Clare Brown, Sean G. Young, Mick Tilford, Jenil Patel, Suman Maity, Jyotishka Datta, Benjamin C. Amick III, Mark L. Williams*

*corresponding author

December 4, 2020
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 four types of assessments for this bi-weekly report: 1) forecasts and projections of cases and infections, along with maps of community spread; 2) models of hospitalizations, ICU admissions, and ventilations; 3) forecasts of COVID-19 deaths; and 4) findings from the Arkansas Pandemic Poll.

All forecasts and projections were developed using COVID-19 data from the Arkansas Department of Health through Nov. 29. Findings related to the Arkansas Pandemic Poll are from data collected by the COPH from May 5 through Nov. 29.

Summary points are:

- 15-day models continue to predict increasing numbers of daily cases, hospitalizations, and deaths due to COVID-19. The 15-day model forecasts 153,548 cumulative confirmed COVID-19 cases in Arkansas by Dec. 14. Including confirmed and probable cases, the 15-day model forecasts 180,542 cases by Dec. 14. Note that these forecasts are assuming no changes in the rate of spread due to Thanksgiving gatherings; therefore, these forecasts are likely low. The increase in the number of cases in the next two weeks will equal the number of cases in the state between March 11 and July 4.
- 15-day models continue to show Arkansans between 35 and 59 will have the highest number of COVID-19 cases. Young adults 18 to 34 will have the second highest number of cases. These two age groups will make up about two-thirds of the COVID-19 caseload in the state.
- All counties in Arkansas reported new COVID-19 cases in the past two weeks. Seven counties had two-week change rates greater than 100%, compared to 14 counties in the previous report.
- The 15-day models are forecasting 9,756 cumulative hospitalizations and 3,066 cumulative intensive care patients by Dec. 14.
- The trend for the greatest number of hospitalizations continues to be in adults 60 to 74 years. Children younger than 17 continue to have the fewest number of hospitalizations. Nevertheless, the number of hospitalizations in children is increasing, and we can expect to see more children hospitalized with COVID-19 disease.
- The 15-day model is forecasting 2,709 cumulative deaths by Dec. 14. If the 15-day forecast holds true, Arkansas can expect to see more deaths due to COVID-19 in the next two weeks than in the first four months of the pandemic.
- The long-term eSIR model suggests the pandemic will peak in late March 2021 with up to 40,000 active infections.
- Taking all statistics presented in this report as a whole, we conclude COVID-19 in Arkansas is now in a phase of a community spread in which the virus is so prevalent it can no longer be associated with a person or a place. We do not yet know the consequences of the Thanksgiving weekend, but expect it will add to the current growth in cases, hospitalizations, and deaths.

So, what does community spread mean? What it means, using a forest fire as an analogy, is that the fire in Arkansas up to mid-November was smoldering. The fire was burning, but it was
burning at a rate some could choose to ignore, being mostly smoke, and believing it would just go away. But, the fire was still there, gaining energy and strength. In mid-November, the fire had built up enough strength to begin jumping from dense forests in the state to those parts with fewer trees. At this point, the fire was spreading broadly, burning enough forest to pose a danger to every single person in the state. In fact, the forest fire had grown to cover the entire state and was getting close to endanger the very systems every Arkansan needs for their health and safety. Like all fires, this forest fire will continue to burn until it runs out of fuel or someone puts it out. Fortunately, the fire department, in the form of a public health distribution of vaccines, is on the way. But, it is not here yet. What matters now is what we do until the fire department shows up. We can continue to disregard the fire raging around us, or we can use the tools we have to tamp it down until help arrives. We can mask-up, frequently wash our hands, and avoid situations that bring us in contact with people outside our household. We can also support our families, friends, and community, stay positive, and encourage everyone to protect each other and our state.
COVID-19 Cases and Infection

**15-day forecast of COVID-19 cases in Arkansas.** Confirmed cases are those identified using the PCR test. The Department of Health distinguishes between confirmed and probable cases. Probable cases are diagnosed using an antigen test, which is considered less reliable than the more commonly used PCR test. The Department of Health provides the number of total cases in Arkansas by adding the number of confirmed and probable tests together. Because the Department of Health was not including positive antigen tests until Sept. 2, we included only positive antigen tests on or after Sept. 2.

Figure 1 shows actual and forecast confirmed COVID-19 cases in Arkansas. The model forecasts Arkansas will reach a cumulative **153,548** confirmed COVID-19 cases by Dec. 14. To put this in perspective, in the three months between March 11 and June 20, the state had a total of 16,039 cases. In other words, the state will experience as many confirmed COVID-19 in the next two weeks, an additional 15,739 forecast between Nov. 29 and Dec. 14, as it did in the first three months of the epidemic.

The 15-day forecast in the last report was **136,263** cumulative confirmed cases by Nov. 30, around 1.3% fewer than the 138,056 confirmed cases reported on that date by the Arkansas Health Department.

The 15-day forecast of cumulative confirmed and probable cases for Dec. 14 is **180,542** cases, as shown in Figure 2. Our previous forecast of probable and confirmed cases was 146,446 on Nov. 16. The combined model forecast was approximately 6.9% less than the 157,359 reported by ADH on that date. Again, the difference between the forecast and the actual number of combined COVID-19 cases suggests a significantly steeper increase in the growth curve than was expected. It is possible that some of the increased growth in positive antigen tests is a result of increased antigen testing across the state.
The overall growth rate in COVID-19 cases from the previous report to the current report was 12%, or an increase of nearly 15,000 cases. All age groups saw a growth rate greater than 10%.

**Forecast confirmed cases by age and race.**

As shown in Figure 3, the greatest growth in confirmed COVID-19 cases will continue to be in adults 18 to 59. The 15-day model is forecasting 51,612 confirmed cases in adults 35 to 59 by Dec. 14. The second highest growth will be in young adults 18 to 34. The model is forecasting 43,911 cumulative confirmed cases in young adults 18 to 34 by Dec. 14. Together, these two age groups will account for two-thirds, 66%, of the COVID-19 caseload in the state. The smallest growth will be in adults older than 75, with 11,252 forecast confirmed cases by Dec. 14.

![Figure 3](image_url) 
*Figure 3 Forecast for confirmed COVID-19 cases through Dec. 14 by age*

The 15-day model is forecasting increasing cases in all racial/ethnic groups in Arkansas, as shown in Figure 4. However, as we have pointed out in previous reports, the model forecasts the greatest increase will be in Whites. Indeed, if we compare the slopes for Blacks and Hispanics to that of Whites, the slope is increasing far more rapidly in Whites than Blacks or Hispanics. The 15-day model is forecasting 79,360 cumulative confirmed COVID-19 cases among Whites by Dec. 14, an increase of approximately 8,200 cases over the number reported through Nov. 30.

**Relative change in community COVID-19 cases.** Map 1 shows the relative change in each Arkansas county’s case rate in the last two weeks. The relative change is determined by calculating the percent change between case rates from the most recent two-week period, Nov. 16 to Nov. 29, with the case rates from the prior two-week period, Nov. 2 to Nov. 15. Counties in red had increases in rates, while counties in green had declines.
There were 37 counties with no change or a reduction in county-level rates, and 12 counties had growth rates greater than 50%. Seven counties had a growth rate greater than 100%, which represents a doubling of cases. Counties with positive change rates greater than 50% are shown on Map 1 in the darkest shade of red. These counties are scattered throughout the state, with some clustering in southeastern Arkansas.

For this report, we identified 12 counties with a positive rate of change over 50%, compared to 17 counties in the previous report. The previous report identified seven counties with change rates above 200%. There are no counties with rates over 200% in this report. The highest change rate is 172% in Bradley County.

It is important to note that the rate of change, if viewed without knowing underlying rates, may not tell the full story of a county’s COVID-19 burden. A steady rate of 250 cases per 10,000 from one reporting period to the next would have a rate of change of 0%, even though the disease rate is high.

What can be said about a county’s COVID-19 burden is limited when assessing change rates alone, and more can be learned by considering them with other data. Map 2 shows the number of COVID-19 cases in the last 2 weeks per 10,000 population for each county. Per capita rates are concerning when high. The five counties with the highest per capita rates in the last two weeks were Greene, Ouachita, Polk, Craighead, and Clay which all had rates greater than 80 per 10,000. Three of these counties are contiguous in northeast Arkansas. As with the previous report, the Northeast appears to have among the highest rates during the last two weeks. However, there also appears to be new clustering of high rates in southeastern counties.
COVID-19 positivity rates. 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 COVID-19 transmission in the state. A higher rate is indicative of greater COVID-19 transmission. The positivity rate is dependent on the number of tests conducted. The positivity rate has also taken on greater significance as part of CDC guidelines for local schools having in-person classes. According to guidelines, the ideal positivity rate is less than 5%, but for practical purposes less than 10% is acceptable.

Testing for COVID-19 in the state remains on par with the national average (3.3/1,000 versus 4.7/1,000). Figure 5 shows the seven-day moving average of the positivity rates for Arkansas and the United States. Following the second week in May, the positivity rate in Arkansas increased and has remained above the national average, except for two drops below the national average for short periods in August and September. As of the end of November, the positivity rate in Arkansas was 12.9%, which is higher than the national rate of 9.6%.

Mid-term forecast of COVID-19 cases. The mid-term forecast provides a look at what might happen between the end of November to the end of January 2021. We used a SEIR model to predict a seven-day rolling average.

As shown in Figure 6, the 60-days model forecasts 219,722 cumulative cases on Jan 31. If the forecast holds true, Arkansas will add 62,363 new cases over the number reported to the Department of Health by the end of November. However, our expectation is that this number is a conservative forecast. Current short-term trends suggest the number of new cases will be higher.
Long-term projection of active cases. As shown below in Figure 7, the eSIR model is projecting the peak of the epidemic in Arkansas will be in late March, with a mean prediction of 40,348 active infections. The light-pink shaded region in Figure 7 shows the uncertainty in the confidence interval, while the red line shows the mean estimate.

Summary. The short-term forecast describes significant continued growth in COVID-19 cases over the next 15 days. A plausible reason for this outcome is that portions of the community do not see themselves at high risk of infection and are behaving accordingly. A second plausible reason is pandemic fatigue. While not measured, it is described by many as people and households simply tired of following CDC and state guidelines about the pandemic. The greatest number of cases are in adults between the ages of 18 and 59. Adults younger than 60 may have developed the impression that COVID-19 is not a significant risk for them, or if infected they will not develop serious disease. In terms of public health messaging about COVID-19 infections, targeting people younger than 60 and showing younger adults with the disease may be necessary to increase awareness of risk.

The long-term model’s projected peak increased by almost 20% from the previous report. This may be a reflection of the recent acceleration in new COVID-19 cases. However, the lower confidence boundary remains extremely low, indicating a wide range of uncertainty in long-term projections. Nevertheless, the long-term model is currently suggesting active COVID-19 infections in the state will gradually peak at around 40,000 in late March. As before, the shape of the model’s curve is concerning. Rather than a rapid increase and slow decline, as indicated by previous projections, the model is projecting a more gradual increase and decrease at higher sustained numbers of infections (>20,000 active infection) through July 2021. This suggests we could have large numbers of active COVID-19 infections with high rates of hospitalizations and deaths during the first six to seven months of 2021. We should expect high active infection rates until the COVID-19 vaccines are widely distributed.

Taken as a whole, the statistics in the report, especially those at the county level, strongly suggest COVID-19 is now spreading in communities and can no longer be associated with
specific places or events. This is not to say large public events cannot increase the rapidity of COVID-19 transmission in the community. Rather, everyday activities in a community in which people are not wearing facemasks are highly likely to spread the virus. Community spread also means controlling the virus will be more difficult, as contact tracing will be less likely to include the source of infection. Indeed, people may not know where they may have come in contact with the virus because the possibility of transmission from any one contact is high and because it may take days before symptoms appear.

We should expect case management and contact tracing to become more burdensome as the number of infected residents continues to grow. For example, in the next two weeks, Arkansas should expect 24,295 new COVID-19 cases. If we assume conservatively each case has four contacts, the state will be expected to contact, order into quarantine, and monitor 97,180 persons. This number will continue to grow in the next few months. While we have not evaluated and cannot evaluate the ability of the state to effectively conduct contact tracing, where we may first see system failure is in testing, contact tracing, and case management.
COVID-19 Hospitalizations and ICU Admissions

Short-term forecasts of hospitalizations. Figure 8 shows the 15-day forecast for COVID-19 hospitalizations in the state on Dec. 14. The estimated trend in hospitalizations is consistent with the increasing trend in confirmed and probable cases. The 15-day model forecasts there will be 9,756 cumulative hospitalizations in Arkansas by Dec. 14, an increase of 819 or 9% in hospitalizations over Nov. 30.

Figure 9 below shows a similar growth pattern for patients needing intensive care. The 15-day model is forecasting 3,066 COVID-19 cumulative intensive care patients by Dec. 14, an increase of 191 or 7% over Nov. 30. We should expect approximately a quarter of persons hospitalized for COVID-19 disease in the state will require intensive care.

In our last report, forecast hospitalizations and patients needing intensive care were fairly close to actual numbers, within 4% and 8% respectively. The model forecast 9,307 cumulative hospitalizations by Nov. 30. The actual number of hospitalizations was 8,937. Cumulative intensive care patients were forecasted to be 3,103, compared to actual number of intensive care patients on Nov. 30 of 2,875.

Likewise, the forecasted number of hospitalizations by age in Figure 10 echoes Figure 3’s overall growth pattern for cases. The current report forecasts the greatest number of hospitalizations will be in adults 60 to 74. Adults 60 to 74 are forecast to have 3,161 cumulative hospitalizations by Dec.14, increasing by 299 hospitalizations. This compares to 2,885 hospitalizations in adults 35 to 59, the second highest number.
The hospitalization rate of adults 60 to 74 diagnosed with COVID-19 is 16%, almost three times higher than the hospitalization rate of 6% among adults 35 to 59. Hospitalizations in adults 35 to 59 are forecast to increase by 97. The group with the third highest number of hospitalizations is adults over 75. Around 24% of adults over 75 diagnosed with COVID-19 will be hospitalized.

The groups with the fewest hospitalizations are young adults between 18 and 34 and children 17 or younger. Young adults have a relatively low rate of growth in hospitalizations compared to older adults. Nonetheless, the number of actual hospitalizations is not trivial. Young adults 18 to 34 are forecast to have 832 hospitalizations by Dec. 14, an increase of 15. Children younger than 17 are forecast to have approximately 207 cumulative hospitalizations by Dec. 14. While this number of cumulative hospitalizations is small compared to other age groups, this group continues to have growing hospitalization numbers. The number of cumulative hospitalizations in children under 17 was 194 on Nov. 30. An increase of 13 hospitalizations represents a 10% growth in just two weeks.

Our forecasts of hospitalizations by age groups for Nov. 30 were fairly accurate for all groups, with differences less than 12% between actual and forecasted hospitalizations.

We also forecast hospitalizations by race, as shown in Figure 11. All races are forecast to show steady increases in hospitalizations. As expected, the majority of hospitalizations will be in Whites. By Nov. 30, we expect hospitalizations to rise from 5,093 to 5,845 among Whites, 2,243 to 2,628 among Blacks, and 834 to 961 among Hispanics.

**Hospitalizations by county.** Evaluating the distribution of hospitalizations across counties can help us understand the impact COVID-19 may have on regional and county hospitals. We created two graphics related to county-level hospitalization.
For privacy reasons, two counties with fewer than 10 hospitalizations were excluded from the analyses.

**Map 3** Hospitalization rates per 100,000 residents by county

Map 3 provides the hospitalization rates per 100,000 residents. Make note that these are per 100,000, rather than per 10,000 like the maps related to positive cases. There are 73 counties with hospitalization rates greater than 100 per 100,000. A per capita rate of 100 per 100,000 means that one of every 1,000 people in nearly every Arkansas county has been hospitalized for COVID-19. Eight counties have rates greater than 500 hospitalizations per 100,000 population. To put it another way, one of every 200 residents has been hospitalized for COVID-19.

Similarly, understanding the percent of COVID-19 positive patients who have been hospitalized can be an important measure of disease spread and an indicator of future hospitalizations when combined with the number of new local cases. Map 4, provides the percent of confirmed COVID-19 cases hospitalized by county. For example, a value of 5% means that five out of 100 COVID-19 cases originating in a county have been hospitalized. Eleven counties have hospitalization rates above 10%. This rate means that...
one of every 10 COVID-19 cases originating in these 11 counties have been hospitalized. Eight counties have rates less than 5%. High hospitalization rates may indicate counties with less testing capacity. In these counties, cases may be identified only later in the infection when patients are sicker.

**Mid-term hospitalization projections through Jan 31.** Based on the SEIR prediction of the total cases, we factored in the hospitalization rate, estimated over 15-day average to adjust for higher variability, to predict the total number of cases requiring hospitalization at any given time. As shown in Figure 12, the number of hospitalizations will continue to increase through the end of January. By Jan. 31, hospitalizations are forecast to reach 12,538 cumulative hospitalizations, an increase of 3,602 over end of November. These results are based on limited data, which means the estimates are likely conservative.

![Projected hospitalizations by Jan. 31](image)

**Long-Term Projections.**

Table 1 shows the long-term projections for COVID-19 hospitalizations. Compared to previous reports, the proportion of active infections estimated to require hospitalization has been increased to better reflect recent trends in Arkansas data. Of the over 40,000 active infections on March 24, the model projects 2,663 individuals will be hospitalized for COVID-19 disease. Of these hospitalizations, 932 will require intensive care. We also consider a worst-case scenario. The worst-case scenario projects 4,622 hospitalizations based on over 70,000 active infections on March 23. If the worst-case projection holds true, the number of patients requiring intensive care would be 1,618.

For the long-term projection, it is important to understand that the number of projected hospitalizations is based on projected active infections for the date of March 24 only. These projections are not cumulative from the start of the pandemic, but they do include all COVID-19 patients in the hospital on that day.

**Table 1**: Long-term projections of active infections, hospitalizations, intensive care and ventilations in Arkansas

<table>
<thead>
<tr>
<th></th>
<th>Mean-Case Estimates</th>
<th>Worst-Case Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Date</td>
<td>March 24</td>
<td>March 23</td>
</tr>
<tr>
<td>Active Infections</td>
<td>40,348</td>
<td>70,037</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>2,663</td>
<td>4,622</td>
</tr>
<tr>
<td>Intensive Care</td>
<td>932</td>
<td>1,618</td>
</tr>
<tr>
<td>Ventilations</td>
<td>326</td>
<td>566</td>
</tr>
</tbody>
</table>
Summary. The 15-day models are forecasting the greatest number of hospitalizations due to COVID-19 will be in adults 60 to 74. Almost a fourth of adults 60 and over who test positive for COVID-19 will likely be hospitalized. Currently, growth in COVID-19 cases among adults over 60 is increasing, and it is expected the number of hospitalizations will increase accordingly.

The per capita hospitalization rate and the rate of hospitalization for COVID-19 patients strongly suggest an increasing pressure on regional and county hospitals due to COVID-19 patients. Hospitals in larger urban areas, including UAMS, should expect not just pressure from COVID-19 cases originating in the cities where they are located, but also from transfers as regional and county hospitals are unable to meet the demand or provide care for patients with severe COVID-19 disease.
COVID-19 Deaths

15-day forecast of COVID-19 deaths. The 15-day model is forecasting cumulative 2,709 deaths in Arkansas due to COVID-19 by Dec. 14, as shown in Figure 13. The forecast is an increase of **207 or 11%** over deaths reported on Nov. 30. Our previous forecast of COVID-19 deaths was within 1% of actual numbers, a difference of 25. Again, putting the number of deaths in perspective, Arkansas can expect to see more COVID-19 deaths in the next two weeks than we saw between March 11 and June 21.

Figure 13 Projected COVID-19 deaths through Dec. 14

Mid-term projections of COVID-19 deaths. Mid-term projections provide a look at what might happen between the end of November and late-January. As has been stressed previously, the farther out in time a model projects, the less confidence we have in model outcomes. We use a SEIR model to predict a seven-day rolling average.

As shown in Figure 14, the seven-day rolling average forecast of cumulative deaths in the state on Jan. 31 is 3,623. This is an increase of 1,121 deaths compared to actual number of deaths at the end of November.

Figure 14 Projected COVID-19 deaths through Jan. 31

Summary. Consistent with increasing cases and hospitalizations over the last two weeks, deaths rates are expected to continue to increase and to do so for the foreseeable future. The recent large increases in cases and hospitalizations are likely to be reflected as higher death rates in the upcoming forecasts, as we know deaths lag both cases and hospitalizations. As the slope of the 15-day forecast suggests, the number of deaths will increase at a high rate in the next two weeks.
Arkansas Pandemic Poll

The Fay W. Boozman College of Public Health at the University of Arkansas for Medical Sciences (COPH) has been conducting a poll of a random sample of Arkansans every two weeks since May 2020. The intent of the poll, called a pulse poll, is to assess the attitudes, beliefs, opinions, and behaviors of Arkansans since the advent of the COVID-19 pandemic. Since May, we have polled nearly 11,000 Arkansans. To ensure the results reflect the adult population of Arkansas, when possible, survey results are weighted to accurately reflect age, gender, and racial/ethnic distributions in the state. In this report, we present results that illuminate Arkansans’ plans for holidays gatherings and travel.

Between Nov. 19 and Nov. 30, we asked 621 Arkansans about their upcoming Thanksgiving, Christmas and New Year’s holiday plans.

- Fifty-eight percent (58%) said they had changed their holiday plans because of COVID-19. Women (64%) were more likely than men (50%) to have said they changed plans. Younger Arkansans, aged 18 to 39, were most likely to report having changed plans (61%), while older Arkansans were least likely to say they changed plans (52%).
- Blacks (66%) were more likely to report having changed plans compared to Whites (55%).
- Arkansans living in Central Arkansas (69%) were more likely to report having changed plans than those living in Southeastern Arkansas (47%).
- On average, a third of Arkansans (30%) said they will attend family reunions during the holiday season. However, fewer Blacks (20%) said they intend to attend a family reunion than Whites (34%). Of those attending family reunions, more than a third (39%) will attend reunions with 10 or more people. More Whites (43%) said they will attend family reunions with more than 10 people than Blacks (9%).
- Greater percentages of Arkansans living in either Northeast (45%) or Northwest (42%) said they intended to attend a large family reunion.
- Only a fifth (20%) of Arkansans said they will attend family parties this holiday season. Respondents older than 60 (13%) and Blacks (12%) had the lowest intentions to attend a family party. Among those planning to attend a family party, more than half (58%) said the parties will have 10 or more people. Intentions to attend a large family party were highest among men 18 to 39 (63%) or Arkansans living in the Northeast (64%).
- Almost a fifth of respondents (22%) said they are planning travel from one county in Arkansas to another. A third of adults 18 to 39 said they would travel within the state. Only 10% of respondents said they are planning travel to another state.

Summary: Arkansans are being encouraged not to travel this holiday season. Almost two-thirds of a representative sample of Arkansans say they changed their holiday plans because of COVID-19. This is a high percentage of Arkansans and suggests most Arkansans are not planning to travel. The numbers tell us that many have heard the message and are willing to participate in slowing the spread of the virus. However, there are still many people intending to attend family reunions or parties with more than 10 people. Unfortunately, this is not in alignment with public health recommendations. Future public health messaging should focus on the dangers of spreading COVID-19 among family members with whom one does not live. Messaging should also acknowledge the difficulty of this request and reinforce the positive attributes of staying home, such as protection of the family.

Black respondents reported the highest intent to change holiday plans and the lowest intention to attend either family reunions or parties with 10 or more people. Public health messaging targeting the Black community should positively reinforce these intentions.
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, ICU admissions, 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.

**Mid-term Projections.** The SEIR model projects COVID-19 cases and deaths using the same basic parameters — susceptible (S), exposed (E), infected (I), and recovered (R), that have been widely used to model epidemics since the 1920s. In addition, SEIR models account for the changing social conditions, such as the face mask order and opening schools, changing infection probabilities, and symptomatic and asymptomatic spread of cases. To arrive at the best model fit for mid-term projections of COVID-19, we first used a SEIR model (Exposed (E)) to model existing cases. The resulting fit was very good, but required a second step to project cases out to a predicted date. The difficulty with SEIR-like models is that actual COVID-19 cases may not accurately represent viral spread. This can occur for a number of reasons, including variation in rates of testing and limited knowledge of the contribution of asymptomatic infections to viral spread. To extend our SEIR model projections, we calculated a seven-day rolling average model using the number of cases to date. Results between the SEIR and seven-day rolling average estimates were consistent, with a fit coefficient above 75%.

**Long-term projections.** The eSIR model is based on the extended state-space SIR (eSIR) model. A standard SIR model has three components: susceptible (S), infected (I), and removed (R), including both recoveries and deaths. The proportion of the population falling into each mutually exclusive category is assumed to vary over time, creating the standard epidemic curve. The model creates projections of active infections, including mild and asymptomatic infections, over time. Active infections are not cumulative infections from the beginning of the pandemic, nor are they restricted to new cases on a given day. Rather, the model estimates the proportion of the population with an unresolved infection at a given point in time.

**Changing model assumptions and their impact on projections.** Since the last report, the model’s assumption regarding the proportion of active infections who will be hospitalized has been adjusted upward to better match recent trends in Arkansas data. The eSIR model was originally developed using assumptions based on data from China, such as the \( R_0 \) estimate. \( R_0 \) (pronounced R-naught) is a measure of how many people one infected person can infect. The model learns and improves over time by adjusting internal assumptions as more Arkansas-specific data become available. For example, the \( R_0 \) changed in the model over time from 3.15 to 1.39. Earlier versions of the model, working with less Arkansas data, relied more heavily on the assumptions derived from Chinese studies. Consequently, in the beginning, the model predicted a more aggressive epidemic than we have observed in Arkansas. As more Arkansas data have become available, the model has adjusted itself to better reflect the more extended epidemic curve we now observe.

**Comparison to other models.** Curve fitting models, like the widely cited University of Washington IHME model, tend to make strong assumptions, which are unlikely to hold as more data become available. In addition, curve fitting models cannot account for epidemic dynamics.
This often results in severe reductions in predictive strength beyond short-term windows. SIR/eSIR models, like we use in this report, have a stronger theoretical basis for long-term projections. Regarding the eSIR model’s relatively late date for a peak, this is in line with other long-term projection models, such as the CIDRAP Viewpoint, which predicts the COVID-19 pandemic will last 18 to 24 months. Furthermore, reports from week to week cannot be compared to each other. As more data are added to a model, differences reflect new Arkansas-specific data. Therefore, the results reported above should not be compared to the previous reports.

**Arkansas Pandemic Poll.** One the challenges of looking at responses by race/ethnicity is that some racial/ethnic groups in the poll have too few numbers to be included in the analyses. For example, we do not have enough respondents who are Marshallese to include them in the analyses. However, the Marshallese are an important racial/ethnic group in the state with respect to the COVID-19 pandemic.

**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

**ICU** = intensive care unit admission

**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