Science Journal of Clinical Medicine
2021; 10(4): 152-163
http://www.sciencepublishinggroup.com/j/sjcm
doi: 10.11648/j.sjcm.20211004.23
ISSN: 2327-2724 (Print); ISSN: 2327-2732 (Online)

US COVID-19 State Mortality and Case Progression – A Second Midterm Report Card (Delta Surge)

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To cite this article:

Vernon Wen-Hau Lin, Daniel Lin, Xiaoming Zhang. US COVID-19 State Mortality and Case Progression – A Second Midterm Report Card (Delta Surge). *Science Journal of Clinical Medicine*. Vol. 10, No. 4, 2021, pp. 152-163. doi: 10.11648/j.sjcm.20211004.23

Received: November 17, 2021; **Accepted**: December 16, 2021; **Published**: December 29, 2021

Abstract: The US has led the world with over 667,000 deaths due to COVID-19, partly fueled by the spread of the Delta Variant since the spring of 2021. The "Delta Surge" has especially impacted the southern states, despite the rolling out of three effective vaccines (Pfizer/BioNTech's Comirnaty, Moderna, and Johnson & Johnson's Jansen) since early 2021. This is an interim report of each state (50 states, Washington DC, and Puerto Rico), in terms of mortality rate (MR, the number of cumulative deaths per 100,000 population due to COVID-19 by July 27th, 2021) and Case Rate Progression (CRP, the percent change in the number of cumulative cases per 100,000 population increased from June 1st to August 1st, 2021). The study provided an A-F grade report card for each state when compared to one another. The results showed that the states that received F's in MR are the following (starting from the worst): New Jersey, New York, Massachusetts, Rhode Island, and Mississippi. The 3 states that received an A rating were (starting from the best): Hawaii, Vermont, and Alaska. The following states received F's in CRP (starting from the worst): Louisiana, Arkansas, Florida, Missouri, Nevada, and Mississippi. A poor CRP grade reflects rampant increases in new COVID-19 cases, followed by resulting increases in hospitalization, health resource utilization, and mortality. It is critical that we as a nation remain vigilant to observe these lingering effects of COVID-19 by participating in public health efforts, continuing to vaccinate the public, and observing social distancing, healthy hygiene practices, and masking as per CDC guidance.

Keywords: COVID-19, Mortality Rate, Case Rate Progression, Report Card, Delta Variant

1. Introduction

The World Health Organization (WHO) recognized and named the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS0CoV-2) that was first reported in Wuhan, China in December 2019, as Coronavirus Disease 2019 (COVID-19) on Feb. 11th, 2020 [1]. Since then, this virus has mutated into several major variants and has resulted in waves of human devastation with increasing cases, hospitalizations, deaths, and untold societal costs throughout the world. The Delta variant that was first reported in India in late 2020, is now the predominant strain in the world, demonstrating increased transmissibility, higher viral loads in the respiratory tract, further spread to many regions of the world, and infection of fully vaccinated people [2-4]. By August 12th, 2021, the world has reported 224 million (M) cases and 4.62 M victims succumbed to SARS-CoV-2. By WHO regions, the fatalities are the following: America (2.14 M), Europe (1.30 M), South-East Asia (661,928), Eastern Mediterranean (277,637), Africa (140,019), and Western Pacific (100,860) [5]. Highest mortalities are observed in the following countries: USA (659,336), Brazil (587,797), India (443,928), Mexico (269,016), Peru (198,840), Russian Federation (195,835), Indonesia (139,682), The United Kingdom (134,647), Italy (130,100), Colombia (125, 713), Iran (115,619), and Argentina (113,816) [6].

In the US, by September 16th, 2021, the death toll reached 667,000, and 41.6 million cases were reported. There were two major surges in terms of cases and deaths in the US

during the pandemic. The first surge was in the spring of 2020, where the daily death rate (2,752 deaths) peaked on April 15th. Particularly involved were New York City as the epicenter, some New England States, and some west coast states. The second surge was during the winter months of 2020, where the daily death rate (4,406 deaths) peaked on January 12th, 2021, affecting nearly all states and jurisdictions within the US [7].

The FDA approved the Pfizer/BioNTech mRNA vaccine for Emergency Use Authorization (EUA) on December 11th, 2020, with healthcare workers being vaccinated by December 14th, 2020. Since then, two other vaccines received EUAs: Moderna (another mRNA vaccine) on Dec. 18th and Johnson & Johnson's Jansen COVID-19 vaccine (a viral vector vaccine) on Feb. 27th [8]. The new Biden administration has made vaccination of all Americans a major public health emphasis and has nearly reached their initial target of vaccinating 70% of adult Americans (at least one dose) by Independence Day. As a result, many businesses and organizations have eased mask and COVID restrictions. On August 23rd, 2021, the FDA approved the Pfizer/BioNTech vaccine (which will be marketed as Comirnaty) for the prevention of COVID-19 in individuals 16 years of age and older. This vaccine will continue to be available under EUA for individuals 12 through 15 years of age [9].

While there are ample vaccines available to the general public free of charge, many states have lagged behind in vaccination rates—especially the southern states—creating another pandemic of the unvaccinated and causing the third surge in COVID-19 cases. This third surge (the Delta Surge), characterized mostly by the Delta variant, occurs mostly in unvaccinated patients and affects younger individuals compared to prior surges. The recent death rate peaked on September 9th, 2021 (3,232 deaths) and the daily new cases recently peaked at nearly 301,138 on September 7th, 2021 [7]. Many states are again faced with tremendous demands for medical resources, including hospital beds, intensive care unit beds, emergency room beds, ventilators, and medical personnel.

Our prior publication, *US COVID-19 State Mortality and Case Progression – A Midterm Report Card*, was aimed at providing an interim report to the US public on all 52 US states/jurisdictions (50 states plus Washington DC and Puerto Rico) regarding the mortality rate and the significant rise in both new cases and deaths associated with COVID-19 after the end of the national lockdown in May/June 2020 [10]. It provided an A-F grade report card for each state when compared to one another. Now, 12 months later, we observed a similar trend, mostly due to the Delta variant. This second interim report will provide a summary to the US public about the latest mortality and recent surge in cases in all the states and provide a grade comparison for all states. In addition, we also added the % population vaccinated in each state as another comparison in our report. Our research group, Health Care First Study Group, was established with a mission to improve access to health care for all Americans through relevant health service research and healthcare provider forecasts [11-13].

2. Methodology

2.1. Design and Sample

COVID-19 related deaths, cases, and state vaccination rate data were obtained from public sources, namely John Hopkins University's Coronavirus Resource Center [14]. This second midterm report card presents 2 grades for each state: the Mortality Rate (MR) grade and the Case Rate Progression (CRP) grade. In addition, we also added the Vaccine Rate (VR) from each state, which enabled us to better understand the latest surge in cases that were mostly caused by the Delta variant (the Delta Surge). The first grade given was the cumulative MR (# of deaths per 100,000 people) which each state had reached by July 27th, 2021. The second grade—the CRP grade—was given based upon the percentage of the increase in the number of cases between June 1st and August 1st, 2021.

2.2. Mortality Rate (MR) Model

The MR model was based on the number of COVID-19 certified deaths per state. The MR of each state is determined by the cumulative deaths by July 27th, 2021, per 100,000 people. The MR was then utilized to give a grade to each state. The equation for the MR model is as follows:

$$MR_s = ([\text{July 27 State Cumulative Deaths}]/[\text{Pop}]) \times 10^5 \quad (1)$$

where MR_s = Mortality Rate (MR) for each state; Pop = Spring 2021 World Population Review Data.

2.3. Mortality Rate (MR) Grade

The grading method used for MR is the cumulative deaths (up to July 27th, 2021) for each state per 100,000 population. Each state was given a grade based on the MR determined for each state and how it compared to the national norm. See Table 1 below for the designated grade distributions associated with each state's MR calculation:

Table 1. *Grade distribution for mortality rate (MR) and case rate progression (CRP) in % increased.*

Grade	MR	CRP (% Increased)
A	0-57	0-180
B	57-120	180-235
C+	120-151	235-396
C	151-183	396-535
C-	183-214	535-791
D	214-245	791-1036
F	245-300	1036-1753

2.4. Case Rate Progression (CRP) Model

The Case Rate Progression (CRP) model was designed to monitor the rate of changes in case rates in all states between June 1st and August 1st, 2021. The case rate was defined as the number of COVID-19 cases cumulatively reported in a

designated time. June 1st, 2021 was chosen as the starting point because most states began easing up on lockdown restrictions of businesses and public spaces. August 1st, 2021 was the selected end date because it is a recent data point that clearly shows a significant spike in the increase of cases from June 1st caused by the Delta Surge. A given state's CRP is defined by the percentage (%) increase in case rates from the beginning time point (June 1st, 2021) to the ending time point (August 1st, 2021). The equation for the CRP is as follows:

$$CRPs = ([(A_1/Pop*10^5)/(J_1/Pop*105)]-1) \times 100 \quad (2)$$

Where CRPs = Case Rate Progression (in %) change per state; A1 = state positive COVID-19 cumulative case count on August 1st, 2021; J1 = state positive COVID-19 cumulative case count on June 1st, 2021; Pop = Spring 2021 World Population Review Data

2.5. Case Rate Progression (CRP) Grade

The CRP value, or percentage change in case rates from June 1st through August 1st, 2021, was used to designate a grade for each state. Referring again to the table above, a given CRP value calculated for each state corresponds with a designated letter grade based upon the grade distribution assigned.

2.6. Vaccine Rate (VR) Model

The Vaccine Rate model was designed to show the number of people who were vaccinated up till July 27th, 2021 [14]. The VR of a territory was given by the number of people who were vaccinated per 100,000 people. The VR was then used to give each state a grade based upon their relation to the national norm. The equation for the VR model is as follows:

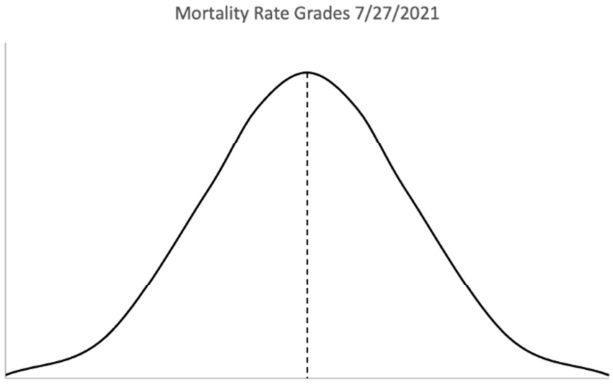
$$VR_s = ([\text{July 27 Cumulative vaccinations}]/[Pop])x10^5 \quad (3)$$

where VRs = Vaccine Rate (VR) for each state; Pop = Spring 2021 World Population Review Data [15].

3. Results

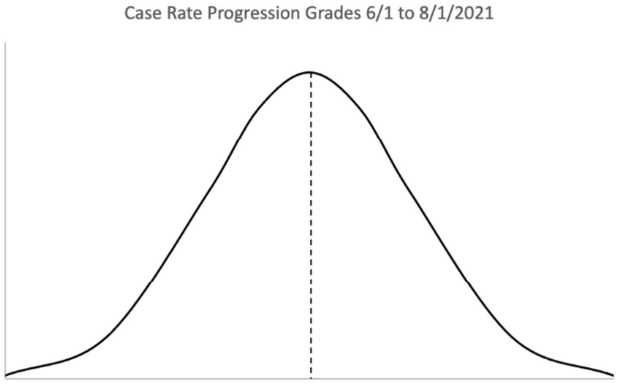
For this paper, we covered data from all 50 states plus Washington DC and Puerto Rico. MR grading showed that 5 territories received F grades (MR greater than 245 deaths per 100,000) (Table 2). These states were (from worst MR) New Jersey, New York, Massachusetts, Rhode Island, and Mississippi. The 3 states that received an A rating (MR less than 57 deaths per 100,000) were (starting from best MR) Hawaii, Vermont, and Alaska (Figure 1).

CRP grading showed that 6 states received F grades (CRP greater than 879% increase in new cases per 100,000 people). These states were (from worst/highest CRP) Louisiana, Arkansas, Florida, Missouri, Nevada, and Mississippi. The 4 states that received an A rating (CRP less than 180% increase in new cases per 100,000 people) were (starting from best/lowest CRP) South Dakota, Vermont, Maryland, and New Hampshire (Figure 2). In terms of VR, the following states had a VR below 40%: (from the lowest VR) Alabama, Mississippi, Arkansas, Wyoming, Louisiana, Idaho, Tennessee, Georgia, South Carolina, North Dakota, and Oklahoma. The following territories that had the highest VR (VR greater than 60%) were (from the highest VR) Vermont, DC, Rhode Island, Massachusetts, and Hawaii (Table 2).



Grade	A	B	C+	C	C-	D	F
MR per(100,000)	≤57	≤120	≤151	≤183	≤214	≤245	≥245
1	HI	OR	NC	MT	TN	PA	MS
2	VT	ME	WY	DC	NV	SD	RI
3	AK	UT	VA	MD	OK	AL	MA
4		WA	MN	MO	SC	CT	NY
5		PR	WI	CA	IA	LA	NJ
6		NH		KY	GA	AZ	
7		NE		WV	AR		
8		CO		DE	ND		
9		ID		OH	IL		
10				FL	IL		
11				TX	NM		
12				KS	MI		

Figure 1. *List of states (in abbreviation) with their associated grade in the Mortality Rate (MR) Report Card.*



Grade	A	B	C+	C	C-	D	F
CRP per(100,000)	≤180	≤235	≤396	≤535	≤791	≤1036	≥1036
1	SD	PA	OH	NM	CO	KS	MS
2	VT	MI	DC	MT	TN	OK	NV
3	MD	CT	WI	IL	GA	UT	MO
4	NH	MN	VA	CA	SC	WY	FL
5		ME	NE	HI	KY	AL	AR
6		MA	NY	OR	TX		LA
7		ND	NJ	ID	AZ		
8		IA	DE	WA	AK		
9			PR	NC			
10			RI				
11			WV				
12			IL				

Figure 2. *List of states (in abbreviation) with their associated grade in the Case Rate Progression (CRP) Report Card.*

Table 2. *List of 50 US states and two jurisdictions (DC & Puerto Rico), and their respective, mortality rate (MR), Case Rate Progression (CRP), and % Vaccination.*

States	Population	Deaths 7-27	MR	MR Ranking	MR Grade	CRP	CRP Ranking	CRP Grade	%Vaccinated
United States	334537941	610952	182.63		C	537.92		C-	48.78
Alabama	4934193	11483	232.72	44	D	878.77	46	D	33.87
Alaska	724357	384	53.01	3	A	713.32	41	C-	45.94
Arizona	7520103	18171	241.63	47	D	639.50	40	C-	44.20
Arkansas	3033946	6077	200.30	36	C-	1548.68	51	F	35.81
California	39613493	64267	162.24	22	C	444.21	28	C	52.83
Colorado	5893634	6924	117.48	11	B	534.49	34	C-	52.81
Connecticut	3552821	8288	233.28	45	D	190.61	7	B	63.15
DC*	990334	1698	160.61	19	C	240.56	14	C+	51.44
Delaware	714153	1147	171.46	25	C	269.51	20	C+	67.29
Florida	21944577	38670	176.22	27	C	1401.16	50	F	47.43
Georgia	10830007	21628	199.70	35	C-	568.00	36	C-	38.35
Hawaii	1406430	529	37.61	1	A	464.30	29	C	60.45
Idaho	1860123	2188	117.63	12	B	486.37	31	C	36.81
Illinois	12569321	25842	205.60	39	C-	339.18	24	C+	51.11
Indiana	6805663	13965	205.20	38	C-	439.10	27	C	43.50
Iowa	3167974	6170	194.76	34	C-	226.99	12	B	49.12
Kansas	2917224	5245	179.79	29	C	791.27	42	D	44.87
Kentucky	4480713	7319	163.34	23	C	611.58	38	C-	45.12
Louisiana	4627002	10914	235.88	46	D	1753.27	52	F	36.78
Maine	1354522	897	66.22	5	B	208.49	9	B	62.69
Maryland	6065436	9808	161.70	20	C	150.03	3	A	58.36
Massachusetts	6912239	18053	261.17	50	F	213.45	10	B	63.42
Michigan	9992427	21146	211.62	41	C-	181.95	6	B	48.61
Minnesota	5706398	7746	135.74	16	C+	206.93	8	B	52.89
Mississippi	2966407	7508	253.10	48	F	1036.30	47	F	34.55
Missouri	6169038	9981	161.79	21	C	1326.01	49	F	40.68
Montana	1085004	1695	156.22	18	C	426.91	26	C	43.47
Nebraska	1951996	2284	117.01	10	B	258.50	17	C+	48.75
Nevada	3185786	5837	183.22	31	C-	1088.27	48	F	42.53
New Hampshire	1372203	1385	100.93	9	B	161.71	4	A	57.49
New Jersey	8874520	26579	299.50	52	F	268.08	19	C+	59.12
New Mexico	2105005	4400	209.03	40	C-	396.25	25	C	56.50
New York	19299981	53610	277.77	51	F	259.56	18	C+	57.07
North Carolina	10701022	13580	126.90	13	C+	499.54	33	C	45.54
North Dakota	770026	1569	203.76	37	C-	222.33	11	B	39.50
Ohio	11714618	20467	174.71	26	C	235.42	13	C+	46.12
Oklahoma	3990443	7454	186.80	32	C-	826.70	43	D	39.54
Oregon	4289439	2838	66.16	4	B	469.74	30	C	54.78
Pennsylvania	12804123	27827	217.33	42	D	180.66	5	B	51.88
Puerto Rico*	3194374	2569	80.42	8	B	274.67	21	C+	80.42
Rhode Island	1061509	2739	258.03	49	F	277.53	22	C+	67.00
South Carolina	5277830	9882	187.24	33	C-	576.39	37	C-	39.35
South Dakota	896581	2043	227.87	43	D	111.31	1	A	46.02
Tennessee	6944260	12683	182.64	30	C-	538.78	35	C-	38.25
Texas	29730311	53037	178.39	28	C	632.69	39	C-	42.36
Utah	3310774	2434	73.52	6	B	858.68	44	D	44.33
Vermont	623251	259	41.56	2	A	130.61	2	A	68.40
Virginia	8603985	11596	134.77	15	C+	257.51	16	C+	53.73
Washington	7796941	6089	78.09	7	B	498.88	32	C	55.92
West Virginia	1767859	2936	166.08	24	C	329.38	23	C+	43.46
Wisconsin	5852490	8253	141.02	17	C+	248.54	15	C+	51.27
Wyoming	581075	766	131.82	14	C+	876.48	45	D	36.21

4. Discussion

4.1. Mortality Rate (MR)

The first reported US fatality due to COVID-19 was on Feb. 6th, 2020 [16]. This was followed by waves of cases affecting bi-coastal regions in subsequent months. The initial epicenter was at New York City (due to European travelers) and reached an initial US peak fatality of 2232 (7-day average) on April 15th, 2020 [7]. This was followed by the first 100,000 US fatalities on May 27th, 2021 [17]. By the time that we reported our first study in September 2020, the following states showed an "F" grade in terms of mortality ratio (MR): New Jersey (worst), New York, Massachusetts, Connecticut, Washington DC, Rhode Island, and Louisiana [10]. Louisiana happened to be a popular travel destination because of Mardi Gras in Feb. 2020, along with its many attractive venues and activities. The national lockdown that began in April 2020 provided a temporary reduction in cases and mortalities in many states.

Starting in mid-May 2020, the country began to gradually loosen on the lockdown and the CDC provided guidance on phased re-opening for various businesses and religious venues based upon infection rates and the number of new cases. This resulted in increased cases and mortalities in many states. The US reached 200,000 fatalities due to COVID-19 on Sep. 22nd, 2020 [18]. This was followed by the winter COVID-19 surge with 300,000 fatalities reported on Dec. 14th, 2020 [19]. The daily mortality rate reached a peak of 3352 (7-day average) on Jan. 12th, 2021 [7], and 400,000 fatalities were reached on Jan. 19th, 2021 [20]. Subsequently, the US reached 500,000 fatalities on Feb. 22nd, 2021 [21] and 600,000 fatalities on June 15th, [22] despite the rolling out of very effective vaccines in the early months of 2021.

In this second mid-term report card, the following states demonstrated an "F" or "D" in the MR category: (from

highest MR with F) New Jersey, New York, Massachusetts, Rhode Island, Mississippi, (with "D") Arizona, Louisiana, Connecticut, Alabama, South Dakota, and Pennsylvania. The eastern states, such as New Jersey, New York, Massachusetts, Rhode Island, and Connecticut, were mostly affected by the earlier waves of pandemic-related cases and death tolls. Pennsylvania had a relatively high death rate earlier and had a much worse mortality rate during the winter months in 2020. Other states were affected by community spread especially during the winter months and lately, low vaccination rates such as in Mississippi, Arizona, Louisiana, Alabama, and South Dakota increased their mortality rate. Out of these states, three states had a VR of less than 40%: Alabama, Louisiana, and Mississippi. These three states will continue to face significant COVID-19 infections well into 2022 unless effective vaccination campaigns take place in these communities.

The state of California (population 39,613,493) led the nation in terms of the highest number of deaths from COVID-19 to date with 64,267 deaths, an MR of 162.24/100,000 population, and a peak death rate (7-day average) of 561 deaths on Jan. 27th, 2021. This was followed by the state of New York (population 19,299,981) with 53,610 deaths, an MR of 277.77/100,000 population, and a peak death rate of 978 on April 13th, 2020. Next was the state of Texas (population 29,730,311), with 53,037 deaths, an MR of 178.39/100,000 population, and a peak death rate of 342 on Jan. 27th, 2021. Finally, the state of Florida (population 21,944,577), had 38,670 deaths, an MR of 176.21 / 100,000 population, and a peak death rate of 350 (7-day average) on September 10th, 2021. These four most populous states had the following vaccination rates: (highest) New York (57.07%), California (52.83%), Florida (47.43%), and Texas (42.36%). Using VR as predictors for future infections, the states of Florida and Texas will continue to see a significant rise in COVID-19 cases for many months to come.

On a more encouraging note, the three states that shared the "A" grade in terms of MR were Alaska, Hawaii, and Vermont. They shared similar success stories and characteristics: relative geographic isolation; vigilant public health officials who championed proactive implementations of contact tracing, physical distancing, and mask-wearing; and prudent public policies on phased opening closely following the CDC guidelines during the pandemic [23-25].

When comparing our second midterm report card with the prior study published one year earlier, in terms of MR, only one state/jurisdiction showed significant improvement with a jump of nearly two grades—Washington DC, improving from an "F" to a "C" grade. At the same time, three states dropped nearly two grades: Montana and West Virginia which both dropped from an "A" grade to a "C" grade with Wyoming dropping from an "A" grade to a "C+" grade. The following states had modest improvements: Colorado (from C- to B), Connecticut (from F to D), Delaware (from D to C), Louisiana (from F to D), Nebraska (from C to B), Vermont (from B to A), and Washington state (from C to B). In addition, several states had a worsening of MR: Arizona (from C- to D), Arkansas (from B to C-), Kansas (from B to C), Mississippi (from D to F), and Puerto Rico (from A to B).

4.2. Case Rate Progression (CRP)

As we remember those who have succumbed to COVID-19, MR acts as a historical data point while CRP becomes a projection for the future. As CRP increases, MR correspondingly does as well—albeit with a slight lag as people progress through the stages of the disease. The more cases there are in a jurisdiction, the more mortality there will be. An emphasis is placed on the states who received an "F" grade in the CRP category because these will become the states that will suffer the highest mortality and greatest stress to their healthcare system. These states (from worst) include Louisiana, Arkansas, Florida, Missouri, Nevada, and Mississippi.

As the state of Louisiana (VR of 36.78%) began to open, the recent Delta Surge resulted in the highest CRP (1,753.27%) which correlated well to the actual increases in cases and hospitalizations. As of Aug. 6th, 2021, the Louisiana governor reported four straight days of record hospitalizations in the state: Aug. 3rd (2,112), Aug. 4th (2,247), Aug. 5th (2,350), and Aug 6th (2,421). The previous record of 2,069 deaths was set on Jan. 7th, 2021, causing Louisiana to lead the nation in terms of COVID cases per capita [26]. By Aug. 26th, 2021, the death toll for the state reached 64 (7-day average) [7]. With the recent landing of Hurricane Ada, there was catastrophic flooding with associated property damage, infrastructure ruins, and untold human suffering for the residents in Louisiana.

The state of Arkansas shared similar characteristics with Louisiana: low vaccination rates (35.81%) and a very high CRP (1,549% increases in cases in recent two months). The case rate increased recently and reached its peak of 2,351 (7-day average) new cases on Aug. 7th, 2021. The hospitalization rate for Arkansas hit a record of 1,435 on Aug. 10th for the second day straight and exceeded the previous highest hospitalization rate in January. The rate of death peaked at 32 (7-day average) on Aug. 27th, 2021. On Aug. 10th, 2021, Governor Hutchinson began to increase the Medicaid reimbursement rate to physicians for COVID-19 vaccinations from $40 to $100 to improve vaccination rates in this vulnerable population [7, 27].

The state of Florida (the third-largest state) with a population of 21,944,577 had a VR of 47.43%. A high percentage of the population openly rejected CDC public health guidelines (especially social/physical distancing and masking), resulting in the highest observed caseload during the pandemic at 29,711 (7-day average) cases on August 16th, 2021. The prior peak was 17,991 (7-day average) cases on Jan. 8th, 2021. According to the Florida state record, the daily hospitalizations due to COVID-19 reached a record of 17,269 (7-day average) on Aug. 23rd, 2021. The death rate peaked at 350 (7-day average) on September 10th, 2021, surpassing prior daily death rates of 185 (7-day average) on Aug. 5th, 2020, and 185 (7-day average) on Jan. 28th, 2021. Many

hospitals across the state of Florida were forced to cancel non-emergency surgical procedures as the number of people hospitalized with COVID-19 increased, resulting in significant health care provider shortage and emotional anguish [7,28].

The state of Missouri had a vaccination rate of 40.68% and showed a CRP % increase of 1326.01%. As expected, COVID-19 cases increased recently in August and reached a peak on Aug. 5th, 2021, with 2,972 (7-day average) cases. Previous COVID-19 case peaks were 5,007 (7-day average) cases on Nov. 19th, 2020, and 7,167 (7-day average) cases on March 14th, 2021). Similarly, the state of Nevada, with a population of 3,185,786 and a VR of 42.53% saw a recent rise in CRP by 1,088.27%. Correspondingly, COVID-19 cases increased steadily to a peak of 1,465 cases (7-day average) on September 13th, 2021, and the number of deaths peaked at 23 (7-day average) on Aug. 31st, 2021. The prior peaked daily death rate was 45 (7-day average) on Jan. 17th, 2021. Lastly, the state of Mississippi (population 2,966,407) with a VR of 34.55% (one of the lowest in the nation) showed a CRP increase of 1,036% and saw a dramatic increase in COVID-19 cases and hospitalizations. The new COVID-19 cases rose to a peak of 3586 (7-day average) on Aug. 22nd, 2021, whereas the prior peaked new cases were on July 26th, 2020 (1,381 cases in 7-day average) and on Jan. 12th, 2021 (2,359 cases, 7-day average). The daily death rate recently also peaked at 54, on September 14th, 2021, with prior peaked death rates of 30 (7-day average) on Aug. 4th, 2020, and 48 (7-day average) on Jan. 18th, 2021. According to the Mississippi State Department of Health hospitalization data [29], the hospitalizations of patients with confirmed COVID-19 reached a record high of 1667 on Aug. 19th, 2021, compared with prior peak hospitalizations of 1,433 on Jan. 5th, 2021 [7].

4.3. Demographics

During 2020, COVID-19 was listed as the third underlying or contributing cause of 377,883 deaths (91.5 per 100,000 population) in the US, following heart disease (690,882 deaths) and cancer (598,932). Children aged 1-4 years (0.2 per 100,000 population) and 5-14 years (0.2) had the lowest death rates among COVID-19 patients, and patients aged ⩾ 85 years (1,797.8) had the highest death rates. When adjusted for age, the male (115.0 per 100,000 population) COVID-19-associated death rate was higher than that among females (72.5). When adjusted for age, there were differences observed in COVID-19- associated death rates by race/ethnicity. The highest death rates were among American Indian or Alaskan Natives (187.8 per 100,000 population) and Hispanic persons (164.3), followed by black (non-Hispanic) (151.1), w hite (non-Hispanic) (72.5), Asian persons (66.7), and multi-racial persons (31.8), respectively [30]. In a related study, pneumonia (45%) and acute respiratory failure (20%) were the most common chain-of-event ICD-10 diagnosis codes that listed COVID-19 on Part I of the death certificate and the most common significant contributing conditions were essential hypertension (18%) and diabetes mellitus (10%) [31].

4.4. Mental Health Concerns

As a baseline in 2019, approximately 51 million US adults (age >18 years) reported a mental illness of any kind and 7.7% reported a past-year substance use disorder. During the COVID-19 pandemic, there were reports of significant rises in mental illness and substance use disorders, especially in populations that bear responsibilities as public health workers or caregivers and vulnerable populations. Comparing 2019 and April/May 2020, the prevalence of depression in adults increased from 7.0% to 28.6%, and suicidal thoughts/ideation increased from 4.8% to 8.4%. Depression was higher in Hispanic persons (40.3%) than in non-Hispanic white persons (25.3%); suicidal thoughts/ideation were also higher among Hispanic persons (22.9%) than in multiracial and non-Hispanic persons of other races (8.9%), white persons (5.3%), and non-Hispanic black persons (5.2%). Rate of substance use was highest among Hispanic respondents (36.9%), compared with 14.3%-15.6% among all other respondents. The sources of psychosocial stress among US adults included health of family members (36.3%), feelings of isolation (28.6%), concern about COVID-19 infections (25.7%), death of loved ones (15.25), exposure at work (13.5%), and being blamed for spreading COVID-19 (4.1%). Estimates of stress and worry about social determinants of health included possible job loss (27.1%), inability to obtain needed health care (18.4%), lack of food (14.4%), and housing instability (11.8%) [32].

Similarly, in a more recent study period during the pandemic (August 19th-31st, 2020 through December 9th-12th, 2020), there were significant increases in anxiety disorder in adults (from 31.4% to 36.9%), depressive disorder (from 24.5% to 30.2%), or at least one of these disorders (from 36.4% to 42.4%). Largest increases were among adults aged 18-29 years (from 49% to 57%), and among those with less than a high school education (from 41.8% to 49.6%). Adults were observed to take more prescription medications and receive more mental health counseling (from 22.4% to 25%); with the percentage of adults needing but not receiving counseling also increasing (from 9.2% to 12.4%) [33].

Emergency Department (ED) visits for suspected suicide attempts a mong adolescents and young adults (12-25 years), from March 29th-April 25th, 2020 were relatively low. S uicide rates began to increase significantly by May 2020, especially among adolescent girls. By July 26th-August 22nd, 2020, adolescent girls' weekly ED visits for suspected suicide attempts were 26.2% higher compared with the same period the previous year. The suspected suicide attempts rate increased to 50.6% by February 21st-March 20th, 2021, when compared with the same period in 2019. Similarly, when compared with the suspected suicide attempts among young adults (18-25 years) at baseline in 2019, the rate increased to 1.6 times as high during spring 2020, 1.1 times as high during the summer 2020, and 1.3 times as high during winter 2021 [34].

A special study evaluating the symptoms of depression, anxiety, post-traumatic stress disorder, and suicidal ideation among state, tribal, local, and territorial public health workers during the COVID-19 pandemic in the US was conducted by the CDC March-April 2021. Among 26,174 respondents, 53.0% reported symptoms of at least one mental health condition in the preceding 2 weeks, including depression (32.0%), anxiety (30.3%), PTSD (36.8%), or suicidal ideation (8.4%). The highest prevalence of symptoms of a mental health condition was among respondents aged ⩽29 years and in transgender or nonbinary persons (i.e., those who identified as neither male nor female) of all ages. Public health workers who reported being unable to take time off from work were more likely to report adverse mental health symptoms [35].

A study conducted between December 2020 and February-March 2021 on the mental health among parents of children aged ⩽ 18 years and unpaid caregivers of adults during the COVID-19 pandemic showed the following: 1. 42.5% of the 10,444 US adult respondents identified as parents of children, caregivers of adults, or both, with 8.4% as parents only, 11.2% as caregivers only, and 22.9% as parents-caregivers. 2. 45.0% of respondents were women and 50.2% were aged 25-44 years. 3. 70% of all caregivers reported adverse mental health symptoms, such as anxiety or depression (55.3%), COVID-19 trauma- or stress-related disorders (TSRD) (53.8%), or passive (39.3%) or serious (32.2%) suicidal ideation. 4. 85% of the 2391 parents-caregivers experienced one or more adverse mental health symptoms and approximately 50% reported past-month serious suicidal ideation [36].

4.5. Delta Variant and Effectiveness of Vaccines

The Delta variant or the B.1.617.2 lineage of the SARS-CoV-2 virus was first identified in October 2020 in India and quickly reached more than 400,000 cases and 4,000 deaths each day in early May 2021. The Delta variant subsequently spread to other countries and is now the predominant strain of infected patients in the US, responsible for greater than 99% of cases tested in the hospitals. In a study from the Guangdong Province in China, the Delta variant has been found to produce about 1000 times the viral load from oropharyngeal swabs when compared with earlier strains [3].

When isolating the Delta variant from individuals with COVID-19 and examining the sensitivity of this strain to monoclonal antibodies and antibodies from recovered patients, the Delta variant was found to be resistant to neutralization by some anti-NTD (N-terminal domain) and anti-RBD (receptor-binding domain) monoclonal antibodies (including bamlanivimab) and these antibodies showed impaired binding to the spike protein [37]. They also determined that sera from individuals who had received one dose of the Pfizer or the AstraZeneca vaccine had a barely discernible inhibitory effect on the Delta variant. Administration of two doses of the vaccine generated a neutralizing response in 95% of individuals but with titers three to five-fold lower against the Delta variant than against the Alpha variant. Comparable findings were observed in a recent study [38] where one dose of the Pfizer vaccine had a much lower (30.7%) effectiveness against the Delta variant than against the Alpha variant (48.7%). When two doses of vaccines were given, the effectiveness went up to 88.9% against the Delta variant as compared with an effectiveness of 93.7% against the Alpha variant. While two doses of vaccines may have higher effectiveness against the Delta variant, there are growing cases of breakthrough infections in patients who are fully vaccinated. In general, in vaccine breakthrough infections, symptoms have been less severe and the duration of illness has been shorter compared to cases among unvaccinated people. Among hospitalized or fatal breakthrough cases reported to the CDC as of July 19th, 2021, 74% were aged 65 years or older [8]. One US study observed that 44% of breakthrough infections were among people who were immunocompromised [39].

As of July 30th, 2021, among the three COVID-19 vaccines authorized for use in the US, only the Pfizer-BioNTech COVID-19 vaccine is authorized for adolescents aged 12-17 years. The Food and Drug Administration (FDA) issued an Emergency Use Authorization (EUA) for the Pfizer-BioNTech vaccine for use in persons aged >16 years on December 11th, 2020. The EUA was expanded to include adolescents aged 12-15 years on May 10th, 2021, based on results from a Phase 3 clinical trial. Beginning in June 2021, cases of myocarditis and myopericarditis after receiving the Pfizer-BioNTech vaccine began to be reported, primarily among young males after the second dose. On June 23rd, 2021, the CDC's Advisory Committee on Immunization Practices reviewed available data and concluded that the benefits of COVID-19 vaccinations to individuals and the population outweighed the risks for myocarditis and recommended continued use of the vaccine in persons aged ⩾ 12 years [40]. On August 23rd, 2021, the FDA approved the first COVID-19 vaccine, which has been known as the Pfizer-BioNTech COVID-19 Vaccine, and will now be marketed as Comirnaty, for the prevention of COVID-19 in individuals 16 years of age and older [9].

On August 18th, 2021, the public health and medical experts of the Department of Health and Human Services released a joint statement stating that the COVID-19 vaccines authorized in the US continued to be remarkably effective in reducing the risk of severe disease, hospitalization, and death—even against the widely circulating Delta variant. The available data made it very clear that protection against SARS-CoV-2 infection began to decrease over time following the initial doses of the vaccination and there was evidence of reduced protection against mild and moderate disease. They concluded that a booster shot would be needed to maximize vaccine-induced protection and prolong its durability. They would be prepared to offer booster shots for all Americans beginning the week of September 20th, starting 8 months after an individual's second dose [41].

For moderately to severely immunocompromised people, the CDC also recommended receiving a booster dose. These included patients receiving active cancer treatment of the

blood, an organ transplant (currently taking immunosuppressants), or a stem cell transplant (within the last 2 years or currently taking immunosuppressants). Also included are individuals with moderate to severe primary immunodeficiency (such as DiGeorge syndrome, Wiskott-Aldrich syndrome) or advanced or untreated HIV infection [42].

A recent CDC study compared not fully vaccinated and fully vaccinated adults in two time periods: April 4th-June 19th (when the Delta Variant was responsible for ⩽ 50% of cases), and June 20th-July 17th (when the Delta variant was responsible for ⩾ 50% of cases). They used the average weekly age-standardized incidence rate ratios (IRRs) to examine COVID-19 cases, hospitalizations, and death. They found that between the two time periods, IRRs for cases decreased from 11.1 to 4.6, IRRs for hospitalizations decreased from 13.3 to 10.4, and IRRs for deaths decreased from 16.6 to 11.3. The above showed that fully vaccinated adults still maintained significant advantages in terms of protection from getting infected (nearly 5 times), being hospitalized (more than 10 times), and dying (more than 11 times) when compared to not fully vaccinated adults, even while the Delta variant runs rampant [43].

Another recent CDC report studied vaccine effectiveness (VE) during the period of the Delta v ariant (June-August 2021) by analyzing 32,867 medical encounters among adults of all ages. The report showed vaccine effectiveness of the three authorized COVID-19 vaccines (Moderna, Pfizer-BioNTech, and Johnson & Johnson's Jansen) combined, to be high against hospitalization (86%), emergency departments (ED s) and urgent care (UC) clinic encounters (82%). H owever, VE was lower in older adults aged ⩾75 years (76%) when compared with those aged 18-74 years (89%). Positive SARS-CoV-2 infections were confirmed in 28.9% of the unvaccinated and 7.0% of fully vaccinated patients. When comparing VE in all ages, they found the following VE with respect to the vaccines: Jansen (60%), Pfizer-BioNTech (80%), and Moderna (95%) [44].

4.6. Post-COVID Conditions

Post-COVID conditions consist of a variety of new, recurrent, or persistent health conditions that patients experience after 4 or more weeks of COVID-19 infections. These symptoms or illnesses may have the following manifestations: shortness of breath, dyspnea, cough, fatigue, early exhaustion after brief physical or mental exertion, fast beating heart (palpitations), chest or abdominal pain, headache, joint or muscle pain, nerve pain or pins-and-needles feeling, diarrhea, sleep disturbance, fever, dizziness on standing (lightheadedness), mood changes, change in smell or taste, rash, or changes in period cycles [45].

In a CDC telephone survey of 292 adults with a positive SARS-CoV-2 test, 35% of 274 symptomatic respondents reported not having returned to their usual state of health 2 weeks or more after testing. C ommon symptoms included: cough (43%), fatigue (35%), and shortness of breath (29%). The 95 patients (35%) that had chronic COVID-19 conditions had the following occurrence rates based on age: aged 18-34 (26%), aged 35-49 (32%), aged ⩾ 50 (47%). In people aged ⩾ 50 (adjusting for the factors of age, sex, and race/ethnicity), their reported three or more chronic medical conditions, obesity (body mass index >30 kg per sq. meter), and a psychiatric condition, were all associated with more than a two fold odd of not returning to the ir usual health when compared to 18-34 year olds. The ones that returned to their usual health, 175 (65%), took a median of 7 days (IQR=5-12 days) from the date of testing [46].

In another study performed in China, 1733 of 2469 discharged patients with COVID-19 (with a median age of 57.0) were followed for 186 days (175-199 days) after the onset of symptoms. These patients continued to show fatigue or muscle weakness (63%), sleep difficulties (26%), and anxiety or depression (23%). By using a 6-minute walking distance test and studying CT scans, they found that patients who were more severely ill during their hospital stay had more severely impaired pulmonary diffusion capacities and abnormal chest imaging manifestations [47].

A Michigan study involving 1250 patients discharged at 60 days found 6.7% of the patients had died, while 15.1% of patients required re-admission. Of the 488 who completed the telephone survey, 32.6% had persistent symptoms, including 18.9% with new or worsened symptoms: dyspnea while walking up the stairs (22.9%), cough (15.4%), and persistent loss of taste and/or smell (13.1%) [48].

Another study following 236,379 survivors of COVID-19 at 6 months showed that 33.62% had a neurological or psychiatric diagnosis, with 12.84% receiving a first-time diagnosis. For patients who were admitted to ICUs, the estimated incidence of having a neurological or psychiatric diagnosis was 46.42% and 25.79% had a first- time diagnosis. The whole COVID-19 cohort had an estimated incidence of 0.56% for intracranial hemorrhage, 2.1% for ischemic stroke, 0.11% for parkinsonism, 0.67% for dementia, 17.39% for anxiety disorder, and 1.4% for psychotic disorder, among others [49].

4.7. Public Health Guidance

The CDC published guidance for improving community transmission of COVID-19 by recommending assessing the level of community transmission using two metrics: 1. new COVID-19 cases per 100,000 persons in the last 7 days and percentage of positive tests in the last 7 days in the community and 2. classified transmission values as low, moderate, substantial, or high. Each given area should be re-assessed at least weekly. In areas of substantial or high transmission, the CDC recommends community leaders to encourage vaccination and universal masking in indoor public spaces in addition to other layered prevention strategies to prevent further spread. Proven effective strategies against SARS-CoV-2 transmission (beyond vaccination) include using masks consistently and correctly, maximizing ventilation both through dilution and filtration of air, maintaining physical distance, and avoiding crowds. Basic public health measures such as staying home when sick,

handwashing, and regular cleaning of high-touch surfaces should also be encouraged. [50].

The CDC also provided further guidance regarding COVID-19 prevention in K-12 schools to keep schools safe. These include: 1. students benefit from in-person learning, 2. vaccination is the leading public health prevention strategy to end the COVID-19 pandemic, 3. CDC recommends universal indoor masking of all students (age 2 and older), staff, teachers, and visitors to K-12 student, regardless of vaccination status, 4. implementation of at least 3 feet of physical distancing between students within classrooms, 5. improving ventilation, testing, screening, handwashing, and respiratory etiquette, staying home when sick, and implementation of contact tracing in combination with quarantine and isolation, and emphasis on cleaning and disinfection of the school environment frequently [51].

4.8. Study Limitations

This mid-term report only provides an interim summary for each state at a certain point in time, reflecting their collective public health efforts, using MR as a historical data point and CRP as a projection point. It does not give the entire picture, especially when the US vaccination rate is only at 53.2%. The limitation of this study is also reflected by the special properties that were embedded in our methodology. These grades and ratios were designed to be relatively dynamic—especially the CRP—to amplify the sudden elevation in the number of COVID-19 cases in certain states. In some states with relatively low baseline case numbers, a small rise may magnify their changes in CRP. The design of the CRP was to identify these changes, so we may predict near-future changes. The goal of these grading systems is designed to alert the American public so each state would follow the best public health guidelines and reach high vaccination rates, high public safety and hygiene practices, which ultimately result in lower infection rates, case rate progression, and mortalities.

5. Conclusion

This is a second interim report card addressing the effectiveness of combating COVID-19 in all 52 US states and jurisdictions (including Puerto Rico and Washington DC). This report was generated after the initial surge in COVID-19 cases in the spring of 2020, the national lock-down in March-May, 2020, the second COVID-19 surge in the fall/winter of 2020, the rolling-out of three very effective COVID-19 vaccinations in the US in early 2021, and the recent "Delta Surge" caused by the "Delta variant" that proved to be much more transmissible and virulent than prior variants. In terms of Mortality Rate (MR), more geographically isolated states such as Alaska, Hawaii, and Vermont, have led the nation with the lowest mortality rate ("A" Grade). These states also showed effective public health leadership that followed CDC guidelines closely. Eastern states, such as New Jersey, New York, Massachusetts, and Rhode Island, along with a Southern state, Mississippi, had much higher mortality rates and all received an "F" grade. In terms of Case Rate Progression (CRP), the worst states with the highest recent growth in COVID-19 cases and who received an "F" Grade in CRP were the following: Louisiana, Arkansas, Florida, Missouri, Nevada, and Mississippi. These states will continue to observe increases in cases, hospitalizations, ICU utilization, and COVID-related deaths in the months to come. These states are also often associated with low vaccination rates (VR). Invariably, a certain percentage of the population in these states were resistant to following CDC guidelines, such as receiving vaccines, practicing social distancing, and wearing masks. While our very young (age 12 and under) population has not had the chance to be protected through vaccination, it is necessary that the rest of us do our part to ensure that we all can be maximally protected from the ramifications of COVID-19.

Acknowledgements

The authors would like to acknowledge the editorial assistance of Ms. Jang-Ai Rebecca Lin (University of Missouri-Kansas City School of Medicine).

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