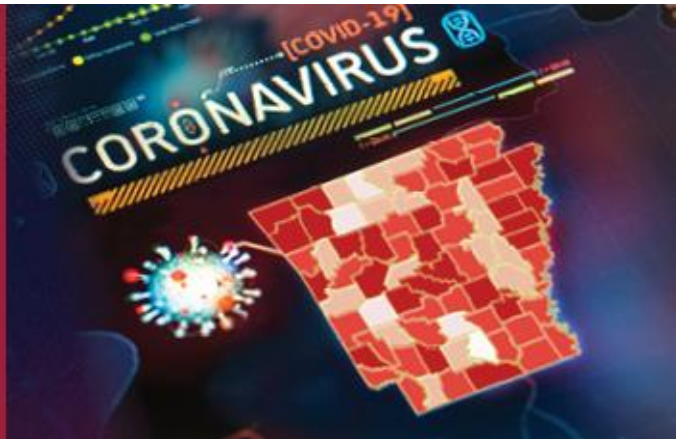
COVID-19 Forecasts in Arkansas

UAMS | Fay W. Boozman College of Public Health



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COVID-19 Forecasts, Projections, and Impact Assessments

University of Arkansas for Medical Sciences (UAMS) Fay W. Boozman College of Public Health (COPH) faculty conducted three types of assessments for this bi-monthly report: 1) short-term forecasts of confirmed cases, deaths, and hospitalizations; 2) long-term projections of infections and hospitalizations; and 3) findings from the Arkansas Pandemic Poll. All forecasts and projections were developed using COVID-19 data from the Arkansas Department of Health through Oct. 4. These results exclude cases identified with antigen tests. All findings related to the Arkansas Pandemic Poll come from data collected by the COPH from May 5 through Oct 5.

Summary points are:

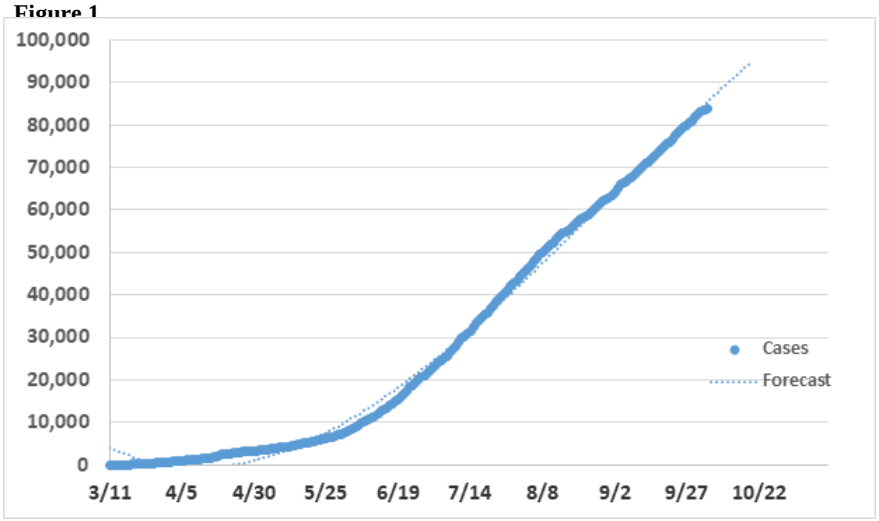
- 15-day forecasts continue to predict increasing numbers of daily cases, hospitalizations, and deaths due to COVID-19. The 15-day model is forecasting 94,681 cumulative COVID-19 cases in Arkansas by Oct. 19.
- The 15-day models are forecasting 6,542 cumulative hospitalizations, 2,213 patients needing intensive care, and 1,674 cumulative deaths by Oct. 19. Most hospitalizations will be in adults 35 to 60.
- All counties in Arkansas have reported new COVID-19 cases in the past two weeks. Five counties had two-week rates of change greater than 100%. Two of those counties had rates of change greater than 300%. Counties with positive growth rates remain largely rural.
- Fifteen-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 70% of the COVID-19 caseload.
- The greatest number of hospitalizations will be in adults 35 to 59, followed by adults 60 to 74, and adults over 75. Children younger than 17 will continue to have the fewest number of hospitalizations.
- The long-term eSIR model suggests the pandemic will peak in early March 2021 at 52,000 active infections. Changes in the long-term model may be due to a slowing of new infections in the last month, with the epidemic spreading over more months with fewer cases at its peak.
- Using data from the Arkansas Pandemic Poll, we found considerable racial and ethnic disparities in terms of food and economic insecurity. About a quarter of Hispanics and a tenth of Blacks said they did not have enough money to buy food for their families. Of those who said they did not have enough money to buy food, a third said they went without food in the past two weeks.
- About one in five Blacks and one in four Hispanics said they were worried they could not pay their rent or mortgage in the two weeks before they responded to the survey.

COVID-19 Forecasts

In this report, we have moved all methodological discussions to the end in Methodological Notes. The short-term models in this section forecast 15 days into the future.

Current forecasts of COVID-19 cases in Arkansas. Figure 1 shows actual and forecast COVID-19 cases in Arkansas. The model forecasts Arkansas will reach 94,681 COVID-19 cases by Oct. 19.

Figure 1



As shown in Figure 1, COVID-19 cases continue to grow, with little change in the slope of the curve since July. As the model predicts future cases based on past cases, the model forecasts continued growth in cases over the next 15-day period. The 15-day model is forecasting 94,681cumulative COVID-19 cases in Arkansas by Oct. 19, an increase of 10,983 cases over actual cases on Oct. 5. The 15-day forecast in the last report forecasted for Oct. 5 was 86,118 cases, 3% higher than the 83,698 cumulative confirmed cases reported on that date.

Forecasts of hospitalizations, ICU admissions, and deaths. Figure 2 shows the 15-day forecast for COVID-19 hospitalizations in the state on Oct. 19. The estimated trend in hospitalizations is consistent with the increasing trend in observed cases. The 15-day model forecasts there will be 6,542 cumulative hospitalizations in Arkansas by Oct. 19, 16% over hospitalizations on Oct 5. The increase is 737 hospitalizations.

Figure 3 shows similar results for patients needing intensive care, with continued steady growth. The model is forecasting 2,213 COVID-19 patients requiring intensive care by Oct. 19 or an 11% increase since Oct. 5.

Figure 2
Forecast Hospitalizations

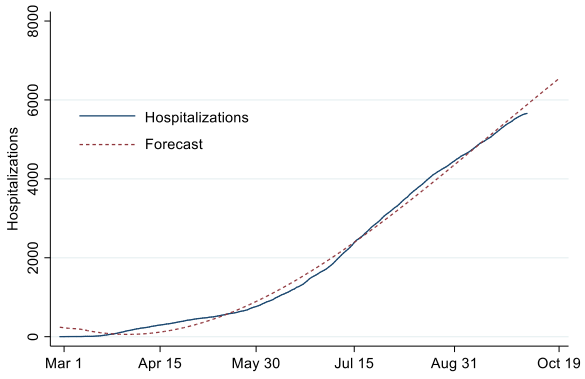
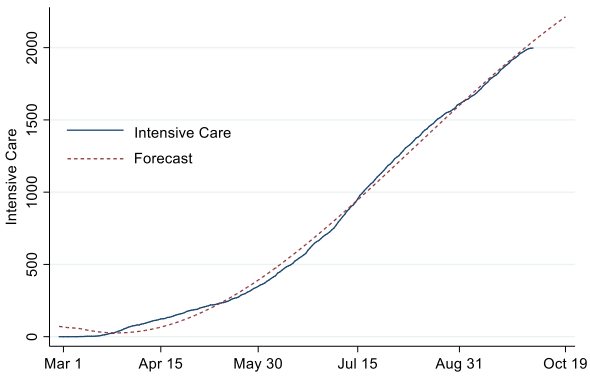


Figure 3
Forecast Intensive Care



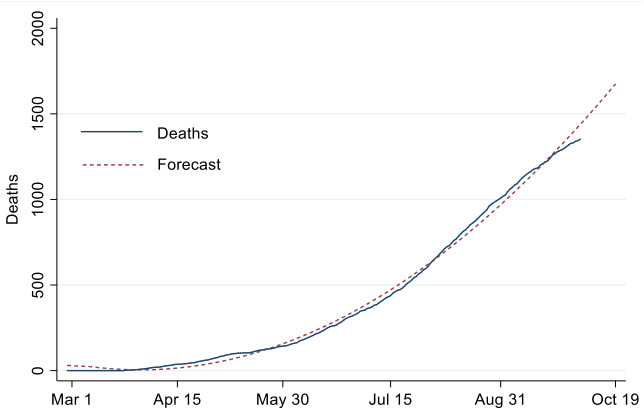
In our last report, the forecast for hospitalizations and patients needing intensive care were within 9% and 4% of the actual numbers, respectively. The model forecast 6,144 hospitalizations by Oct. 5 while the

actual number was 5,661, a difference of 453 hospitalizations. Intensive care patients were forecasted to be 2,069, while the actual number of intensive care patients on Oct. 5 was 2,000, a difference of 69.

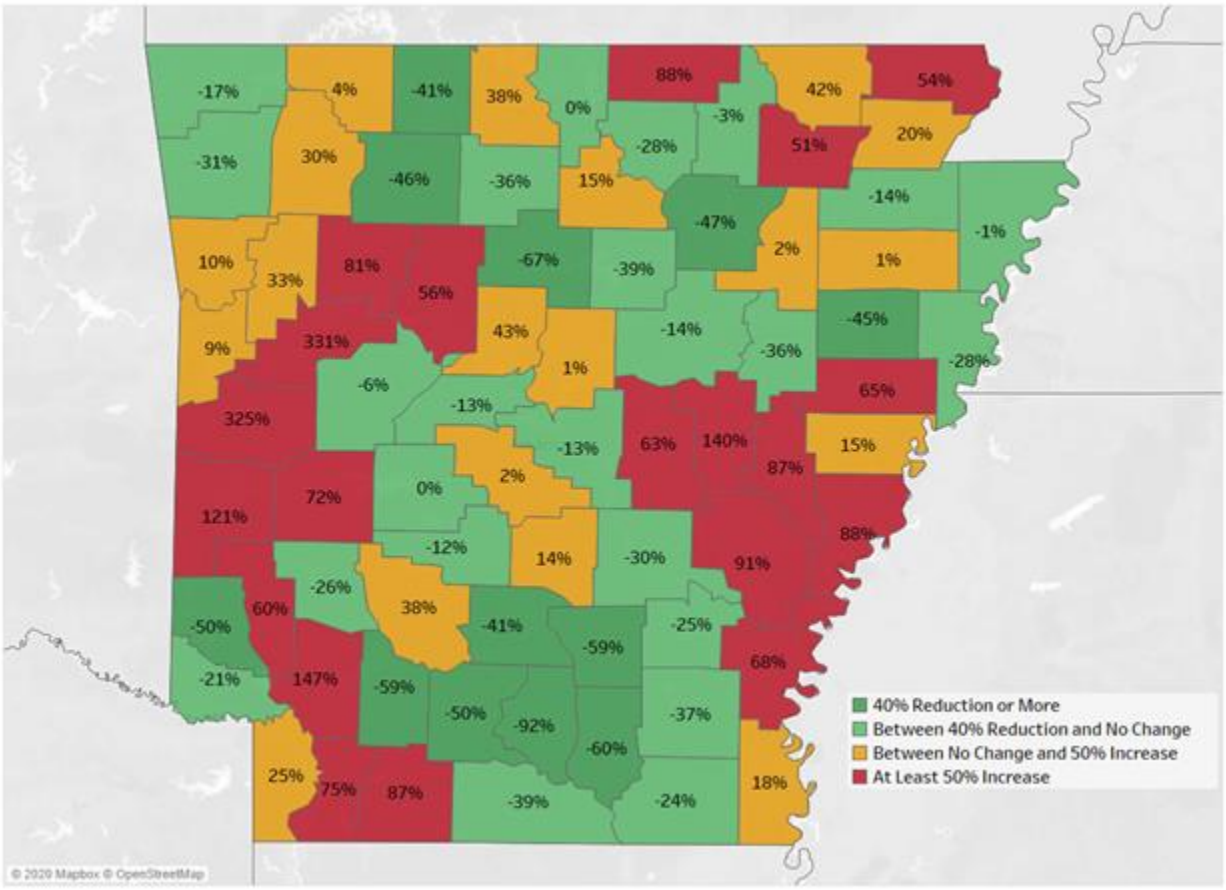
Forecast of COVID-19 deaths. The model is forecasting 1,674 deaths by Oct. 19 an increase of 322 or 24% over actual deaths on Oct. 5.

Our previous forecast of COVID-19 deaths was within 2% of actual numbers. The model forecast 1,375 deaths by Oct. 5. The actual number was 1,352, a difference of 23 deaths.

Figure 4
Forecast Deaths



Map 1
Relative change in COVID-19 community cases in the last two weeks



Relative change in community COVID-19 cases in the last two weeks. Map 1 shows the relative change in each 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, Sept. 20 to Oct. 4, with the case rates from the prior two-week period, Sept. 6 to Sept. 19. Counties in red had the greatest relative change. More counties are showing large change rates in this report than in the previous report.

Counties with positive rate change greater than 50%, red on the map, tend to be concentrated in rural counties in Arkansas. Five counties in this report also showed at least 50% positive change rates in the last report. In the current report, we also identified five counties with positive rate changes over 100%. Two had change rates greater than 300%, Scott and Logan counties. Thirty-five of the 75 Arkansas counties had no change or negative change rates. This suggests growth in cases in these counties may be slowing.

The dynamics of the pandemic in Arkansas have been such that the highest growth rate is in urban counties, followed by high growth rates in rural counties. While this suggests a pattern, none is apparent over time. Instead, high growth rates tend to pop up in different areas almost at random. This strongly suggests, residents in counties not experiencing significant growth at one time, should not be complacent –growth in cases can change quickly.

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 lower positivity rate is indicative of less transmission, and a higher rate is indicative of greater COVID-19 transmission. 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 is on par with the national average (2.9/1,000 versus 2.6/1,000). 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 started to increase and remained above the national average, except for a drop below 3% on Sept. 28. The October positivity rate has declined compared to rates in August or September. As of Oct. 5, the positivity rate in Arkansas was 6.5%. Arkansas's positivity rate is higher than the national rate, 4.3%.

Figure 5
COVID-19 positivity rate for Arkansas and the U.S.

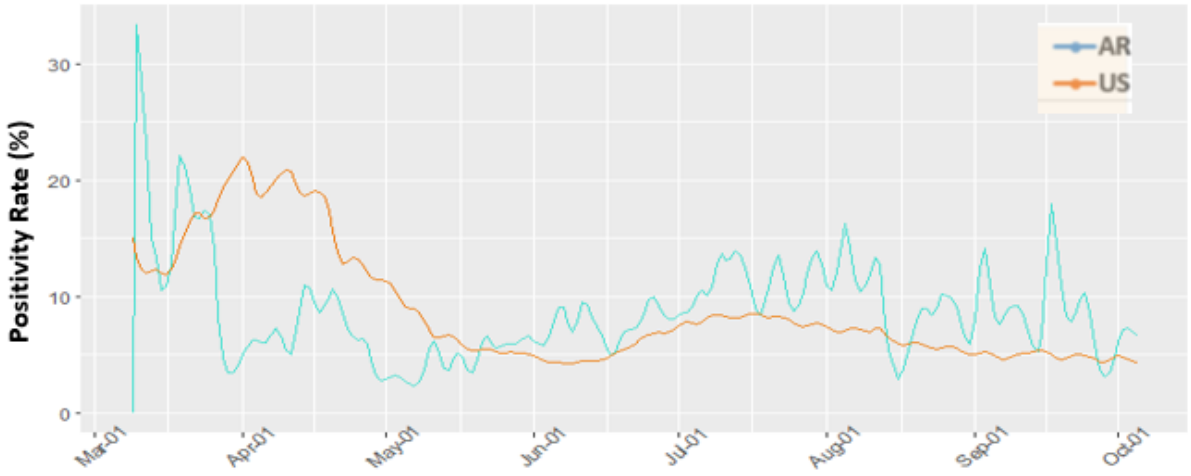
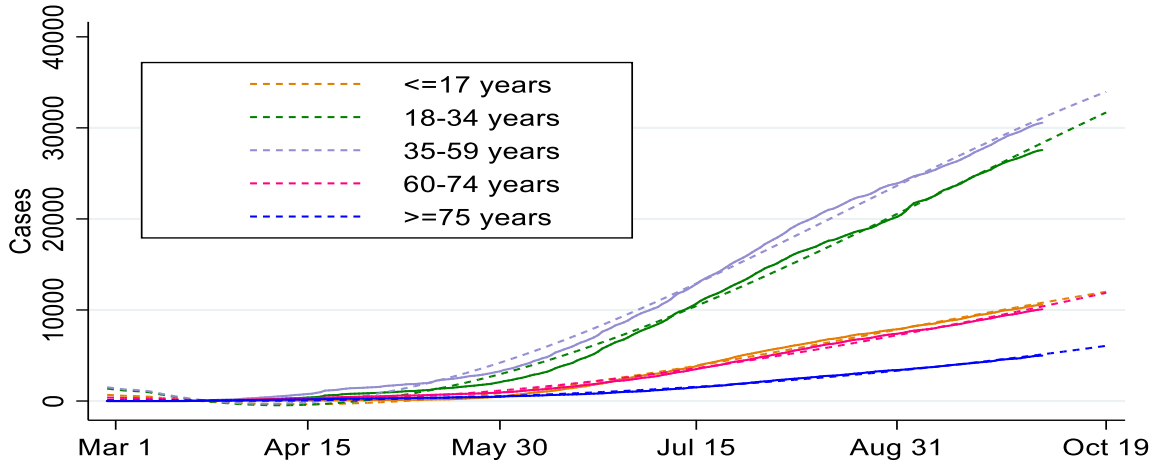


Figure 6
Forecast COVID-19 cases by age



Forecasts of COVID-19 cases and hospitalizations by age group. As shown in Figures 6 and 7, COVID-19 cases and hospitalizations differ by age. The age group with the highest number of COVID-19 cases continues to be adults 35 to 59. The 15-day model forecasts this age group will have 33,964 cumulative cases by Oct. 19.

The next largest group of COVID-19 cases are among young adults between 18 and 34. This group is forecast to have 31,696 cumulative cases by Oct. 19. As indicated in Figure 6, the line indicating the number of cumulative cases in younger adults will likely merge or overtake the line representing cases in adults 35 to 59. This is because young adults 18 to 35 have seen the highest growth in cases in the last two weeks. The third largest group of cases is in children 17 or younger. This group is forecast to have 12,001 cumulative cases by Oct. 19.

The group with the smallest number of cumulative cases in Arkansas is adults over 75, as shown in Figure 6. The 15-day model is forecasting 6,066 cumulative cases among adults older than 75 by Oct. 19. This suggests adults older than 75 are socially isolating either voluntarily or because they live in a nursing home. Nursing homes, as we know, restrict outside visitors thereby limiting contacts with their residents.

We compared our forecasts with the actual number of cases for Oct. 5. Differences between actual and forecasted numbers were less than 10% for all groups.

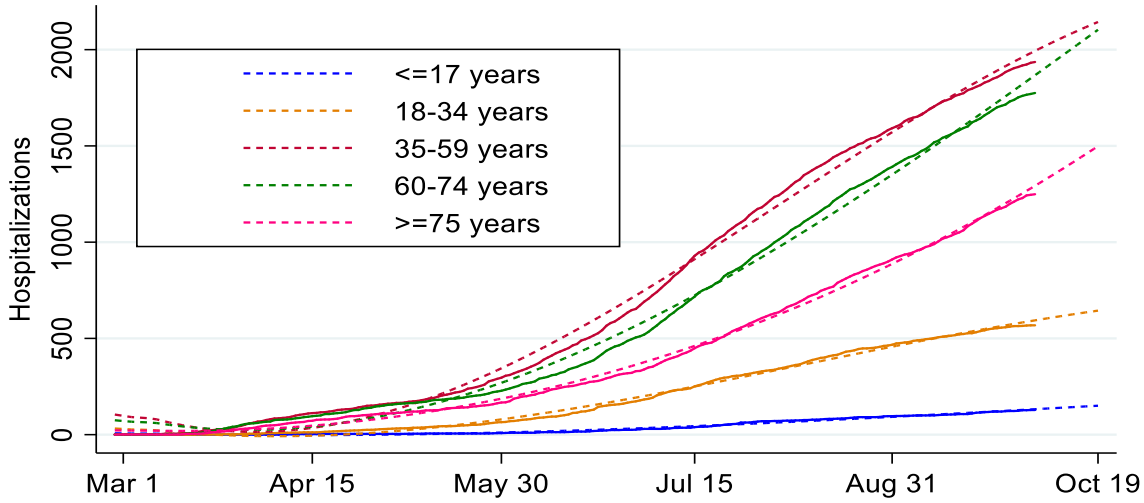
The forecast of hospitalizations by age, shown in Figure 7, presents a different growth pattern compared to Figure 6, and emphasizes the reasons why mitigation is important, especially for older adults. The group with the highest number of hospitalizations are adults between 35 and 59, as would be expected given this group also has the largest number of cases. This group is forecast to have 2,144 cumulative hospitalizations by Oct. 19. The hospitalization rate of adults 35 to 59 is 6%.

The second largest hospitalized group by age is adults between 60 and 74. Hospitalizations among this group are increasing and are forecast to reach around 2,103 cumulative hospitalizations by Oct. 19. If current trends continue, adults 60 to 74 are likely to become the group with the most cumulative hospitalizations in Arkansas. The third most hospitalized group are adults over 75. Slightly more than a quarter of this group diagnosed with COVID-19 have been hospitalized.

The groups with the fewest hospitalizations are young adults between 18 and 34 and children 17 or younger. Children younger than 17 are forecast to have approximately 150 cumulative hospitalizations by Oct. 19.

Our forecasts for Oct. 5 on hospitalizations by age groups have been fairly accurate and close to actual hospitalizations observed for all groups, with differences less than 12% between actual and forecasted hospitalizations.

Figure 7
Forecast COVID-19 hospitalizations by age group



Conclusions. The 15-day models are forecasting continued growth in COVID-19 cases over the next 15 days. The slower growth is reflected in a lower positivity rate which has been declining over the past few months.

There is significant growth in COVID-19 cases, hospitalizations, and deaths. A plausible reason for this outcome is that significant portions of the community do not see themselves at high risk of infection and are behaving accordingly. The greatest number of cases are in adults between ages 18 and 59. Adults younger than 60 may have developed the impression that COVID-19 is not a significant risk for them or, just as badly, may believe, even if infected, they will not develop serious disease. However, the greatest number of hospitalizations due to COVID-19 are in adults 35 to 60. Even though adults 18 to 60 may be at lower risk of death than those over 70, there is still significant risk. Furthermore, a disease with a fairly high risk of hospitalization is extremely serious, and, given the possible long-term consequences of COVID-19 infection, should not be taken lightly.

The high growth in COVID-19 cases and hospitalization among adults 18 to 65 is important. The vast majority of the workforce is between the ages of 18 and 65. Even if not hospitalized with COVID-19 disease, these adults will likely be out of the workforce for extended periods of time in isolation. Isolating persons with COVID-19 will have a ripple effect, as persons in close contact with infected persons are quarantined. As the pandemic in Arkansas continues to increase, isolating infected persons and quarantining their contacts will result in significant numbers of people unable to work. For example, on Oct. 5, the state reported 485 new cases. If we assume each person had seven close contacts, then 3,395 people would be ordered into quarantine. This would mean, assuming 80% of people in quarantine were between the ages of 18 and 65, 3,201 persons would be out of the workforce for an average of two weeks.

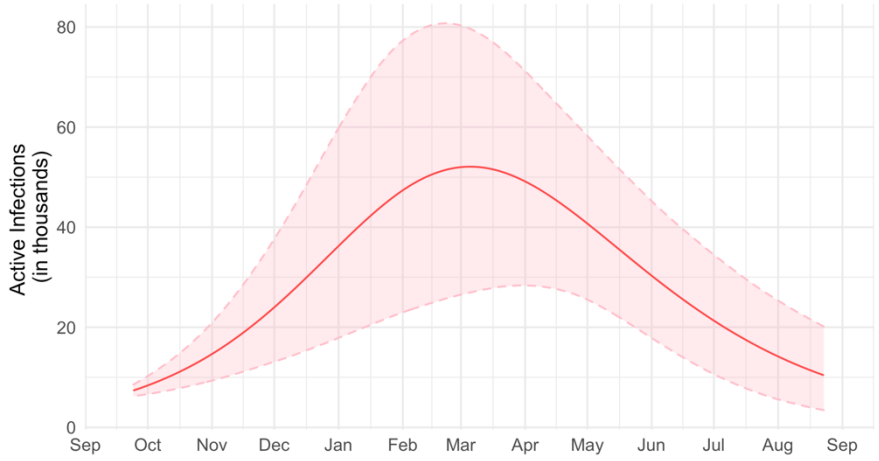
The forecast cases and hospitalizations continue to be worrisome for older Arkansans and emphasizes the need for continuing mitigation practices by all age groups. Almost a fifth of adults 60 and over who have tested positive for COVID-19 will be hospitalized. Currently growth in COVID-19 cases among these age groups is relatively slow. But, with family holidays approaching, with expected interaction among family members of all ages, infection rates in older adults could markedly increase. If this were to happen, hospitalizations will also dramatically increase.

Long-term Projections

As shown in Figure 8, the eSIR model is projecting the peak of the epidemic in Arkansas will be in March, with approximately 52,000 active infections. The light-pink shaded region in Figure 10 shows the uncertainty in the model (90% confidence interval).

Figure 8 and Table 1 show projected hospitalizations, intensive care, and ventilations. Based on Arkansas data, the model assumes approximately 2.4% of predicted COVID-19 infections will require hospitalization. Of those hospitalized, the model assumes 35% will require intensive care, and 35% of intensive care patients will require ventilation.

Figure 8
Projected active COVID-19 infections



At the pandemic's peak on March 5, the eSIR model is projecting that 1,250 people will be hospitalized with COVID-19, of whom 437 will require intensive care. The model is also projecting 152 patients will be on ventilators on March 5. These are based on the mean-case estimates of active infections, the solid line on Figure 10. Estimates for the "worst-case scenario" are also provided in Table 1 for comparison, shown on the next page. The "worst-case scenario" is the upper limit of the 90% confidence zone, and has a less than 5% chance of being the actual numbers for that time period.

Conclusions. The number of cases at the peak of the pandemic has changed significantly from the previous three projections, and the projected peaks have moved further out in time. What this suggests is, since the number of people susceptible to infection remains the same, COVID-19 is spreading more slowly through the the pool of susceptible Arkansans.

The most apparent difference from our previous long-term models is that the peak of the pandemic is projected for early March, with fewer active infections at the time of the peak. This change in the projection may be due to a slowing of the current growth curve. The long-term model, unlike the short-term models, does not react to daily or even weekly changes in the growth curve. Instead, the model reacts to longer term data trends. Within the model, the rate at which cases, or infections, have been growing has been slowly decreasing in recent weeks. In the last week, the number of diagnosed cases has been erratic, with some high and some low days. While this type of erratic change would be apparent in the 15-day model, long-term models are less likely to react. However, if a trend continues for a number of weeks, it will be reflected in the long-term models.

Table 1

Long-term projections of infections, hospitalizations, intensive care, and ventilations needed for Arkansas

	Mean-Case Estimates	Worst-Case Estimates
Peak Date	March 5	Feb. 22
Active Infections	52,087	80,753
Hospitalizations	1,250	1,938
Intensive Care	437	678
Ventilations	152	237

We can think of the pandemic somewhat like a rubber band. When the number of active infections is going down, the rubber band begins to stretch out, reflecting an extended pandemic, with fewer active infections on any given day in the future. When the number of active infections goes up, the rubber band contracts, with a larger number of active infections on any given day in the future. But, the actual size of the rubber band, the number of people who are susceptible, has not changed. There are still approximately 3 million Arkansans who can be infected. Even though the long-term projection suggests a less severe epidemic on any given future day, at least in terms of numbers of infections, this does not mean the course of the COVID-19 pandemic in Arkansas will be inconsequential.

Arkansas Pandemic Poll

The Fay W. Boozman College of Public Health at the University of Arkansas for Medical Sciences (COPH) instituted a random digit dial (RDD) telephone poll to assess Arkansan's views on the COVID-19 pandemic. The pulse poll is intended to capture a random sample of adults in Arkansas using random digit dialing. However, there is a much larger response to the poll by older adults because of a higher likelihood of being home during times calls are made. To make the results reflective of the adult population of Arkansas as a whole, we weighted survey results based on age and gender. To date, over 6,000 Arkansans have completed the survey. Findings in this report are based on new questions answered by approximately 2,700 respondents.

In this week's report, we explore whether the beliefs about the risk of getting the coronavirus and wearing a face mask vary by race/ethnicity or age. We also present findings on food and economic insecurity.

Beliefs about chances of contracting COVID-19 by race/ethnicity and age over time. One assessment made by the poll asks about the chance a respondent believes s/he will be infected by the coronavirus. Figure 9 shows beliefs about the risk of becoming infected with COVID-19 by race/ethnicity and age. Five percent more Hispanics than whites believed they had a high chance of being infected with COVID-19. More than a quarter of adults younger than 60 said they had a high chance of becoming infected compared to less than 20% of adults over 60. Beliefs have changed little since May. No more than 26% of Arkansans said they believed they had a high chance of having a COVID-19 infection.

Figure 9
Beliefs about chances of contracting COVID-19 by race/ethnicity and age over time

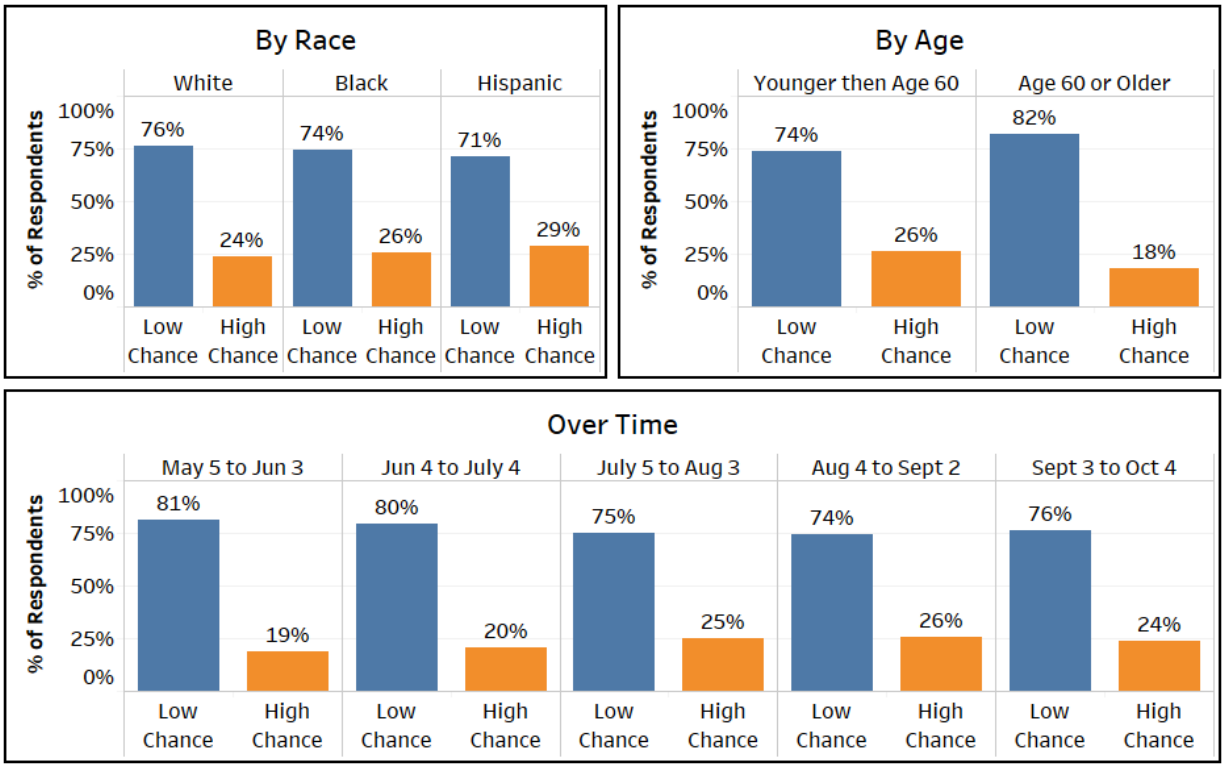
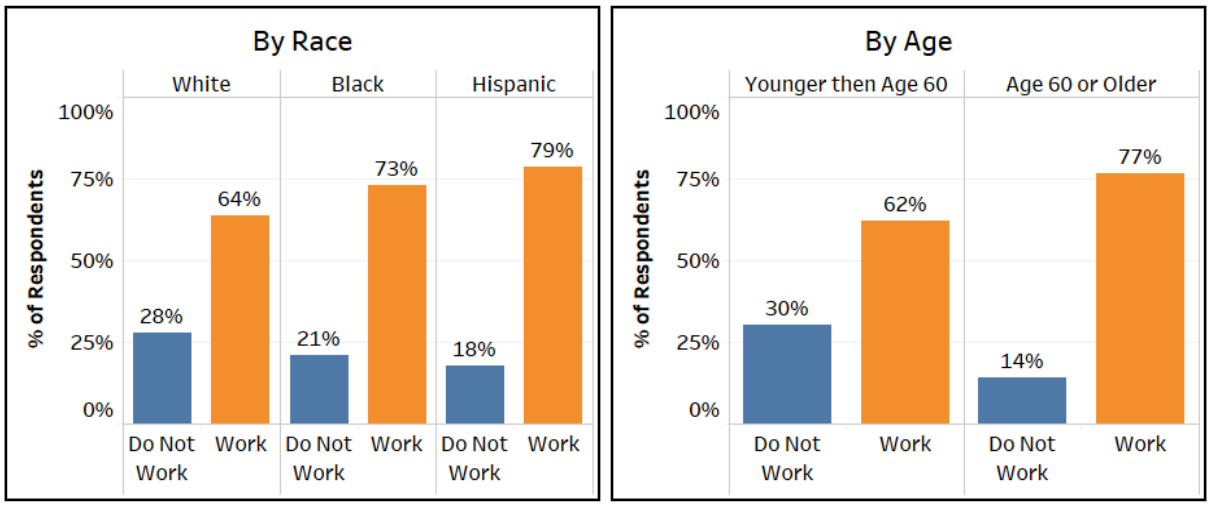


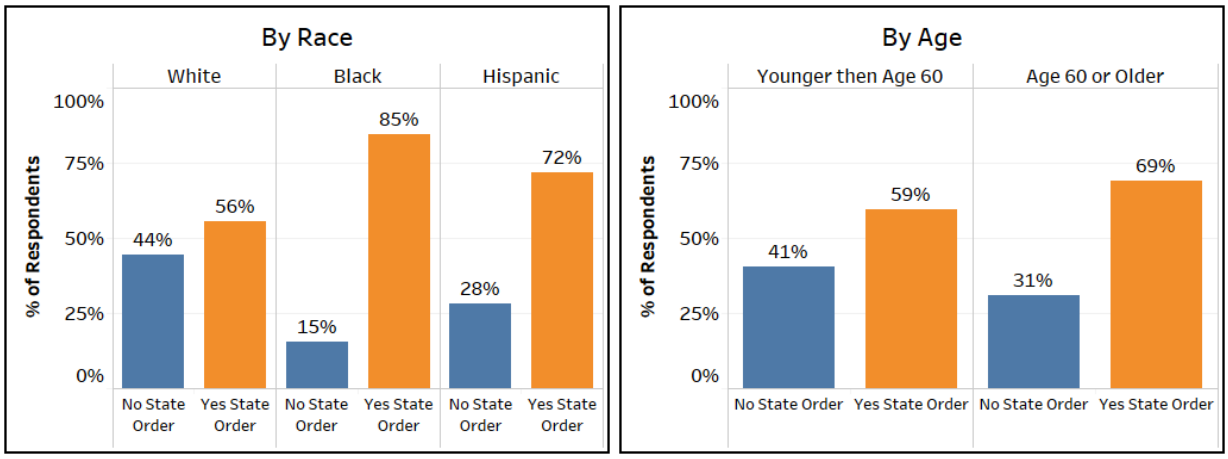
Figure 10
Beliefs about the effectiveness of face masks by race/ethnicity and age



Beliefs about face masks by race and age over time. Poll respondents were asked if they believed "wearing a mask helps stop the spread of the COVID-19 virus." This question was introduced on Sept. 5, so data are not shown over time for this measure. As shown in Figure 10, beliefs about the effectiveness of face masks varied by race/ethnicity. Blacks and Hispanics were more likely to say face masks are effective than were whites. Respondents older than 60 were more than twice as likely to say face masks are effective compared to respondents under 50.

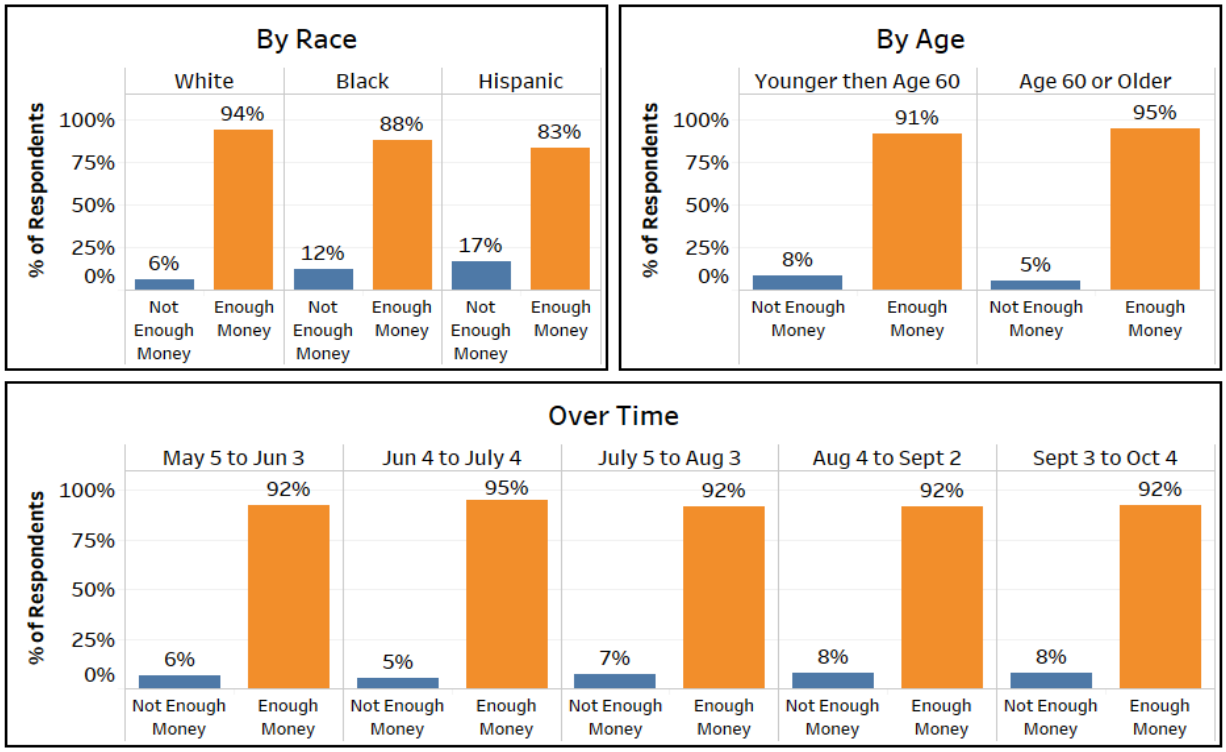
As shown in Figure 11, the majority of Arkansans said they supported the order that face masks be worn in public. Fewer whites than Blacks and Hispanics and adults older than 60 than adults under 60 said they supported the order.

Figure 11
Beliefs about the order mandating facemasks by race/ethnicity and age



Food and Economic Insecurity by Race, Age and Over Time

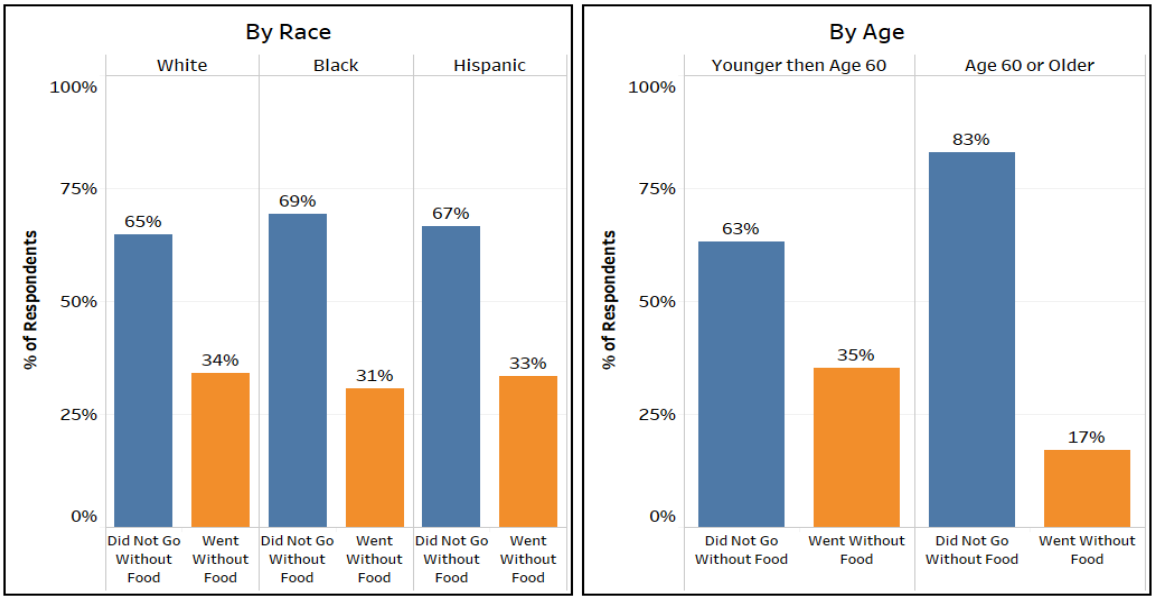
Figure 12
Enough money to buy food by race/ethnicity and age over time



The poll includes questions about food insecurity. Food insecurity is an indicator for hunger in Arkansas. We ask if a respondent had, "enough money to buy the food [their] family needs" in the past two weeks. As shown in Figure 12, the vast majority of Arkansas said they had enough money to buy food. Even so, there were differences by race/ethnicity. Almost 20% of Hispanics and more than 10% of Blacks said they did not have enough money to buy food. The rates of food insecurity have remained consistent over the course of the pandemic.

Almost 600 people responding to the poll said they did not have enough money for food in the last two weeks. Of these, nearly 1 in 3 said they or their family went without food as a result, as shown in Figure 13 (shown on the next page). There was no variation by race/ethnicity or age.

Figure 13
Among those reporting not enough money to buy food, how many went without food by race/ethnicity and age



In addition to food insecurity, the Arkansas Pandemic Poll measures economic insecurity. Economic insecurity assesses the degree a household is financially unstable. Economic insecurity can create personal stress, making household members more susceptible to illness. Those experiencing increased stress may also be less likely to see a health care provider if they become ill, be more susceptible to

Figure 14
Worried about paying the mortgage/rent by race and age over time

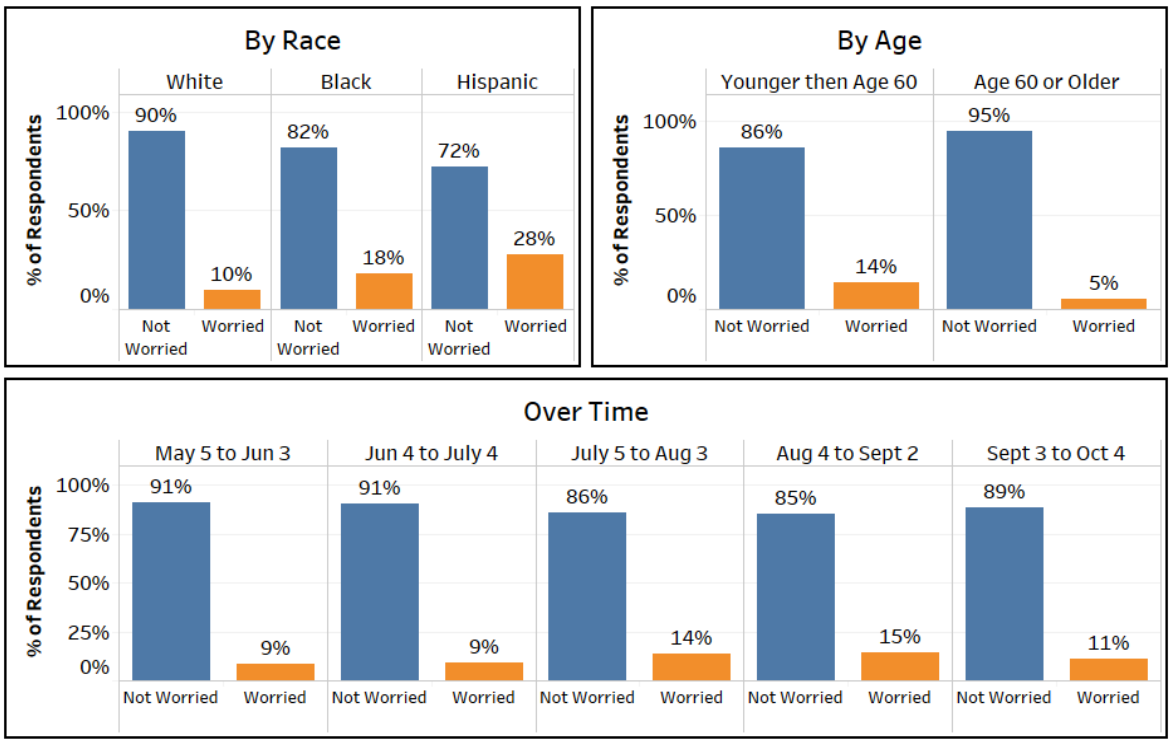


Figure 15
Worried about losing a job by race over time

mental health problems, and even ignore basic pandemic mitigation practices. We asked respondents if they were worried about paying their mortgage/rent or losing their job in the past 2 weeks. As shown in Figure 14, shown on the previous page, 28% of Hispanics and 18% of Blacks said they were worried about paying rent or their mortgage. Also, 14% of adults younger than 60 said they were worried about paying their rent or mortgage.

Finally, the poll asked respondents if they were worried about becoming unemployed in the next 14 days. As shown in Figure 15, there are large differences in worry about losing a job by race/ethnicity. More than four times as many Hispanics and twice as many Blacks than whites said they were worried they might lose their jobs in the next two weeks.

Conclusions. Despite small changes in unemployment in Arkansas since the beginning of March, we cannot directly attribute food and financial insecurity directly to the impact of COVID-19. Nevertheless, disparities in food and economic insecurity by race/ethnicity are especially apparent. Hispanics and Blacks feel less food and economically secure. However, this does not appear to be related to fears of being infected with COVID-19. Only slightly more Hispanics and Blacks said they believe they have a high change of becoming infected with COVID-19. The feelings of food and economic insecurity may be related to COVID-19's destabilizing impact on the economy. If COVID-19 is having a direct effect on food and income security it may be more apparent by type of employment. Jobs in the service or restaurant sector may be less secure than other types of employment.

While the potential for job loss certainly results in a multitude of hardships, stress associated with being unable to buy food for your family or to pay the rent or mortgage can lead to poor mental health and reduced productivity. Furthermore, it has been proven that higher levels of stress can lower immune functioning, perhaps increasing the risk of COVID-19 infections. Given the financial hardships associated with the pandemic, we will continue to monitor disparities related to food and financial insecurity.

Methodological Notes

Short-term forecast. Time series forecasting is a type of prediction 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 ahead 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 denotes a "case" as a COVID-19 test result reported and posted by the Department of Health. As indicated by recent research, the number of COVID-19 infections in the community may be higher by 40 to 50%. We cannot provide a precise number of infections in the community, as an antibody seroprevalence study has not yet been completed in the state.

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 likelihood of transmission has been adjusted slightly upward to better match Arkansas data. The model was also extended an additional six months into the future to better observe the predicted post-peak dynamics. 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. However, the eSIR model may be suggesting the COVID-19 growth curve may be leveling off.

Arkansas Pandemic Poll. One the challenges in looking are variation in responses by race is that some racial categories have too few numbers to be included. For example, we do not have enough sample to look at Marshallese. Questions are described by Figure:

Figure 12 shows the percentage of individuals who felt that they have a low chance of getting infected in the last two weeks. Response categories vary from 1 (no chance) to 5 (high chance). Responses 1, 2, and 3 were recoded as low chance and 4 and 5 are recoded as high chance of contracting COVID-19.

All face mask questions (Figures 10 and 11) are yes/no questions for the past two weeks.

We measure food insecurity with two questions (Figures 12 and 13). Respondents are asked if they have enough money to buy the food their family needs and for those that answer no, we have they went without food over the past two weeks

We measure economic insecurity by asking respondents if they are worried about paying their mortgage/rent or losing their job in the last two weeks. Specifically, individuals are asked on a scale of 1 to 5, with 1 being very worried and 5 being not worried at all. Responses 1, 2, and 3 were recoded as not worried, and 4 and 5 as worried.

We ask respondents if they are worried about becoming unemployed in the next 14 days, as shown in Figure 18. For this graphic, we have limited to only those respondents who had a paid job in the last two weeks and were under age 60. Responses were measured using a 5 point scale that ranged from not worried at all (1) to very worried (5). Responses 1, 2, and 3 were recoded as not worried, and 4 and 5 as worried.

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

Non-incarcerated (NI) = representative of an individual who is not in a jail or in a correctional facility

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