



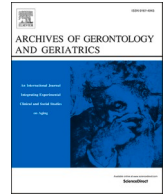
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## Editorial

## National health care quality and COVID-19 case fatality rate: International comparisons of top 50 countries



## ARTICLE INFO

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Since the first cluster of pneumonia cases of unknown etiology reported in 31 December 2019, later named as coronavirus disease 2019 (COVID-19), it has become the most eye-catching keyword internationally, and continuously brought new challenges to the world on daily basis (Sepúlveda-Loyola, et al., 2020; Parasher, 2021). Patients with COVID-19 infections not only suffered from the risk of critical illness and in-mortality, but also the potential long-term effects or post-acute sequelae across pulmonary and extrapulmonary organ systems, including nervous system (e.g., neurocognitive disorders and mental health disorders), cardiovascular disorders, signs and symptoms related to poor general well-being (e.g., fatigue, and musculoskeletal pain) (Groff, et al., 2021; Higgins, Sohaei, Diamandis and Prassas, 2021). The previous report showed that survivors of COVID-19 infections experienced at least 1 persistent post-acute sequelae at the 1<sup>st</sup> month, at 2<sup>nd</sup>-5<sup>th</sup> months and at 6<sup>th</sup> or more months were 54% (45–69%), 55% (34.8–65.5%), and 54% (43.5–67.0%) (Groff, et al., 2021). Overall, the COVID-19 pandemic not only threatened individuals' health, but also devastated healthcare, social and economic systems due to the incremental loss of disability-adjusted life years (DALYs) and the productivity loss (Nurchis, et al, 2020). Therefore, the challenges of COVID-19 pandemic to the healthcare systems are not only issues of infection controls, emergency and critical care, but also post-acute, long-term, community, and mental health care.

The Impact of COVID-19 infections to every country vary greatly due to differences in social, cultural, and public health backgrounds. Nevertheless, the performance, health care quality, and resilience of healthcare systems may affect clinical outcomes. Older age has been recognized as an important factor in COVID-19 infections, treatment and recovery (Nurchis, et al., 2020), but the impacts may be caused by multiple complex comorbid conditions rather than age alone. Older age was often featured by higher prevalence of multimorbidity, frailty, sarcopenia, dementia and impaired of intrinsic capacity, and these factors also increased the COVID-19 mortality risk for older adults (Nurchis, et al., 2020; Hariyanto, Putri, Arisa, Situmeang, Kurniawan,

2021; Lim, et al., 2021; Pranata, et al., 2021). In addition, during the lockdown, older adults tended to suffer from decreasing their resilience and increasing risk of frailty, sarcopenia, cognitive declines and depressive symptoms due to social distancing, holdup of community activities, and unable to regular contact their medical clinics (Chen, 2020; Webb, 2021). Therefore, the COVID-19 mortality rate may represent the complex interactions between disease severity, social support, and the quality of healthcare systems.

Evaluating the quality of healthcare systems on national levels is difficult until the development of Healthcare Access and Quality Index (HAQI) (GBD 2016 Healthcare Access and Quality Collaborators, 2018). HAQI was developed from the Global Burden of Diseases (GBD), and provided foundations for international comparisons. Nevertheless, major components of GBD are non-communicable diseases, so the effectiveness of HAQI in assessing the quality of healthcare systems on COVID-19 pandemic remains uncertain. Hence, we examined the relationships between HAQI and COVID-19 case fatality rate among major countries based on HAQI ranking. HAQI results of top 50 countries (excluding Puerto Rico and Bermuda) were retrieved for analysis, together with COVID-19 caseloads, percentage of older people, and COVID-19 case fatality rate of these countries from the World Bank database (Table 1). Pearson correlation showed a significant negative association between HAQI and country-specific COVID-19 case fatality rate ( $\gamma$ : -0.342,  $p = 0.017$ ) (Fig. 1). Adjusted for COVID-19 caseloads, percentage of older population of each county, multiple linear regression showed significant negative associations between HAQI and COVID-19 case fatality rate remained still (beta coefficient: -0.073,  $p = 0.004$ ), as well as the positive associations between percentage of older population of each country and COVID-19 case fatality rate (beta coefficient: 0.063,  $p = 0.042$ ). Despite potential confounders, current analysis supported the original design of HAQI to evaluate the quality of healthcare systems at country levels. It also implied that the ability of a country to manage non-communicable diseases was parallel to the ability to managing the COVID-19 pandemic.

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**Table 1**  
Status of COVID-19 caseloads, mortality rate and the health access and quality index of top 40 countries

Rank <sup>1</sup>	Country	Health Access & Quality Index 2016 <sup>1</sup>	Total population 2020 <sup>2</sup>	Older/total population (%) 2020 <sup>2,3</sup>	COVID-19 case number (until Oct 31 2021) <sup>4</sup>	COVID-19 case number/total population (%) <sup>2,4</sup>	COVID-19 mortality cases (until Oct 31 2021) <sup>4</sup>	COVID-19 mortality rate (%) (COVID-19 mortality number/ COVID-19 case number, until Oct 31 2021) <sup>4</sup>
1	Iceland	97	366,425	15.6	13,492	3.68	33	0.24
2	Norway	97	5,379,475	17.5	207,280	3.85	900	0.43
3	Netherlands	96	17,441,139	20.0	2,170,000	12.44	18,850	0.87
4	Luxembourg	96	632,275	14.4	81,683	12.92	843	1.03
5	Australia	96	25,687,041	16.2	172,030	0.67	1743	1.01
6	Finland	96	5,530,719	22.6	157,531	2.85	1158	0.74
7	Switzerland	96	8,636,896	19.1	872,558	10.10	11,234	1.29
8	Sweden	95	10,353,442	20.3	1,170,000	11.30	15,025	1.28
9	Italy	95	59,554,023	23.3	4,770,000	8.01	132,100	2.77
10	Andorra	95	77,265	13.0	15,516	20.08	130	0.84
11	Ireland	95	4,994,724	14.6	445,594	8.92	5,436	1.22
12	Japan	94	125,836,021	28.4	1,720,000	1.37	18,264	1.06
13	Austria	94	8,917,205	19.2	830,981	9.32	11,357	1.37
14	Canada	94	38,005,238	18.1	1,720,000	4.53	29,022	1.69
15	Belgium	93	11,555,997	19.3	1,360,000	11.77	25,994	1.91
16	New Zealand	92	5,084,300	16.4	6,595	0.13	28	0.42
17	Denmark	92	5,831,404	20.2	390,727	6.70	2,716	0.70
18	Germany	92	83,240,525	21.7	4,610,000	5.54	95,735	2.08
19	Spain	92	47,351,567	20.0	5,010,000	10.58	87,368	1.74
20	France	92	67,391,582	20.8	7,270,000	10.79	118,625	1.63
21	Slovenia	91	2,100,126	20.7	335,850	15.99	4,745	1.41
22	Singapore	91	35,009,006 <sup>5</sup>	16.0 <sup>5</sup>	198,374	0.57	407	0.21
23	UK	90	67,215,293	18.7	9,100,000	13.54	141,055	1.55
24	Greece	90	10,715,549	22.3	742,170	6.93	15,938	2.15
25	South Korea	90	51,780,579	15.8	366,386	0.71	2,858	0.78
26	Cyprus	90	1,207,361	14.4	124,017	10.27	575	0.46
27	Malta	90	525,285	21.3	37,653	7.17	461	1.22
28	Czech Republic	89	10,698,896	20.1	1,760,000	16.45	30,753	1.75
29	USA	89	329,484,123	16.6	46,010,000	13.96	746,946	1.62
30	Croatia	87	4,047,200	21.3	470,348	11.62	9,220	1.96
31	Estonia	86	1,331,057	20.4	193,969	14.57	1,531	0.79
32	Portugal	86	10,305,564	22.8	1,090,000	10.58	18,157	1.67
33	Lebanon	86	6,825,442	7.5	642,024	9.41	8,502	1.32
34	Taiwan	85	23,561,236	16.1	16,412	0.07	847	5.16
35	Israel	85	9,216,900	12.4	1,330,000	14.43	8,100	0.61
36	Slovakia	83	5,458,827	16.7	898,926	16.47	13,034	1.45
39	Poland	82	37,950,802	18.7	3,030,000	7.98	76,999	2.54
40	Hungary	82	9,749,763	20.2	863,419	8.86	30,729	3.56
41	Qatar	82	2,881,060	1.7	239,247	8.30	610	0.25
42	Montenegro	81	621,718	15.8	144,314	23.21	2,103	1.46
43	Latvia	81	1,901,548	20.7	219,139	11.52	3,253	1.48
44	Kuwait	81	4,270,563	3.0	412,678	9.66	2,461	0.60
45	Lithuania	80	2,794,700	20.6	408,715	14.62	5,873	1.44
46	Belarus	79	9,398,861	15.6	600,168	6.39	4,631	0.77
47	Romania	78	19,286,123	19.24	1,650,000	8.56	47,751	2.89
48	China	78	1,402,112,000	12.0	97,320	0.01	4,636	4.76
49	Chile	78	19,116,209	12.2	1,700,000	8.89	37,757	2.22
50	Serbia	77	6,908,224	19.1	1,140,000	16.50	9,955	0.87

<sup>1</sup> GBD 2016 Healthcare Access and Quality Collaborators. Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. *GBD 2016 Healthcare Access and Quality Collaborators. 2018*;391(10136):2236-2271.

<sup>2</sup> Population, total - World Bank Open Data. <https://data.worldbank.org/indicator/SP.POP.TOTL>

<sup>3</sup> Population ages 65 and above, total - World Bank Open Data. <https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS>

<sup>4</sup> Cumulative confirmed COVID-19 deaths vs. cases - Our World in Data. <https://ourworldindata.org/grapher/covid-19-cumulative-confirmed-cases-vs-confirmed-deaths>

<sup>5</sup> National Population and Talent Division, Strategy Group, Prime Minister's Office, Singapore Department of Statistics, Ministry of Home Affairs, Immigration & Checkpoints Authority, Ministry of Manpower. 2020/09. <https://www.strategygroup.gov.sg/files/media-centre/publications/population-in-brief-2020.pdf>

COVID-19 pandemic has substantially changed the health care services and healthcare systems, and the effects may last much longer than expected (Metzl, Maybank, & De Maio, 2020). Parohan, et al., published a meta-analysis and showed the older men with multimorbidity were at higher risk of COVID-19 mortality (Parohan, et al., 2020), but other studies also indicated that the adverse health outcomes of older age were not simply due to aging (Hajek & König, et al., 2020; Lee, Peng and Chen, 2020). Eventually, advancing age significantly increased the heterogeneity of health characteristics of older people in their late life

(Duim & Lima Passos, 2020; Jeon, 2020), and functional impairment or disability was more important in predicting their quality of life and mortality (Pivetta, et al., 2020; Li, et al., 2021), which may be applied to COVID-19 pandemic as well. Instead, studies have shown that frailty strongly impacted on the in-hospital mortality risk among older persons with COVID-19 (De Smet, et al., 2020; Pranata, et al., 2021). Hence, the COVID-19 case fatality risk may be partly explained by the frailty status and the responses of healthcare systems to frail older adults. Michel, et al., have proposed ending the disease concept in caring older persons

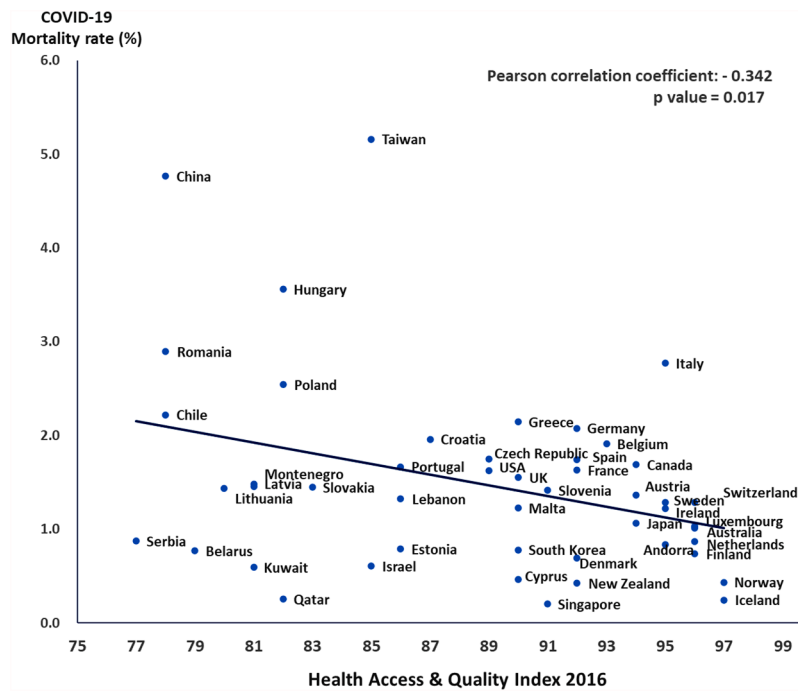


Fig. 1. Correlation between health access & quality index and COVID-19 mortality rate

with multiple complex care needs and shifted the focus on functional performance while treating diseases of older adults (Michel, et al, 2020). The climate changes in Europe, either heat waves or cold spells, have changed the health care services to older adults (Wanka, et al., 2014), and COVID-19 pandemic may be another trigger to reinforce health and social services for older adults, as well as the prevention and management of frailty. Performance of individual country on HAQI may be the potential guide to improve the quality of healthcare systems, and reduced the impacts of frailty and disability on the population levels. The reduction of disease-specific DALYs based on HAQI may also be considered as the approach to compress morbidity and disability as people age, and may be beneficial to respond to COVID-19 pandemic or other related challenges.

Reference

Chen, L. K. (2020). Older adults and COVID-19 pandemic: Resilience matters. *Archives of Gerontology and Geriatrics*, 89, Article 104124.

De Smet, R., Mellaerts, B., Vandewinckele, H., Lybeert, P., Frans, E., Ombelet, S., et al. (2020). Frailty and mortality in hospitalized older adults with COVID-19: Retrospective observational study. *Journal of the American Medical Directors Association*, 21(7), 928–932. e1.

Duim, E., & Lima Passos, V. (2020). Highways to Ageing - Linking life course SEP to multivariate trajectories of health outcomes in older adults. *Archives of Gerontology and Geriatrics*, 91, Article 104193.

GBD 2016 Healthcare Access and Quality Collaborators. (2018). Measuring performance on the healthcare access and quality index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. *Lancet*, 391(10136), 2236–2271 (London, England).

Groff, D., Sun, A., Ssentongo, A. E., Ba, D. M., Parsons, N., Poudel, G. R., et al. (2021). Short-term and long-term rates of postacute sequelae of SARS-CoV-2 infection: A systematic review. *JAMA Network Open*, 4(10), Article e2128568.

Hajek, A., & König, H. H. (2020). Feeling too old? Consequences for subjective well-being. Longitudinal findings from the German ageing survey. *Archives of Gerontology and Geriatrics*, 90, Article 104127.

Hariyanto, T. I., Putri, C., Arisa, J., Situmeang, R., & Kurniawan, A. (2021). Dementia and outcomes from coronavirus disease 2019 (COVID-19) pneumonia: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, 93, Article 104299.

Higgins, V., Sohaei, D., Diamandis, E. P., & Prassas, I. (2021). COVID-19: from an acute to chronic disease? Potential long-term health consequences. *Critical Reviews in Clinical Laboratory Sciences*, 58(5), 297–310.

Jeon, H. O. (2020). Correlation of physical, psychological, and functional factors with independent medication adherence in Korean older adults with chronic illness: Using the 2017 national survey of older Koreans. *Archives of Gerontology and Geriatrics*, 90, Article 104130.

Lee, W. J., Peng, L. N., & Chen, L. K. (2020). Metabolic syndrome and its components are associated with frailty: a nationwide population-based study in Taiwan. *Ageing Medicine and Health Care*, 11, 47–52.

Li, H. W., Lee, W. J., Lin, M. H., Peng, L. N., Loh, C. H., Chen, L. K., et al. (2021). Quality of life among community-dwelling middle-aged and older adults: function matters more than multimorbidity. *Archives of Gerontology and Geriatrics*, 95, Article 104423.

Lim, J. P., Low, K., Lin, N., Lim, C., Ong, S., Tan, W., et al. (2021). Predictors for development of critical illness amongst older adults with COVID-19: Beyond age to age-associated factors. *Archives of Gerontology and Geriatrics*, 94, Article 104331.

Metzl, J. M., Maybank, A., & De Maio, F. (2020). Responding to the COVID-19 pandemic: The need for a structurally competent health care system. *JAMA*, 324(3), 231–232.

Michel, J. P., Graf, C., Ma, L., & Ecartot, F. (2020). The end of the disease concept in geriatric medicine. *Ageing Med. Healthcare*, 11(1), 3–9.

Nurchis, M. C., Pascucci, D., Sapienza, M., Villani, L., D'Ambrosio, F., Castrini, F., et al. (2020). Impact of the Burden of COVID-19 in Italy: Results of disability-adjusted life years (DALYs) and productivity loss. *International Journal of Environmental Research and Public Health*, 17(12), 4233.

Parasher, A. (2021). COVID-19: Current understanding of its Pathophysiology, clinical presentation and treatment. *Postgraduate Medical Journal*, 97(1147), 312–320.

Parohan, M., Yaghoubi, S., Seraji, A., Javanbakht, M. H., Sarraf, P., & Djalali, M. (2020). Risk factors for mortality in patients with Coronavirus disease 2019 (COVID-19) infection: a systematic review and meta-analysis of observational studies. *The Aging Male: The Official Journal of the International Society for the Study of the Aging Male*, 23(5), 1416–1424.

Pivetta, N., Marincolo, J., Neri, A. L., Aprahamian, I., Yassuda, M. S., & Borim, F. (2020). Multimorbidity, frailty and functional disability in octogenarians: A structural equation analysis of relationship. *Archives of Gerontology and Geriatrics*, 86, Article 103931.

Pranata, R., Henrina, J., Lim, M. A., Lawrensia, S., Yonas, E., Vania, R., et al. (2021). Clinical frailty scale and mortality in COVID-19: A systematic review and dose-response meta-analysis. *Archives of Gerontology and Geriatrics*, 93, Article 104324.

Sepúlveda-Loyola, W., Rodríguez-Sánchez, I., Pérez-Rodríguez, P., Ganz, F., Torralba, R., Oliveira, D. V., et al. (2020). Impact of social isolation due to COVID-19 on health in older people: Mental and physical effects and recommendations. *The Journal of Nutrition, Health & Aging*, 24(9), 938–947.

Wanka, A., Arnberger, A., Alex, B., Eder, R., Hutter, H. P., & Wallner, P. (2014). The challenges posed by climate change to successful ageing. *Zeitschrift für Gerontologie und Geriatrie*, 47(6), 468–474.

Webb, L. (2021). COVID-19 lockdown: A perfect storm for older people's mental health. *Journal of Psychiatric and Mental Health Nursing*, 28(2), 300.

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