once the template was finalized, the study

team split up the remaining transcripts and completed the summary templates independently. The study team then created a matrix of findings in order to synthesize data across all interviews within each domain.

### **Surveys**

We analyzed survey data using descriptive statistics to summarize responses for each of the three surveys. The survey data serves as a complement to qualitative data from key informant interviews and is included in certain sections of the report to strengthen our findings and provide support for recommendations.

### **Social Media Analyses**

We conducted sentiment analysis of tweet content using a pre-trained VADER model from NLTK. VADER Sentiment Analyzer uses a lexical approach, utilizing a list of words with predetermined sentiment scores. This model was created to process shorter text, making it suitable for our use in a social media setting. Based on the sentiment of the input tweet, the model returns 3 values – positive, negative, and neutral, as well as a compound value that summarizes all three sentiments into a value that ranges between -1 to 1, with -1 being negative and 1 being positive. Values below -0.05 are then classified as negative, and values above 0.05 are classified as positive. An OLS regression model was used to evaluate the relationship between sentiment and numbers of likes.

## Call Disposition Definitions

Call disposition definitions were taken from the NYC Health + Hospitals [Public Report Data Dictionary](#).<sup>7</sup>

### **Not Attempted**

- ◆ “Call Scheduled”: default disposition prior to first attempt.
- ◆ “No Phone Number”: No phone number included when uploaded to Trace database. Automatically assigned to Information Gatherers’ queue.
- ◆ “No Validation DOB/Address”: No date of birth or address included with record when uploaded to Trace database. Automatically assigned to special investigation or supervisor queue.

### **Attempted, not Reached**

- ◆ “Busy/No Answer”: Call is attempted, but there is no answer and no voicemail option. Automatic move to callback queue.
- ◆ “Incorrect or Inactive Number”: Call is attempted and number is out of service. Automatic move to the Information Gatherers’ queue to search for new contact information.
- ◆ “Left Voicemail”: Call is attempted, but reaches voicemail. Trace staff leaves voicemail. Automatic move to callback queue.
- ◆ “Three Failed Attempts”: Given after the first day if three call attempts are unsuccessful. Automatically assigned to Information Gatherers’ queue.
- ◆ “Unable to Locate - Final”: Resident cannot be located. Supervisor manually assigns this disposition after all methods to find case or contact have been exhausted.

### **Reached, not Completed**

- ◆ “Call Back Requested”: The resident is reached, cannot complete the intake at the current time, and requests a call back for a different time.
- ◆ “Call Dropped”: The resident is reached, but the call disconnects before the intake is completed. Automatic move to callback queue.
- ◆ “Call Back Scheduled”: The resident is reached, but intake is not completed and a call back is scheduled.
- ◆ “Duplicate / Already Completed”: filtered out, not in numerator or denominator. Duplicates are confirmed if first and last name, address, and phone number all match in the Trace database. Automatic move to supervisor queue for confirmation of duplicate and retiring of intake. Example: A duplicate may occur if a resident has both a confirmed positive test and a presumed positive contact record in the Trace database. The resident does not need to complete the intake twice, so one record will be retired. Before any record is retired, residents are contacted to ensure they know their results of the positive test before intakes are assigned this disposition.
- ◆ “Emergency”: The resident is reached and needs emergency assistance. Trace staff will assist, if able, by calling emergency services and the call will be ended. Automatic move to supervisor queue for a supervisor to attempt a call.
- ◆ “In Progress”: someone from the Special Investigations team (community engagement specialist or information gatherer) are working on the intake (e.g., finding additional information, traveling to attempt intake completion in-person, etc.).
- ◆ “Language Barrier”: uncommon. The resident is reached and Trace staff cannot understand the preferred spoken language of the resident. Automatic move to supervisor queue for a supervisor to attempt a call with the appropriate language resources.
- ◆ “Refused”: The resident is reached, refuses to participate in the program, and will not be contacted further.

### **Completed**

- ◆ “Call Completed”: The resident is reached and intake is completed. Automatic move to monitoring queue.

- ◆ “Incapable of Responding/No Proxy”: The resident is reached and unable to complete intake for themselves. There is no health proxy available to speak on their behalf and no further action is taken.
- ◆ “Out of jurisdiction”: Resident is reached and address is confirmed to be outside of New York City limits. Automatic move to Out of Jurisdiction (OOJ) queue, where OOJ team will transfer record to proper contact tracing team for that jurisdiction, if applicable.
- ◆ “Potentially deceased”: The call is attempted and Trace staff informed that resident is not alive. Automatic move to Information Gatherers’ queue to confirm.
- ◆ “Referred to NYC Health Department Congregate Settings Team”: Call is reached and the resident lives in one of the following congregate settings:
  - Nursing Home
  - Assisted living facility
  - Correctional facility (jail/prison/detention)
  - Homeless shelter
  - Group Home
  - Supportive housing settings
  - Residences for individuals with developmental disabilities, serious mental illness, or substance use disorders
- ◆ “Refused - Reports Vaccination”: Contact is reached and self-reports vaccination (with details on date and type), but full vaccination cannot be verified in New York City’s vaccine registry (CIR). This may be due to being vaccinated outside of the city or the vaccination provider did not submit to the CIR.
- ◆ “Vaccine Immune”: Contact is reached, self-reports vaccination, and full vaccination is confirmed in New York City’s vaccine registry (CIR).

***Specific to Monitoring***

- ◆ “Completed”: case completed initial intake with Trace staff and was moved to the monitoring queue. Monitoring intake is completed via phone or SMS.
- ◆ “Pending”: automated when SMS is scheduled to be sent to the resident in monitoring.

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## Appendix B. Community-Based Organizations by Roles within the Test & Trace Program

Community-Based Organizations	CAB Members	Test and Trace-Funded CBOs	Take Care-Funded CBOs
Academy of Medical and Public Health Services	X		
African Communities Together		X	
African Services Committee	X	X	
American Red Cross	X		
Arthur Ashe Institute for Urban Health	X		
Boriken Neighborhood Health Center	X		
Brownsville Multi-Service Family Health Center	X		
Bronx Health REACH Coalition	X		
BronxWorks			X
Brooklyn College	X		
Brooklyn Defender Services	X		
Brooklyn Perinatal Network	X		
Brooklyn Public Library	X	X	
CAMBA	X		
Catholic Charities of New York	X		X
Center for Independence of the Disabled (CIDNY)	X		
Center for the Integration and Advancement of New Americans, Inc. (CIANA)	X	X	
The Central Family Life Center	X	X	
The Child Center of NY, Inc.	X	X	
Chinese American Family Alliance for Mental Health	X		
Chinese American Planning Council			X
City University of New York School of Public Health			X
Coalition for Asian American Children and Families	X		
Columbia University	X		
Commission on the Public's Health System	X		
Community Health Action of Staten Island (CHASI)	X	X	
Community Meditation Services, Inc.		X	
DBGM	X	X	
The Door	X		
Fifth Avenue Committee, Inc	X	X	
The Fortune Society		X	
Harlem Community Justice Center	X	X	
Health People, Inc	X	X	
Hebrew Educational Society of Brooklyn		X	
The Hetrick-Martin Institute, Inc.		X	
Housing Works	X		
Human Services Council	X		
Hunter College AANAPISI Project	X		

India Home Inc	X	X	
Institute for Family Health	X	X	
Jacob A Riis Neighborhood Settlement			
Jewish Community Center of Staten Island			X
Jewish Community Council of Greater Coney Island, Inc.		X	
Jewish Community Relations Council of New York	X		
Korean-American Family Service Center, Inc.	X	X	
Latino Commission on AIDS	X		
LES Ready!	X		
Make the Road NY	X	X	X
Maspeth Town Hall, Inc.		X	
Mexican Coalition for the Empowerment of Youth and Families	X	X	
Mixteca Organizations, Inc.	X	X	
Mosholu-Montefiore Community Center (MMCC)	X	X	
National Black Leadership Commission on Health	X	X	
New York Disaster Interfaith Services	X		
The New York Immigration Coalition, Inc.	X	X	
New York Lawyers for the Public Interest	X		
New York Medical College	X		
NYCEM	X		
NYCHA	X		
NYCHA-REES	X		
The Osborne Association, Inc.	X		
Pinnacle Social Impact	X		
Planned Parenthood of Greater New York	X		
Pride Center of Staten Island, Inc	X		
Project Hospitality	X	X	
Public Health Solutions	X	X	
Riseboro			X
Samuel Field YM&YWHA dba Commonpoint Queens (SFY)	X	X	
SCAN-Harbor		X	
SCO Family of Services		X	X
Services for the Underserved	X		
SoBro			X
Southern Brooklyn COAD	X		
Staten Island COAD/LTRO	X		
Staten Island Partnership for Community Wellness	X		
Sure We Can, Inc	X	X	
Treatment Action Group	X		
UJA-Federation of New York	X		X
Upward Bound			
Urban Health Plan	X		
YAI, Inc	X		

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## Study Team

The NYU Grossman School of Medicine (NYU GSoM) study team includes faculty and staff with diverse expertise from the NYU GSoM's Department of Population Health (DPH).

### **Principal investigators include:**

- **Dr. Lorna Thorpe**, Professor & Director, Division of Epidemiology; expertise in public health surveillance
- **Dr. Carolyn Berry**, Professor; expertise in public health program and policy evaluation
- **Dr. Nadia Islam**, Associate Professor; expertise in health equity and community engagement
- **Dr. Anna Bershteyn**, Assistant Professor; expertise in infectious disease prevention

Our team included additional faculty co-investigators and staff from DPH, listed below, as well as two key partner minority- and women-owned business enterprises, Analytics Intell for data analysis and visualization and APartnership for dissemination.

The team was guided by a Scientific Advisory Board (SAB) and Community Advisory Board (CAB) to ensure the evaluation addressed high-priority questions and applied a health equity lens. Both boards, as well as a core team of New York City Health + Hospitals (H+H) representatives, provided feedback on drafts of the report.

### **Members are listed here.**

#### **Scientific Advisory Board:**

- **Marc N. Gourevitch (Co-Chair)**, NYU GSoM;
- **Melody Goodman (Co-Chair)**, NYU School of Global Public Health;
- **Tabia Henry Akintobi**, Morehouse School of Medicine;
- **Arthur L. Caplan**, NYU GSoM;
- **Giselle Corbie-Smith**, UNC School of Medicine;
- **Terry Huang**, CUNY Graduate School of Public Health and Health Policy (CUNY SPH);
- **Denis Nash**, CUNY SPH

#### **Community Advisory Board:**

- **Marilyn Fraser (Co-Chair)**, Arthur Ashe Institute;
- **Jeremy Reiss (Co-Chair)**, Henry Street Settlement;
- **Hector Cuevas**, CAMBA;
- **Sara Kim**, Korean Community Services of Metropolitan New York;
- **Moses Mansu**, NYU GSoM;
- **Malcolm Punter**, Harlem Congregations for Community Improvement (HCCI);
- **Becca Telzak**, Make the Road New York

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## Glossary of Acronyms

**CAB:** *Community Advisory Board*

**CBO:** *Community-based organization*

**CDC:** *U.S. Centers for Disease Control and Prevention*

**CES:** *Community engagement specialist: staff for T2 program who conducted door-to-door outreach*

**CI:** *Case investigator: staff for the T2 program who performed tracing telephonically*

**CIMS:** *Citywide Incident Management System*

**DPH:** *Department of Population Health (at NYU GSoM)*

**DSNY:** *The City of New York Department of Sanitation*

**DOHMH:** *New York City Department of Health and Mental Hygiene, the city's municipal public health agency*

**DoITT:** *Department of Information Technology and Telecommunications (NYC municipal agency, now the New York City Office of Technology and Innovation)*

**EDC:** *Economic Development Corporation*

**EOC:** *Emergency Operations Center*

**FQHCs:** *Federally Qualified Health Centers*

**H+H:** *New York City Health + Hospitals, comprising the city's public health care system of 11 hospitals, as well as neighborhood health centers, long-term care, nursing homes, and home care*

**HPI:** *Healthy Places Index*

**HRO:** *New York City Mayor's Office of Housing Recovery Operations*

**ICS:** *Incident Command System*

**KI:** *Key informant*

**MOO:** *Mayor's Office of Operations*

**NYC:** *New York City*

**NYU GSoM:** *NYU Grossman School of Medicine*

**OMB:** *New York City Office of Management and Budget*

**PPE:** *Personal protective equipment*

**PRL:** *Pandemic Response Lab*

**T2:** *NYC Test & Trace program, later Test & Treat*

**TRIE:** *Taskforce on Racial Inclusion and Equity*

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