

Arizona and COVID-19: Three-Year Experience 2020-22

Howard J Eng*

Mel and Enid Zuckerman College of Public Health, R. Ken Coit College of Pharmacy, The University of Arizona, USA.

*Corresponding Author

Howard J Eng, Mel and Enid Zuckerman College of Public Health, R. Ken Coit College of Pharmacy, The University of Arizona, USA. E-mail: hjeng@email.arizona.edu.

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Abstract

It had been more than three years COVID-19 appeared in the world. Since Arizona Governor Doug Ducey had declared a State of Emergency to combat COVID-19 on March 11, 2020, the state had gone through three Reopening Phases. ABC and NBC News reported that the state had the highest new cases per capital in the world during Arizona's Reopening Phase 2 winter surge in 2020. The state had been in Reopening Phase 3 since March 5, 2021. Arizona is about the same size as Italy. The study examined three years of the state's COVID-19 pandemic. On December 28, 2022, there were 2,378,334 COVID-19 cases, 127,887 hospitalizations, 32,182 deaths, and 13,599,422 vaccine doses administered. The COVID-19 virus had been persistence. The virus continued to mutate, multiple, and spread. New variants emerged and resisted vaccines and therapeutics. During the three years, case numbers rose (542,653 in 2020, 838,835 in 2021, and 996,846 in 2022) and there has been periodic case surges. Between 2021 and 2022, the case hospitalization and death percentages had declined.

Keywords: COVID-19, Longitudinal Study, Arizona and COVID-19

Introduction

It has been three years since COVID-19 (coronavirus) first appears in Wuhan, China in December 2019. Since then, more than 100 million cases have appeared in the United States (U.S.). The virus is a respiratory disease (attacks primarily the lungs) that spreads by person to person through respiratory droplets (coughs, sneezes, and talks) and contaminated surfaces or objects. It is also known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

On December 28, 2022, the Johns Hopkins University reports that there are 658,920,979 total cases and 6,684,508 deaths associated with the virus in the world [1]. The U.S. has the highest total cases (100,582,859) and deaths (1,091,474) in the world [1].

The U.S. uses a three-pronged attack against the virus by encouraging the public to practice health behaviors that reduces the risks of getting respiratory infections (e.g., coronavirus, flu, and cold), and using vaccines and therapeutics. The preventive health behaviors include, but not limited to, practicing physical and social distancing, washing hands frequently and thoroughly, and wearing face masks. Johns Hopkins reports that more than 13.16 billion vaccine doses have been administered in the world and the U.S. has administered more than 651 million vaccine doses (December 28, 2022) [1].

Arizona is about the same size as Italy (301,340 square kilometer) and the sixth largest in size of the U.S. 50 states (113,990 square

miles/295,233 square kilometers) [2,3]. The state population estimate is 7,359,197 (July 1, 2022) [4]. On December 28, 2022, Arizona is ranked 13th in total COVID-19 cases (2,378,334) and 11th in total deaths (32,182) of the 50 U.S. states [1]. The state has the highest death rate per capital of all the 50 states reported by the Centers for Disease Control and Prevention (CDC) [5,6].

The first Arizona case appears on January 22, 2020. Arizona Governor Doug Ducey has declare the State of Emergency to combat COVID-19 on March 11, 2020. Since then, there has been three Arizona Reopening Phases. During Arizona's Reopening Phase 2 winter surge in 2020, ABC and NBC News report that the state has the highest new cases per capital in the world [7,8]. The state has been in Reopening Phase 3 since March 5, 2021.

A partnership between each of the 50 states and the U.S. federal government is required to address the COVID-19 pandemic [9]. The federal government provides the national guidance primarily through the CDC and needed logistical support (e.g., provide federal supplemental funding, needed medical personnel and resources, and other needed assistance). The states determine what actions to take and when to carry out those actions; the state COVID-19 restrictions; when to carry out each reopening phase; the state vaccination plan; and when the pandemic emergency is over. Governor Ducey has ended the COVID-19 Emergency Declaration on March 30, 2022.

Even though the state's emergency declaration has ended, the COVID-19 pandemic still exists. This study examines the COVID-19 pandemic looking at changes in the state number new COVID-19 cases, hospitalizations and deaths, and what we know about the virus after three years.

Methods

This was a three-year longitudinal study (January 1, 2020 to December 28, 2022). The Arizona Department of Health Services (the state health department) COVID-19 dashboard database was the data source used. The study examined the changes in the numbers of new COVID-19 cases, hospitalized cases, deaths, and vaccines administered.

There were several data limitations. The COVID-19 case numbers represented the numbers of positive tests reported. When more than one test given to the same person (e.g., during hospitalization, at work, and mandatory testing), there were individual case duplications. Aggressive testing resulted in increases in false positive and false negative testing results. The case numbers did not include most positive home testing results. A person could be infected by the virus more than once.

Delays in the data submitted to the state health department affected the timeliness of data reported and caused fluctuations in the number of cases, hospitalizations, deaths, and vaccinations. The case, hospitalization, death, and vaccination statistics did not use

the same reporting periods. The state health department continued to adjust the reported numbers that may take more than a month to correct the numbers. The deaths associated with the coronavirus may cause by more than one serious underlying medical conditions and the virus may not be the primary cause of death.

The public reporting period had changed during February 2022. It had changed from daily to weekly reporting.

Results

The COVID-19 case, hospitalization, death, and vaccination three-year trends are shown in Table 1. On December 28, 2022, there were 2,378,334 COVID-19 cases, 127,887 case hospitalizations, 32,182 deaths associated with the virus, and 13,599,422 vaccine doses administered in Arizona. The cases increased each year, but there were fewer hospitalizations and deaths in 2022 than in 2021. During the three years, the case hospitalization percentages declined (7.03% in 2020, 6.36% in 2021, and 3.65% in 2022). The 2020-21 death percentages had increased from 1.67% to 1.81%, but decreased in 2022 (1.81% to 0.79%).

Tables 2 tracks the weekly total and weekly numbers of COVID-19 cases, hospitalized cases, and deaths for the last three months in 2022. The highest number of cases occurred during the week of December 7, 2022, while the highest number of hospitalizations occurred during week of December 21. The week of December 28 had the highest number of deaths.

Table 1: Arizona Total Numbers of COVID-19 Cases, Hospitalizations, Deaths, and Vaccine Administered: January 1, 2020 to December 28, 2022.

Time Period	Cases	Hospitalizations	Deaths	Vaccinations
Jan. 1 to June 30, 2020	79,894	4,989 (6.24%)	1,653 (2.07%)	NA
July 1 to Dec. 31, 2020	462,759	33,167 (7.17%)	7,422 (1.60%)	95,160
Jan. 1 to Dec. 31, 2020	542,653	38,156 (7.03%)	9,075 (1.67%)	95,160
Jan. 1 to June 30, 2021	352,323	27,477 (7.80%)	8,874 (2.52%)	6,356,233
July 1 to Dec. 31, 2021	486,512	25,890 (5.32%)	6,350 (1.30%)	3,375,453
Jan. 1 to Dec. 31, 2021	838,835	53,367 (6.36%)	15,224 (1.81%)	9,731,686
Jan. 1 to June 29, 2022	744,079	20,380 (2.74%)	6,286 (0.85%)	2,178,019
June 30 to Dec. 28, 2022	252,767	15,984 (6.32%)	1,597 (0.63%)	1,594,557
Jan. 1 to Dec. 28, 2022	996,846	36,364 (3.65%)	7,883 (0.79%)	3,772,576
Jan. 1, 2020 to Dec. 28, 2022	2,378,334	127,887	32,182	13,599,422

Source: Arizona Department of Health Services COVID-19 Dashboard. Arizona 2020 population is 7,151,502, April 1, 2020, Arizona 2021 population estimate is 7,276,316, July 1, 2021, and Arizona 2022 population estimate is 7,359,197, July 1, 2022-U.S. Census.

Table 2: Arizona total and weekly numbers of COVID-19 cases, hospitalizations, and deaths.

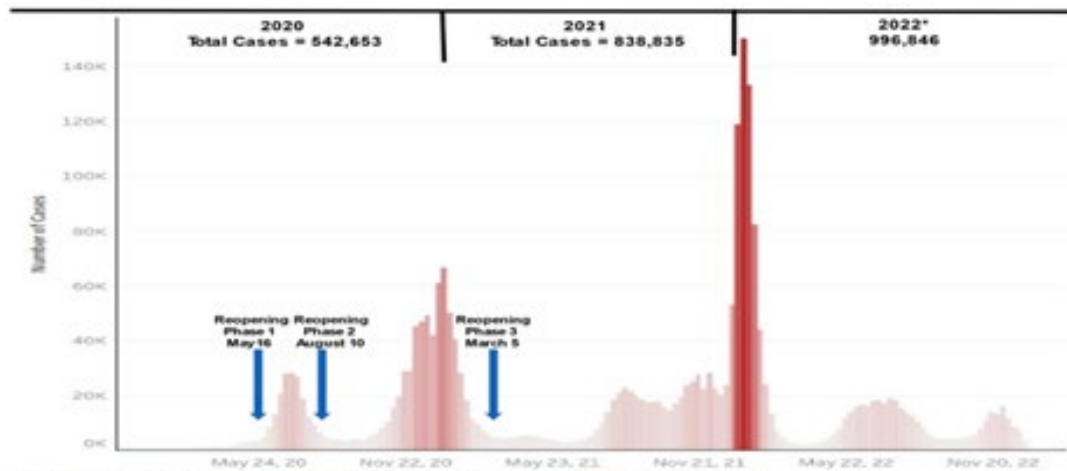
Date	Total Cases	Weekly Case	Total Hospital	Weekly Hospital	Total Deaths	Weekly Deaths
10-05-2022	2,275,235	3,675	118,099	240	31,406	36
10-12-2022	2,277,635	2,400	118,321	222	31,455	49
10-19-2022	2,283,073	5,438	118,606	285	31,514	59
10-26-2022	2,287,886	4,813	118,960	354	31,548	34
11-02-2022	2,293,015	5,129	119,326	366	31,573	25

11-09-2022	2,300,375	7,360	119,789	463	31,613	40
11-16-2022	2,311,150	10,775	120,214	425	31,647	34
11-23-2022	2,324,560	13,410	120,907	693	31,709	62
11-30-2022	2,337,547	12,987	121,942	1,035	31,751	42
12-07-2022	2,353,530	15,983	123,237	1,295	31,822	71
12-14-2022	2,365,080	11,550	124,797	1,560	31,929	107
12-21-2022	2,373,361	8,281	126,479	1,682	32,038	109
12-28-2022	2,378,334	4,973	127,887	1,408	32,182	144

Source: Arizona Department of Health Services COVID-19 Dashboard. Arizona 2022 population estimate is 7,359,197, July 1, 2022-U.S. Census

A case could be mild (no symptoms), moderate (sick, but can recover at home), and severe (require hospitalization and/or result in death). Most people recovered and did not require hospitalization. There were six case surges in the three years: three summers, one fall, and two winters (Figure 1).

Figure 1: Arizona weekly COVID-19 cases: January 1, 2020 to December 31, 2022.

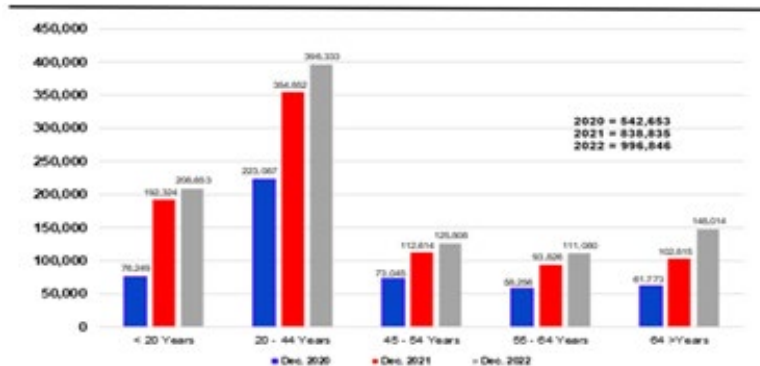


Source: Arizona Department of Health Services Arizona COVID-19 Weekly Cases Graph *2022 cases as of December 28.

During the 2020 fall, there was a significant decline of cases. The dominant variant during the 2021 summer and fall surges was Delta, and Omicron was the dominant variant during the 2021-22 winter surge. The 2021-22 winter surge peak was twice as high as 2020-21 winter. There was a minor case surge in late 2022 fall, but it had declined (Figure 1 and Table 2).

Figure 2 shows the number of cases for five age groups in the three years. The two age groups that had the largest case increases were 20-44 years and younger than 20 years. There were more females (53%) than males (47%) who got the virus. The two largest state race/ethnicity groups diagnosed with COVID-19 were White, non-Hispanics (40%) and Hispanics (28%).

Figure 2: Arizona COVID-19 cases by age groups for 2020, 2021, and 2022.

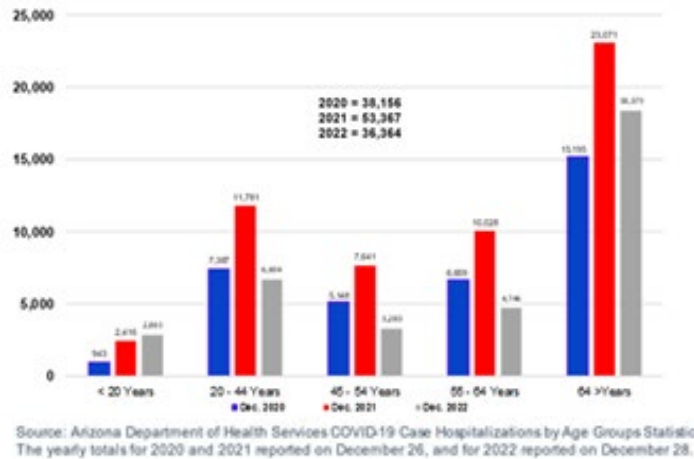


Source: Arizona Department of Health Services COVID-19 Cases by Age Groups Statistics. The yearly totals for 2020 and 2021 reported on December 26, and for 2022 reported on December 28.

The hospitalization numbers for each age group in the three years are shown in Figure 3. As expected, seniors had the highest percentage of the total hospitalizations (44.7%) and those under 20 years of age had the lowest percentage (4.9%) on December 28, 2022. Eighteen percent (18.1%) of seniors diagnosed with

COVID-19 were hospitalized, while 1.3 percent of those under 20 years of age were hospitalized. There were more males (51.8%) than females (48.2%) who were hospitalized. The three-year case hospitalization percentages had been declining.

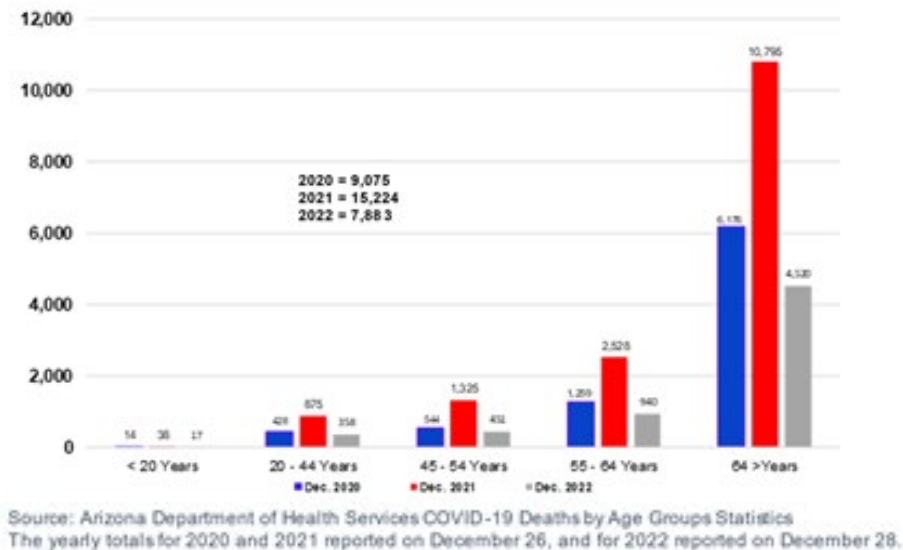
Figure 3: Arizona COVID-19 cases by hospitalizations by age group for 2020, 2021, and 2022.



Seniors had the highest percentage of total deaths (71.8%) and those under 20 years of age had the lowest percentage (0.2%) on December 28, 2022. Seven percent (7.3%) of the seniors diagnosed with COVID-19 died, while 0.015 percent of those under 20 years of age died. There were more males (59%) than females (41%) who died. The rate of fatalities per 100,000 population was 441.7.

The death percentages had declined between 2021 and 2022 (1.81% to 0.79%). The decrease in deaths was primarily due to the decline of the senior death percentages (10.5% in 2021 to 3.1% in 2022). Figure 4 shows the death numbers for each age group in the three years.

Figure 4: Arizona COVID-19 deaths by age groups for 2020, 2021, and 2022.



The first U.S. COVID-19 vaccine, Pfizer/BioNTech Comirnaty, was approved for use by the Food and Drug Administration (FDA) on December 11, 2020. Arizona began to administer vaccines in late December. There were three vaccines (Pfizer/BioNTech Comirnaty, Moderna Spikevax, and Johnson & Johnson Jcovden) available in 2021. The fourth vaccine, Novavax Nuvaxivud, was

approved in July 2022. The vaccines provided different levels of protection against COVID-19 and its variants.

There were several COVID-19 boosters available. The first booster was Comirnaty approved in September 2021. Soon after, Spikevax booster became available. The latest booster approved was

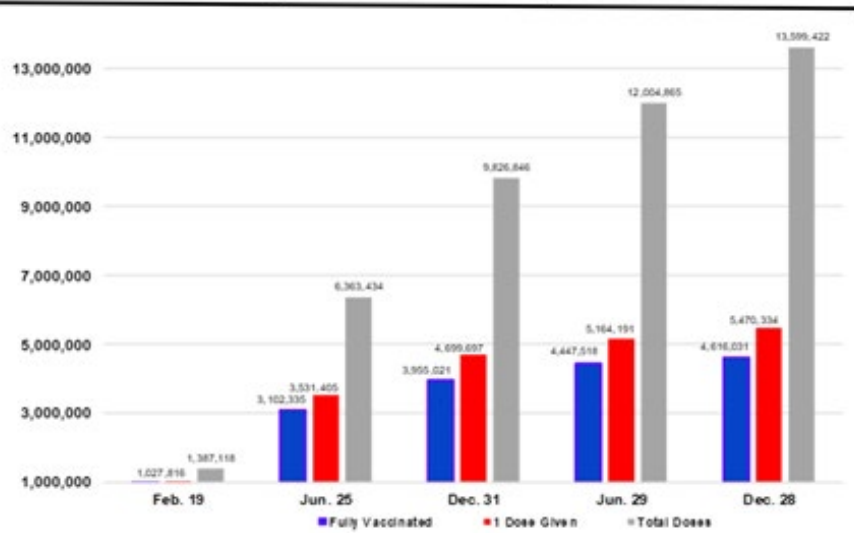
Nuvaxivud (October 2022). In August 2022, the FDA approved the new Pfizer/BioNTech and Moderna bivalent COVID-19 vaccines that include both the original virus and the Omicron BA.4 and BA.5. It was used as another vaccine booster.

The Arizona Department of Health Services reported 126,090 vaccine doses were administered and 124,322 who were partial protected against COVID-19 on January 8, 2021. This had grown to 13,599,422 vaccine doses were administered and 4,616,031

who were fully vaccinated against the virus (December 28, 2022). Figure 5 shows the numbers of COVID-19 vaccines that were given in Arizona (total doses given, persons receiving at least one dose, and persons fully vaccinated) from February 19, 2021 to December 28, 2022.

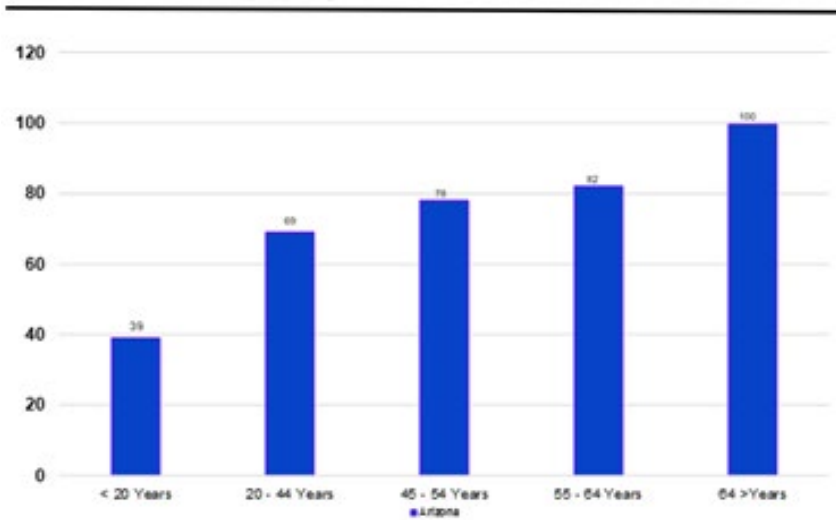
Those 65 years and older had the highest vaccination percentage, while those under 20 years of age had the lowest on December 28, 2022 (see Figure 6).

Figure 5: Arizona COVID-19 vaccination numbers: February 19, 2021 to December 28, 2022.



Source: Arizona Department of Health Services Arizona COVID-19 Vaccination Statistics

Figure 6: Arizona COVID-19 vaccination percentages (at least one shot) by age groups on December 28, 2022.



Source: Arizona Department of Health Services COVID-19 Vaccinations by Age Group Statistics

Discussion

After three years of the COVID-19 pandemic, the virus has not disappeared, but is still active in Arizona. The state has moved to a new normal of low numbers of severe cases and deaths, and manageable hospitalization numbers. There are periodic case surges: summer 2020, 2021, and 2022, fall 2021, and winter 2020-

21 and 2021-2022. The coronavirus case numbers increase each of the three years.

Without vaccines and therapeutics in the first year, the primary 2020 strategies used to confront the virus were to encourage the public to practice preventive health behaviors that reduces

the risks of getting respiratory infections and stay-at-home. For those who have or have been exposed to the coronavirus had to be quarantined. Arizona Governor Douglas Ducey stay at home policy and practicing preventive health behaviors kept the cases low that allow the state to build up its healthcare resources.

During the second and third years (2021-22), a three-pronged attack was used against the virus: (1) encourage preventive health behaviors, (2) increase vaccination numbers, and (3) use therapeutics. The highest priority in receiving the vaccines were given to those who have the highest risks of getting the virus. As more people were vaccinated and those infected recovered and have immunity against the virus; the numbers of severe cases, hospitalizations, and deaths would be low; COVID-19 would be manageable; and the state would be able to return to pre-pandemic normal [10].

After the state had administered more than two million vaccine doses and several weeks of declining cases, the Arizona Governor began Reopening Phase 3 (final phase) on March 5, 2021 [11,12]. The state continued its efforts to vaccinate its population, and the vaccination numbers continued to rise. During the three years, the highest numbers of fully vaccinated persons occurred in the week of April 17 to 23 (249,755) [13]. Soon after, the pace of vaccination had slowdown.

Overtime, the early vaccines became less effective against the later Delta and Omicron variants comparing to the original Alpha. There were breakthrough infections and vaccines waned over time. Those whose vaccine protection were waning received booster vaccines to extend their immunity protection. Even though the vaccines and boosters reduced the risks in getting a severe case, one could still get the virus. Some therapeutics became less effective against the new variants (e.g., the monoclonal antibodies).

There were signs of the public experiencing COVID-19 fatigue (e.g., significant numbers did not wear masks during the 2022 summer and fall case surges and paid little attention to the daily/weekly number of case increases). Many felt that the pandemic was over. There was more vaccine hesitancy in 2022 than in 2021. On December 28, 2022, there were significant fewer 5 years and older (15.1%) and seniors (37.5%) who received bivalent boosters than those who were fully vaccinated (5 \geq years old-73.1% and seniors-94.0%) [14].

Many still had anxiety/depression/stress associated with the virus. The causes for the mental anguish were the uncertainty of the virus, constant emergent of new variants, vaccine limitations, the lack control of the situation, and no end to the virus. There were persons who have not adapt to the new normal and had limited their interactions with people.

The Arizona COVID-19 population exhibited several characteristics. Those who had highest risk of acquiring COVID-19 were those immune compromised, who had severe medical conditions, adult

65 and older, and those who were obese. The age group had the highest number of cases were those adults 20-44 years. The next age group with highest number of cases was those under 20 years of age. The Omicron case numbers increased significantly in this age group in 2022. As expected, those who are under 20 years of age had the lowest numbers of case hospitalizations and deaths, while those 65 and older had the highest numbers of case hospitalizations and deaths. Women had a higher percentage of cases than men, but men had higher percentage of hospitalizations and deaths than women.

Even though the last three weeks of the third year of the virus there are declines in cases, the first week in the fourth year the cases increase by 1,214 in the state. It is expected that the cases will continue to rise after the winter holidays as students return to school and workers return to their jobs. There are outbreaks of the new Omicron XBB.1.5 variant in the northeast and southeast during the first week of 2023 [15]. As the new variant move westward, the cases in Arizona will rise.

Conclusion

The COVID-19 virus is a survivor. The virus continues to mutate, multiple, spread, and infect the population. New variants emerge and resist vaccines and therapeutics. During the three years, case numbers continue to rise. There have been cyclic case surges, and the normal is not zero cases. The Arizona's normal going into the fourth year is low numbers of severe cases and deaths and manageable hospitalization numbers.

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