

Vulnerability, Inequity, and COVID-19: A Portrait of the Pandemic in Allegheny County

Tracking Evolving Disparities in Testing, Cases,
Hospitalizations, Deaths, and the Ability to Practice
Physical Distancing—Appendixes

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Preface

Although coronavirus disease 2019 (COVID-19) has touched every community in the United States, certain geographic areas and populations have been affected more than others. To examine vulnerability to COVID-19 and the pandemic’s impacts within a specific community, the RAND Corporation, the Black Equity Coalition, and Surgo Ventures partnered to consider disparities in Allegheny County in southwest Pennsylvania. Allegheny County, which is home to the City of Pittsburgh, is representative of many of the challenges faced throughout the country in combating the coronavirus. The Allegheny County Health Department offers granular, public data describing how testing, cases, and deaths have been distributed across neighborhoods and populations. When we combine this data with Surgo Ventures’ COVID-19 Community Vulnerability Index (CCVI), a Centers for Disease Control and Prevention resource that identifies communities that are most in need of support during the pandemic, we explore how COVID-19 testing, cases, and deaths have played out on a local scale throughout the pandemic. Additionally, we use other publicly available data resources, such as measures of physical distancing, to explore potential drivers of the spread of COVID-19. The results of these analyses describe lessons learned and aim to inform individual and policymaker efforts to mitigate the spread of COVID-19 during the late winter and spring months of 2021, prior to widespread vaccine dissemination.

This tool was revised in July 2021 to include data on the *number* of COVID-19 tests conducted over time. These data replace the tool’s original estimates of the number of COVID-19 tests conducted and positivity rates, which were based on data reported at the *individual* level. The newly included test-level data provide a more accurate measure of changes in testing and positivity rates. Because the newly included data source does not feature geographic information, the study team retained the individual-level data to provide additional geographic context. Instances in which the individual-level data are used now refer to the number of “individuals tested” rather than the number of tests.

This tool should be of interest to policymakers, COVID-19 testing providers, and institutional leaders in Allegheny County who are responsively adapting approaches to COVID-19 testing and mitigation strategies to current conditions. Other local entities (e.g., foundations, social services providers) also might be interested in the changing picture of COVID-19 in their community. Additionally, the insights gained from Allegheny County might be applicable to policymakers and others throughout the country as they attempt to mitigate the spread of COVID-19 in their own communities. We hope that this tool also provides a model for tracking inequities in future pandemic response.

This research was jointly conducted by the Community Health and Environmental Policy Program in RAND Social and Economic Well-Being, the Black Equity Coalition, and Surgo

Ventures. Surgo developed the CCVI and all organizations contributed to the analyses described in this technical appendix.

Community Health and Environmental Policy Program

RAND Social and Economic Well-Being is a division of the RAND Corporation that seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. This research was conducted in the Community Health and Environmental Policy Program within RAND Social and Economic Well-Being. The program focuses on such topics as infrastructure, science and technology, community design, community health promotion, migration and population dynamics, transportation, energy, and climate and the environment, as well as other policy concerns that are influenced by the natural and built environment, technology, and community organizations and institutions that affect well-being. For more information, email chep@rand.org.

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Finally, we thank the quality assurance reviewers for this project: David Groves, a senior policy researcher at RAND, and Priya Shete, assistant professor of medicine in the Division of Pulmonary and Critical Care Medicine at the University of California, San Francisco. Their thoughtful and constructive comments significantly improved the tool and these appendixes. Any remaining errors are the sole responsibility of the authors.

Abbreviations

ACHD	Allegheny County Health Department
ACS	American Community Survey
AHN	Allegheny Health Network
API	application programming interface
BEC	Black Equity Coalition
CARES Act	Coronavirus Aid, Relief, and Economic Security Act
CCVI	COVID-19 Community Vulnerability Index
CDC	Centers for Disease Control and Prevention
CMU	Carnegie Mellon University
COVID-19	coronavirus disease 2019
FDA	U.S. Food and Drug Administration
FQHC	federally qualified health center
ICU	intensive care unit
K–12	kindergarten through grade 12
NPI	nonpharmaceutical intervention
PA DOH	Pennsylvania Department of Health
PA-NEDSS	Pennsylvania—National Electronic Disease Surveillance System
PCR	polymerase chain reaction
PPS	Pittsburgh Public Schools
SVI	Social Vulnerability Index
UPMC	University of Pittsburgh Medical Center
WPRDC	Western Pennsylvania Regional Data Center

Appendix A. Introduction, Methods, and How to Use the Tool

Introduction

To examine vulnerability to the coronavirus disease 2019 (COVID-19) and the pandemic's impacts within a specific community, RAND Corporation researchers, the Black Equity Coalition (BEC), and Surgo Ventures partnered to consider disparities in Allegheny County. The county is representative of many of the challenges faced throughout the country in combating COVID-19, and the Allegheny County Health Department (ACHD) offers granular, public data describing how testing, cases, and deaths have been distributed across neighborhoods and populations. Combining this data with Surgo Ventures' COVID-19 Community Vulnerability Index (CCVI), we explore how COVID-19 testing, cases, and deaths have played out on a local scale throughout the pandemic (Surgo Ventures, undated). Additionally, we use other publicly available data resources, such as measures of physical distancing, to explore potential drivers of the spread of COVID-19. The results of these analyses describe lessons learned and aim to inform individual and policymaker efforts to mitigate the spread of COVID-19, prior to comprehensive community vaccination. Findings related to testing access also may help inform the equitable distribution of and access to vaccines.

Vulnerability, as Defined by the CCVI

Recognizing the role of vulnerability in the pandemic's effects on communities around the world, Surgo Ventures developed the CCVI. Vulnerability is not uniform, and Surgo defined *vulnerability to COVID-19* as a limited ability to mitigate, treat, and delay transmission of the virus and to weather its secondary effects on health, economic, and social outcomes. By definition, vulnerability is a multidimensional construct, and Surgo designed a modular index to reflect this. The CCVI combines indicators of social vulnerability, such as socioeconomic status, living conditions, and language barriers, with indicators of vulnerability that are unique to the COVID-19 pandemic, such as access to health care and the presence of comorbidities among the population. The combination of factors that constitute the CCVI definition of vulnerability can result in various health, economic, and social outcomes, including severe COVID-19 spread, growth in unemployment, loss in income, decreased food security, and increased eviction and foreclosure.

The CCVI has been recognized by the Centers for Disease Control and Prevention (CDC) as a valuable tool in COVID-19 research and pandemic response planning and has been recommended by the National Academy of Sciences, Engineering, and Medicine as a tool for equitable vaccine allocation (CDC, 2020; Gayle et al., 2020).

To correctly interpret an index like the CCVI, it is important to understand the data-collection processes, technologies, transformation methods, biases, and absences of data that are used to construct the composite indicator, along with how decisions were made to include or exclude particular data sets. The methodology for constructing these indicators also includes weighting and aggregating the data and using statistical methods. We include more information on the methodology behind the CCVI in the Methods section of this appendix. The final step in understanding complex composite indicators can involve an assessment of the data with other indicators, models, and analyses. For this reason, we chose to take a deeper dive into the data available on COVID-19 testing access, testing rates, cases, and outcomes for communities experiencing inequity in Allegheny County. These analyses are included in the tool, along with analyses by vulnerability, and are described in more detail in the Methods section of this appendix.

Communities Experiencing Vulnerability and Inequity in Allegheny County, Pennsylvania

Allegheny County in Southwestern Pennsylvania is home to more than 1.2 million residents, about one-third of whom reside in the City of Pittsburgh, the largest of the county's 130 municipalities (U.S. Census Bureau, undated-b). The county's population is approximately 80 percent White and 13 percent Black, with Asian Americans, Hispanic Americans, and other races and ethnicities making up the remaining 7 percent (U.S. Census Bureau, undated-a). The region is often ranked highly in overall livability because of its low cost of living and wide variety of economic, cultural, and recreational opportunities.

However, residential segregation and income disparities mean that these opportunities are not universally shared. The City of Pittsburgh has a larger proportion of Black residents than the county at large. Moreover, Pittsburgh comprises 90 neighborhoods, and about 30 percent of the city's Black population live in communities that have not fully experienced the city's economic recovery and face economic and racial inequity (De Vita and Farrell, 2014). For example, in 2019, the median household income for White, non-Hispanic Pittsburgh residents was \$63,054. Median income for Black residents, by contrast, was only \$32,041 (U.S. Census Bureau, 2019h). In the county at large, median incomes were higher but disparities were similar, with the median income for White residents at \$69,935 and for Black residents at \$36,842 (U.S. Census Bureau, 2019g).

The county's population has skewed older in recent decades. The proportion of elderly residents (ages 65 and older) in Allegheny County was 19 percent in 2019, compared with roughly 16 percent for the country as a whole (U.S. Census Bureau, undated-b). This proportion is projected to continue to grow, mirroring national demographic trends (Musa et al., 2014). However, the county is also home to seven four-year institutions, and the region has a large population of young adults. In 2019, 18-to-24-year-olds constituted roughly 9 percent of the county population and 16 percent of the city population (U.S. Census Bureau, 2019d).

Throughout the pandemic, Americans of color—particularly Black Americans—and older adults have been more likely to experience the negative impacts of COVID-19, including hospitalization and death (CDC, 2020). Race is correlated with other indicators of social vulnerability, including low-income status, exposure to environmental pollutants, and low access to health care and health insurance—all of which have been shown to influence COVID-19 vulnerability worldwide (Ro, 2020).

We assessed geographic communities in Allegheny County along the six themes of the CCVI: socioeconomic status, household composition and disability, minority status and language, housing type and transportation, epidemiological factors, and health care system factors. The socioeconomic status factor is characterized by unemployment, low income, and education levels in the community. The household composition and disability factor notes the prevalence of single-parent households and households with elderly or disabled members. Minority status and language indicates the prevalence of racial or ethnic minorities and populations with limited English proficiency in the community. The housing type and transportation factor indicates the prevalence of households experiencing crowded living arrangements or a lack of access to transportation. Epidemiological factors include high population density, high flu and pneumonia mortality among the population, and underlying chronic conditions among the population. Finally, health care system factors include health system capacity and preparedness of the community.

According to the CCVI,¹ COVID-19 vulnerability in Allegheny County is primarily driven by socioeconomic factors and household composition and disability, as reflected by average scores for each theme across census tracts at each level of vulnerability (Surgo Ventures, undated). High-vulnerability neighborhoods or municipalities are made up of the top one-third of neighborhoods or municipalities in overall vulnerability as measured by the CCVI. Low-vulnerability neighborhoods or municipalities are made up of the bottom one-third of neighborhoods or municipalities in overall vulnerability as measured by the CCVI. The absolute difference in the average vulnerability between high- and low-vulnerability tercile neighborhoods or municipalities is greatest for the socioeconomic status and household composition and disability themes (see Table A.1).

¹ This research was completed in fall 2020 and uses a previous version of Surgo's CCVI (Surgo Ventures, 2020b).

Table A.1. Allegheny County Vulnerability Scores, by CCVI Theme

	Socio-economic Status	Household Composition and Disability	Minority Status and Language	Housing Type and Transportation	Epidemiological Factors	Health Care System Factors
High vulnerability	0.73	0.74	0.49	0.58	0.52	0.25
Medium vulnerability	0.36	0.42	0.26	0.43	0.51	0.25
Low vulnerability	0.17	0.29	0.18	0.23	0.46	0.25

NOTES: Scores by CCVI theme were calculated on a 0–1 scale (where 0 = least vulnerable and 1 = most vulnerable). Scores presented here are averaged for each theme across neighborhoods or municipalities at each level of vulnerability.

Vulnerability varies by geography across Allegheny County. Table A.2 shows the communities with the highest and lowest CCVI scores in the county. (Neighborhoods in the City of Pittsburgh are indicated in parentheses.)

Table A.2. Highest and Lowest CCVI Scores Among Communities in Allegheny County

Highest CCVI Scores		Lowest CCVI Scores	
Municipality or Neighborhood	CCVI Score	Municipality	CCVI Score
Crawford-Roberts (Pittsburgh)	0.94	Thornburg	0.01
Homestead	0.92	Rossllyn Farms	0.01
Homewood West (Pittsburgh)	0.89	Pine	0.01
Bedford Dwellings (Pittsburgh)	0.88	Bell Acres	0.01
Northview Heights (Pittsburgh)	0.87	Reserve	0.01

COVID-19 Response in Allegheny County

The COVID-19 response in Allegheny County, which is coordinated by ACHD, consists of a testing strategy and nonpharmaceutical interventions (NPIs), such as business closures, mask ordinances, and physical-distancing requirements. Data on COVID-19 outcomes by race indicated that Black residents were being disproportionately affected early in the pandemic and prompted an equity-oriented response.

COVID-19 Testing

Since March 2020, COVID-19 testing in Allegheny County has largely followed CDC guidance (see Figure A.1 for a timeline of COVID-19 testing by ACHD). Early on, most testing

was reserved for people who were symptomatic, residents and staff of long-term and personal care facilities, and health care workers. Prior to early summer 2020, ACHD ran a testing site of last resort for uninsured people, who made appointments for testing via 2-1-1 calls and poison control referrals. Asymptomatic testing was recommended to be limited to those whose employers mandated testing before returning to work and those attending mass protests in response to the police killing of George Floyd in Minneapolis (Western Pennsylvania Regional Data Center [WPRDC], 2020c).

Starting in late May and early June 2020, ACHD began to expand testing through federally qualified health centers (FQHCs), enabling anyone who wanted a test to receive one after scheduling an appointment, regardless of their insurance status. ACHD and affiliated FQHCs test for COVID-19 with polymerase chain reaction (PCR) tests from the company Curative, Inc.,² which operates a website for appointments for all county-run testing (Curative, Inc., undated). When cases surged in mid-July 2020, tests were limited once again to those with symptoms, those who had confirmed contact with someone with COVID-19, and health care workers (Boden, 2020b). When CDC guidance changed in late August 2020, de-emphasizing testing among close contacts of a person with COVID-19, ACHD maintained its recommendations to test close contacts (Harris, 2020; Lauer, 2020). Mobile and facility-based testing has been available in various locations, including at a site in McKeesport that opened in November 2020 and that is not affiliated with an FQHC (ACHD, undated-d). The county publishes testing locations on an interactive map, and ACHD encourages residents to check its Facebook and Twitter pages for the latest updates (ACHD, undated-b; ACHD, undated-e; ACHD, undated-g). Starting on November 23, 2020, Curative began accepting and billing insurance for the cost of COVID-19 tests. Prior to November, ACHD had utilized funding available through the Coronavirus Aid, Relief, and Economic Security (CARES) Act to pay for all COVID-19 testing (ACHD, undated-d). Legislation passed in December 2020 extended the CARES Act funding and added funds for states to continue testing, contact tracing, and other COVID-19 mitigation efforts (Public Law 116-260, 2020; U.S. Congress, 2020). As of this writing, specific funding allocations for Allegheny County have not been determined.

² On January 4, 2021, the U.S. Food and Drug Administration (FDA) released an alert warning of false results with the Curative SARS-Cov-2 test for COVID-19. The FDA warned of the likelihood of false negative results, particularly when the tests were not used as indicated (e.g., to test asymptomatic patients). Implications for our analysis are described in the Methods section of this appendix.

Figure A.1. Timeline of COVID-19 Testing by the ACHD, 2020

Late March	COVID-19 testing begins through ACHD following CDC guidelines
Late May	ACHD begins to expand testing through FQHCs, enabling anyone who wants a test to receive one after scheduling an appointment
Mid-July	ACHD testing is limited to those with symptoms or with confirmed contact to someone with COVID-19
Late July	ACHD prioritizes testing for those with symptoms or confirmed contact
Late November	Curative begins accepting and billing insurance for the cost of COVID-19 tests
Late December	Legislation extends the CARES Act and adds funds for states to continue testing, contact-tracing, and other COVID-19 mitigation efforts

Throughout the pandemic, testing also has been available through local health systems, including the University of Pittsburgh Medical Center (UPMC) and Allegheny Health Network (AHN), although this testing has largely been restricted to those who participate in affiliated health insurance plans, those who have symptoms, and those with a physician referral. At the same time as testing of the general population was occurring, such institutions as local universities, professional sports teams, and public school districts created their own evolving testing recommendations and procedures (Fowler, 2020; Pittsburgh Public School District, undated; University of Pittsburgh, undated).

All PCR COVID-19 tests ordered by health plans, hospital systems, health departments, and institutions (e.g., universities) in Pennsylvania are entered as individual records into the Pennsylvania—National Electronic Disease Surveillance System (PA-NEDSS), Pennsylvania’s electronic disease reporting system, operated by the Pennsylvania Department of Health (PA DOH).³ The PA-NEDSS is compatible with and feeds into CDC’s National Electronic Disease Surveillance System. After they are administered, most tests are processed at an external lab (e.g., Quest Diagnostics), which reports results into the PA-NEDSS within an expected timeline of one week, although actual turnaround time has been variable and weekends and holidays have introduced additional delays (WPRDC, 2020c). Tests that are returned positive are noted as confirmed cases in PA-NEDSS. People with symptoms of COVID-19 or who have had a close contact with a known case of COVID-19 but whose tests are returned negative are considered probable cases in PA-NEDSS (ACHD, undated-c).

Nonpharmaceutical Interventions and Policies

NPIs, including physical-distancing guidelines, mask ordinances, social-gathering limits, business-operating restrictions and closures, and stay-at-home orders have been put in place by both state and local health officials in Allegheny County over the course of the pandemic.

³ Results of antibody tests are not included in the PA-NEDSS reporting system.

Pennsylvania Governor Tom Wolf and Health Secretary Dr. Rachel Levine issued the first business closure order because of COVID-19 on March 19, 2020. This was closely followed by the first stay-at-home order (except for life-sustaining activities, the order prohibited gatherings and required physical distancing) for seven counties, including Allegheny County, on March 23, 2020. The stay-at-home order was steadily expanded to 33 counties through March 31, 2020, became statewide on April 1, 2020, and expired on June 4, 2020, after several extensions (Office of the Governor, Commonwealth of Pennsylvania, 2020a; 2020b; 2020c; 2020d). Those businesses deemed essential were allowed to remain open and had to comply with specified COVID-19 mitigation procedures (PA DOH, 2020b). A brief timeline of NPIs and mitigation policies is shown in Figure A.2.

Figure A.2. Timeline of Select Nonpharmaceutical Interventions in Allegheny County, 2020 and 2021

March 19, 2020	Governor Wolf and Secretary Levine issue the first business closure order because of the COVID-19 pandemic
March 23	First stay-at-home order and business closures is issued for seven counties, including Allegheny County
April 1	Statewide stay-at-home order is issued
April 27	County-by-county, three-phase plan for reopening is issued. All counties start the process in the red phase, under which only life-sustaining businesses may operate
May 15	Allegheny County moves into the yellow phase, allowing retail businesses to resume in-person operations and school and child care centers to reopen
June 12	Allegheny County enters the green phase, reopening all businesses (although telework must continue where feasible), including indoor dining at bars and restaurants
July 1	Governor Wolf orders a statewide mask mandate in all public spaces
Early July	ACHD orders a one-week closure of bars, restaurants, and casinos and the cancellation of all activities or events with more than 25 people
July 16	All restaurants statewide are required to serve food with any alcohol purchase and to limit occupancy to 25 percent
September 21	Restaurants are allowed to increase indoor capacity to 50 percent
November 18	Allegheny County announces a stay-at-home advisory
December 14	Business and large-gathering restrictions are reinstated, including prohibitions on indoor dining, closure of entertainment venues, and prohibitions on kindergarten through grade 12 (K–12) sports
January 4, 2021	Restrictions on indoor dining, entertainment venues, etc., are lifted and businesses may operate at 50-percent capacity
April 4	Restaurants may resume bar service, most may operate at 75-percent capacity, and outdoor venues may operate at 50-percent capacity. Physical distancing and masks are still required.

On April 27, 2020, Governor Wolf’s office released a county-by-county, three-phase plan for reopening (Office of the Governor, Commonwealth of Pennsylvania, 2020k). Criteria for reopening include “having fewer than 50 new confirmed cases per 100,000 population reported to [PA DOH] in the previous 14 days,” having adequate testing and contact-tracing capacity, and having adequate safeguards in high-risk settings, such as long-term care facilities. All counties started the process in the red phase, under which only life-sustaining businesses may operate, stay-at-home orders are in place, and schools and child care facilities are closed. (A description of the phases appears in Figure A.3.) Allegheny County moved into the yellow phase on May 15,

2020, allowing retail businesses to resume in-person operations and school and child care centers to reopen, but prohibiting gatherings of more than 25 people; prohibiting restaurant operations outside takeout and delivery; and maintaining closures of indoor recreation facilities, gyms, salons, and entertainment facilities (Office of the Governor, Commonwealth of Pennsylvania, 2020e). As of June 12, 2020, Allegheny County entered the green phase, reopening all businesses (although telework must continue where feasible), including indoor dining at bars and restaurants, and resuming operations at salons, gyms, and theatres, with capacity restrictions (Office of the Governor, Commonwealth of Pennsylvania, 2020f).

Figure A.3. Restrictions During Each Phase of Pennsylvania’s Plan for Reopening

COVID-19 REOPENING PHASES		
	WORK & CONGREGATE SETTINGS	SOCIAL SETTINGS
RED PHASE	<ul style="list-style-type: none"> • LIFE-SUSTAINING BUSINESSES ONLY • RESTRICTIONS IN PLACE FOR PRISON + CONGREGATE CARE • SCHOOLS CLOSED FOR IN-PERSON INSTRUCTION • MOST CHILD CARE CLOSED 	<ul style="list-style-type: none"> • STAY AT HOME ORDERED • LARGE GATHERINGS PROHIBITED • RESTAURANTS/BARS LIMITED TO CARRY-OUT + DELIVERY • ONLY TRAVEL FOR LIFE-SUSTAINING PURPOSES
YELLOW PHASE	<ul style="list-style-type: none"> • TELEWORK MUST CONTINUE WHERE FEASIBLE • BUSINESSES WITH IN-PERSON OPERATIONS MUST FOLLOW SAFETY ORDERS • CHILD CARE OPEN WITH WORKER + BUILDING SAFETY ORDERS • RESTRICTIONS IN PLACE FOR PRISON + CONGREGATE CARE • SCHOOLS CLOSED FOR IN-PERSON INSTRUCTION 	<ul style="list-style-type: none"> • STAY AT HOME RESTRICTIONS LIFTED IN FAVOR OF AGGRESSIVE MITIGATION • LARGE GATHERINGS PROHIBITED • IN-PERSON RETAIL ALLOWED CURBSIDE/DELIVERY PREFERRED • INDOOR RECREATION, HEALTH AND WELLNESS FACILITIES (SUCH AS GYMS, SPAS), AND ALL ENTERTAINMENT (SUCH AS CASINOS, THEATERS) REMAIN CLOSED • RESTAURANTS/BARS LIMITED TO CARRY-OUT + DELIVERY
GREEN PHASE	<ul style="list-style-type: none"> • ALL BUSINESSES MUST FOLLOW CDC AND PA DEPARTMENT OF HEALTH GUIDELINES 	<ul style="list-style-type: none"> • AGGRESSIVE MITIGATION ORDERS LIFTED • INDIVIDUALS MUST FOLLOW CDC AND PA DEPARTMENT OF HEALTH GUIDELINES

SOURCE: Tom Wolf [@GovernorTomWolf], 2020.

Rising COVID-19 cases statewide and in Allegheny County through summer 2020 precipitated the implementation of several additional NPIs after reopening occurred. Allegheny County health director Dr. Debra Bogen took steps to stem the spread of COVID-19, including ordering a one-week closure of bars, restaurants, and casinos and the cancellation of all activities or events with more than 25 people at the beginning of July 2020. Indoor dining remained restricted through the middle of July (ACHD, undated-f). On July 1, 2020, Governor Wolf instituted a statewide mask mandate in all public spaces, and on July 16, 2020, executive orders required all restaurants statewide to serve food with any alcohol purchase and to limit occupancy to 25 percent (Office of the Governor, Commonwealth of Pennsylvania, 2020g; 2020h). The state also began to release guidance for reopening schools, requiring districts to submit reopening plans for approval by the district's governing body ("Wolf Administration Updates Guidance for Reopening Pennsylvania Schools," 2020). On August 19, 2020, the Department of Education announced that mask mandates would apply to all students over two years old (Pennsylvania Department of Education, 2020).

In September 2020, restrictions began easing again, with the announcement that restaurants could increase indoor capacity to 50 percent starting on September 21, 2020 (Office of the Governor, Commonwealth of Pennsylvania, 2020i). September 2020 also brought the announcement of the release of a new COVID-19 exposure app, which would notify users if they had been in contact with someone who would later test positive for COVID-19 (Office of the Governor, Commonwealth of Pennsylvania, 2020j).

Anticipating increased spread over the Thanksgiving holiday, state and county officials began announcing travel restrictions in November 2020. On November 18, 2020, Allegheny County announced a stay-at-home advisory, which was followed by a statewide stay-at-home advisory starting November 23, 2020 (ACHD, undated-f; Office of the Governor, Commonwealth of Pennsylvania, 2020l). Business and large-gathering restrictions, including prohibiting indoor dining, closing entertainment venues, and prohibiting K–12 sports, were reinstated in December 2020 and continued through early January 2021 (Office of the Governor, Commonwealth of Pennsylvania, 2020m). Restrictions began to be lifted again in the early spring, with limitations on restaurants, indoor and outdoor recreation venues, and other businesses gradually easing.

Local institutions, such as the University of Pittsburgh, Carnegie Mellon University (CMU), Pittsburgh Public Schools (PPS), UPMC, and AHN, have played a central role in NPI implementation. These institutions operate under the health jurisdiction of the state of Pennsylvania and Allegheny County and are responsible for developing and gaining approval for their operational postures during the pandemic. Both major universities have implemented NPIs, including limiting in-person classes for students, closing residence halls, limiting student activities, and banning large gatherings (CMU, undated; University of Pittsburgh, undated).

There are 43 school districts in Allegheny County, in addition to many private, independent, and religious schools. Each district or private school has been making decisions to deliver

instruction remotely, in person, or using hybrid models. PPS has been almost universally delivering instruction remotely (although some students with special needs have been able to attend school in person), but transitioned to a hybrid model for most students in April 2021 (Pittsburgh Public School District, undated). Several other districts that had been delivering in-person instruction transitioned to remote learning following late fall spikes in COVID-19 cases (“The List: Pittsburgh-Area School Districts Extend Remote Learning as COVID-19 Cases Surge,” 2021). When possible, UPMC and AHN have transitioned care to telehealth, reduced the density of waiting rooms, altered visitation policies, and paused elective procedures, in addition to implementing other mitigation measures (AHN, undated; UPMC, 2020).

Equity-Oriented Response

The BEC, a group of predominantly Black health care providers, researchers, community foundation employees, and local officials who support “the creation of equitable systems to affirm the dignity of every human being through collaborations, networks, and policymaking,” formed to specifically address COVID-19 in vulnerable populations in the Pittsburgh region (BEC, undated-b). Throughout the pandemic, the BEC has advocated for an equitable, community-oriented response to COVID-19, relying on data that support a culturally relevant response and a health care infrastructure that is able to respond to emergent needs among Pittsburgh residents of color.

As data on COVID-19 outcomes (e.g., cases, hospitalizations, deaths) were made public via ACHD dashboards in late May 2020, the BEC combined these data with other sources and published analyses disaggregated by race through a dashboard on their website and updates on their Facebook page (Black Equity Coalition, undated-a; undated-b).⁴ These BEC analyses made it clear that the pandemic was disproportionately affecting Black residents in Allegheny County. Consequently, the BEC advocated that the ACHD implement a comprehensive, transparent, data-driven approach that centered FQHCs to provide testing and other wraparound services that would be more accessible to the priority communities. FQHCs typically serve low-income, largely racial and ethnic minority populations, and the CARES Act funding allowed ACHD to test anyone who needed it for free. As a result of the BEC’s advocacy, FQHCs in Allegheny County have offered free COVID-19 testing to their patients and, starting in fall 2020, embedded culturally competent contact tracers within the FQHCs who have worked in close coordination with ACHD.

In addition to its data analysis, publications, and advocacy efforts, the BEC also has engaged in health communication strategies in partnership with community-based organizations, via web-based seminars, and on social and traditional media (Boden, 2020a; Brown, 2020; “The Lynne Hayes-Freeland Show,” 2021). These messaging efforts have provided information about COVID-19 to the community and encouraged residents to practice physical distancing,

⁴ The BEC COVID-19 dashboard is available at BEC, undated-b.

handwashing, mask-wearing, and other NPIs. The BEC also has promoted equitable vaccine distribution as vaccines have become available in the county. Although COVID-19 response is its current focus, the coalition aims to continue to advocate for health and social systems that serve populations of color in the county after the pandemic is over (Boden, 2020a).

Objectives of the Tool

This tool (1) identifies disparities in the effects of COVID-19 in Allegheny County; (2) examines how the two main policy levers—testing and physical distancing—have been employed as well as their effects and disparities; and (3) provides lessons for Allegheny County and other communities in their attempts to mitigate the spread of COVID-19. The results of these analyses create a portrait of communities that are most vulnerable to COVID-19 and illuminate existing racial inequities in testing, cases, and deaths. The results also identify the successes of policymakers—including targeting testing to the most vulnerable—and provide recommendations to shore up weaknesses and address new challenges as the pandemic evolves. We hope that this tool provides a model for tracking inequities in future pandemic response.

This tool incorporates multiple public data sources to describe how the impact of the pandemic has varied by neighborhood and municipality and by race. The public data that we incorporate are

1. COVID-19 tests, cases, deaths, and other outcomes from the ACHD (WPRDC, 2020b)
2. Surgo's CCVI data (Surgo Ventures, 2020b)
3. measures of physical distancing (i.e., time spent at home) from SafeGraph, Inc. (SafeGraph, undated)
4. additional neighborhood and municipality characteristics from the American Community Survey (ACS) (U.S. Census Bureau, 2020).

Each of our analyses relies on one or more of these data sources. The foundational data for our analyses are the publicly available counts of tests, cases, hospitalizations, and deaths from ACHD. Different versions of these data offer breakdowns by date, neighborhood or municipality, and race. With these data, we capture trends and geographic distributions. These ACHD data are used in Visualization 1 in the tool, as are the ACS data describing neighborhood and municipality characteristics. Visualizations 2, 3, 4, and 6 also use the ACHD and ACS data. Table 1 in the tool describes community vulnerability using the CCVI and is the same as Table A.2. Visualization 5 also uses the CCVI and ACS data to describe the locations of COVID-19 test sites. With these data, we examined attempts by policymakers to target testing to communities experiencing the most vulnerability by comparing test site proximity (in terms of distance and travel time) by level of neighborhood or municipality vulnerability. To further our understanding of access to testing, we obtained supplemental information about the hours of operation and requirements for testing among the various testing sites. Visualizations 7 and 8 use the SafeGraph data along with the CCVI and ACS data. These data describe physical-distancing measures (specifically, the percentage of time spent at home) and their variation by vulnerability

and neighborhood or municipality characteristics. Using these data, we modeled the relationships between tests, cases, and deaths as a function of physical distancing. Our models also accounted for neighborhood and municipality characteristics and time trends, and we explored variation by neighborhood and municipality vulnerability. These analyses show how physical distancing generally reduces the strain on testing, how certain groups are less able to physically distance, and what that means for their testing and health outcomes.

Using this tool, one can learn about

1. sociodemographic characteristics and the vulnerability to COVID-19 of each neighborhood or municipality
2. trends in such outcomes as testing, cases, hospitalizations, intensive care unit (ICU) admissions, ventilator applications, and deaths by sociodemographic characteristics (e.g., race) and geography
3. how testing access has been distributed throughout the county
4. trends in physical distancing and how distancing has varied by spatial vulnerability
5. how the testing and physical-distancing policy levers have affected health outcomes.

Ultimately, the results of these analyses describe lessons learned and aim to inform individual and policymaker efforts to mitigate the spread of COVID-19 as the pandemic continues, prior to widespread vaccine dissemination.

Methods

This research was conducted in partnership between RAND, the BEC, and Surgo Ventures. Surgo Ventures developed the CCVI and contributed to neighborhood- and municipality-level vulnerability analyses and access-to-testing analyses. The BEC contributed historical context about the evolution of the pandemic and its impact on vulnerable populations in Allegheny County. The BEC also contributed data related to trends in COVID-19 by municipality or neighborhood over time from its ongoing dashboard and contributed to the interpretation of data and the recommendations in this report. RAND researchers conducted the remainder of the analyses. All data sources used for the tool appear in Appendix B.

COVID-19 Community Vulnerability Index

Data Sources

The CCVI is inspired by CDC's Social Vulnerability Index (SVI) but adapts the indicators and themes within the index to be more-specifically informed by research on COVID-19 risk (CDC, undated). Specifically, the CCVI adds two themes to the SVI: one on underlying health conditions, which aggregates the rates of known COVID-19 comorbidities within a population, and another on health system, infrastructure, and resources to capture the state of existing public health resources.

The CCVI necessarily incorporated a large range of indicators to capture the many facets of vulnerability. One way to construct such an index is in a data-driven approach, where features for the index (e.g., ICU units per 100,000 people, level of unemployment) are selected based on their measured correlations with outcomes (e.g., mortality, job loss). However, by the time such data on outcomes would have become available, it would have been too late. Instead, Surgo Ventures started with a validated index—the SVI—that was readily available at the census tract level. The SVI contains four themes—socioeconomic status, household composition and disability, minority status and language, and housing type and transportation—that capture populations that are disproportionately affected by disasters. The CCVI ranks each geographic area (e.g., census tract) relative to one another on a 0–1 scale (where 0 = least vulnerable and 1 = most vulnerable).

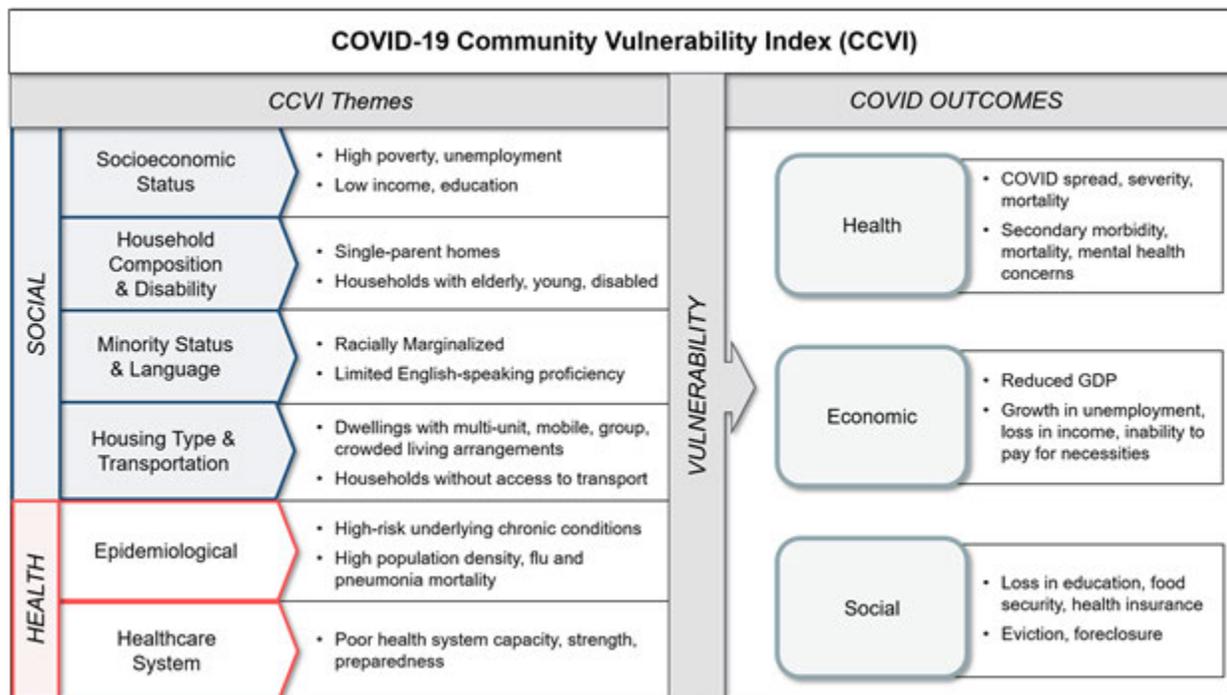
For this analysis, we used the CCVI reported at the census tract level, which was generated via the following steps:

1. For each individual variable (e.g., percentage of the population living below the poverty line) at the census tract level (or geographic unit), percentile ranks were applied to generate a range of 0–1 for each census tract (or county or state) across the United States.
2. For each percentile-ranked variable within a specific theme (e.g., theme 1, socioeconomic status), ranks were summed across each census tract (or county or state).
3. Percentile ranking was once again applied to these aggregated ranks, giving the theme ranks for each of the modular themes (ranks between 0 and 1).
4. The theme ranks were again summed to get the aggregated ranking for the entire CCVI for each census tract.
5. Percentile rankings were applied to this final aggregation to get the overall CCVI score at the census tract level.

Although the SVI is a rigorous tool that is applicable to disease outbreaks, it was not designed specifically for COVID-19 pandemic challenges, which are dependent on epidemiologic determinants and structural conditions. In particular, the SVI did not include a range of risk factors for poor clinical outcomes from the virus or metrics of health system capacity. Early reports suggest that both factors are critical in determining the severity of impact in a given region (Ritchie and Roser, 2020; World Health Organization, 2020). We therefore added themes 5 and 6 to account for the epidemiological and health care system factors, respectively (see Figure A.4). Epidemiological factors (theme 5) were selected according to CDC guidance on high-risk populations and incorporate factors that are linked with COVID-19 transmission and high transmissibility in previous outbreaks. Health care system factors (theme 6) reflect health care capacity, strength, and preparedness, all of which are needed to effectively identify and treat patients. Whereas the SVI is defined at the census tract level, indicators for themes 5 and 6 were available only at coarser geographic levels, such as the county, state, or hospital referral region. We assigned these scores to every census tract within the higher-level geography without applying further corrections.

Together, the six CCVI themes provide a multidimensional picture of a community’s vulnerability to the impacts of COVID-19 (Figure A.4).⁵

Figure A.4. CCVI Themes, Subthemes, and Outcome Measures



SOURCE: This figure was provided by Surgo Ventures and is used with permission.

NOTE: The themes of the index cover a variety of underlying factors that drive vulnerability to a wide variety of adverse pandemic outcomes, some of which are listed on the right of the figure.

In December 2020, Surgo released an updated version of the CCVI, adjusting for new data on case rates and death rates from the previous nine months (Surgo Ventures, undated). Given the release timing, the analysis in this report was conducted using the original version of the CCVI. However, although the updated version does cause small shifts, overall trends remain consistent.

Analysis

To use the CCVI to analyze data in Allegheny County by levels of vulnerability, we needed to convert the CCVI—which exists at a small, census tract level (i.e., a neighborhood unit of approximately 5,000 households)—to a bigger geographic unit that would match the Allegheny County’s data reporting. Allegheny County COVID-19 cases, deaths, and testing rates are reported at the level of county municipality (WPRDC, 2020b). For the City of Pittsburgh, the

⁵ A complete description of the methodology used to construct the index, including all data sources, weighting schematics, and validation metrics, is available at Surgo Ventures, 2020a.

municipal boundary is further broken down into city neighborhoods. To convert the CCVI from the small census tract unit to the larger municipality and/or neighborhood unit, we constructed a crosswalk using WPRDC’s census block geographies data file (WPRDC, 2016). Census tract–level CCVI for Allegheny County was projected down to the census block level (the smallest level of geography), and then a population-weighted mean based on 2010 decennial U.S. Census data was taken across census blocks to construct the CCVI at the neighborhood level. Because of minor discrepancies in the municipal boundary and the City of Pittsburgh neighborhood files, individuals whose city neighborhood cannot be identified are listed as “undefined (Pittsburgh)” in Allegheny County’s COVID-19 counts. These individuals were not assigned a CCVI score.

The result of this was that each municipality and/or neighborhood in Allegheny County was assigned its own unique vulnerability score, which was a weighted average of the CCVI for the census tracts that it encompasses. For a subset of analyses, the neighborhood vulnerability score was classified into categories, creating low (bottom third of all neighborhoods, representing the communities experiencing the lowest vulnerability), medium (middle third of all neighborhoods), and high (top third of all neighborhoods, representing the communities experiencing the highest vulnerability) groups.

Limitations

Composite indexes, such as the CCVI, can simplify complex subjects and enable comparisons across places. However, one limitation of the CCVI is that it can be difficult to correctly interpret. Correct interpretation requires an understanding of the data-collection processes, technologies, transformation methods, biases, and absences of data that are used to construct the composite indicator. It also requires understanding how decisions were made to include or exclude particular data sets. For this reason, we have described each of these points in detail, and additional information is published in Surgo’s methodology (Surgo Ventures, 2020a).

Additionally, although the CCVI and its constituent themes have been validated at the county level using nationally representative outcome metrics and several localized case studies, the predictive power of the index may vary across specific geographic areas. Furthermore, the multipurpose nature of the index means that it is not optimal for any one outcome. Also, the index does not reflect mitigation policies that were already enacted, such as additional care capacity, and home testing kits (for those without transportation). There is a temporal limitation to the CCVI used in these analyses as well. The CCVI was developed in response to COVID-19 outcome data through the end of 2020. The social, economic, and health impacts of the pandemic could change in the future, which might alter the distribution of disease impact.

Another limitation is the inability to infer the magnitude of vulnerability from the index, and heterogeneity within a community might misrepresent the vulnerability of subpopulations or geographies within each area because the index does not capture individual-level data. The CCVI is also entirely specific to COVID-19 and, therefore, infrastructure and training to support these

tools would be limited and not generalizable to other conditions unless a different area-based socioeconomic measure or vulnerability index is used.

COVID-19 Tests, Cases, Hospitalizations, and Deaths

Data Sources

COVID-19 Data

Analyses of COVID-19 tests, cases, hospitalizations, and deaths rely on public data from ACHD. Every day, ACHD extracts a list of cases and tests from PA-NEDSS using SAS code developed by PA DOH. Data from this extract appear in the WPRDC open data portal (WPRDC, 2020a). Table A.3 lists the COVID-19 tests, cases, hospitalizations, and deaths data sets and the variables included.

Table A.3. Variables in COVID-19 Tests, Cases, Hospitalizations, and Deaths Data Sets Hosted on WPRDC Data Portal and Used in This Analysis

Data Set	Variables Included
Allegheny County COVID-19 tests and cases	<ul style="list-style-type: none"> • Individual identification • Collection date • Test result (positive or negative) • Case status (not a case, confirmed, probable) • Hospital flag (indicates whether the individual was admitted to the hospital) • Hospital flag (indicates whether the individual was admitted to the ICU) • Vent flag (indicates whether the individual was put on a ventilator for COVID-19) • Age bucket • Sex • Race • Update date
Allegheny County COVID-19 individual test results ^a	<ul style="list-style-type: none"> • Test identification • Test result (positive or negative) • Collection date • Race • Update date
Allegheny County COVID-19 deaths, by demographic group	<ul style="list-style-type: none"> • Category (age bucket, ethnicity, race, sex) • Demographic (demographic type being summed) • Deaths (number of deaths for the given demographic category) • Update date (date on which all deaths took place or were reported before)
Allegheny County COVID-19 counts by municipality and Pittsburgh neighborhood	<ul style="list-style-type: none"> • Pittsburgh neighborhood or Allegheny County municipality • Individuals tested • Cases (confirmed and probable) • Deaths • Update date

^a The individual test results data were added in the June 2021 revision to this tool. The new test-level data provide a more accurate measure of the changes in testing and the positivity rate.

The testing and case data provided through the WPRDC are updated daily. Each row in the Allegheny County COVID-19 tests and cases data set represents an individual who was tested, and records are overwritten with updates. When people are tested more than once, their row is updated using the following rules: (1) Positive tests overwrite negative tests, (2) PCR tests overwrite antibody or antigen tests, and (3) the first positive PCR test is never overwritten. (Data collected from additional tests do not replace the first positive PCR test.) Information about individual test results is also updated daily. This resource contains the details and results of individual tests, along with the demographic information of the individual tested, but this information is not linked to specific individuals. Only PCR and antigen tests are included.

New U.S. Department of Health and Human Services guidelines for reporting COVID-19 test data were issued on June 4, 2020 (U.S. Department of Health and Human Services, 2020). These

guidelines require reporting on age, race, ethnicity, sex, and residence. At the outset of the pandemic, race and ethnicity and addresses were not captured for a majority of cases in Pennsylvania. (As of June 2020, race was missing from about 57 percent of new cases.) Collaborating with the BEC to understand limitations to collecting data by race and the importance of reporting disaggregated data, ACHD began using information from other sources, including the county's data warehouse, beginning in the second week of June 2020 to improve the availability of data by race and ethnicity in PA-NEDSS. FQHCs also may enter information about race manually into PA-NEDSS. It is still unclear how some labs entering data into PA-NEDSS obtain information on race.

Allegheny County geocodes addresses that were obtained from PA-NEDSS in order to report statistics for neighborhoods and municipalities. Testing at congregate facilities (e.g., jails, long-term care facilities, nursing homes), universities (e.g., the University of Pittsburgh, CMU), and other institutions are reported through PA-NEDSS using the addresses provided by the ordering organization.

Hospitalizations and deaths are updated in the WPRDC portal weekly. Hospitalization data are entered by ACHD into PA-NEDSS through the case investigation process (e.g., if the person is hospitalized at the time that the case investigation is conducted). Local hospitals also send lists of patients hospitalized with COVID-19 to ACHD at least weekly, with some hospitals sharing every day. The county then reconciles these lists with the case data in PA-NEDSS. Because the reconciliation process can take some time, there might be a lag in hospitalization data updates. Death data are based on death events reported in Pennsylvania's Electronic Death Registration System, which is designed to report death events in an accurate and timely fashion. Each U.S. state, territory, and the District of Columbia operates its own Electronic Death Registration System and uses it to report death event data to CDC. Information from funeral homes and medical examiners populates death certificates, which are filed with the state. Deaths are then reported to CDC, where International Statistical Classification of Diseases and Related Health Problems (ICD) codes are added. The state issued specific guidance and information on reported deaths related to COVID-19. The state guidance states that "COVID-19 should be reported for all decedents where the disease caused or is assumed to have caused or contributed to death" (PA DOH, 2020a). Other underlying conditions may be listed as contributing causes in the death record. ACHD includes deaths in which a person had a positive COVID-19 test or the death certificate identifies COVID-19 as a contributing factor in the death.

Limitations

As described previously, ACHD and its testing partners use tests provided by the company Curative to test for COVID-19. On January 4, 2021, the FDA released an alert warning of false results with the Curative SARS-Cov-2 test for COVID-19. The FDA warned of the likelihood of false negative results, particularly when the tests were not used as indicated (e.g., to test asymptomatic patients) (FDA, 2021). Implications for our analysis include potential

underreporting of positive cases in Allegheny County, particularly among populations that rely more heavily on testing through ACHD (e.g., patients seen at FQHCs). As a result, we might be underreporting positive cases among patients who are more likely to be seen at FQHCs, including Black residents and those residing in low-income areas of the county.

Multiple agencies report into PA-NEDSS. Ideally, individuals with multiple tests are combined by the PA DOH as described earlier, creating one record for each individual. However, data inaccuracies across agencies (e.g., misspelled names, use of nicknames, inaccurate dates of birth) make this merging imperfect. Allegheny County has run its own local person-matching algorithm to try to address these issues and has been able to tie together multiple testing records. This local algorithm ties together records (using the *row_id*) but does not merge them. In local reporting (dashboards), these records count as one individual record and are treated the same as the state's merged records. Over time, data corrections have been made and occasionally have been of a large-enough magnitude to affect cumulative case or test counts. These changes are noted where they affect visualizations in the tool.

Other data-quality issues have been identified over the course of the pandemic. There have been instances of the same test being reported by multiple entities (e.g., ordering entity, labs, referring labs, subcontracting labs), and subcontracting arrangements between labs can sometimes affect data quality. Data reported for personal care facilities in Pennsylvania have been reported to have known quality issues (Feldman, 2020). According to an article by Jamie Martines of Spotlight PA on September 2, 2020, the PA DOH is not consistently reporting results for more than 100 of the state's 693 nursing homes, is relying only on self-reported statistics provided by the facilities, and is not using data from PA-NEDSS (Martines, 2020). (It is not known whether Allegheny County facilities are missing from this list.)

Demographic Data

This tool uses U.S. Census Bureau ACS five-year estimates (2015–2019), which were released in December 2020 (U.S. Census Bureau, 2020). We downloaded population estimates by age, sex, and race; and by census block group or for Allegheny County in aggregate to construct per-capita rates of testing, cases, hospitalizations, and deaths. For mapped results, block group data are summed to describe demographic characteristics of the 90 neighborhoods in the City of Pittsburgh and 129 additional municipalities in Allegheny County.

Specific data tables used are

- Table S0101, age and sex, five-year estimates (U.S. Census Bureau, 2019e)
- Table S0601, selected characteristics, five-year estimates (U.S. Census Bureau, 2019f)
- Table B02001, race and ethnicity, five-year estimates (U.S. Census Bureau, 2019a).

In addition, we present ACS estimates of median household income for City of Pittsburgh neighborhoods and Allegheny County municipalities in Visualization 1 in the tool. These estimates derive from the following two ACS tables:

- Table B19001, household income in the past 12 months, five-year estimates (U.S. Census Bureau, 2019b)
- Table B19013, median household income in the past 12 months, five-year estimates (U.S. Census Bureau, 2019c).

The U.S. Census Bureau, 2019c, provides estimates of median household income by municipality in Table B19013, so we present these estimates directly for all municipalities outside Pittsburgh. For city neighborhoods, by contrast, we constructed estimates of median household income using ACS estimates of the number of households in each income bin for each block group in a given neighborhood. This approach uses the pooling and median recalculation method described by the State of California Department of Finance (California State Data Center, Demographic Research Unit, 2011). As noted in that publication, this approach is not exact, because “it assumes an even distribution of incomes within the range and it assumes that there are no duplicate values for the households in the range” (p. 2). We determined this approach to be suitable for the purpose of this tool, which is to illustrate and map the range of household incomes across different communities in Allegheny County.

Data Processing and Analysis

We developed an automated process to update and process COVID-19 data from the WPRDC data portal. Developed using the R programming language, these scripts support the following processing steps:

1. Download the data sets described earlier using the WPRDC application programming interface (API).
2. For data sets that are updated weekly that do not include a longitudinal history (i.e., deaths by demographic subgroup; tests, cases, and deaths by municipality or neighborhood), update a time series data set dating back to the project start date (August 30, 2020) and calculate the weekly or monthly marginal change.
3. For the individual-level data set, calculate a weekly summary of the count of tests, cases, hospitalizations, ICU admissions, and ventilators used by demographic subgroup. For the test-level data set, calculate a weekly summary of the test positivity rate by demographic subgroup.
4. Merge in five-year ACS demographic estimates for key subgroups in Allegheny County (e.g., race) and calculate per-capita rates (counts per 100,000 people) for all measured COVID-19 outcomes.
5. Save resulting summary time-series tables, which are used to dynamically update the tool visualizations.

These scripts are re-run at the beginning of each week to update the data tables that underlie the Tableau visualizations presented in the tool.

COVID-19 Test Site Access

Data Sources

To analyze the level of access to COVID-19 testing across different communities, we used raw, crowdsourced data on test site location and characteristics from the GISCorps API that are updated regularly (GISCorps, undated-a). The data are crowdsourced using news articles and search engine results, official health department dashboards of state and local governments, health institution and federal government websites, and self-reporting by the test sites themselves. The data collection and cleaning and validation is done by more than 1,000 GISCorps volunteers across the United States.

These data include longitude and latitude and other test site variables, such as the types of tests offered and any requirements or criteria to be met before going to the test site (see Appendix C for the full list of variables). These data were validated for Allegheny County through detailed online analysis and qualitative local stakeholder interviews (see the Qualitative Data Collection section of this appendix). This validation process provided updated data for the hours of operation of test sites in Allegheny County and qualitative context about the operational capacity of and resource constraints faced by COVID-19 test sites. Test site locations are updated as of November 12, 2020. We used the following other online sources to get additional information beyond just the number and location of test sites in the county:

1. Google Maps distance matrix API to get distance (miles) and time to travel (minutes) to the nearest test site using public transit or by walking (Google Maps, 2021)
2. MapQuest directions API to get distance (miles) and time to travel (minutes) to the nearest test site by driving (MapQuest, undated)
3. web scraping the Google Maps search results for “covid test Allegheny Pennsylvania” and their criteria or restrictions on who can get tested.

Finally, all of the above data were merged with geographical data on neighborhood CCVI context.

Analysis

To develop insights on testing access and equity, we conducted the following analyses using the tools and methods indicated:

- **Neighborhood vulnerability.** We used R to allocate census block group CCVI values to the neighborhood level using population weights. These values were merged with preexisting shapefiles of Allegheny County neighborhoods and subsequently were mapped using Tableau.
- **Test site location versus vulnerability.** We built a data pipeline using Python to preprocess test site location and characteristics variables at the census tract level. These data were merged with corresponding CCVI vulnerability data and mapped using Tableau to show the distribution of test sites across high-, medium-, and low-vulnerability areas.

- **Test site access: distance and time to travel.** Distance and time from the geographical center of each census tract to the nearest test site were calculated using the Google distance matrix API (for public transit) and MapQuest directions API (for driving) (Google Maps, 2021; MapQuest, undated). The median distance across the high-, medium-, and low-vulnerability census tracts was calculated and compared to assess the level of equitable access to test sites. We also conducted an analyses of highly vulnerable census tracts with a longer-than-median commute to the nearest test site and higher-than-median percentage of people without a vehicle. It is worth noting that, although distance and time to travel are valuable metrics, they do not necessarily directly map to use of or access to testing by individuals. This is meant to indicate only how easy it would be to go to a test site if an individual had the will and resources to do so. Furthermore, these data do not always capture nontraditional testing locations, such as mass, mobile, or temporary testing sites.
- **Test site access: other barriers, criteria and capacity.** To get a better, more nuanced understanding of access to test sites, we calculated test site appointment requirements and average capacity and hours of operation. We obtained test site criteria through web scraping the top Google Maps search results. Qualitative analysis explained the resource and capacity challenges that led to test sites opening for only a few hours per day.

Mobility

Data Sources

To analyze changes in mobility—or the percentage of time spent at home—throughout the COVID-19 pandemic, we obtained access to and used data from data company SafeGraph. Specifically, we used SafeGraph’s Social Distancing Metrics database (SafeGraph, 2021). This database contains daily records going back to January 1, 2019, but we relied on data beginning January 1, 2020. The data are generated using a panel of GPS pings from anonymous mobile devices. The data identify the user’s home, distance traveled, and points of interest to which they travel. For this tool, we were particularly interested in the amount of time spent at home. The mobile device user’s home is determined by identifying the common nighttime location of each mobile device over a six-week period to a Geohash-7 granularity (about 153m × about 153m). The data are then aggregated to the date and census block group. For each date and census block group, the data describe the median amount of time spent at home, from which we derived the median percentage of time spent at home.

After obtaining these SafeGraph data, we performed two types of aggregations. First, to minimize noise in the data, we aggregated from daily data to weekly data. Second, we crosswalked the census block group to the neighborhood or municipality, which is the geographic unit of interest in Pittsburgh. The census block groups are aggregated to the neighborhood or municipality level using population-weighted averages.

To perform the analysis (which we describe in the next section), we linked the mobility data to the CCVI data and to the neighborhood or municipality characteristic data from the ACS. The resulting data that we analyzed are at the neighborhood or municipality level, by week.

Analysis

We modeled the relationships between physical distancing (specifically, the median percentage of time spent at home) and the following outcomes: individuals tested (per 1,000 people), individual-level positivity rate (confirmed or probable cases per total number of individuals tested), and mortality rate (deaths per total confirmed or probable cases). The units of analysis are the neighborhood or municipality (n) and the period or week (t). To assess the relationship between the median percentage of time spent at home (D_{nt}) and the outcomes (Y_{nt}) of individuals tested, cases, and deaths, the distributed lag models that we estimated included controls for potentially confounding neighborhood and municipality characteristics (X_{nt}) and time (week) fixed effects (μ_t).

For our main analysis, we sought to understand how physical distancing differentially correlated with tests, cases, and deaths by the neighborhood's or municipality's characteristics. The neighborhood and municipality characteristics that we examined include vulnerability (or CCVI score), vulnerability within the housing and transportation theme of the CCVI, the percentage of Black residents, the percentage of Asian residents, the percentage of residents ages 65 and older, and the median household income. Using each of these characteristics, each neighborhood and municipality was classified into terciles—low (L_n), medium (M_n), and high (H_n) vulnerability (or other characteristic). To assess how the association between physical distancing and the outcomes varied by neighborhood or municipality vulnerability (or other characteristic), we estimated the following interactive model:

$$Y_{nt} = \alpha + \beta_1 D_{nt} + \beta_2 M_n + \beta_3 H_n + \gamma_1 D_{nt} \times M_n + \gamma_2 D_{nt} \times H_n + \delta X_{nt} + \mu_t + \varepsilon_{nt} \quad (\text{A.1})$$

In Equation A.1, β_1 describes the relationship between the median percentage of time spent at home in neighborhoods and municipalities where $L_n = 1$ (low vulnerability, low percentage of Black residents, low percentage of Asian residents, low percentage of residents ages 65 and older, and low median household income) and the outcome Y_{nt} for tests, cases, or deaths. γ_1 conveys how the outcome is related to time spent at home in neighborhoods and municipalities where $M_n = 1$ (e.g., medium vulnerability), and γ_2 describes how the outcome is related to time spent at home in neighborhoods and municipalities where $H_n = 1$ (e.g., high vulnerability). In each case, the relationships implied by β_1 , γ_1 , and γ_2 are conditional on the characteristics of the neighborhoods and municipalities and on the general time trend in the outcome. In other words, we estimate β_1 , γ_1 , and γ_2 by comparing neighborhoods and municipalities that are similar in observable ways, and we adjust the comparison to account for a general expansion in testing or greater spread of the virus.

In our preferred specifications, the potentially confounding neighborhood and municipality characteristics (X_{nt}) that we control for include measures of the neighborhood's or municipality's distribution of age, sex, race, household size, education, income level, economic

conditions (i.e., unemployment), housing values, transportation patterns (e.g., percentage of people who use public transportation), and distance and duration of travel time to testing sites. Although the results we present in the tool represent our preferred specifications, we also estimated models that included only indexes of neighborhood or municipality characteristics or models that included a more limited set of potentially confounding neighborhood or municipality characteristics.

Our analyses are relatively robust to the set of included confounding neighborhood and municipality characteristics. Additionally, as part of our robustness checks, we examined alternative lag structures. We explored models that included lags up to four weeks prior, which demonstrate that the correlation between the percentage of time spent at home drops with each successive week. The preferred lag structure uses the current and previous week measures.

Limitations

Two significant limitations of this analysis are that (1) the data are observational and (2) the SafeGraph mobility data may be selective. Having observational data without a natural experiment or other quasi-experimental variation that is unrelated to other, unobserved potential determinants of the number of individuals tested, cases, and deaths means that we cannot identify causal relationships. Throughout the pandemic, many factors related to individuals tested, cases, and deaths have been changing with mobility. For instance, mobility restrictions, testing distribution, and other factors have often changed at the same time as mask mandates, and both mobility and masking have likely influenced the spread of the virus and the number of individuals tested. The co-occurrence, rapid evolution, and variation in society's response to the pandemic makes isolating the effects of a particular response difficult. Because we have observational data and no natural experiment or other source of variation in mobility that is unrelated to other potential determinants of individuals tested, cases, and deaths, we refrain from any causal language that would imply that changes in mobility caused a particular outcome. Instead, we employ correlational language and describe our results as suggestive or indicative of relationships between mobility and individuals tested, cases, and deaths.

The second limitation is that the SafeGraph mobility data might be selective, and the selection might be correlated with factors that are related to vulnerability (e.g., race, age, socioeconomic status). The SafeGraph mobility data are generated using a panel of GPS pings from anonymous mobile devices. The panel of anonymous mobile devices is the result of partnerships between SafeGraph and mobile application services that have opt-in consent from users to collect location data. The partnerships allow SafeGraph to see location data from approximately 35 million unique devices in a given month (Painter and Qiu, 2020). Although SafeGraph does not disclose the applications or other data streams that they use, typical sources for these data include weather and shopping applications (Andersen, Bryan, and Slusky, 2020). The first selection concern is that, in the cross-section, the sample of users of the apps that partner with SafeGraph is selective and does not accurately represent certain groups (e.g., the

most vulnerable by CCVI score; those living in high Black, Asian, or elderly communities; those living in communities with low household income). Although the aggregated data that we obtained from SafeGraph cannot explore this concern, prior studies using SafeGraph data find that the data are generally representative of the U.S. population (Chen et al., 2019). The second selection concern is longitudinal: that changes in the use of the partner apps might be correlated with changes in mobility over time and among certain groups. The size of the SafeGraph panel of devices evolves over time as individuals install and remove apps from their phones and because immobile devices do not provide GPS pings. Although we cannot explicitly examine this concern, qualitative insights from SafeGraph suggest that there appears to have been relatively little *app-churn* (i.e., a high rate of installing and removing apps among individuals in the sample) during the pandemic (Andersen, Bryan, and Slusky, 2020).

Qualitative Data Collection

To supplement information that is available from the county on test site locations, hours, and requirements (e.g., symptoms, referrals, appointments), we attempted outreach to the major testing providers in the county. We attempted to contact the following test providers for which we had missing information about their test sites:

- Central Outreach Wellness Center
- Squirrel Hill Health Center
- Greentree Medical Center PC
- Metro Community Health Center
- Primary Care Health Services
- Rite Aid
- Sto-Rox Neighborhood Health Council, Inc.
- UPMC.

We were able to conduct informal conversations and interviews with representatives of three test providers. Conversations lasted from 30 minutes to one hour and covered the following topics:

- test site locations
 - permanent sites versus mobile sites
 - determining locations for mobile sites
 - test eligibility (e.g., symptoms, referrals, whether appointments are required)
 - hours of operation
- Allegheny County testing strategy
 - partnerships between ACHD and FQHCs
 - determining locations for new test sites
- funding for county-affiliated testing
 - billing private insurance, CARES Act funds

- anticipated changes in funding.

Subsequent interviewees confirmed what we heard from previous interviewees, suggesting that we had a comprehensive understanding of these domains. We incorporated findings from outreach into our description of the county context, testing strategy, and the analysis of test site access. We were unable to fully fill gaps in our information about test sites (e.g., hours of operation), and outreach suggested that this information changed frequently as ad hoc test sites were established in the county. Therefore, we decided to conduct an analysis of test site access as of mid-November 2020 (see the earlier section on COVID-19 Test Site Access) and have noted that data were up to date as of November 12, 2020, and do not reflect the fluid nature of test site access in the county.

Data Visualization in Tableau

We used the commercially available Tableau software to develop the interactive visualizations presented in the tool. The tests, cases, hospitalization, and deaths data specifically support tool visualizations 2, 3, 4, 6, and 8. For the most part, the visualizations directly present the post-processed data described in the earlier sections. However, in some cases, we needed to conduct additional processing steps using other data to generate the final visualizations. For example, we recalculated the overall test positivity rate in Tableau using pooled test counts and population numbers to avoid biasing from rates calculated previously for different demographic subgroups. In some cases, we convert weekly totals to daily values using a simple average to improve interpretability.

We used ACHD’s definitions for tests, cases, deaths, and rates per 100,000 as described in its interactive ACHD dashboard (ACHD, undated-a). Following ACHD’s guidelines, we also treat the most recent week of data as preliminary, and some visualizations omit the immediate prior week to avoid confusion or misinterpretation based on incomplete observations.

Specific analytical decisions made for individual visualizations are described in the following sections:

- Visualization 2. Monthly COVID-19 Cases and Individuals Tested, by Municipality or Pittsburgh Neighborhood

Weekly data updates from ACHD corrected preliminary data from previous weeks. In a small number of situations, this resulted in negative values for the number of individuals tested and the number of cases. To address these issues, we suppressed any negative or zero values for new monthly individuals tested and cases. Monthly tests were capped at 500, meaning that bubbles representing new counts of individuals tested that are above 500 are all sized the same. Cumulative cases were capped at 15,000 per 100,000, so case counts above 15,000 per 100,000 appear in the darkest shade of gray.

- Visualization 3. Average New COVID-19 Cases, by Race, and Weekly Cumulative Cases, by Race

We combined data on new daily confirmed or probable cases reported for “other” racial and ethnic groups, which include biracial and multiracial and “other” race categories from the source data. Data on American Indian and Pacific Islander subgroups were excluded because of small sample sizes. We also did not break out data on Hispanic and Latino subgroups separately because analyses used race (versus ethnicity) data from the source data.

- Visualization 6. Positivity Rates and Number of Tests Conducted per 100,000 People, by Race and by Week

We combined data on positivity rates reported for “other” racial and ethnic groups, which include biracial, multiracial, and “other” race categories from the source data. Data on American Indian and Pacific Islander subgroups were again excluded, data on Hispanic and Latino subgroups were not reported separately, and data on tests for individuals of unknown race were excluded because we were unable to calculate per-capita rates without total population estimates. We suppressed positivity rates when the number of average daily tests was less than 25. This suppression resulted in segments of trend lines visualizing positivity rates for Asian residents appearing disjointed.

- Visualization 7. Changes in Time Spent at Home in Allegheny County, by Week

We aggregated daily census block data on the percentage of time spent at home to the week and neighborhood levels using population-weighted averages. Variation can be seen by neighborhood-level measures of population characteristics.

- Visualization 8. Changes in Individuals Tested and Deaths Associated with a 10-Percent Increase in Time Spent at Home

Using data at the neighborhood or municipality level, by week, we estimated models of individuals tested (per 1,000 people) and deaths among those who tested positive. The relationships described in the figures are correlations that are conditional on neighborhood characteristics, such as average age, race, and household income (for more details on the models, see the earlier section on Mobility and, particularly, the Analysis subsection).

How to Use the Tool

The tool includes a variety of features (maps and figures), many of which are interactive and allow the user to see the information in a different way or dive deeper into the data. In this section, we describe how one can interact with each of the tool’s features.

Visualization 1. Vulnerability and Socioeconomic Characteristics, by Municipality or Pittsburgh Neighborhood

Visualization 1 shows two maps of Allegheny County with the administrative boundaries of each neighborhood and municipality. The colors of the map provide information about the vulnerability (CCVI tercile) (on the left) and socioeconomic characteristics (percentage of Black residents, percentage of Asian residents, percentage of residents over age 65, and median

household income) (on the right) for each neighborhood and municipality. Selecting each element in the legend highlights associated geographies in the map and grays out others.

Visualization 2. Monthly COVID-19 Cases and Individuals Tested, by Municipality or Pittsburgh Neighborhood

Visualization 2 shows how the geographic distribution of the number of individuals tested and the number of cases have changed over time with maps of cumulative and monthly individuals tested and cases per 100,000 people in each Allegheny County municipality or City of Pittsburgh neighborhood. Bubbles within each municipality or neighborhood are sized to represent the number of new individuals tested monthly. Geographic areas are shaded along a color scale representing the cumulative number of cases per 100,000 people during the selected month. By moving along the time slider, it is possible to explore monthly cumulative and new individuals tested and cases for each month since September 2020. Selecting each element in the legend highlights associated geographic areas in the map and grays out others.

Visualization 3. Average New COVID-19 Cases, by Race, and Weekly Cumulative Cases, by Race

Visualization 3 shows how the number of confirmed and probable cases has changed over time and accumulated. The unit of time displayed on the horizontal axis of this figure is each week, but the numbers presented are average daily values within that week. The feature allows the user to view the information in different ways, including average new confirmed and probable cases, cumulative confirmed and probable cases, and cumulative confirmed and probable cases by race. Additionally, users can hover over the bars and lines to a period of interest and the figure will show the specific value of new cases or cumulative cases. Selecting each element in the legend highlights associated lines or bars in the chart and grays out others.

Visualization 4. Total Hospitalizations, ICU Admissions, Ventilator Use, and Deaths Because of COVID-19 by Race, per 100,000 People

Visualization 4 shows how the rate of hospitalizations, ICU admissions, ventilator use, and deaths has accumulated over time in the county per 100,000 people, by race. The unit of time displayed on the horizontal axis of this figure is the week. Additionally, users can hover over the lines to a period of interest and the tool will show the specific value. Selecting each element in the legend highlights associated lines in the chart and grays out others.

Visualization 5. Test Sites, by Neighborhood or Municipality Vulnerability, and Census Tracts with Test Site Access Challenges

Visualization 5, like Visualizations 1 and 2, shows a map of Allegheny County with the administrative boundaries of each neighborhood and municipality. Additionally, the points

displayed on this figure may represent test site locations. Each neighborhood or municipality is shaded by its vulnerability, as defined by the CCVI (either overall vulnerability or vulnerability specific to the housing and transportation theme of the CCVI). Users can toggle between maps showing the test site locations and the vulnerability of each neighborhood and municipality, vulnerability within the housing and transportation theme of the CCVI, or the areas with longer-than-median travel times to the nearest test site or larger-than-median percentages of residents without access to a vehicle. Selecting each element in the legend highlights associated geographic areas in the map and grays out others.

Visualization 6. Positivity Rates and Number of Tests Conducted per 100,000 People, by Race and by Week

Visualization 6 shows how testing and test positivity rates have evolved in Allegheny County throughout the pandemic. The unit of time displayed on the horizontal axis of this figure is the week, although the numbers again reflect a daily average over a given week for improved interpretability. The visualization allows the user to view the information in different ways, including the average positivity rate (i.e., the number of positive tests divided by the total number of tests), the average positivity rate by race, and the rate of average daily tests by race (per 100,000 people). The average positivity rate is displayed alongside the benchmark positivity rate of 5 percent set by the World Health Organization, which is shown with a blue line in the top graph. (The benchmark rate is from Johns Hopkins University of Medicine Coronavirus Resource Center, 2021.) Additionally, users can hover over the bars for a period of interest and the tool will show the specific value of test levels, rates, or positivity rate. Selecting each element in the legend highlights associated lines in the chart and grays out others.

Visualization 7. Changes in Time Spent at Home in Allegheny County, by Week

Visualization 7 shows how the percentage of time spent at home has changed throughout the pandemic and how the percentage of time at home has varied by vulnerability (CCVI score), the percentage of Black residents, the percentage of Asian residents, the percentage of residents ages 65 and older, and the median household income. The unit of time displayed on the horizontal axis of this figure is the week. Periods when Allegheny County was in the red, yellow, and green phases of reopening are shaded. The feature allows the user to toggle between overall mobility to tercile breakdowns by vulnerability, as defined by the CCVI (either overall or within the housing and transportation theme), and other neighborhood and municipality demographic and socioeconomic characteristics. Additionally, users can hover over the lines to a period of interest and the figure will show the precise percentage of time spent at home. Selecting each element in the legend highlights associated lines in the chart and grays out others.

Visualization 8. Changes in Individuals Tested and Deaths Associated with a 10-Percent Increase in Time Spent at Home

Visualization 8 shows how a 10-percent decrease in mobility (i.e., an increase in the percentage of time spent at home) is associated with changes in the number of individuals tested and death rates among those who have tested positive for COVID-19. The feature allows the user to toggle between tercile breakdowns by vulnerability, as defined by the CCVI (either overall or within the housing and transportation theme), and other neighborhood and municipality demographic and socioeconomic characteristics (e.g., percentage of Black residents, percentage of Asian residents, percentage of residents ages 65 and older, and median household income) to see how increasing time spent at home is associated with changes in the number of individuals tested and deaths for each characteristic. Selecting each element in the legend highlights associated bars in the chart and grays out others.

Links Between Our Analyses and the Recommendations

In this section, we describe how our analyses led to the recommendations presented in the tool. The recommendations are informed both by the quantitative analyses described earlier and by the qualitative insights gathered from those in policymaking, advocacy, and health care positions in Allegheny County. Although each of the analyses and the qualitative insights are retrospective, insights can be drawn from the results to inform the planning and policies undertaken during the remainder of the pandemic. These lessons can be applied by local policymakers in Allegheny County and can inform policymakers throughout the country.

Our first recommendation involves data collection and reporting. Specifically, we highlight the importance of access to and the monitoring of disaggregated data by race and linked to geography because the impacts of the pandemic across different populations and communities change over time. Implied here is the recommendation to make relevant data publicly available and accessible; otherwise, the monitoring of the data (and our study) would not be possible. This recommendation is also based on qualitative insights provided by those involved in advocacy. Additionally, the data must be constructed to inform questions of equity. This recommendation was informed by analyses describing variation in test access, testing, cases, deaths, and physical distancing by measures of vulnerability and by neighborhood and municipality characteristics.

Our second recommendation suggests the need for greater assistance to help communities experiencing the most vulnerability practice physical distancing and the need for mobile testing so that those experiencing higher vulnerability can receive the testing that they need. This recommendation is the result of the analysis of deaths and physical distancing, which shows dramatic reductions in deaths among communities experiencing the highest vulnerability when both physical distancing and testing are achieved.

The third recommendation is that the county could appoint an equity-focused executive governance panel to provide continuous expert advice and feedback on critical issues and

interventions moving forward. This recommendation arises from qualitative insights describing the partnerships between the county and local FQHCs to provide access to testing and other services to priority communities, as well as from concerns about ongoing inequity in COVID-19 outcomes. The quantitative results support this recommendation: They show that efforts to target testing among the communities experiencing the highest vulnerability have generally been effective.

The fourth recommendation is that, to achieve equitable distribution of vaccine across communities in Allegheny County, identified best practices (e.g., test site distribution, FQHC partnerships) should be replicated with a focus on funding sources that support equitable access and resources. This recommendation is forward-looking and therefore is not directly related to the retrospective data and results highlighted in this study. However, this recommendation represents an attempt to learn from the responses of Allegheny County to the COVID-19 pandemic that worked and where additional resources can be targeted to improve on what has been done. Consequently, this recommendation draws on all of the qualitative and quantitative insights that have demonstrated successes (e.g., high testing rates among select and/or communities experiencing the highest vulnerability) and limitations (e.g., the need for greater assistance to both physically distance and receive testing).

Appendix B. Data Sources

In Table B.1, we present all of the data sources we used for the online tool.

Table B.1. Data Sources Used for the Tool

Name of Data Source	Organization	Source Citation
Allegheny County COVID-19 tests, cases, and deaths <ul style="list-style-type: none"> Allegheny County COVID-19 tests and cases Allegheny County COVID-19 individual test results Allegheny County COVID-19 deaths, by date Allegheny County COVID-19 deaths, by demographic group Allegheny County COVID-19 counts, by municipality and Pittsburgh neighborhood 	ACHD	WPRDC, 2020b <ul style="list-style-type: none"> WPRDC, undated-b WPRDC, 2021; WPRDC, undated-d WPRDC, undated-e WPRDC, undated-c WPRDC, undated-a
Allegheny County testing site locator map	Allegheny County	ACHD, undated-b.
ACS <ul style="list-style-type: none"> Table S0101, Age and Sex—United States, 5-Year Estimates Table S0601, Selected Characteristics of the Total and Native Populations of the United States, 5-Year Estimates Table S1903, Median Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars)—Allegheny County, Pennsylvania, and Pittsburgh City, Pennsylvania, 5-Year Estimates Table B02001, Race & Ethnicity, 5-Year Estimates Table B19001, Household Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars), 5-Year Estimates Table B19013, Median Household Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars), 5-Year Estimates 	U.S. Census Bureau	<ul style="list-style-type: none"> U.S. Census Bureau, 2019e U.S. Census Bureau, 2019f U.S. Census Bureau, 2019g; U.S. Census Bureau, 2019h U.S. Census Bureau, 2019a U.S. Census Bureau, 2019b U.S. Census Bureau, 2019c
CDC SVI	CDC	CDC, undated
GISCorps COVID-19 Testing Sites Locator	GISCorps	GISCorps, undated-b
Google Maps	Google	Google Maps, undated

Name of Data Source	Organization	Source Citation
Google Maps distance matrix API	Google	Google Maps, 2021
MapQuest directions API	MapQuest	MapQuest, undated
SafeGraph social distancing metrics	SafeGraph	SafeGraph, 2021

Appendix C. GISCorps Testing Data Variables

We used the following variables in the GISCorps testing data set (GISCorps, undated-b):

- facility name
- complete address of facility (includes street address, city, state, zip code)
- municipality (city or town where the testing site is located)
- name of owner (a county health department, a private lab, a hospital, etc.)
- owner type (state, county, private, etc.)
- hours of operation
- contact name (a person who can be contacted for updated information about the testing site)
- contact phone number
- contact email
- website (of testing facility or facility operator)
- comment (This is any information the public should know. This will appear on the public pop-up. There is a 500 character limit.)
- instructions (Specifics: Who can be tested? What do they need to bring? This will appear on the public pop-up below the comment. There is a 500 character limit.)
- vehicle capacity (for drive-through testing centers only)
- daily testing capacity (the number of people who can be tested in a day)
- status (testing suspended, testing discontinued, operational, scheduled to end testing, scheduled to begin testing, impacted, testing restricted [for hospitalized patients; symptomatic health care workers, first responders only, current patients only, veterans only; students or employees of an institution only], invalid, not publicly shared, pending review, missing information). Only points with the following status values will appear in the public map: operational, testing restricted, impacted, scheduled to open, scheduled to close, testing suspended, and testing discontinued.
- referral required (yes or no)
- drive-through testing (yes or no)
- appointment required (yes or no)
- virtual or telehealth screening (available, required, no)
- services offered (testing only, screening only, screening and testing)
- health department website (URL for the health department with jurisdiction over that testing site)
- state (two-letter abbreviation for U.S. state or territory name)
- data source (indicate where you found the information [for internal use only])
- county (or parish or district, etc.)
- start date (the date testing will begin)
- end date (the final date of testing)
- kind of test (see test type options below)
- processing location (point-of-care [on-the-spot results], on-site lab, off-site lab, lab [unspecified location], not specified, not applicable)

- red flag: This defaults to no, but you can change it to yes if you find a testing site that appears to be fraudulent, appears to be unethical, or is using tests that are not FDA-authorized.
- volunteer notes (Leave explanatory information here that will be helpful to other volunteers or people analyzing the data in the future. 500 characters or less.)
- fine print: This defaults to no. Setting this to yes indicates that there is some kind of stipulation or requirement for testing. Examples include centers that require patients to donate blood in order to get an antibody test result or centers that require that people participate in a research study to be tested.
- test type options:
 - molecular (lab test). These include the PCR tests that we have been seeing most so far. They are usually swab tests (nasal or oral) that are sent to a lab for processing. These tests confirm the presence of the virus by targeting its genetic material in a tissue sample (usually a swab). Sometimes the lab is on-site and sometimes the lab is off-site. Processing time varies. Example: CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel (CDC).
 - molecular (point-of-care test). These are usually swab tests that can be administered and processed on the spot by a trained person, usually returning results within minutes. These tests confirm the presence of the virus within minutes by targeting its genetic material in a tissue sample (usually a nasal or oral swab). They are not sent to a lab, either on-site or off-site. Example: recently authorized Abbott ID NOW Rapid test.
 - antibody (lab test). These are blood tests (also called serology or serological tests) that are sent to a lab, either on-site or off-site, for processing. Processing time varies. Antibody tests are used as screening tests; they indicate previous exposure but cannot diagnose current infection. Example: Abbott's IgG antibody test.
 - antibody (point-of-care test). These are the finger-prick blood tests (also called serology or serological tests) that are processed on the spot by a trained person, usually returning results within minutes. They are not sent to a lab, either on-site or off-site. Antibody tests are used as screening tests; they indicate previous exposure but cannot diagnose current infection. None of these have been authorized by the FDA yet, but there have been some testing sites that offer these tests.
 - antigen. These are tests that look for proteins specific to the virus. They are diagnostic tests and were approved in the second week of May 2020. So far, we have not seen them in use but no doubt we will start seeing them soon.
 - molecular and antibody. Sites offering both molecular and antibody testing.
 - molecular and antigen. Sites offering both molecular and antigen testing.
 - antibody and antigen. Sites offering both antibody and antigen testing.
 - all three. This is for testing sites that are offering molecular, antibody, and antigen testing.
 - none (screening only). This is for dedicated screening sites that are not collecting specimens of any kind.
 - not specified. Choose this option if the website does not provide test type information.

- needs more research. If the website provides vague test type information and you are not able to make a determination, either call the testing center and ask or choose this option.

References

ACHD—*See* Allegheny County Health Department.

AHN—*See* Allegheny Health Network.

Allegheny County Health Department, “Allegheny County COVID-19 Information,” Tableau data, undated-a. As of January 22, 2021:

https://tableau.alleghenycounty.us/t/PublicSite/views/AlleghenyCountyCOVID-19Information_15912788131180/Landingpage?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3AshowVizHome=no&%3Aorigin=viz_share_link&%3Amobile=true

Allegheny County Health Department, “Allegheny County COVID-19 Testing Locations,” ArcGIS map, undated-b. As of December 14, 2020:

<http://alcogis.maps.arcgis.com/apps/Nearby/index.html?appid=472bad5ba19f4247a094d55e712195c8>

Allegheny County Health Department, “Coronavirus: COVID-19 Testing—Information on COVID-19 Testing,” webpage, undated-c. As of December 14, 2020:

<https://www.alleghenycounty.us/Health-Department/Resources/COVID-19/Information-on-COVID-19-Testing.aspx>

Allegheny County Health Department, “Coronavirus: McKeesport Testing Site—Allegheny County COVID-19 Testing,” webpage, undated-d. As of December 14, 2020:

<https://www.alleghenycounty.us/Health-Department/Resources/COVID-19/McKeesport-Testing-Site.aspx>

Allegheny County Health Department, Facebook page, undated-e. As of December 14, 2020:

<https://www.facebook.com/AlleghenyCountyHealth/>

Allegheny County Health Department, “News Releases,” webpage, undated-f. As of January 5, 2021:

<https://www.alleghenycounty.us/Health-Department/Resources/Public-Health-Information/News-Releases.aspx>

Allegheny County Health Department, Twitter page, undated-g. As of December 14, 2020:

<https://twitter.com/healthallegheny>

Allegheny Health Network, “Your Coronavirus Resource,” webpage, undated. As of January 6, 2021:

<https://www.ahn.org/coronavirus.html>

Andersen, Martin, Sylvia Bryan, and David Slusky, *COVID-19 Surgical Abortion Restriction Did Not Reduce Visits to Abortion Clinics*, Bonn, Germany: Institute of Labor Economics, October 2020.

BEC—*See* Black Equity Coalition.

Black Equity Coalition, Facebook page, undated-a. As of January 6, 2021:

<https://www.facebook.com/blackequitypgh>

Black Equity Coalition, homepage, undated-b. As of January 6, 2021:

<https://www.blackequitypgh.org/>

Boden, Sarah, “New Pittsburgh Coalition Tackles Racial Inequities and the Pandemic,” WESA Pittsburgh, June 8, 2020a. As of January 6, 2021:

<https://www.wesa.fm/post/new-pittsburgh-coalition-tackles-racial-inequities-and-pandemic#stream/0>

Boden, Sarah, “To Meet Demands of Coronavirus Surge, County Health Department Changes Testing Guidelines,” WESA Pittsburgh, July 15, 2020b. As of December 14, 2020:

<https://www.wesa.fm/post/meet-demands-coronavirus-surge-county-health-department-changes-testing-guidelines#stream/>

Brown, Fred, “Brown’s Viewpoint: ‘This Is Something You Can’t Walk Away From,’”

Pittsburgh Business Times, June 12, 2020. As of March 12, 2021:

https://www.bizjournals.com/39pittsburgh/news/2020/06/12/browns-viewpoint-cant-walk-away.html?fbclid=IwAR1BxBft9Cuy6ejpaEiB67c_21eTaoaBUameQlxRrksX8hKJ9PxcWCn-jKc

California State Data Center, Demographic Research Unit, “Re-Calculating Medians and Their Margin of Errors for Aggregated ACS Data,” Sacramento, Calif.: State of California Department of Finance, February 3, 2011. As of January 21, 2021:

https://www.dof.ca.gov/Forecasting/Demographics/Census_Data_Center_Network/documents/How_to_Recalculate_a_Median.pdf

Carnegie Mellon University, “COVID-19 Updates: Information and Resources for the CMU Community,” webpage, undated. As of January 6, 2021:

<https://www.cmu.edu/coronavirus/preparing-campus/service-postures/index.html>

CDC—*See* Centers for Disease Control and Prevention.

Centers for Disease Control and Prevention, “CDC Social Vulnerability Index (SVI),” data set, undated. As of April 26, 2021:

<https://data.cdc.gov/Health-Statistics/CDC-Social-Vulnerability-Index-SVI-/u6k2-rtt3/data>

Centers for Disease Control and Prevention, “COVID-19 Secondary Data and Statistics,” webpage, updated May 6, 2020. As of December 15, 2020:
<https://www.cdc.gov/library/researchguides/2019novelcoronavirus/datastatistics.html>

Chen, M. Keith, Kareem Haggag, Devin G. Pope, and Ryne Rohla, “Racial Disparities in Voting Wait Times: Evidence from Smartphone Data,” *Review of Economics and Statistics*, August 2019, pp. 1–27.

CMU—See Carnegie Mellon University.

Curative, Inc., homepage, undated. As of December 14, 2020:
www.curative.com

De Vita, Carol J., and Maura R. Farrell, *Poverty and Income Insecurity in the Pittsburgh Metropolitan Area*, Washington, D.C.: The Urban Institute, November 2014.

FDA—See U.S. Food and Drug Administration.

Feldman, Nina, “‘We Don’t Even Know Where They Got This Information’: Pa. Nursing Home Data Release Is Riddled with Errors,” WHYY Philadelphia, May 21, 2020. As of January 7, 2021:
<https://whyy.org/articles/we-don-t-even-know-where-they-got-this-information-pa-nursing-home-data-release-is-riddled-with-errors/>

Fowler, Jeremy, “NFL to Test Players for Coronavirus Daily Until Sept. 5,” *ESPN.com*, August 12, 2020. As of December 14, 2020:
https://www.espn.com/nfl/story/_/id/29646635/nfl-test-players-daily-sept-5-source-says

Gayle, Helene, William Foege, Lisa Brown, and Benjamin Kahn, eds., *Framework for Equitable Allocation of COVID-19 Vaccine*, Washington, D.C.: The National Academies Press, 2020.

GISCorps, “GISCorps COVID-19 Resources: Apps and Data Created by GISCorps Volunteers,” webpage, undated-a. As of April 26, 2021:
<https://covid-19-giscorps.hub.arcgis.com/>

GISCorps, “Locate COVID-19 Testing Sites,” data set, undated-b. As of April 26, 2021:
<https://www.giscorps.org/covid-19-testing-site-locator/>

Google Maps, homepage, undated. As of April 20, 2021:
<https://www.google.com/maps>

Google Maps, “Web Services: Distance Matrix API,” webpage, updated April 20, 2021. As of April 26, 2021:
<https://developers.google.com/maps/documentation/distance-matrix/overview>

- Harris, Richard, “CDC’s Changed Testing Guidelines Could Lead to Less Testing, Experts Fear,” *NPR.org*, August 26, 2020. As of December 14, 2020:
<https://www.npr.org/sections/health-shots/2020/08/26/906389823/cdcs-changed-testing-guidelines-could-lead-to-less-testing-experts-fear>
- Johns Hopkins University of Medicine Coronavirus Resource Center, “Which U.S. States Meet WHO Recommended Testing Criteria?” webpage, updated May 3, 2021. As of May 3, 2021:
<https://coronavirus.jhu.edu/testing/testing-positivity>
- Lauer, Hallie, “COVID-19 Update: Allegheny County’s Total Cases Exceed 10,000; Health Director Reconsidering Crowd Limits,” *Pittsburgh Post-Gazette*, 2020. As of December 14, 2020:
<https://www.post-gazette.com/news/health/2020/08/26/COVID-19-allegheny-county-pittsburgh-pennsylvania-data-deaths-cases/stories/202008260101>
- “The List: Pittsburgh-Area School Districts Extend Remote Learning as COVID-19 Cases Surge,” *Pittsburgh Post-Gazette*, January 1, 2021. As of January 6, 2021:
<https://www.post-gazette.com/news/education/2021/01/01/Pittsburgh-western-pennsylvania-schools-education-closings-remote-virtual-learning-COVID-19-cases-3-1/stories/202101010117>
- “The Lynne Hayes-Freeland Show,” KDKA-2 CBS Pittsburgh, January 2021. As of March 12, 2021:
<https://pittsburgh.cbslocal.com/video/program/754/5129324-impact-of-covid-19-vaccine-part-1/?fbclid=IwAR1OcSfNCm3K4svFFmR-E76eodNI-GjY7I4CCiOVIJItYwZaZ7cVSVwnBzI>
- MapQuest, “Directions API,” webpage, undated. As of April 26, 2021:
<https://developer.mapquest.com/documentation/directions-api/>
- Martines, Jamie, “Nursing Home COVID-19 Case, Death Data Still Missing from PA’s Public Reports,” *Spotlight PA*, September 2, 2020. As of January 7, 2021:
<https://www.spotlightpa.org/news/2020/09/pa-nursing-home-coronavirus-deaths-cases-public-data-missing/>
- Musa, Donald, Scott Beach, Christopher Briem, Janet Schlarb, and Richard Schulz, *The State of Aging in Allegheny County*, Pittsburgh, Pa.: Center for Social and Urban Research, University of Pittsburgh, October 2014.
- Office of the Governor, Commonwealth of Pennsylvania, *Order of the Governor of the Commonwealth of Pennsylvania Regarding the Closure of All Businesses That Are Not Life Sustaining*, Harrisburg, Pa., March 19, 2020a.

Office of the Governor, Commonwealth of Pennsylvania, *Order of the Governor of the Commonwealth of Pennsylvania for Individuals to Stay at Home*, Harrisburg, Pa., March 23, 2020b.

Office of the Governor, Commonwealth of Pennsylvania, *Amendment to the Order of the Governor of the Commonwealth of Pennsylvania for Individuals to Stay at Home*, Harrisburg, Pa., March 31, 2020c.

Office of the Governor, Commonwealth of Pennsylvania, *Order of the Governor of the Commonwealth of Pennsylvania for Individuals to Stay at Home*, Harrisburg, Pa., April 1, 2020d.

Office of the Governor, Commonwealth of Pennsylvania, “Gov. Wolf Announces 13 Counties Will Move to Yellow Phase of Reopening on May 15,” news release, May 8, 2020e. As of December 15, 2020:

<https://www.governor.pa.gov/newsroom/gov-wolf-announces-13-counties-will-move-to-yellow-phase-of-reopening-on-may-15/>

Office of the Governor, Commonwealth of Pennsylvania, “Gov. Wolf: 12 More Counties Going Green on June 12,” news release, June 5, 2020f. As of December 15, 2020:

<https://www.governor.pa.gov/newsroom/gov-wolf-12-more-counties-going-green-on-june-12/>

Office of the Governor, Commonwealth of Pennsylvania, “Gov. Wolf: Sec. of Health Signs Expanded Mask-Wearing Order,” news release, July 1, 2020g. As of January 5, 2021:

<https://www.governor.pa.gov/newsroom/gov-wolf-sec-of-health-signs-expanded-mask-wearing-order/>

Office of the Governor, Commonwealth of Pennsylvania, “Wolf Administration Announces Targeted Mitigation Efforts in Response to Recent COVID Case Increases,” news release, July 15, 2020h. As of January 5, 2020:

<https://www.governor.pa.gov/newsroom/wolf-administration-announces-targeted-mitigation-efforts-in-response-to-recent-covid-case-increases/>

Office of the Governor, Commonwealth of Pennsylvania, “Governor Wolf Announces Restaurants May Increase Indoor Occupancy to 50 Percent Starting September 21,” news release, September 8, 2020i. As of January 5, 2021:

<https://www.governor.pa.gov/newsroom/governor-wolf-announces-restaurants-may-increase-indoor-occupancy-to-50-percent-starting-september-21/>

Office of the Governor, Commonwealth of Pennsylvania, “Wolf Administration Launches COVID Alert PA App, Encourage PA to Unite to Stop the Spread,” news release, September 22, 2020j. As of January 5, 2021:

<https://www.governor.pa.gov/newsroom/wolf-administration-launches-covid-alert-pa-app-encourage-pa-to-unite-to-stop-the-spread/>

Office of the Governor, Commonwealth of Pennsylvania, “Process to Reopen Pennsylvania,” webpage, updated November 19, 2020k. As of December 15, 2020:

<https://www.governor.pa.gov/process-to-reopen-pennsylvania/>

Office of the Governor, Commonwealth of Pennsylvania, *Limited-Time Stay at Home Advisory of the Governor of the Commonwealth of Pennsylvania*, Harrisburg, Pa., November 23, 2020l.

Office of the Governor, Commonwealth of Pennsylvania, “Gov. Wolf, Sec. of Health Announce New Protective Mitigation Efforts to Put Pennsylvania on Pause Through Early January,” news release, December 10, 2020m. As of January 6, 2021:

<https://www.governor.pa.gov/newsroom/gov-wolf-sec-of-health-announce-new-protective-mitigation-efforts-to-put-pennsylvania-on-pause-through-early-january>

PA DOH—See Pennsylvania Department of Health.

Painter, Marcus, and Tian Qiu, “Political Beliefs Affect Compliance with Government Mandates,” *Journal of Economic Behavior and Organization*, April 6, 2020.

Pennsylvania Department of Education, “Answers to FAQs: Universal Face Coverings Order,” webpage, updated November 17, 2020. As of January 5, 2020:

<https://www.education.pa.gov/Schools/safeschools/emergencyplanning/COVID-19/Waivers/MaskWearing/Pages/default.aspx?fbclid=IwAR0lSqaEy1bITo908sBH4TS00GsmcYkQfoQw0GGbh-hwKnqG8SZhQvDQwPM>

Pennsylvania Department of Health, “Additional Guidance for Medical Professional: Reporting of Deaths Attributed to COVID-19,” State Registrar Notice 2020-13, April 8, 2020a. As of January 8, 2021:

<https://www.health.pa.gov/topics/Documents/Reporting-Registries/SRN%202020-13%20Additional%20Guidance%20for%20Medical%20Professionals%20-%20Reporting%20of%20Deaths%20Attributed%20to%20COVID-19.pdf>

Pennsylvania Department of Health, *Order of the Secretary of the Pennsylvania Department of Health Directing Public Safety Measures for Businesses Permitted to Maintain In-Person Operations*, April 15, 2020b. As of December 14, 2020:

<https://www.governor.pa.gov/wp-content/uploads/2020/04/20200415-SOH-worker-safety-order.pdf>

Pittsburgh Public School District, “Reopening Our Schools,” webpage, undated. As of December 14, 2020:

<https://www.pghschools.org/domain/1387>

Public Law 116-260, Consolidated Appropriations Act of 2021, December 27, 2020.

Ritchie, Hannah, and Max Roser, “What Do We Know About the Risk of Dying from COVID-19?” Our World in Data, March 25, 2020. As of May 1, 2021:

<https://ourworldindata.org/covid-mortality-risk>

Ro, Christine, “Coronavirus: Why Some Racial Groups Are More Vulnerable: From Discrimination to Language, a Variety of Factors Are Affecting Different Groups’ Vulnerability to Coronavirus—with Sometimes Devastating Results,” BBC Future, April 20, 2020. As of January 6, 2021:

<https://www.bbc.com/future/article/20200420-coronavirus-why-some-racial-groups-are-more-vulnerable>

SafeGraph, homepage, undated. As of January 22, 2021:

<https://www.safegraph.com/>

SafeGraph, “Social Distancing Metrics,” webpage, 2021. As of January 22, 2021:

<https://docs.safegraph.com/docs/social-distancing-metrics>

Surgo Ventures, “The U.S. COVID Community Vulnerability Index (CCVI),” webpage, undated. As of January 21, 2021:

<https://precisionforcovid.org/ccvi>

Surgo Ventures, “COVID-19 Community Vulnerability Index (CCVI) Methodology,” Google document, March 24, 2020a. As of April 23, 2021:

https://docs.google.com/document/d/1aN9BcOYojcr7p9zRnwBHYJ_02fKDyJJavnjTl3A0JT0/edit#

Surgo Ventures, “COVID-19 Community Vulnerability Index (CCVI),” Google spreadsheet, May 5, 2020b. As of April 23, 2021:

<https://docs.google.com/spreadsheets/d/1qEPuziEpxj-VG11IAZoa5RWEr4GhNoxMn7aBdU76O5k/edit#gid=617443512>

University of Pittsburgh, “Operational Postures,” webpage, undated. As of December 14, 2020:

<https://www.coronavirus.pitt.edu/operational-postures>

University of Pittsburgh Medical Center, “Latest Updates on COVID-19,” webpage, 2020. As of January 6, 2021:

<https://www.upmc.com/coronavirus>

UPMC—*See* University of Pittsburgh Medical Center.

- U.S. Census Bureau, “QuickFacts: Allegheny County, Pennsylvania,” webpage, undated-a. As of December 14, 2020:
<https://www.census.gov/quickfacts/alleghenycountypennsylvania>
- U.S. Census Bureau, “Quick Facts: United States; Allegheny County, Pennsylvania,” undated-b. As of December 14, 2020:
<https://www.census.gov/quickfacts/fact/table/US,alleghenycountypennsylvania/PST045219>
- U.S. Census Bureau, “Table B02001, Race & Ethnicity, 5-Year Estimates,” American Community Survey table, 2019a. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=Table%20B02001&tid=ACS5Y2019.B02001>
- U.S. Census Bureau, “Table B19001, Household Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars), 5-Year Estimates,” American Community Survey table, 2019b. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=Table%20B19001&tid=ACS5Y2019.B19001>
- U.S. Census Bureau, “Table B19013, Median Household Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars), 5-Year Estimates,” American Community Survey table, 2019c. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=Table%20B19013&tid=ACS5Y2019.B19013>
- U.S. Census Bureau, “Table S0101: Age and Sex—Allegheny County, Pennsylvania,” American Community Survey table, 2019d. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=allegheny%20county%20age&tid=ACS1Y2019.S0101&hidePreview=true>
- U.S. Census Bureau, “Table S0101, Age and Sex—United States, 5-Year Estimates,” American Community Survey table, 2019e. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=Table%20S0101&tid=ACS5Y2019.S0101>
- U.S. Census Bureau, “Table S0601, Selected Characteristics of the Total and Native Populations of the United States, 5-Year Estimates,” American Community Survey table, 2019f. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=Table%20S0601&tid=ACS5Y2019.S0601>
- U.S. Census Bureau, “Table S1903: Median Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars)—Allegheny County, Pennsylvania,” American Community Survey table, 2019g. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=allegheny%20county%20pa%20median%20income&tid=ACS1Y2019.S1903&hidePreview=true>

- U.S. Census Bureau, “Table S1903: Median Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars)—Pittsburgh City, Pennsylvania,” American Community Survey table, 2019h. As of December 14, 2020:
<https://data.census.gov/cedsci/table?q=pittsburgh%20pa%20median%20income&tid=ACSS T1Y2019.S1903&hidePreview=true>
- U.S. Census Bureau, “U.S. Census Bureau Releases 2015–2019 ACS 5-Year Estimates,” webpage, December 10, 2020. As of January 22, 2021:
<https://www.census.gov/programs-surveys/acs/news/updates.2020.html>
- U.S. Congress, Text of the House Amendment to the Senate Amendment to H.R. 133, Showing the Text of the Consolidated Appropriations Act, 2021, Washington, D.C., Rules Committee Print 116-68, December 21, 2020. As of January 5, 2021:
<https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf>
- U.S. Department of Health and Human Services, “HHS Announces New Laboratory Data Reporting Guidance for COVID-19 Testing,” webpage, updated September 23, 2020. As of January 7, 2021:
<https://www.hhs.gov/about/news/2020/06/04/hhs-announces-new-laboratory-data-reporting-guidance-for-covid-19-testing.html>
- U.S. Food and Drug Administration, “Risk of False Results with the Curative SARS-Cov-2 Test for COVID-19: FDA Safety Communication,” webpage, January 4, 2021. As of January 8, 2021:
<https://www.fda.gov/medical-devices/safety-communications/risk-false-results-curative-sars-cov-2-test-covid-19-fda-safety-communication>
- Western Pennsylvania Regional Data Center, “0f214885-ff3e-44e1-9963-e9e9062 [Allegheny County COVID-19 counts, by municipality and Pittsburgh neighborhood],” Excel data file, undated-a. As of April 26, 2021:
<https://data.wprdc.org/datastore/dump/0f214885-ff3e-44e1-9963-e9e9062a04d1>
- Western Pennsylvania Regional Data Center, “4051a85a-bf92-45fc-adc6-b31eb8e [Allegheny County COVID-19 tests and cases],” Excel data file, undated-b. As of April 26, 2021:
<https://data.wprdc.org/datastore/dump/4051a85a-bf92-45fc-adc6-b31eb8efaad4>
- Western Pennsylvania Regional Data Center, “7507526c-1e28-49be-8b62-808fdd0 [Allegheny County COVID-19 deaths, by demographic group],” Excel data file, undated-c. As of April 26, 2021:
<https://data.wprdc.org/datastore/dump/7507526c-1e28-49be-8b62-808fdd0b4029>

Western Pennsylvania Regional Data Center, “covid_19_tests [Allegheny County COVID-19 individual test results],” Excel data file, undated-d. As of June 10, 2021:
https://data.wprdc.org/dataset/80e0ca5d-c88a-4b1a-bf5d-51d0aaeeac86/resource/0f214885-ff3e-44e1-9963-e9e9062a04d1/download/covid_19_cases_by_place.csv

Western Pennsylvania Regional Data Center, “dd92b53c-6a90-4b83-9810-c6e8689 [Allegheny County COVID-19 deaths, by date],” Excel data file, undated-e. As of April 26, 2021:
<https://data.wprdc.org/datastore/dump/dd92b53c-6a90-4b83-9810-c6e8689d325c>

Western Pennsylvania Regional Data Center, “2010 Census Blocks with Geographic Codes Southwestern PA,” data set, August 11, 2016. As of January 22, 2021:
<https://data.wprdc.org/dataset/2010-census-blocks-with-geographic-codes-southwestern-pa>

Western Pennsylvania Regional Data Center, “Allegheny County COVID-19 Counts by Municipality and Pittsburgh Neighborhood,” data set, August 14, 2020a. As of January 7, 2021:
<https://data.wprdc.org/dataset/allegheny-county-covid-19-tests-cases-and-deaths/resource/0f214885-ff3e-44e1-9963-e9e9062a04d1>

Western Pennsylvania Regional Data Center, “Allegheny County COVID-19 Tests, Cases and Deaths,” data set, August 14, 2020b. As of December 14, 2020:
<https://data.wprdc.org/dataset/allegheny-county-covid-19-tests-cases-and-deaths/>

Western Pennsylvania Regional Data Center, “Unofficial Guide to COVID-19 Data in Allegheny County Pennsylvania,” Google document, 2020c. As of January 7, 2021:
https://docs.google.com/document/d/19fvMCYYWXdB81C7augb84kaCEvm--G-_N9UkW_pG_vw/edit?usp=sharingG-_N9UkW_pG_vw/edit?usp=sharing

Western Pennsylvania Regional Data Center, “Allegheny County COVID-19 Individual Test Results,” data set, April 21, 2021. As of June 10, 2021:
<https://data.wprdc.org/dataset/allegheny-county-covid-19-tests-cases-and-deaths/resource/ec9ced6e-9d5e-4982-a591-459252725937>

“Wolf Administration Updates Guidance for Reopening Pennsylvania Schools,” PAHomepage.com, July 16, 2020. As of January 5, 2020:
<https://www.pahomepage.com/top-stories/wolf-administration-updates-guidance-for-reopening-pennsylvania-schools/>

Wolf, Tom [@GovernorTomWolf], “Tonight, I’m announcing our plan to slowly reopen Pennsylvania. We’ll use a measured, scientific approach. We will not just be flipping a switch to go from closed to open. And, ultimately, #COVID19 will set the timeline. There will be three phases: red, yellow, and green,” Twitter post, April 22, 2020. As of April 24, 2021:
<https://twitter.com/GovernorTomWolf/status/1253100989227438081>

World Health Organization, “WHO Director-General’s Opening Remarks at the Media Briefing on COVID-19—11 March 2020,” speech transcript, March 11, 2020. As of May 1, 2020: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>

WPRDC—*See* Western Pennsylvania Regional Data Center.