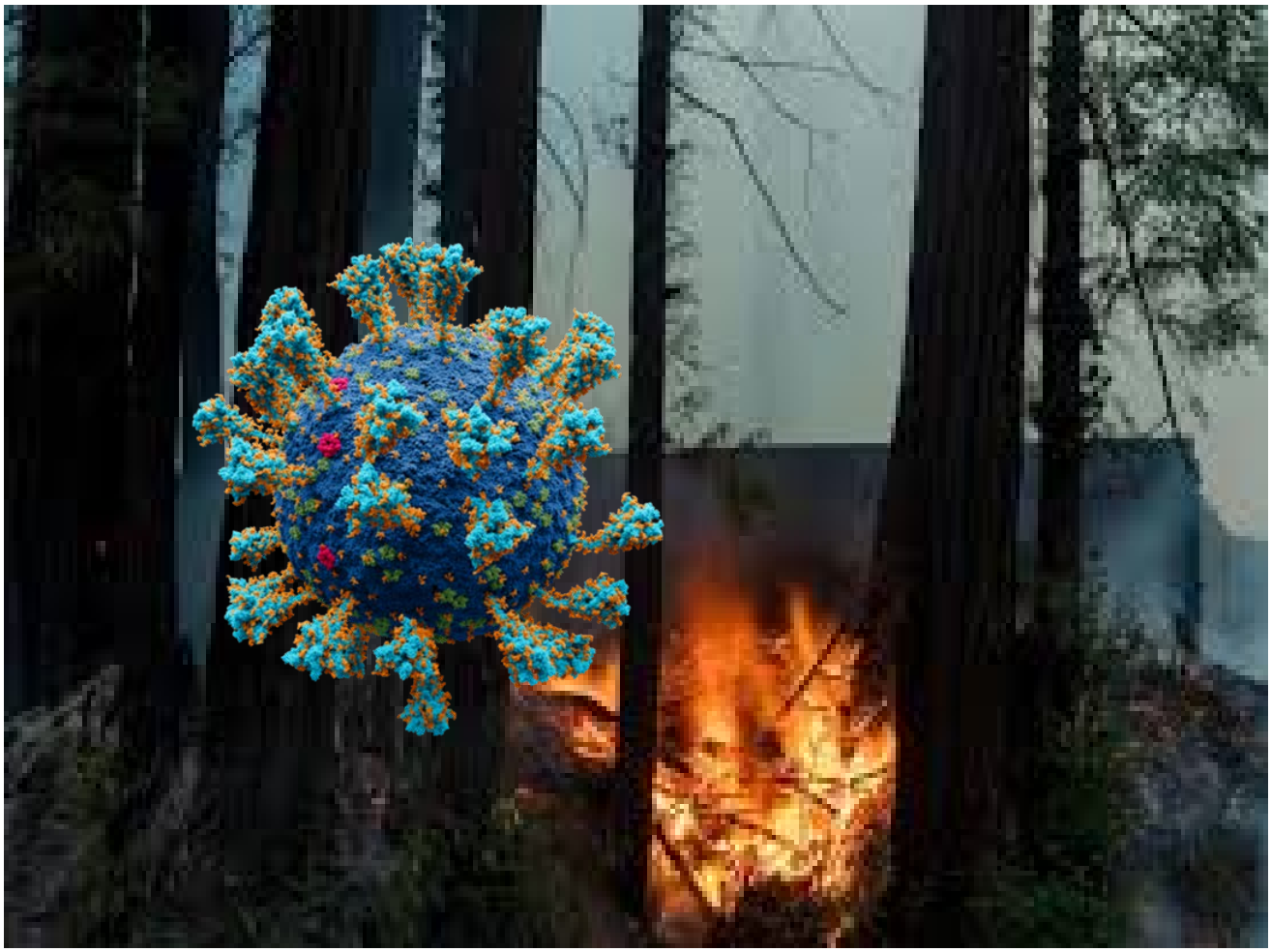
COVID-19 Forecasts in Arkansas

UAMS | Fay W. Boozman College of Public Health

Arkansas Public Health Pandemic Working Group
Mark L. Williams* and the COPH COVID-19 Research Team
September 13, 2021
* corresponding author



COVID-19 Forecasts, Projections, and Impact Assessments

The University of Arkansas for Medical Sciences' (UAMS) Fay W. Boozman College of Public Health (COPH) faculty conducted five types of assessments for this monthly report: 1) a look at the pandemic in Arkansas from a longer-term perspective; 2) forecasts and projections of cases and maps of community spread; 3) forecast models of hospitalizations; 4) forecast model of COVID-19 deaths; and 5) status of COVID-19 vaccination.

All forecasts and projections were developed using COVID-19 data from the Arkansas Department of Health through Sept. 12.

Summary points are:

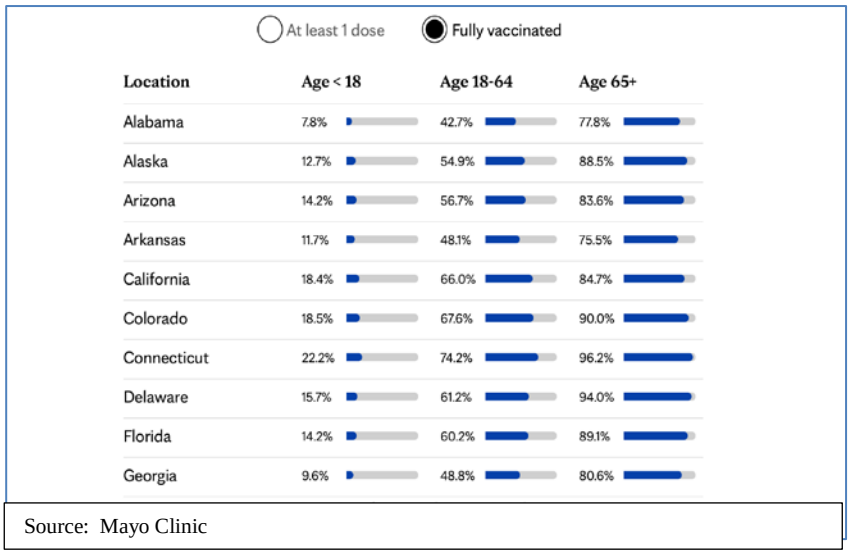
- The COVID-19 positivity rate in the state remains above 10%, only slightly above the national average. This is largely due to increasing numbers of COVID-19 infections nationally rather than a dramatic decrease in cases in the state.
- The models are forecasting a significant decline in new daily COVID-19 cases in the state — forecast to decrease from 2,013 cases on Sept. 13 to 1,300 on Oct. 12.
- The 30-day models continue to show Arkansans between ages 35 and 59 will have the highest number of COVID-19 diagnoses — forecast to increase by 13,000 cases by Oct. 12.
- The highest relative growth in COVID-19 cases will be in children 17 and younger — forecast to increase by 14% by Oct. 12.
- Like cases, the 30-day model forecasts a decline in new hospitalizations in the next 15 days, dropping from 70 to 40 new daily admissions.
- The greatest relative increase in hospitalizations will be in young adults, 18 to 34, increasing by 24% by the end of September.
- The 30-day model is forecasting daily deaths will stabilize at around 30 deaths per day for the next two weeks.
- The 15- and 30-day models are forecasting 7,348 cumulative COVID-19 deaths by Sept. 27 and 8,347 by Oct. 12.
- All counties in Arkansas continue to have slow rates of vaccination. Most counties increased vaccinations by 4% to 6% in the past month.

The models are showing a decline in cases and hospitalizations through Oct. 12. The reason for the decline is unclear. The number of people vaccinated for COVID-19 in Arkansas has not increased sufficiently since our last report in August to warrant a significant decline in cases. What we may be seeing is the pandemic following a wave pattern. A wave pattern of COVID-19 infections has been observed in other nations. The wave may have crested earlier in September and may be now beginning its downward trek. The reason for a wave pattern to the pandemic is unknown.

Part of the reason may be what is referred to as "naturally acquired immunity." Naturally acquired immunity is the result of having been infected with a pathogen. Reports in the scientific literature suggest some of those previously infected with COVID-19 will developed natural immunity strong enough to provide some protection against a new infection with the Delta variant. However, not all people who have had a previous infection appear to develop natural immunity. The reason for this is unknown at this time. More research needs to be done, especially on the likelihood a person might develop natural immunity. Even so, the occurrence of natural immunity for some proportion of those who have had a previous COVID-19 infection and survived may be a possible explanation for the pandemic following a wave pattern. In

suggesting this possibility, it in no way implies people should consider foregoing COVID-19 vaccinations, even if they have had previous infections. The same research on natural immunity suggests those who have been infected, once vaccinated, will develop a "super" immunity. And, not all people who have had a previous infection will develop natural immunity. To forego vaccination is like playing Russian roulette with multiple loaded chambers.

The pattern of vaccinations does, however, likely explain the growing numbers of COVID-19 cases in younger Arkansans. As shown in the chart below, as of Sept. 12, 12% of Arkansas' children 18 and younger were fully vaccinated for COVID-19. If we turn this around, 88% of the state's children are susceptible to infection. Of course, children under 12 cannot be vaccinated at this time. They are completely vulnerable to COVID-19 infection.



Location	Age < 18	Age 18-64	Age 65+
Alabama	7.8%	42.7%	77.8%
Alaska	12.7%	54.9%	88.5%
Arizona	14.2%	56.7%	83.6%
Arkansas	11.7%	48.1%	75.5%
California	18.4%	66.0%	84.7%
Colorado	18.5%	67.6%	90.0%
Connecticut	22.2%	74.2%	96.2%
Delaware	15.7%	61.2%	94.0%
Florida	14.2%	60.2%	89.1%
Georgia	9.6%	48.8%	80.6%

Source: Mayo Clinic

As is easily discernible from the table, the vaccination rate in children is far below the vaccination rate for adults. This is likely the reason the rates of infection and hospitalizations in older adults, especially adults over 75, has essentially plateaued. The vaccination rates also strongly support a conclusion Arkansas's COVID-19 pandemic will continue its shift to young adults and children.

While there is good news in this report, we must also acknowledge the Delta variant has exacted a high cost from Arkansas. At the beginning of June, the Delta variant was just beginning to circulate in the state, and the numbers of new COVID-19 cases were relatively low. The COVID-19 vaccines were readily available to all adults and all adolescents 12 to 17. However, convincing some Arkansans to be vaccinated has been a challenge. Significant numbers have chosen not to be vaccinated. Not being vaccinated has come at a cost; most obvious are the costs associated with hospital stays for COVID-19 patients. Research has shown the average cost to Medicare for a COVID-19 patient is $21,042. Other research has found the median cost for a COVID-19 patient is $16,000. On the other hand, the average cost of a COVID-19 vaccine ranges from $35 to $150, depending on the billing source.

Since June 21, Arkansas has had 5,222 hospitalizations for COVID-19 related disease. If all patients who had been hospitalized since June 21 had been fully vaccinated, the cost of the vaccines for those patients would have ranged from $182,770 ($35 per vaccine) to $783,300 ($150 per vaccine). Keeping those patients out of the hospital would have resulted in a savings from $83,552,000 (median per patient cost) to $109,296,460 (mean per patient cost). These estimates do not take into account other expenses related to testing, diagnosis and aftercare. Of course, dollars are not the only costs associated with COVID-19 hospitalization. Less measurable are costs to patients and their families for lost time from work, family travel, stress and loss of life. There were also costs to the state's hospital system, such as costs associated with worker stress due to increased workloads and trauma associated with caring for COVID-19 patients.

A recent *Washington Post* article reported one in 410 Arkansans has died from COVID-19, higher than the national figure of one in 500. Less than half of Arkansans, 43%, are fully vaccinated against COVID-19. If we are generous and estimate another 250,000 have developed natural immunity because of a prior infection, there are still many more than one million Arkansans susceptible to a highly infectious virus. There is some glimmer of hope in the latest COVID-19 case and hospitalization figures. Nevertheless, new cases and hospitalizations remain extremely high. Daily deaths, which lag case and hospitalization numbers, are forecast to continue at unacceptable levels. The shift in the pandemic towards young adults and children is extremely worrisome. New research suggests children may not be more likely to develop severe COVID-19 disease than adults, but, as larger numbers are infected, larger numbers of children will be hospitalized. Furthermore, we do not yet know the full impact of the Labor Day holiday and potential weekend super-spreader events on future numbers. Although it is comforting to suppose the pandemic is on the downside of an exponential wave, this possibility is uncertain at this time.

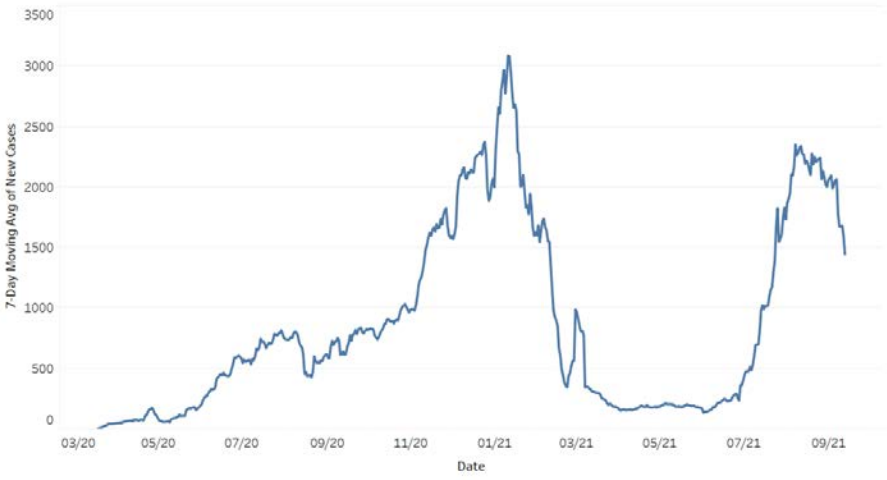
In our last report, we compared the COVID-19 pandemic in Arkansas to a raging forest fire burning its way through the state. The forest fire may have died down a little with outbreaks becoming more localized. While per capita infection rates in the majority of counties have fallen, the seven-day average in some counties remains very high. And, the possibility of a resurgence across the state is still a possibility. COVID-19 has taken a high toll on the people of Arkansas in lives lost, suffering endured, and money. The models are forecasting more pain to come. The state will cross another grim milestone around Oct. 5, with 8,000 COVID-19 deaths. It is past time to end Arkansas's COVID-19 pandemic. We have the tools. What is needed is the will.

The COVID-19 Pandemic in Arkansas

Data shown in this section examines the trajectory of the COVID-19 pandemic in Arkansas, urban/rural differences, and changes in testing and COVID-19 positivity associated with test results.

In April 2021, the statewide face mask mandate expired, and the state entered a new phase of the pandemic. Figure 1 shows the seven-day rolling average of new infections since March 2020. Daily numbers are often considered too "noisy" to accurately reflect an epidemic's growth. To address this noise, we use a rolling average to smooth out meaningless daily differences in infections.

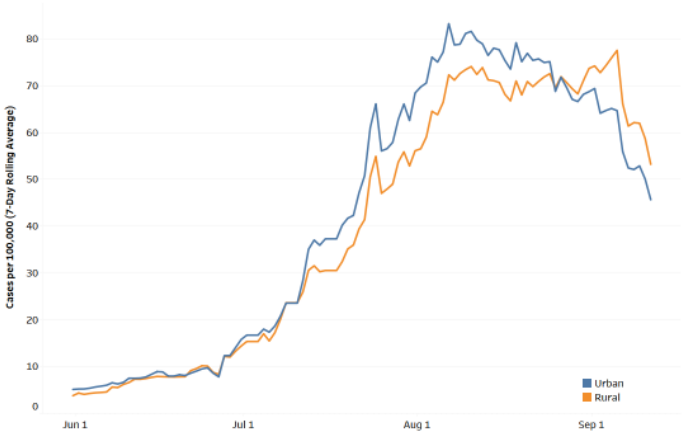
Figure 1 *Seven-Day Rolling Average of Daily COVID-19 Cases*



What is easily discernable from data plotted in Figure 1 is new COVID-19 cases increased over time until early January. February 2021 was the first month in Arkansas in which there was a consistent decline in new COVID-19 infections. The curve flattened somewhat during March, when the state averaged around 380 new infections per day. The seven-day rolling average of infections per day remained essentially flat in April (172), May (192), and June (227). However, by July, new daily cases jumped to over 1,000. In August, daily cases more than doubled to 2,162 per day. There has been a decline since the high in August. Through Sept. 12, the 7-day rolling average has averaged 1,846.

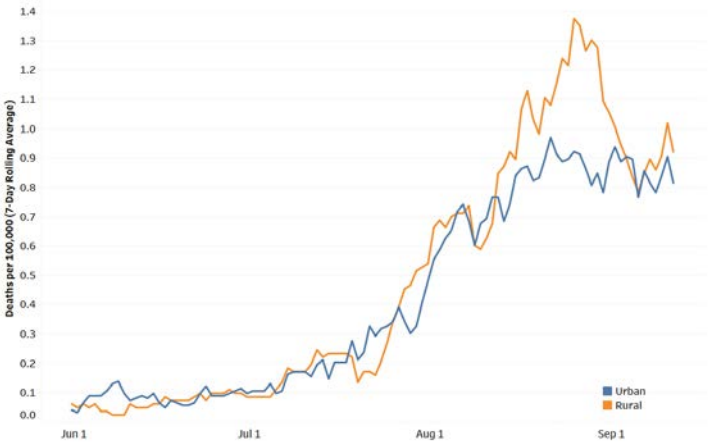
National trends indicate COVID-19 cases are growing more substantially in rural compared to urban areas. Therefore, we assessed daily case and death rates by rural/urban counties in Arkansas. As shown in Figure 2a, case rates per 100,000 were greater in urban areas through August but recently have been greater in rural counties. However, the effect of COVID-19 on deaths has not favored rural counties.

Figure 2a *Seven-day rolling average of daily cases by rural/urban counties*



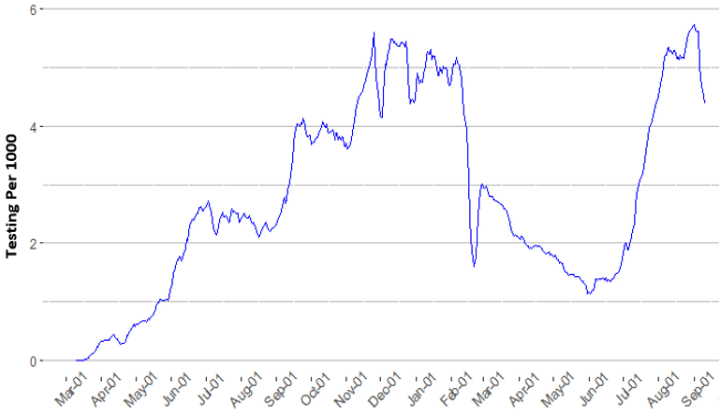
As shown in Figure 2b, the death rates among rural and urban areas remained relatively consistent throughout June, July, and August 2021. However, death rates now are significantly greater in rural counties than death rates in urban counties.

Figure 2b *Seven-day rolling average of deaths by rural/urban counties*



As shown in Figure 3a, using data from the Arkansas Department of Health, testing for COVID-19 in the state peaked in September/October 2020. Since then, the overall testing rate gradually declined. On July 9, the state performed 4.3 tests per 1,000 persons, which was equivalent to the national average of 4.4 per 1,000. However, a higher state positivity rate and relatively low testing level raises serious concerns about surveillance. Without regular, widespread testing, which is the best data for estimating the spread of disease in a population, forecasting future hospitalizations was difficult.

Figure 3a *COVID-19 testing rate per 1,000 through Sept. 10*



Broadly defined, the COVID-19 positivity rate is the number of people who test positive for COVID-19 as a proportion of the number of people who have been tested. The positivity rate is an indicator of viral transmission. A higher positivity rate is indicative of higher transmission relative to the number of tests.

Figure 3b *COVID-19 positivity rates through Sept. 10*

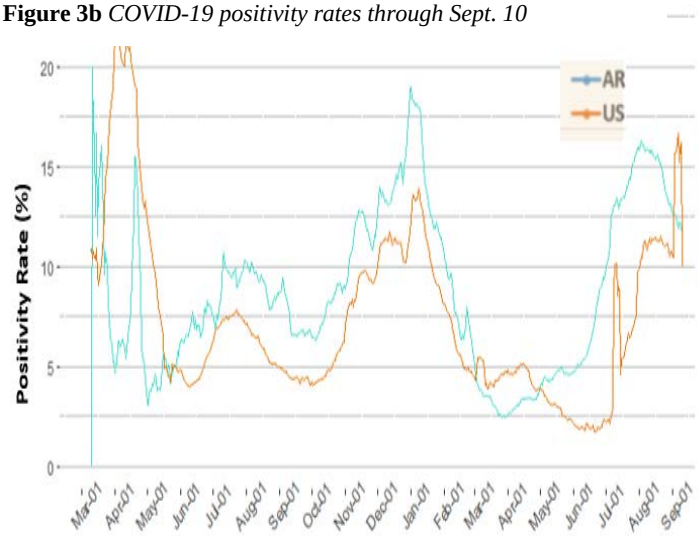


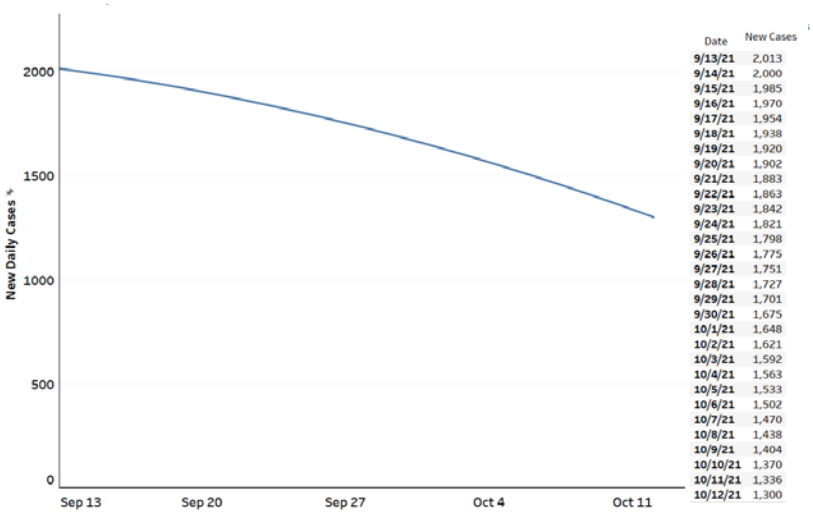
Figure 3b shows the seven-day moving average of the positivity rates for Arkansas and the United States. The positivity rate in Arkansas and the U.S. decreased from December through March. However, during March, Arkansas's positivity rate began to increase until mid-July, when it began to fall. Although it has decreased, the positivity rate remains high. Currently, the state's positivity rate is 12%, above the national rate of 10%.

COVID-19 Cases

COVID-19 cases are those identified using a PCR test. Probable cases are diagnosed using an antigen test. Results of antigen tests have been reported by the Arkansas Department of Health (ADH) since Sept. 2, 2020. ADH continues to distinguish between confirmed and probable cases, but they are combined for this report. We refer to confirmed and probable cases as "cases."

15- & 30-day forecasts of COVID-19 cases in Arkansas. New daily cases for the period between Sept. 13 and Oct. 12 are shown in Figure 4a. Estimates are realized rates. As shown in the figure, the model is forecasting a linear decline in new daily cases from 2,013 on Sept. 13 to 1,300 new cases on Oct. 12.

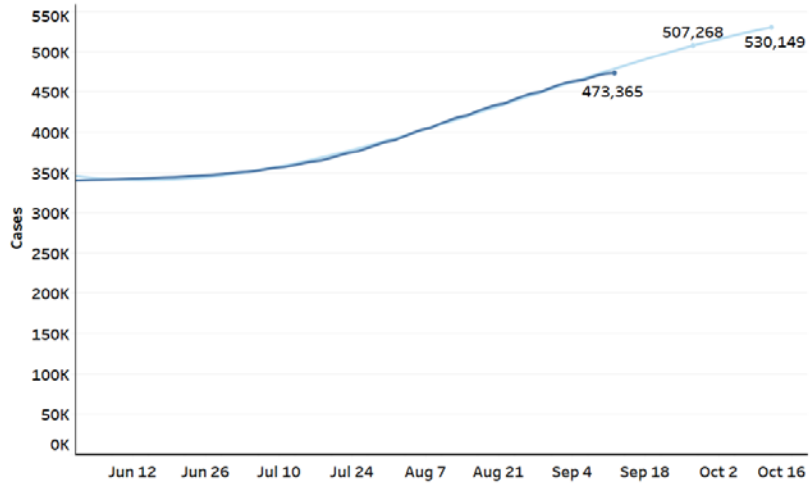
Figure 4a *New COVID-19 cases through Oct. 12*



Date	New Cases
9/13/21	2,013
9/14/21	2,000
9/15/21	1,985
9/16/21	1,970
9/17/21	1,954
9/18/21	1,938
9/19/21	1,920
9/20/21	1,902
9/21/21	1,883
9/22/21	1,863
9/23/21	1,842
9/24/21	1,821
9/25/21	1,798
9/26/21	1,775
9/27/21	1,751
9/28/21	1,727
9/29/21	1,701
9/30/21	1,675
10/1/21	1,648
10/2/21	1,621
10/3/21	1,592
10/4/21	1,563
10/5/21	1,533
10/6/21	1,502
10/7/21	1,470
10/8/21	1,438
10/9/21	1,404
10/10/21	1,370
10/11/21	1,336
10/12/21	1,300

Figure 4b shows the forecast of COVID-19 cases through Oct. 12. The 30-day forecast shows Arkansas will reach a cumulative caseload of 530,149 cases. The 30-day model shows the state will add 33,903 new COVID-19 cases by Sept. 30 and a further 22,881 by Oct. 12.

Figure 4b *Cumulative COVID-19 cases through Oct. 12*

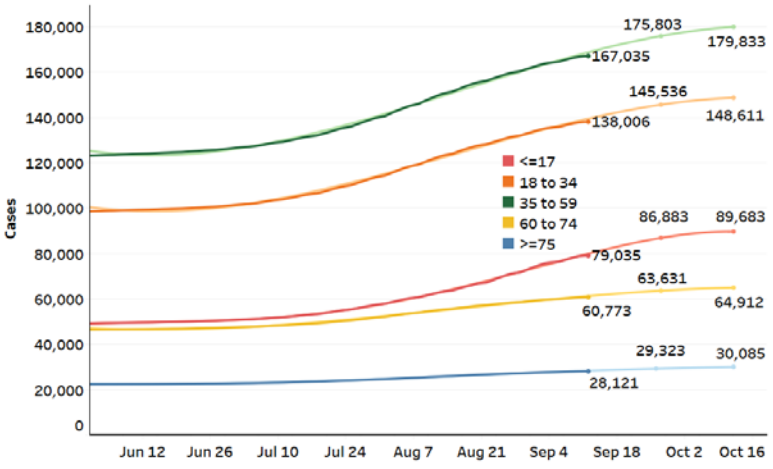


Forecasts by age. As shown in Figure 5a on the next page, the forecast of cumulative cases across age groups shows increases in every group. However, there are significant variations. The age group with the highest forecast number of cases will continue to be those 35 to 59. This age group will add almost 13,000 new cases by Oct. 12, or an average of 425 cases per day. The group with the second highest number of cases will be young adults age 18 to 34. This age group will average just over 350 cases per day through Oct. 12.

Children 17 and under, although third in terms of absolute numbers, will show continued high growth in cases. The model forecasts around 11,000 new cases in children between Sept. 13 and Oct. 12.

Figure 5b provides daily cases among children 17 or younger as a percent of new daily cases. National studies report children under 17 make up around 25% of the new cases. In Arkansas, over 30% of new cases in Arkansas since Aug. 27 have been in children. The trend in Figure 5b shows a continued upward drift.

Figure 5a *Cumulative COVID-19 cases by age through October 12*

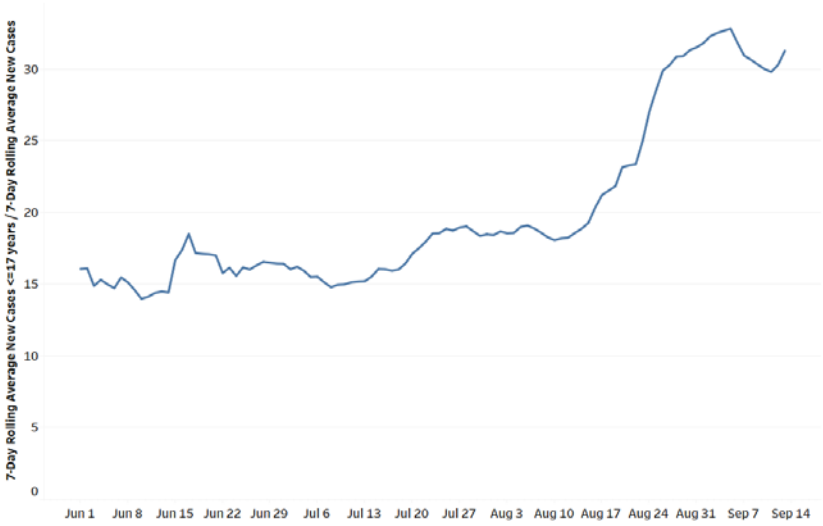


Relative change in COVID-19 cases by county. Map 1, on the next page, shows the relative change in cases across Arkansas counties. Relative change is determined by calculating the percent change between cases during the most recent two-week period, Aug 30 through Sept. 12, to cases from the prior two-weeks, Aug. 16 through Aug. 29.

During the most recent two weeks, the relative change in cases is somewhat mixed across the state. Five counties had relative increases greater than 25%, compared to 14 from the previous report. Fifty-three counties had relative decreases in cases compared to 20 in the previous report. This is a positive development. However, the relative decrease in cases must be considered in light of the absolute number of cases per county. For example, Craighead County had a 21% decline in the case rate; however, the county still has a very high per capita case rate of 140 cases per 10,000 population.

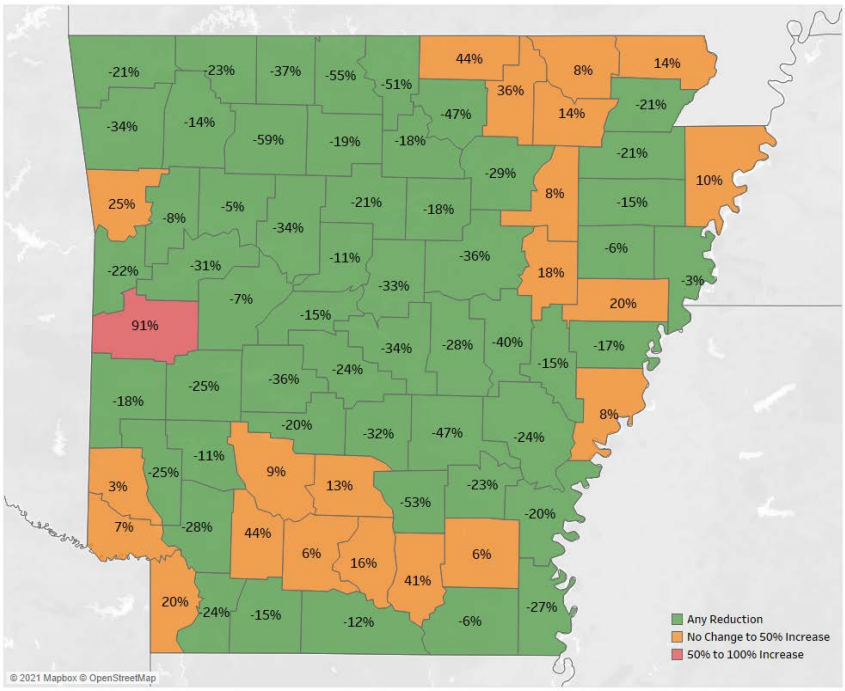
As shown on Map 2 on the next page, all counties in Arkansas had substantial case rates per 10,000 population in the last two weeks. Case rates ranged from 37 to 169 cases per 10,000, with 35 counties having case rates above 100 cases. This is significantly different than what was seen in the July report, when only two counties had per capita case rates greater than 30 per 10,000.

Figure 5b *Percent of the daily caseload among children ≤17*

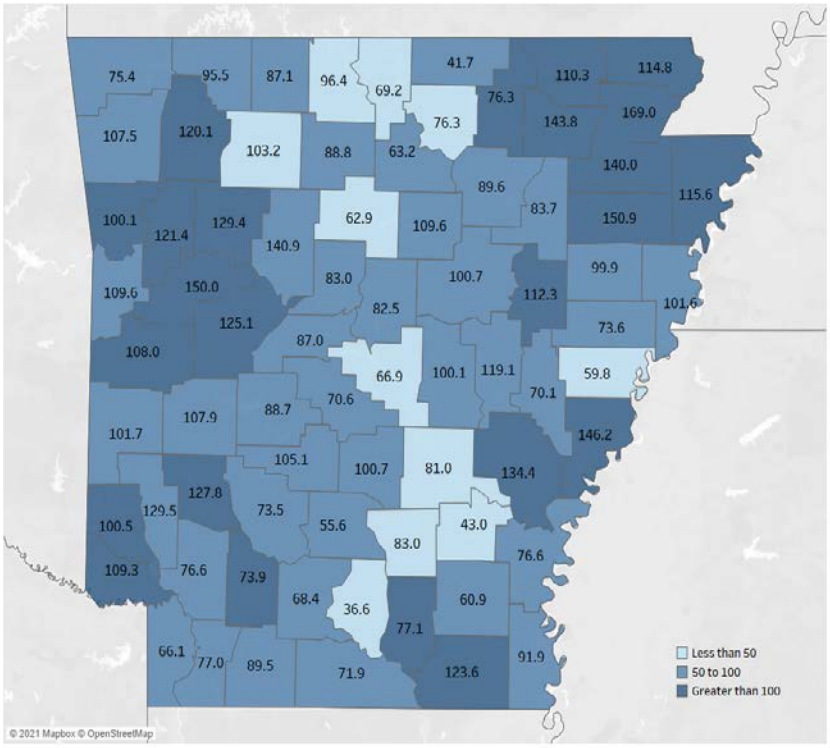


Summary. The 15-day and 30-day models forecast decreasing COVID-19 cases until Oct. 12. It is too early to determine whether the downward trend in cases will be impacted by the Labor Day holiday or large weekend gatherings. The downward trend in new cases may be an indication of the pandemic entering the downside of exponential growth pattern of the pandemic in the state.

Map 1 Relative change in *COVID-19 cases*



Map 2 *COVID-19 two-week per capita case rate*



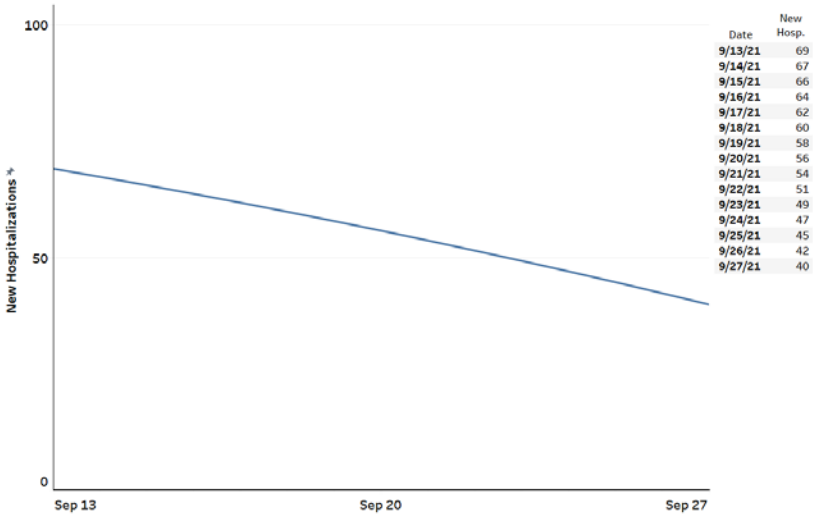
There has been a clear shift in the pandemic toward younger adults and children. The greatest number of new cases will continue to be in adults 34 and 59. However, all age groups are forecast to have growth. The number of cases in children is showing a steady and rapid increase, which does not appear to significantly decline in the next month.

There have been widespread declines in cases in the past two weeks. However, some counties in the state continue to show increasing relative growth in cases, as high as 91%.

COVID-19 Hospitalizations

15- & 30-day forecasts of hospitalizations. Figure 6a shows the realized rate of new hospitalizations in Arkansas between Sept. 13 and Oct. 12. As is easily discernable from the figure, there is a linear trend in daily new hospitalizations, declining over the next 15 days from 69 new patients on Sept. 13 to 40 on Sept. 27.

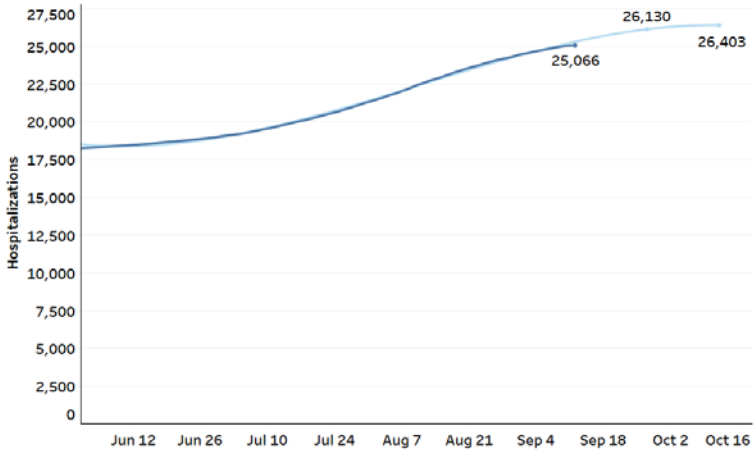
Figure 6a *New daily hospitalizations through Sept. 27*



Date	New Hosp.
9/13/21	69
9/14/21	67
9/15/21	66
9/16/21	64
9/17/21	62
9/18/21	60
9/19/21	58
9/20/21	56
9/21/21	54
9/22/21	51
9/23/21	49
9/24/21	47
9/25/21	45
9/26/21	42
9/27/21	40

The value regularly cited and discussed in news articles includes the number of hospitalized COVID-19 patients. This is an important number for understanding current utilization of hospital personnel and resources. However, an equally important number to focus on is the number of cumulative hospitalizations, noted as "ever hospitalized" in the daily reported values. This value is increasingly important as hospitals reach maximum capacity. That is, current hospitalization counts will remain relatively stable — all beds full — so the number of currently hospitalized cannot increase. What is less discussed is the number of "ever hospitalized" patients, which is also continuing to increase. On Aug. 21, hospitalized patients in Arkansas were reported to have declined by 35. That was excellent news for hospital capacity. However, the number of cumulative hospitalizations increased from 20,423 to 20,545, suggesting 122 additional individuals were hospitalized for COVID-19. As hospitals attempt to release less severely ill COVID patients from inpatient settings in order to treat more severely ill patients, there is more “churn” in hospitalized patients. This suggests cumulative hospitalizations may more accurately reflect the COVID-19 burden on the Arkansas health care system.

Figure 6b *Cumulative Hospitalizations through October 12*



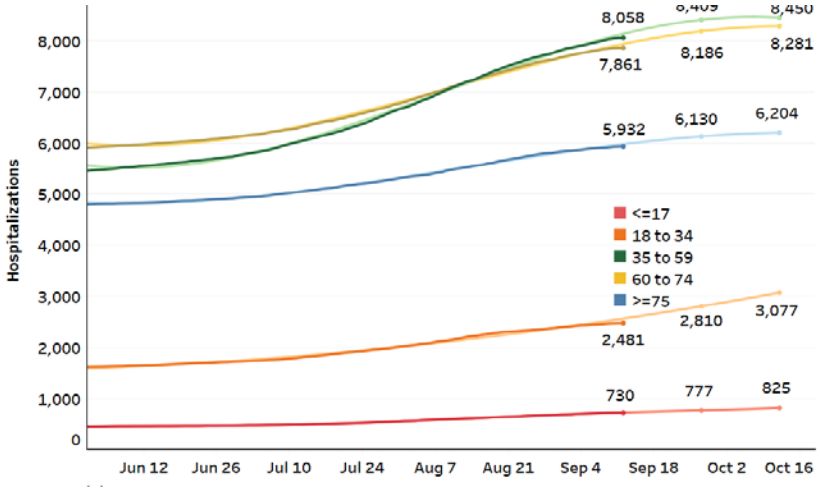
The 15-day and 30-day forecasts for COVID hospitalizations are shown in Figure 6b. The model forecasts a total of 26,403 cumulative hospitalizations by Oct 12, an increase of approximately 1,500 patients.

Figure 7 shows the 15-day and 30-day forecasts of hospitalizations by age through Oct. 12. It is evident in the forecast that hospitalizations in all age groups will increase. The age group with the most

hospitalizations continues to be adults 35 to 59. However, a large proportion of patients will be adults 60 to 74. The model forecasts this group will add 420 new patients by Oct. 12.

Summary. The conclusion we reach from the models is that hospitalizations will decline during the next month. Nevertheless, there will be significant numbers of patients in each age category. The models forecast the greatest number of hospitalizations due to COVID-19 will continue to be in adults 35 to 59. We should expect significant increase in the number of hospitalizations of adults 60 to 74.

Figure 7 *Cumulative hospitalizations by age group through Oct. 12*

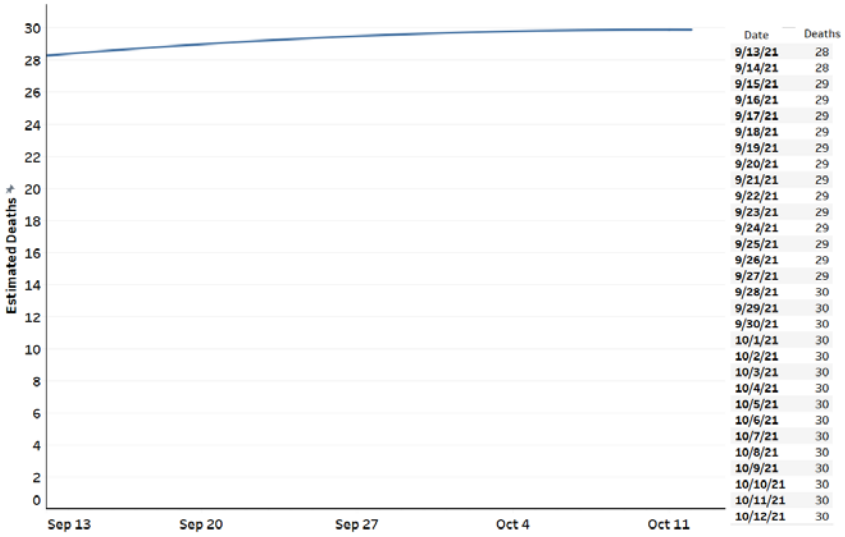


We should also expect greater numbers of young adults 18 to 34 and children under 17 hospitalized. Presently, absolute numbers remain relatively small in these age groups. However, as was stated above, school openings, Labor Day, and large group events will have an impact on the numbers of hospitalizations, especially in younger age groups.

COVID-19 Deaths

30-day forecast of COVID-19 deaths. The realized rate of new COVID-19 deaths in Arkansas from Sept. 13 to Oct. 12 shows a relatively flat linear trend. On Oct. 12, the model suggests Arkansas will have 30 new deaths due to COVID-19. The 15-day model forecasts 7,900 cumulative deaths in Arkansas due to COVID-19 by Sept. 27, or approximately 30 deaths daily from COVID-19.

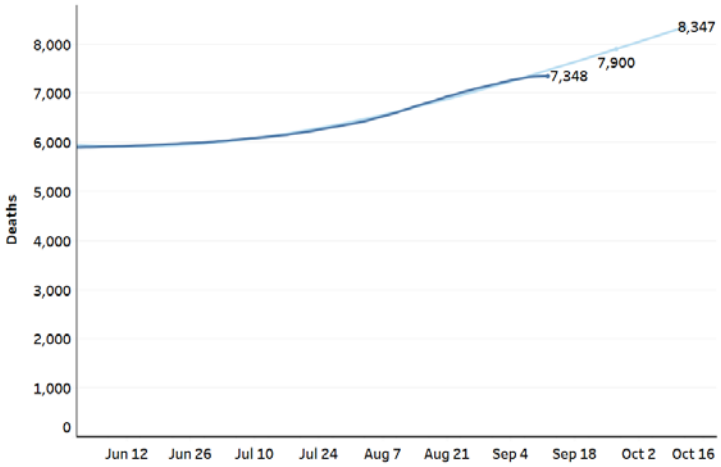
Figure 8a *New daily COVID-19 deaths through Oct. 12*



Date	Deaths
9/13/21	28
9/14/21	28
9/15/21	29
9/16/21	29
9/17/21	29
9/18/21	29
9/19/21	29
9/20/21	29
9/21/21	29
9/22/21	29
9/23/21	29
9/24/21	29
9/25/21	29
9/26/21	29
9/27/21	29
9/28/21	30
9/29/21	30
9/30/21	30
10/1/21	30
10/2/21	30
10/3/21	30
10/4/21	30
10/5/21	30
10/6/21	30
10/7/21	30
10/8/21	30
10/9/21	30
10/10/21	30
10/11/21	30
10/12/21	30

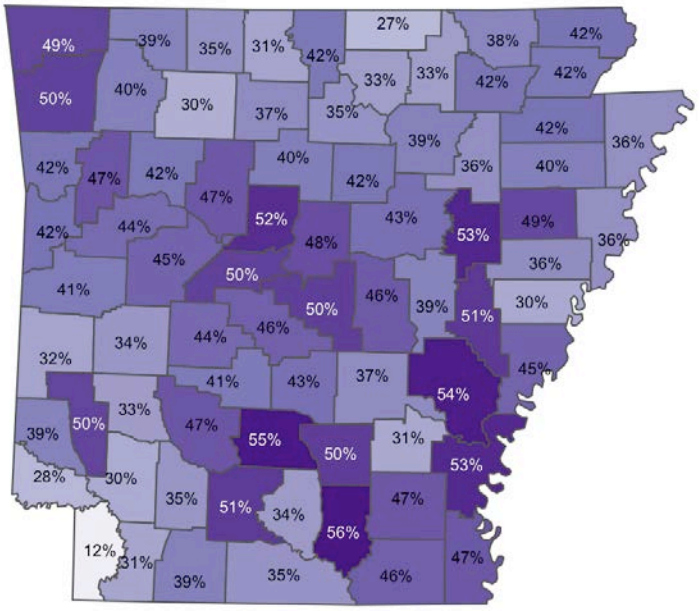
Summary. The number of daily deaths from COVID-19 appears to be relatively stable at around 30 deaths per day. Deaths lag both cases and hospitalizations, which suggests that the number of deaths should begin to decrease if the trend in cases and hospitalizations remains the same. However, even with a relatively stable rate, the models suggest Arkansas will pass the 8,000 COVID-19 deaths threshold around Oct. 1.

Figure 8b *Cumulative COVID-19 deaths through Oct. 12*

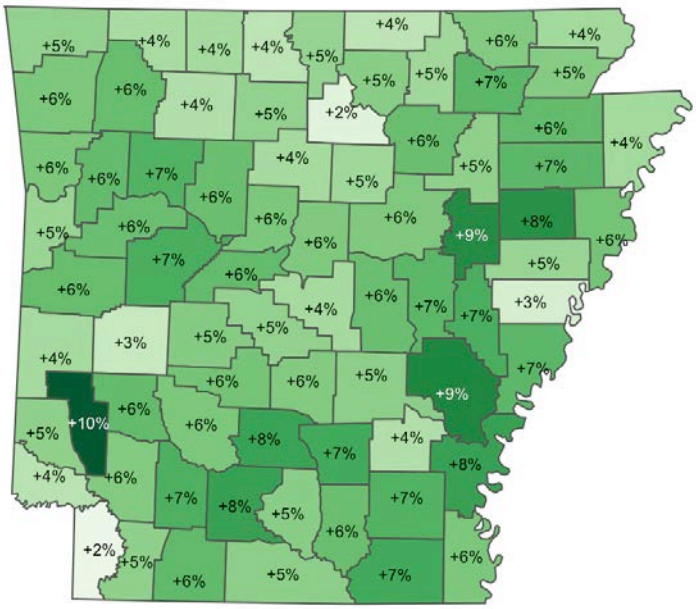


COVID-19 Vaccination.

Map 3 *Percent of the population (12+) fully vaccinated*



Map 4 *Percent change in fully vaccinated (12+) in the past month*



Map 3 shows the percentage of the fully vaccinated population age 12 and over in each Arkansas county as of Sept 12. Vaccination data were processed by Haley Hale using data available from the Arkansas Department of Health's website. There is still a greater than four-fold difference between the county with the highest vaccination rate — 56% in Bradley County — and the lowest — 12% in Miller County. Demographically, Miller County looks like many other counties in Arkansas with much higher vaccination rates. It has been anecdotally reported that many Miller County residents received their vaccinations across the border in Texas. These vaccinations are not being recorded in Arkansas and, consequently, may be skewing the number of adults vaccinated in Miller County. The same could be true for other border counties. It must be noted, with the introduction of the Delta variant into the state and the beginning of classes in schools and colleges, a more accurate picture of vaccinations in the state would include all citizens in Arkansas, including children under 12. If all citizens were included in the denominator, vaccination rates would be lower.

Comparing current vaccination rates with those in the previous report, Map 4 shows the percent change of a county's population vaccinated. The counties with the highest one-month increase were Howard, Arkansas, Woodruff, and Cross counties, each increasing vaccinations by 8% or more. Even so, the rate of vaccination across the state remains slow, with a number of counties vaccinating 5% or less of its population in the last month.

Methodological Notes

Short-term forecasts. Time series forecasting is a method that uses observed data to predict future values. The purpose of the models is to fit the best curve to data and extend the curve into the future. To forecast aspects of the pandemic in Arkansans, the models used COVID-19 cases, hospitalizations, and death data reported to the Arkansas Department of Health. It should be noted the report defines a "case" as a COVID-19 test result reported and posted by the Department of Health. As indicated by recent research, the number of undiagnosed COVID-19 infections in the community may be higher by 40% to 50%. Although an antibody seroprevalence student recently was completed in the state, we have not yet had time to incorporate it into our modeling.

Glossary of Terms

Active infection = a positive infection, with or without a COVID-19 test, that has not yet recovered or died

Case = a positive COVID-19 test result reported to the Arkansas Department of Health

Community = population not in a prison or population not in a prison or nursing home

Cumulative = total number of a given outcome (e.g., cases) up to date

Extended state-space SIR (eSIR) model = a model based on three components: susceptible (S), infected (I), and removed (R, including both recoveries and deaths)

Susceptible-Exposed-Infected-Recovered model (SEIR) = another variant of standard epidemiological model considering exposure as another factor controlling for disease dynamics

Hospitalization = a positive infection or case that was admitted to the hospital

Infection = a COVID-19 infection, with or without a test and regardless of having recovered or died

Positivity Rate = the number of people who test positive for covid-19 as a proportion of people have been tested

Projections = long-term predictions

Recovered = a positive infection that is no longer symptomatic or shedding virus

Susceptible = an individual who can be infected with the disease of interest

Time series forecast = short-term forecast of events through a sequence of time