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# American Journal of Emergency Medicine

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# National analysis of COVID-19 and older emergency physicians



**Table 1**Emergency physician workforce profile and confirmed COVID-19 cases by state, as of October 22, 2020

Demographic information on practicing EPs age ≥ 60 during 2018 was extracted from State Physician Workforce Reports published by the American Association of Medical Colleges (AAMC) [3]. Information recorded included the number of EPs age ≥ 60 per state, proportion of EPs age  $\geq$  60 per state, total number of EPs per state, and state population per EP. Coordinate data (i.e., latitude and longitude) on the cumulative distribution of COVID-19 cases as of October 22, 2020 were obtained from a disease-specific data repository published by the Environmental Systems Research Institute [4]. We integrated both datasets into QGIS geospatial analysis software (version 3.12.1), superimposing them onto state boundary files published by the U.S. Census Bureau [5]. States were grouped into color-coordinated quintiles based on proportion of EPs age ≥ 60, and a logarithmic scale was used to adjust coordinate data points of cumulative COVID-19 cases, resulting in a heatmap depicting the proportion of EPs age ≥ 60 and COVID-19 disease burden for each state. This study was deemed IRB exempt due to the use of deidentified and publicly available data.

The AAMC identified a total of 43,311 clinically active EPs in 2018, of whom 10,804 (24.9%) were age  $\geq$  60 years [3]. The 10 states in the highest quintile of older EPs were West Virginia, New Mexico, Vermont, Hawaii, Maine, Oklahoma, Montana, Alabama, Arkansas, and Arizona (Table 1). The proportion of EPs age  $\geq$  60 ranged from 16.0% in Rhode Island to 40.6% in West Virginia. The five states with the highest number of cumulative COVID-19 cases as of October 22, 2020 were California (889,375 cases), Texas (871,078 cases), Florida (768,091 cases), New York (490,134 cases), and Illinois (363,740 cases). Among the states with the highest proportion of older EPs, Arizona (234,906 cases), Alabama (177,064 cases), Oklahoma (112,483 cases), and Arkansas (102,798 cases) have had a particularly high COVID-19 disease burden (Fig. 1).

Fig. 1 provides a geospatial representation of the risk faced by older EPs during the COVID-19 pandemic. Given the 2.5-fold difference in the proportion of older EPs across states (16.0% to 40.6%), and in light of reported personal protective equipment (PPE) shortages among major

State EPs age ≥ 60 years; per state per state population $n(\%)$ Per State per state population $n(\%)$ Per EPP cases by state  West Virginia 95 (40.6) 236 7652 21,061 New Mexico 108 (33.9) 319 6569 39,377 Vermont 41 (33.3) 123 5092 1987 Hawaii 91 (33.1) 275 5165 14,335 Maine 95 (32.9) 290 4615 6063 Oklahoma 110 (32.5) 342 11,529 112,483 Montana 54 (32.0) 169 6286 25,640 Alabama 128 (31.9) 401 12,189 177,064 Arkansas 80 (31.3) 256 11,773 102,798 Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 763 8770 155,246 Newa 62 (25.1) 251 12,574 111,578 Outh Carolina 194 (26.9) 720 7061 167,485 Ohio 434 (25.8) 1681 6954 190,430 Idaho 62 (25.1) 251 12,574 111,578 Ohio 434 (25.8) 1681 6954 190,430 Idaho 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1139 9236 345,535 Nassa 63 (24.7) 256 11,373 73,968 Wisconsin 196 (24.6) 798 7285 186,100 Oregon 190 (24.5) 778 538 740 155,246 Massachusetts 303 (24.3) 1247 5355 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 515 6937 7316 178,171 Nevada 88 (23.0) 3	tober 22, 2020					
New Mexico 108 (33.9) 319 6569 39,377 Vermont 41 (33.3) 123 5092 1987 Hawaii 91 (33.1) 275 5165 14,335 Maine 95 (32.9) 290 4615 6063 Oklahoma 110 (32.5) 342 11,529 112,483 Montana 54 (32.0) 169 6286 25,640 Alabama 128 (31.9) 401 12,189 177,064 Arkansas 80 (31.3) 256 11,773 102,798 Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 763 8770 155,246 Pennsylvania 498 (27.1) 725 8450 163,275 South Carolina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 Iowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1174 5303 90,199 Georgia 285 (25.0) 1179 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Misconsin 196 (24.6) 778 738 736 1876 Oregon 190 (24.5) 778 738 736 189,566 Massachusetts 303 (24.4) 1158 7356 169,566 Massachusetts 303 (24.1) 136 5422 11,835 North Dakota 19 (22.9) 83 10,629 36,017 Alaska 30 (22.1) 136 6604 137,979 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 New York 542 (19.6) 2777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549	State	60 years;		population	COVID-19	
Vermont         41 (33.3)         123         5092         1987           Hawaii         91 (33.1)         275         5165         14,335           Maine         95 (32.9)         290         4615         6063           Oklahoma         110 (32.5)         342         11,529         112,483           Montana         54 (32.0)         169         6286         25,640           Alabama         128 (31.9)         401         12,189         177.064           Arkansas         80 (31.3)         256         11,773         102,798           Arizona         274 (29.9)         917         7821         234,906           Mississippi         90 (29.5)         305         9792         112,123           Tennessee         203 (29.4)         690         9812         237,907           Idaho         67 (29.1)         231         7594         55,650           New         68 (29.1)         234         5797         9994           Hampshire         Florida         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0) <t< td=""><td>West Virginia</td><td>95 (40.6)</td><td>236</td><td>7652</td><td>21,061</td></t<>	West Virginia	95 (40.6)	236	7652	21,061	
Hawaii         91 (33.1)         275         5165         14,335           Maine         95 (32.9)         290         4615         6063           Oklahoma         110 (32.5)         342         11,529         112,483           Montana         54 (32.0)         169         6286         25,640           Alabama         128 (31.9)         401         12,189         177,064           Arkansas         80 (31.3)         256         11,773         102,798           Arizona         274 (29.9)         917         7821         234,906           Mississippi         90 (29.5)         305         9792         112,123           Tennessee         203 (29.4)         690         9812         237,907           Idaho         67 (29.1)         231         7594         55,650           New         68 (29.1)         234         5797         9994           Hampshire         Florida         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)	New Mexico	108 (33.9)	319	6569	39,377	
Maine 95 (32.9) 290 4615 6063 Oklahoma 110 (32.5) 342 11,529 112,483 Montana 54 (32.0) 169 6286 25,640 Alabama 128 (31.9) 401 12,189 177,064 Arkansas 80 (31.3) 256 11,773 102,798 Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 1832 6991 193,401 Missouri 196 (27.1) 725 8450 163,275 South Carolina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 Iowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1139 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Wisconsin 196 (24.6) 798 7285 186,100 Oregon 190 (24.5) 778 5387 40,443 Michigan 393 (24.4) 1621 6167 170,076 Virginia 283 (24.4) 1158 7356 169,566 Massachusetts 303 (24.3) 1247 5535 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 1010 8820 224,385 Illinois 425 (23.8) 1787 7130 363,740 Louisiana 150 (23.5) 877 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549 Texas 635 (19.1) 3334 8609 871,078	Vermont	41 (33.3)		5092		
Oklahoma         110 (32.5)         342         11,529         112,483           Montana         54 (32.0)         169         6286         25,640           Alabama         128 (31.9)         401         12,189         177,064           Arkansas         80 (31.3)         256         11,773         102,798           Arizona         274 (29.9)         917         7821         234,906           Mississippi         90 (29.5)         305         9792         112,123           Tennessee         203 (29.4)         690         9812         237,907           Idaho         67 (29.1)         231         7594         55,650           New         68 (29.1)         234         5797         9994           Hampshire         Florida         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         1832         6991         193,401           Missouri         196 (27.1	Hawaii		275	5165	14,335	
Montana         54 (32.0)         169         6286         25,640           Alabama         128 (31.9)         401         12,189         177,064           Arkansas         80 (31.3)         256         11,773         102,798           Arizona         274 (29.9)         917         7821         234,906           Mississisppi         90 (29.5)         305         9792         112,123           Tennessee         203 (29.4)         690         9812         237,907           Idaho         67 (29.1)         234         5797         9994           Hampshire         86 (29.1)         234         5797         9994           Hampshire         Florida         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         19	Maine		290	4615	6063	
Alabama 128 (31.9) 401 12,189 177,064 Arkansas 80 (31.3) 256 11,773 102,798 Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 1832 6991 193,401 Missouri 196 (27.1) 725 8450 163,275 South Carolina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 lowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1139 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Misconsin 196 (24.6) 798 7285 186,100 Oregon 190 (24.5) 778 5387 40,443 Michigan 393 (24.4) 1621 6167 170,076 Virginia 283 (24.4) 1158 7356 169,566 Massachusetts 303 (24.3) 1247 5535 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 1010 8820 224,385 Illinois 425 (23.8) 1787 7130 363,740 Louisiana 150 (23.5) 637 7316 178,171 Nevada 88 (23.0) 384 7902 92,853 South Dakota 19 (22.9) 83 10,629 36,017 Alaska 30 (22.1) 136 5422 11,835 North Dakota 19 (21.8) 87 8737 35,052 Maryland 198 (21.7) 915 6604 137,979 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 New York 542 (19.6) 2777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549 Texas 635 (19.1) 3334 8609 871,078	Oklahoma	110 (32.5)	342	11,529	112,483	
Arkansas 80 (31.3) 256 11,773 102,798 Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 1832 6991 193,401 Missouri 196 (27.1) 725 8450 163,275 South Carollina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 lowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1139 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Wisconsin 196 (24.5) 778 5387 40,443 Michigan 393 (24.4) 1621 6167 170,076 Virginia 283 (24.4) 1158 7356 169,566 Massachusetts 303 (24.3) 1247 5535 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 1010 8820 224,385 Illinois 425 (23.8) 1787 7130 363,740 Louisiana 150 (23.5) 637 7316 178,171 Nevada 88 (23.0) 384 7902 92,853 South Dakota 19 (22.9) 83 10,629 36,017 North Dakota 19 (21.8) 87 8737 35,052 Maryland 198 (21.7) 915 6604 137,979 North Dakota 19 (21.8) 87 8737 35,052 Maryland 198 (21.7) 915 6604 137,979 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 New York 542 (19.6) 2777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549 Texas 635 (19.1) 3334 8609 871,078	Montana	54 (32.0)	169	6286	25,640	
Arizona 274 (29.9) 917 7821 234,906 Mississippi 90 (29.5) 305 9792 112,123 Tennessee 203 (29.4) 690 9812 237,907 Idaho 67 (29.1) 231 7594 55,650 New 68 (29.1) 234 5797 9994 Hampshire Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 1832 6991 193,401 Missouri 196 (27.1) 725 8450 163,275 South Carolina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 Iowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1139 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Wisconsin 196 (24.6) 798 7285 186,100 Oregon 190 (24.5) 778 5387 40,443 Michigan 393 (24.4) 1621 6167 170,076 Virginia 283 (24.4) 1158 7356 169,566 Massachusetts 303 (24.3) 1247 5535 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 1010 8820 224,385 Illinois 425 (23.8) 1787 7130 363,740 Louisiana 150 (23.5) 637 7316 178,171 Nevada 88 (23.0) 384 7902 92,853 South Dakota 19 (22.9) 83 10,629 36,017 Alaska 30 (22.1) 136 5422 11,835 North Dakota 19 (21.8) 87 8737 35,052 Maryland 198 (21.7) 915 6604 137,979 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 New York 542 (19.6) 2777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549 Texas 635 (19.1) 3334 8609 871,078	Alabama			12,189	177,064	
Mississippi         90 (29.5)         305         9792         112,123           Tennessee         203 (29.4)         690         9812         237,907           Idaho         67 (29.1)         231         7594         55,650           New         68 (29.1)         234         5797         9994           Hampshire         Florida         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           Iowa         62						
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New Hampshire         68 (29.1)         234         5797         9994           Hampshire         764 (29.0)         2641         8065         768,091           Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           lowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)		` ,				
Florida 764 (29.0) 2641 8065 768,091 Kentucky 149 (28.7) 520 8593 92,299 Wyoming 23 (28.0) 84 6878 10,119 Washington 296 (27.4) 1082 6965 100,525 Indiana 208 (27.3) 763 8770 155,246 Pennsylvania 498 (27.3) 1832 6991 193,401 Missouri 196 (27.1) 725 8450 163,275 South Carolina 194 (26.9) 720 7061 167,485 California 1418 (26.1) 5445 7265 889,375 Ohio 434 (25.8) 1681 6954 190,430 Iowa 62 (25.1) 251 12,574 111,578 Colorado 268 (25.0) 1074 5303 90,199 Georgia 285 (25.0) 1139 9236 345,535 Kansas 63 (24.7) 256 11,373 73,968 Wisconsin 196 (24.6) 798 7285 186,100 Oregon 190 (24.5) 778 5387 40,443 Michigan 393 (24.4) 1621 6167 170,076 Virginia 283 (24.4) 1158 7356 169,566 Massachusetts 303 (24.3) 1247 5535 147,215 Connecticut 123 (23.9) 515 6937 65,373 New Jersey 241 (23.9) 1010 8820 224,385 Illinois 425 (23.8) 1787 7130 363,740 Louisiana 150 (23.5) 637 7316 178,171 Nevada 88 (23.0) 384 7902 92,853 South Dakota 19 (22.9) 83 10,629 36,017 Alaska 30 (22.1) 136 5422 11,835 North Dakota 19 (21.8) 87 8737 35,052 Maryland 198 (21.7) 915 6604 137,979 North Carolina 284 (20.7) 1375 7552 252,992 Minnesota 157 (20.4) 770 7287 128,152 New York 542 (19.6) 2777 7037 490,134 Delaware 24 (19.4) 124 7800 23,528 Utah 83 (19.4) 427 7403 99,549 Texas 635 (19.1) 3334 8609 871,078						
Kentucky         149 (28.7)         520         8593         92,299           Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           lowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)	Hampshire		234	5797	9994	
Wyoming         23 (28.0)         84         6878         10,119           Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           lowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)		, ,				
Washington         296 (27.4)         1082         6965         100,525           Indiana         208 (27.3)         763         8770         155,246           Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           lowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)		, ,				
Indiana   208 (27.3)   763   8770   155,246   Pennsylvania   498 (27.3)   1832   6991   193,401   Missouri   196 (27.1)   725   8450   163,275   South Carolina   194 (26.9)   720   7061   167,485   California   1418 (26.1)   5445   7265   889,375   Ohio   434 (25.8)   1681   6954   190,430   lowa   62 (25.1)   251   12,574   111,578   Colorado   268 (25.0)   1074   5303   90,199   Georgia   285 (25.0)   1139   9236   345,535   Kansas   63 (24.7)   256   11,373   73,968   Wisconsin   196 (24.6)   798   7285   186,100   Oregon   190 (24.5)   778   5387   40,443   Michigan   393 (24.4)   1621   6167   170,076   Virginia   283 (24.4)   1158   7356   169,566   Massachusetts   303 (24.3)   1247   5535   147,215   Connecticut   123 (23.9)   515   6937   65,373   New Jersey   241 (23.9)   1010   8820   224,385   Illinois   425 (23.8)   1787   7130   363,740   Louisiana   150 (23.5)   637   7316   178,171   Nevada   88 (23.0)   384   7902   92,853   South Dakota   19 (22.9)   83   10,629   36,017   Alaska   30 (22.1)   136   5422   11,835   North Dakota   19 (21.8)   87   8737   35,052   Maryland   198 (21.7)   915   6604   137,979   North Carolina   284 (20.7)   1375   7552   252,992   Minnesota   157 (20.4)   770   7287   128,152   New York   542 (19.6)   2777   7037   490,134   Delaware   24 (19.4)   124   7800   23,528   Utah   83 (19.4)   427   7403   99,549   Texas   635 (19.1)   3334   8609   871,078		, ,				
Pennsylvania         498 (27.3)         1832         6991         193,401           Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           Iowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23	0	` ,				
Missouri         196 (27.1)         725         8450         163,275           South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           Iowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)<						
South Carolina         194 (26.9)         720         7061         167,485           California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           Iowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)		, ,				
California         1418 (26.1)         5445         7265         889,375           Ohio         434 (25.8)         1681         6954         190,430           Iowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5) <td></td> <td></td> <td></td> <td></td> <td></td>						
Ohio         434 (25.8)         1681         6954         190,430           lowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)		, ,				
Iowa         62 (25.1)         251         12,574         111,578           Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (21.8)						
Colorado         268 (25.0)         1074         5303         90,199           Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)		, ,				
Georgia         285 (25.0)         1139         9236         345,535           Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8) <td></td> <td>, ,</td> <td></td> <td></td> <td></td>		, ,				
Kansas         63 (24.7)         256         11,373         73,968           Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)						
Wisconsin         196 (24.6)         798         7285         186,100           Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.		, ,				
Oregon         190 (24.5)         778         5387         40,443           Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20		, ,				
Michigan         393 (24.4)         1621         6167         170,076           Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542		, ,				
Virginia         283 (24.4)         1158         7356         169,566           Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (	-					
Massachusetts         303 (24.3)         1247         5535         147,215           Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4) </td <td></td> <td>, ,</td> <td></td> <td></td> <td></td>		, ,				
Connecticut         123 (23.9)         515         6937         65,373           New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)	0	` ,				
New Jersey         241 (23.9)         1010         8820         224,385           Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078		, ,				
Illinois         425 (23.8)         1787         7130         363,740           Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078						
Louisiana         150 (23.5)         637         7316         178,171           Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078		, ,				
Nevada         88 (23.0)         384         7902         92,853           South Dakota         19 (22.9)         83         10,629         36,017           Alaska         30 (22.1)         136         5422         11,835           North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078		, ,				
South Dakota     19 (22.9)     83     10,629     36,017       Alaska     30 (22.1)     136     5422     11,835       North Dakota     19 (21.8)     87     8737     35,052       Maryland     198 (21.7)     915     6604     137,979       North Carolina     284 (20.7)     1375     7552     252,992       Minnesota     157 (20.4)     770     7287     128,152       New York     542 (19.6)     2777     7037     490,134       Delaware     24 (19.4)     124     7800     23,528       Utah     83 (19.4)     427     7403     99,549       Texas     635 (19.1)     3334     8609     871,078						
Alaska     30 (22.1)     136     5422     11,835       North Dakota     19 (21.8)     87     8737     35,052       Maryland     198 (21.7)     915     6604     137,979       North Carolina     284 (20.7)     1375     7552     252,992       Minnesota     157 (20.4)     770     7287     128,152       New York     542 (19.6)     2777     7037     490,134       Delaware     24 (19.4)     124     7800     23,528       Utah     83 (19.4)     427     7403     99,549       Texas     635 (19.1)     3334     8609     871,078		, ,				
North Dakota         19 (21.8)         87         8737         35,052           Maryland         198 (21.7)         915         6604         137,979           North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078		, ,	136		•	
Maryland     198 (21.7)     915     6604     137,979       North Carolina     284 (20.7)     1375     7552     252,992       Minnesota     157 (20.4)     770     7287     128,152       New York     542 (19.6)     2777     7037     490,134       Delaware     24 (19.4)     124     7800     23,528       Utah     83 (19.4)     427     7403     99,549       Texas     635 (19.1)     3334     8609     871,078	North Dakota		87	8737	35,052	
North Carolina         284 (20.7)         1375         7552         252,992           Minnesota         157 (20.4)         770         7287         128,152           New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078	Maryland		915	6604	137,979	
New York         542 (19.6)         2777         7037         490,134           Delaware         24 (19.4)         124         7800         23,528           Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078	North Carolina		1375	7552	252,992	
Delaware     24 (19.4)     124     7800     23,528       Utah     83 (19.4)     427     7403     99,549       Texas     635 (19.1)     3334     8609     871,078	Minnesota	157 (20.4)	770	7287	128,152	
Utah         83 (19.4)         427         7403         99,549           Texas         635 (19.1)         3334         8609         871,078	New York	542 (19.6)	2777	7037	490,134	
Texas 635 (19.1) 3334 8609 871,078	Delaware	24 (19.4)	124	7800	23,528	
Texas 635 (19.1) 3334 8609 871,078	Utah	83 (19.4)	427	7403	99,549	
Nebraska 29 (18.1) 160 12,058 60,308	Texas		3334	8609	871,078	
	Nebraska	29 (18.1)	160	12,058	60,308	
Rhode Island 30 (16.0) 187 5654 29,594	Rhode Island	30 (16.0)	187	5654	29,594	
U.S. (total) 10,804 43,311 N/A 8,392,628 (24.9)	U.S. (total)		43,311	N/A	8,392,628	

Abbreviations: COVID-19, coronavirus disease 2019; EP, emergency physician.

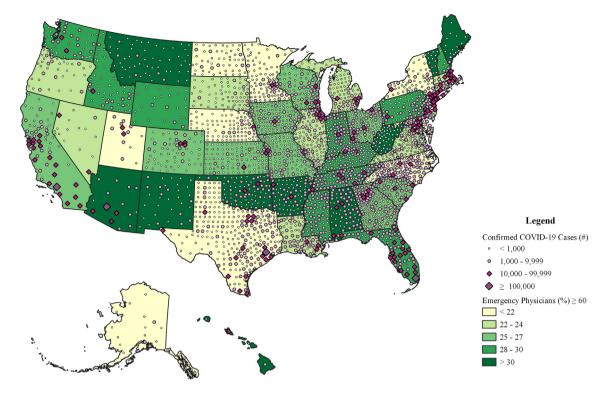


Fig. 1. Geographic distribution of emergency physicians age ≥ 60 years and cumulative COVID-19 case distribution, as of October 22, 2020. States were grouped into color-coordinated quintiles based on relative proportion of older EPs, and cumulative COVID-19 case volumes were adjusted with a logarithmic scale to create proportionally-sized data points.

U.S. distributors [6], supply chain prioritization toward EPs in higher-risk states warrants consideration, especially as cases continue to surge. Emergency departments could also amend operations to prioritize reduction of nosocomial transmission risk among advanced age EPs (e.g., allocating critically limited PPE to higher-risk physicians, geographically cohorting patients with suspected or confirmed COVID-19 infection within an emergency department) [7]. Furthermore, prioritization of routine COVID-19 testing of older EPs, as well as creation of reserve pools of emergency medicine physicians (e.g., EPs from hospital systems relatively less affected by COVID-19), may facilitate the transfer of care duties from older EPs at more heavily affected emergency departments, in the event that they test positive and need to safely self-isolate [8].

Study limitations include not controlling for other individual factors associated with increased COVID-19 severity (e.g., obesity, Black race, Hispanic ethnicity) [9,10], as well as using state-level data, which precludes insights into risk differences by, for example, rural/urban status. Moreover, we acknowledge that utilizing cumulative case volumes does not account for differences in the present rate of COVID-19 spread between states (e.g., rate of COVID-19 spread and confirmed case count in New York have since stabilized from March/April 2020) [1]. Finally, we understand that COVID-19 infection among younger clinicians is a serious problem. Our hope is that the current findings will raise awareness among EPs and assist implementation of safety guidelines and workforce planning. Collectively, we need to ensure that all front-line EPs, including those at higher risk, are properly protected during the COVID-19 pandemic.

## Financial disclosure

The authors report no funding sources relevant to this work.

#### **Author contributions statement**

DXZ and TKJ conceived the study and supervised data collection. EJM assisted in data collection. CAC provided advice on study design. DXZ

drafted the manuscript, and all authors contributed substantially to its revision. DXZ and CAC take responsibility for the paper as a whole.

#### **Declaration of competing interest**

The authors report no conflicts of interest relevant to this work.

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28 October 2020