

Outbreak of SARS-CoV-2 B.1.617.2 (Delta Variant) in a Youth Camp Associated With Community Spread, Nebraska, June–July 2021

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Abstract

Objectives: During June–July 2021, an outbreak of SARS-CoV-2 occurred among attendees of a summer youth camp in Nebraska. We assessed the factors that contributed to onward transmission of disease.

Methods: The Four Corners Health Department conducted an outbreak investigation and recorded both laboratory-confirmed and self-reported cases of SARS-CoV-2 and mitigation measures employed. We generated sequences on positive specimens, created an epidemic curve to assist with outbreak visualization, and examined epidemiologic, genomic, and laboratory outcomes.

Results: Evaluation of 3 index cases led to the identification of 25 people with COVID-19 who interacted directly with the camp. Contact tracing revealed an additional 18 cases consistent with onward community transmission. Most (24 of 35, 68.5%) vaccine-eligible community cases were not vaccinated. We sequenced 8 positive specimens; all were identified as the Delta variant. Precamp planning incorporated local health officials who recommended wearing face masks, practicing social distancing, and using attendee cohorts to limit mixing of people involved in various activities.

Conclusion: Low vaccination levels and poor face mask-wearing habits among attendees resulted in secondary and tertiary spread of SARS-CoV-2 and severe outcomes among young adults. This outbreak of COVID-19 at a youth camp highlights the importance of vaccination and use of other measures to interrupt opportunities for SARS-CoV-2 spread in the community and shows that vaccinated people remain vulnerable to infection when in an environment of high exposure to SARS-CoV-2. Proactive case identification and interruption of chains of transmission can help decrease the number of cases and avoid further severe outcomes.

Keywords

SARS-CoV-2, Delta variant, COVID-19, outbreak, youth camp

SARS-CoV-2 and COVID-19 have left a permanent impact on the world since their 2019 origin. The Delta variant of SARS-CoV-2 (B.1.617.2) had almost twice the reproductive number as the canonical SARS-CoV-2, indicating greater epidemic potential.¹ More viral particles have been found in patients infected with the Delta variant than with previous strains of the virus.² Each subsequent variant has posed its own challenges and differences from others in transmission and severity, impacted by changes in the virus and differences in vulnerabilities of community members, such as vaccine uptake. Vaccination proved to be 88% effective against

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the Delta variant among people with 2 doses and 31% effective for those with 1 dose.³ As of September 10, 2021, 53% of vaccine-eligible people in Nebraska were fully vaccinated, with large differences in vaccine uptake between rural and urban areas.⁴ Nationally, Nebraska ranked 23rd in number of new cases, with 250 cases per 100 000 population, and 19th in number of confirmed hospital admissions, with a rate of 10.7 cases per 100 beds.⁴

Four Corners Health Department (FCHD) serves as the local health department for Polk, Butler, York, and Seward counties in Nebraska. In June 2021, FCHD identified 3 positive cases of SARS-CoV-2 among people with out-of-state home addresses through testing at a local urgent care clinic. Health officials linked the cases to a weeklong, college-hosted summer youth camp where interaction with community members occurred both during an indoor event on day 5 of the camp and during episodic, small-group community service projects. Prior to this outbreak, only 36% of the area's more than 44 000 residents were fully vaccinated. In previously reported COVID-19 transmission in camp settings, underused preventive measures contributed to transmission.^{5,6} High attack rates occurred across age groups and, in some instances, also involved the highly transmissible Delta variant of SARS-CoV-2. This article examines an interstate outbreak associated with a youth summer camp, its local community impact, and its risk management.

Methods

This work was performed under the auspices of local and state public health authority and was an operational activity during local and state-level COVID-19 pandemic response.

Setting

A faith-based summer camp geared toward students in grades 6 through 12 was held in summer 2021 in rural Nebraska. More than 500 camp participants (defined as both campers and staff members) from 10 states gathered at a private college where they attended events, ate, and lodged. Camp officials had sought and received safety precaution recommendations from the health department, which resulted in a COVID-19 mitigation plan. Ultimately, the camp requested (but did not mandate) that face coverings be used and that temperatures should be self-assessed. Vaccination was not required for attendance. While the camp initially planned for 350 campers, to account for limited housing facility space and the potential need for quarantine, they received 400 attendees and 125 staff members during the 1-week camp.

Camp officials reported screening participants for symptoms, although they were not able to confirm how screening was conducted; increased the number of outdoor versus indoor events; and implemented a system of camper cohorts. Camper cohorts were formed based upon familial relation or traveling group and were housed in groups of 2 to 5

attendees. Campers were asked to not enter rooms that were not theirs. Campers were also encouraged to stay in their cohorts during class time and when participating in activities such as group games.

Each day of camp included meals in a cafeteria, worship in an auditorium, and several scattered events that included games, free time, classes, and group prayer. Campers also dedicated 1 day to assist with various service projects in the community. In general, camp events were convened outside; however, on day 5, a night church service was held indoors and included attendance by members of the local community. The total number of community members who attended is unknown. Baptisms were conducted during the service. The single indoor event proved sufficient for onward transmission and an increase in community COVID-19 cases.

Investigation

An outbreak-associated confirmed case was defined as an individual who had a laboratory-confirmed case of SARS-CoV-2 (confirmed through either a polymerase chain reaction [PCR] test or an antigen-based test) and was associated with the outbreak cohort. The outbreak cohort was defined as staff and campers (all participants) as well as anyone who participated in the church service held on day 5 or, in limited circumstances, known contacts from community service activities. A probable case was defined as an individual who was not tested for SARS-CoV-2 but exhibited signs and symptoms of SARS-CoV-2 infection and was associated with the outbreak cohort (epidemiologically linked). The health department assessed all reported cases in its jurisdiction and undertook contact tracing and monitoring. Cases identified among people who resided out of state were reported to their respective state health departments through usual electronic case and laboratory reporting. FCHD conducted case investigations through telephone interviews and collaborated with camp officials to assist with gathering additional self-reported cases from out-of-state participants once they returned home; however, communication was suspended when the camp coordinator fell ill.

The Nebraska Public Health Laboratory (NPHL) performed whole-genome sequencing (WGS) on positive specimens identified by PCR testing with a cycle threshold value ≤ 30 . Samples were sequenced using GridION (Oxford Nanopore Technologies) and SARS-CoV-2 ARTIC version 3 (New England BioLabs Inc) protocol for amplicon sequencing. NPHL used the NextStrain pipeline to align SARS-CoV-2 consensus sequences and generate the phylogenetic tree. We used Auspice.us (NextStrain) for further visualization. In addition, where possible, we determined risk mitigation measures undertaken by the youth camp by interviewing camp administration and analyzing results alongside both laboratory and epidemiologic data.

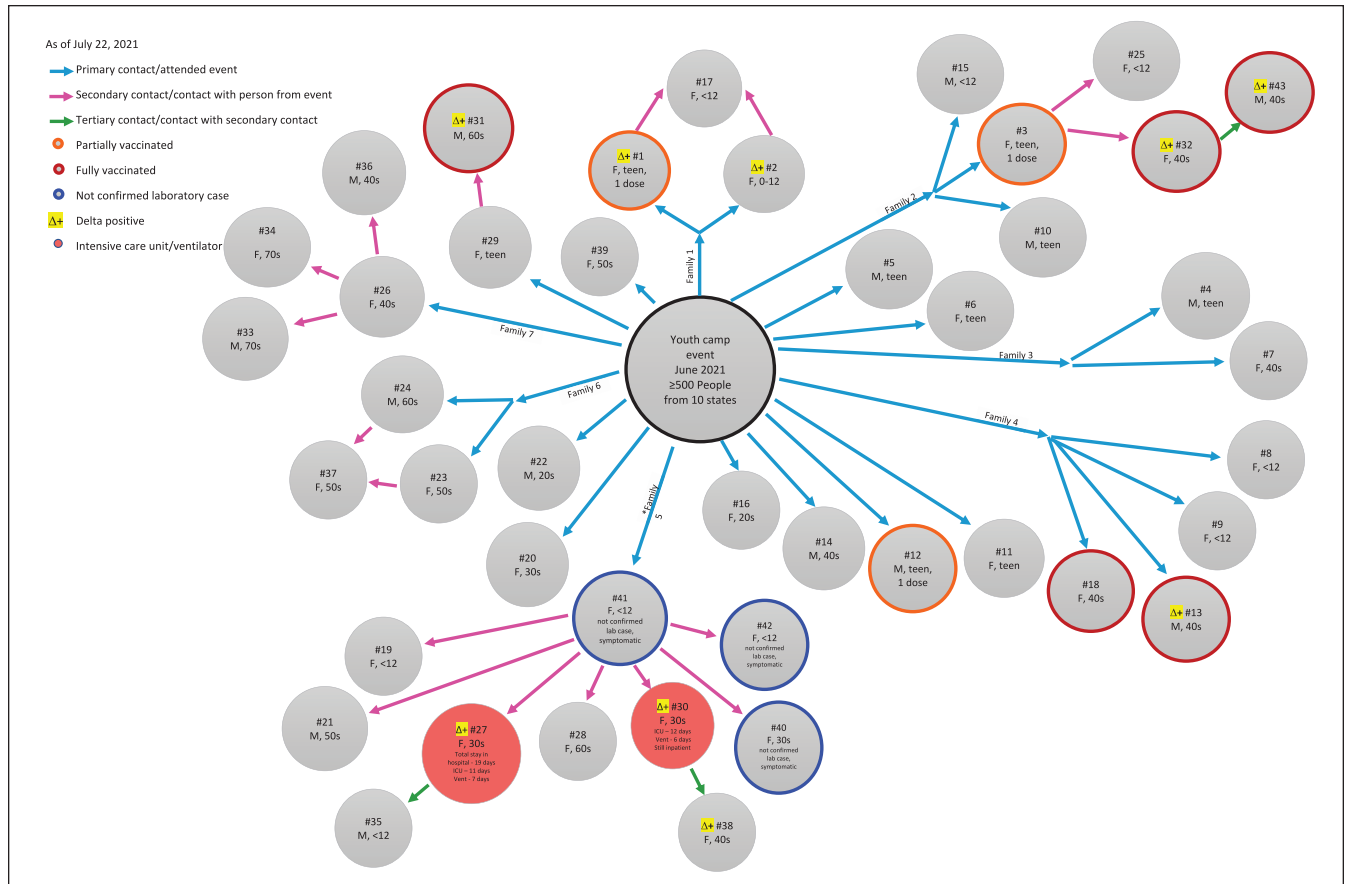


Figure 1. Chain of contacts in an outbreak of COVID-19 at a summer youth camp in Nebraska, June–July 2021. Abbreviations: Δ+, Delta variant; F, female; ICU, intensive care unit; lab, laboratory; M, male; vent, ventilator.

Results

Epidemiologic Investigation

In the 3 weeks from the start of the camp, 43 residents of the counties served by FCHD contracted COVID-19 as a result of exposure to the camp within a compatible incubation period. Of the 43 residents, 12 were campers, 7 were camp staff, and 6 were community members who had attended the indoor event on day 5 of the camp. Of the remaining 18 cases among local residents, 15 were members of the community who probably acquired COVID-19 as a result of secondary contact, and 3 were members of the community who probably acquired COVID-19 as a result of tertiary contact of known confirmed or probable cases within a compatible incubation period (Figure 1). Forward transmission of SARS-CoV-2 between fully vaccinated contacts was observed. Tertiary transmission was also observed, including the spread of SARS-CoV-2 from a child aged <12 years (case 41) to 7 other contacts. Two contacts of case 41, both adults in their 30s, required mechanical ventilation after admission into the intensive care unit (hospitalization rate: 2 of 43; 5%). We confirmed 40 of the 43 outbreak-associated community cases by using laboratory diagnostic testing; 37

cases were assessed by PCR and 3 cases were assessed by antigen testing. Camp officials identified 37 additional people residing out of state who reported to the camp that they had COVID-19 upon their return home. These cases were considered probable cases because of incomplete information and were in Arkansas, Colorado, Kansas, Montana, North Carolina, Oklahoma, and Texas. In summary, this summer youth camp outbreak produced 40 confirmed cases and 40 probable cases of COVID-19.

All 43 outbreak-associated community cases were symptomatic. Among them, females (n = 28) outnumbered males (n = 15) by nearly 2:1 (Table). They were widely distributed by age (range, 7-68 years), with a median age of 30 years. Of those who disclosed their vaccination status to the investigation team, most had not received any dose of a SARS-CoV-2 vaccine (24 of 36 [67%] among those aged ≥12 years).

Laboratory and Epidemiologic Analyses

Each of the 8 sequences generated using WGS were identified as the Delta variant. The sequenced samples were genetically related, monophyletic within 3 single nucleotide variations (SNVs). Branch lengths were scaled to represent

Table. Characteristics of attendees and workers at a summer youth camp who experienced an outbreak of the COVID-19 Delta variant (N = 43), Nebraska, June–July 2021

Characteristic	No. (%)
Age, y	
<12	10 (23)
13-19	9 (21)
20-29	2 (5)
30-39	4 (9)
40-49	9 (21)
50-59	4 (9)
60-69	3 (7)
≥70	2 (5)
Sex	
Male	15 (35)
Female	28 (65)
Vaccination status	
Fully vaccinated laboratory-confirmed case ^a	5 (12)
Partially vaccinated laboratory-confirmed case ^b	3 (7)
Suspected outbreak-associated case ^c	3 (7)
Unvaccinated (aged ≥13 years)	24 (56)
Unvaccinated (aged ≤12 years) ^d	8 (19)

^aRecipient of all recommended doses of Moderna, Pfizer-BioNTech, or Janssen COVID-19 vaccine ≥14 days before a positive SARS-CoV-2 test result.

^bRecipient of 1 dose of Moderna or Pfizer-BioNTech vaccine ≥14 days before a positive SARS-CoV-2 test result.

^cA suspected outbreak-associated case has no confirmatory laboratory testing but meets clinical criteria and epidemiologic linkage.

^dNo COVID-19 vaccination received because of ineligibility.

the number of SNVs (Figure 2). Taken together, these sequencing data indicate a single-point exposure of the Delta variant confirming the linkage of onward case transmission from camp to community.

The index cases were identified within 2 weeks of the beginning of camp, as indicated by their date of laboratory diagnostic confirmation in the epidemic curve, which peaked on the 12th and 13th day after the start of camp (Figure 3). Applying a likely incubation period of less than 1 week revealed compatibility with the camp day 5 indoor event as the predominant source of camp-to-community SARS-CoV-2 crossover.

Public Health Response

Precamp outreach by camp officials together with the resulting FCHD consultation allowed health officials to immediately associate the first out-of-state residents who received a positive test result for SARS-CoV-2 with the camp and so begin notifications and outbreak investigation. Camp officials distributed a notice to all participants reporting the potential exposure risk. They then relayed self-reported cases to the health department. The health department and camp officials worked together to reduce the number of carpools

that mixed COVID-19 cases with non-COVID-19 cases when participants returned home at the conclusion of the camp. Camp officials reportedly encouraged self-quarantine and liberal SARS-CoV-2 testing among participants once they returned home, but the degree of uptake of these or other measures is unknown.

Discussion

In previous outbreak reports from camp settings, lack of preventative measures paired with high attack rates were noted.^{5,6} The camp outbreak we described, involving cases across state lines, had similar trends. We identified onward transmission of the Delta variant in a community with low vaccine uptake that affected both fully and partially vaccinated people. This onward transmission in vaccinated people emphasizes that the presence of people who have not been vaccinated against COVID-19 increases everyone's risk, even those who have been vaccinated.⁷ The Delta variant has been reported to have a shorter incubation period (4 d) than the canonical SARS-CoV-2 strain.⁸ The combination of the introduction of this new viral variant with limited measures at the camp and low community uptake of preventive measures had direct consequences for the entire area. The Four Corners area had a 7-day incidence rate of approximately 14 cases per 100 000 people on day 1 of the youth camp, peaking at 97 per 100 000 population during the outbreak period.⁹ While the ability to minimize COVID-19 risk in summer camps has been demonstrated, this outbreak and others elucidate the critical importance of risk management.^{10,11}

This outbreak resulted in several important lessons learned. One case of forward transmission of SARS-CoV-2 in the outbreak from a fully vaccinated secondary contact to a fully vaccinated tertiary contact was observed, emphasizing the need for the usual mitigation measures even among vaccinated people when case rates are high. COVID-19 risk management decisions even for single gatherings may yield substantial outbreaks, even when aggregated people have only casual interaction. Through both genomic and epidemiologic data, we were able to confirm multiple introductions of SARS-CoV-2 from the same source event that led to the spread of the Delta variant to both vaccinated and unvaccinated members of the community. The impact of ongoing community spread due to the Delta variant is consistent with previous examples of Delta variant-related outbreaks that reported easy transmissibility in settings at high risk of COVID-19 and other respiratory illnesses.¹²⁻¹⁴ Most cases and intensive care unit admissions occurred among unvaccinated people, reflecting the value of vaccination in decreasing transmission even in the setting of newer variants. The importance of vaccinating those who are in close contact with children ineligible for vaccination has been previously reported among outbreaks involving children, such as within elementary schools.¹³ Contact tracing in our event revealed

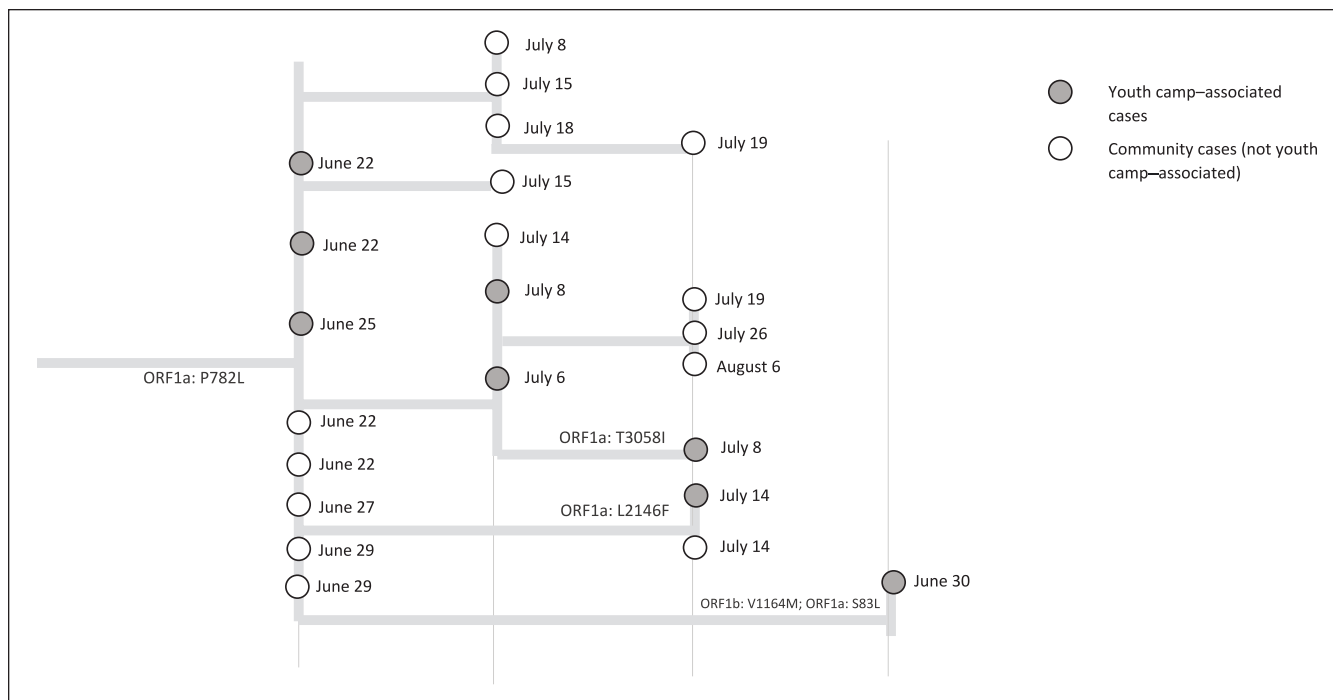


Figure 2. Single nucleotide variation (SNV) analysis linking COVID-19 cases from a summer youth camp with community cases in a SARS-CoV-2 B.1.627.2 (Delta) variant outbreak, Nebraska, June–July 2021. Branch lengths are denoted in SNVs to illustrate the number of mutations from the root. The phylogenetic tree is rooted with the original SARS-CoV-2 genome Wuhan/Hu-1/2019. Nodes on the phylogenetic tree are color-coded to specify cases linked to the summer youth camp outbreak and labeled with the specimen collection date. Vertical lines represent genetically identical viruses; horizontal lines represent genetic descendants with additional SNVs. The phylogenetic tree shows the genetic distance between the sequenced specimens and exposure histories related to the youth camp or in the community. The ORF1a: P782L denotes a site-specific mutation on the open reading frame (ORF) gene where the amino acid proline (P) is substituted with leucine (L) on the monophyletic branch.

multiple people infected from a single child aged <12 years who had COVID-19.

After the outbreak, the public health department experienced a shift in local attitudes toward use of the COVID-19 vaccine, which led to improved vaccination rates in the 4 counties under the jurisdiction of this health department: Polk, York, Seward, and Butler counties. The fully vaccinated rate in York County, for example, increased from 36% at the beginning of June to 40% by the end of the outbreak period¹⁵ and rose to >50% by September 2021.

Limitations

The observations from this event had several limitations. First, the 37 cases self-reported to camp officials once participants had returned home were not further characterized. Second, testing of camp participants and community members who were contacts was incomplete; therefore, we may have underestimated the full scale of the outbreak. Third, more such cases among residents of Nebraska and visitors may have been missed, including onward transmission events in and outside Nebraska. Fourth, additional SARS-CoV-2 strains may have been present during the outbreak. Fifth, the limited number of

sequences made determination of the number of SARS-CoV-2 introductions in the camp uncertain (ie, whether 1 or >1 SARS-CoV-2-infected person may have been a source at the start of camp, each potentially with different variants). Sixth, full characterization of high-risk interactions between campers and camp staff were not elucidated. Finally, it is important to recognize that direct linkage on a phylogenetic tree does not necessarily infer an epidemiological association. Directionality cannot be inferred from the tree alone without the epidemiological context on which the other cases are based. Also, sampling of viral genomes can be heterogenous, and sequencing quality could vary between groups. Therefore, the epidemiological context is crucial for any inferences.

Conclusion

Findings from this investigation reinforce what has come to be understood about the high transmissibility of SARS-CoV-2, particularly with newer variants. Camp directors and the health departments that support them should note this event as a lesson in how a lapse in risk management measures—even during a relatively short camp—can result in substantial negative community impact. Vaccination reduces

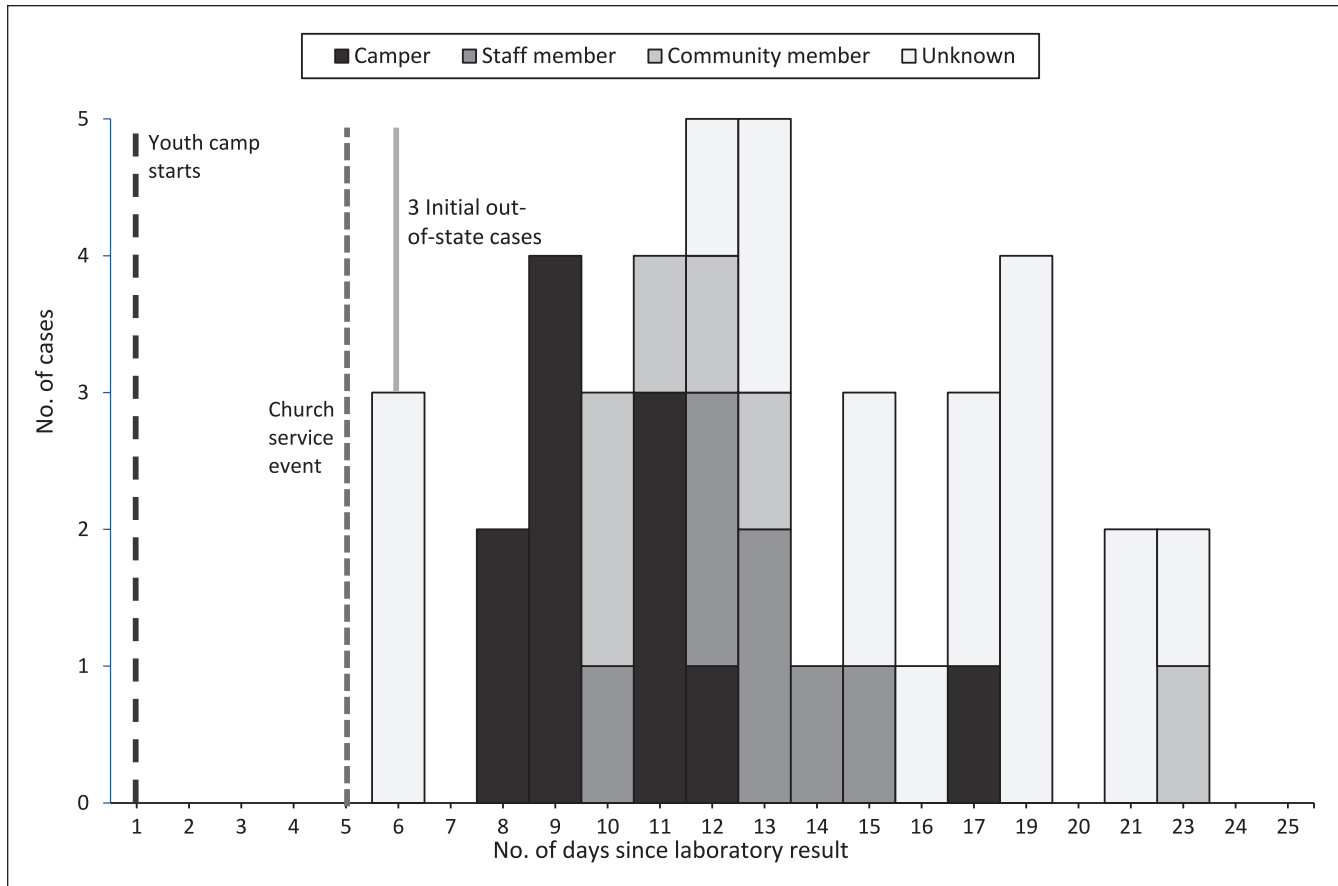


Figure 3. Timeline of summer youth camp– and index event–linked SARS-CoV-2 laboratory diagnosis, from day of camp opening, Nebraska, June–July 2021. Cases marked as unknown during days 12 through 23 are all secondary or tertiary contacts of cases linked to the index event. The 3 day 6 cases were not included in the chain of contacts because of incomplete information. The cases were among people who reside out of state and so likely represent campers or staff. Also, 4 cases are in the chain of contacts but not reflected here: 3 probable cases that were not laboratory confirmed and a case reported in an individual associated with the camp but reported from another jurisdiction without a test date.

both the risk of acquiring COVID-19 and its consequences should infection occur, although in the setting of low vaccination rates, SARS-CoV-2 risks to vaccinated people remain a concern. Increased uptake of SARS-CoV-2 vaccination is needed. Additional measures related to physical and social distancing, face mask wearing, de-densifying aggregate events, and other preventive actions should be prioritized, as should proactive, continual community risk assessment. Constructive partnerships between public health departments and their communities will lead to better prevention and mitigation of COVID-19 events.

Authors' Note

The views represented are those of the authors and do not necessarily reflect those of any federal, state, or local agency.

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