European Journal of Medical and Health Sciences
Vol 6 | Issue 6 | November 2024
ISSN 2593-8339

RESEARCH ARTICLE

Marginal Shortening of Life Expectancy in Japan During COVID-19: A Low Pandemic Impact Country Due to Improved Health Infrastructure and Awareness

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ABSTRACT

The novel coronavirus (SARS-CoV-2) caused the COVID-19 pandemic, which led to a large number of deaths worldwide, particularly in rich and developed countries, thereby decreasing the average life expectancy (ALE) or average lifespan (ALS) of the people living in these countries. We investigated the pandemic's effect on the ALE of the Japanese male and female population. Japan's declining ALE year-over-year was compared with high-ranking LE countries. For both genders, Japan's ALE increased every year until 2020, even though 2020 was a pandemic year. A small decrease due to the pandemic could not reduce Japan's overall LE in 2020. In 2021 and 2022, Japan's overall LE decreased, but once the pandemic ended in 2023, it returned to its pre-pandemic trend of increasing. When considering both genders among the high LE and rich and democratic countries such as Hong Kong, Switzerland, Singapore, Sweden, Norway, Italy, South Korea, and Spain, Japan's ALE was least affected. Due to its improved health infrastructure (% GDP spending on healthcare) and public awareness about the pandemic (mask usage), Japan remained the least affected country during the COVID-19 pandemic. This paper compares the ALE change, % GDP spending on healthcare, and mask usage awareness of the above countries with Japan.

Keywords: % GDP to healthcare, COVID-19, life expectancy shortening, mask awareness.

Submitted: September 23, 2024

Published: November 09, 2024

10.24018/ejmed.2024.6.6.2214

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1. Introduction

Sutandhio *et al*. [1] looked at the effect of the mRNA vaccine's multiple doses by testing the levels of antibodies that can neutralize new types of SARS-CoV-2 variants, such as BQ.1.1 and XBB. The variants raise concerns due to their high immune evasive nature, especially in vulnerable elderly populations. The study included the elderly residents of Hyogo prefecture (Japan) who received the third and fourth mRNA vaccinations from April to October 2022. The percentage of cross-neutralizing antibody positivity against each variant reported after the third vaccination, which has been mentioned in the bracket, was as follows: D614G (conventional virus) (100%), Delta (97%), Omicron BA.2 (81%), BA.5 (51%), BA.2.75 (67%), BQ.1.1 (4%), and XBB (21%). After the fourth vaccination,

the prevalence of antibody neutralization increased for D614G (conventional virus), Delta (100%), Omicron BA.2 (98%), BA.5 (79%), BA.2.75 (92%), BQ.1.1 (31%), and XBB (52%).

Elsewhere in Canada, most of the people (above 75%) have developed hybrid immunity against SARS-CoV-2 through a combination of infection and vaccination [2], [3]. The changing level of seroprevalence from infection, vaccination, and a mix of both (infection and vaccination) was estimated over three periods: March-November 2020 (pre-vaccination), December 2020-November 2021 (vaccine roll-out), and December 2021-March 2023 (Omicron wave). The seroprevalence was low in July 2020, exposing less than 0.3% of the Canadian population to the virus. It reached 9% in November 2021. Infection-acquired seropositivity increased dramatically with the emergence of the Omicron variant. After six months of the Omicron variant circulation in mid-June 2022, seropositivity had risen to 47%. By March 2023, seroprevalence had reached over 75%. Close to 80% of the adults who were under 25 years of age developed antibodies against the virus. About 75% of the cohort 25–39 years old had SARS-CoV-2 antibodies. By spring 2023, 70% of those aged 40–59 years and 60% of those aged 60 and over were seropositive. The infection rates in high-income countries such as Canada, the United States, and Europe were low until the emergence of more contagious Omicron variants. Worldwide, a significant proportion of the population has acquired hybrid immunity against SARS-CoV-2 through Omicron infection and vaccination. A recent study [4], [5] in the Netherlands looked at how mixed-immunity (hybrid immunity) protected against the Omicron variant of the virus, which spreads easily and evades the immune system. The Omicron variant and its sub-variants led to numerous waves of COVID-19 infection around the world. In the Netherlands, Omicron was detected in November 2021 with a 90% share of Omicron BA.1. Since then, the virus has mutated further to give rise to other Omicron sub-variants BA.1, BA.2, and BA.5. With the large proportion of Omicron infection combined with the robust adult vaccination roll-out, most of the adult Dutch population developed hybrid immunity. The research assessed the overall potential benefit of the booster vaccination drive in the population. The results were similar to those of earlier studies that found that hybrid immunity made people less likely to get an Omicron infection than people who had not been infected before but received a booster dose. Antibody levels, cellular immunity, and binding strength all influence the Omicron variant infection neutralization capacity. Another significant discovery regarding hybrid immunity revealed a partial correlation between protection against Omicron infection and mucosal antibodies. However, mucosal antibodies waned significantly faster than serum antibodies. Therefore, the decline in mucosal immunity may be the cause of the faster reduction of hybrid immunity than the vaccine-generated protection. Despite this, hybrid immunity provides better protection against the Omicron variant infection than vaccine-generated immunity alone. Moreover, the sequence of immunizing events did not influence the protection that hybrid immunity generated.

Regarding the vaccine related mortalities, an assessment of vaccine-related deaths revealed that two men in their 30s died within a few days of receiving the second dose of Moderna's vaccine in August 2021 in Japan [6]. They had no history of health issues, such as allergies, that could cause death. The shots were manufactured on the same production line in Spain where contaminated vials were previously found. The exact cause of the death could not be established. It was unclear whether the two recipients received tainted or untainted doses, or if a side effect caused their deaths. The officials stated that the men might have received the tainted doses, before stopping the three lots due to the suspicion of contaminated doses. Of the 1.63 million doses, more than 0.5 million have already been administered from the three paused lots. By August 8, 2021, Japan had reported eleven deaths, or nearly one (0.9) per million, following the inoculation of more than 12.2 million Moderna shots. A causal link between the death of a 42-year-old woman in November 2022 and the COVID-19 vaccine shot she received was acknowledged in Japan [7]. It was the first vaccine-related death of the total nearly 2,000 deaths reported in Japan following the COVID-19 vaccinations. The woman who received a Pfizer vaccine dose targeting the omicron variant on November 5, 2022, developed vaccine side effects and succumbed to acute heart failure in a hospital, 100 minutes after the shot. The woman was obese and suffered from high blood pressure and diabetes. Japan has administered 382 million shots since the vaccination campaign began in February 2021. As of January 2023, Japan has registered 1,963 deaths among vaccine recipients aged 12 or older. The deaths related to the Pfizer vaccines were 1,751 (6.3 per million), Moderna shots with 211 (2.6 per million), and only one (3.7 per million) involving a Takeda-Novavax dose was reported. However, aside from the aforementioned 42-year-old woman's case, one has yet to establish a causal connection between the vaccine shots and the deaths. In contrast, the study [8] found that booster doses of mRNA vaccines did not increase mortality risk. The finding is useful for vaccination campaigns that need to remove vaccine hesitancy.

The other pandemic-related issue is the long-term or post-COVID infection [9], [10], which poses a significant concern for infected patients. The risk of new or prolonged disease and, in some cases, even death remained high and prolonged as long as two years after the infection. The common COVID-19-linked disorders are dangerous, such as blood clots, diabetes, lung, gastrointestinal, and musculoskeletal disease, according to a published [10] study. An estimated 65 million people worldwide suffer from post-COVID syndrome, and this number continues to rise due to a lack of approved treatments and an ongoing global viral spread. Though long-term COVID-19 symptoms improved over time, some remained. Researchers have identified more than 200 possible symptoms that could affect every organ associated with the COVID-19 infection. The study's sample size was 138,818 infected individuals who were exposed in the first year of the pandemic. Patients who were not hospitalized had a risk (31%) of developing health issues even after two years of infection, whereas hospitalized COVID-19-infected patients

had a higher (65%) chance of developing the ailments. The risk of death was higher among hospitalized patients than non-hospitalized ones. The COVID-19 infection may cause long-lasting changes in the innate immune system, the first defense line of the body against pathogens, resulting in persistent inflammation and organ damage. The long COVID has put an extra burden on the already stretched healthcare system. Attempts must be made to develop and identify a treatment for post-COVID symptoms.

Regarding the current status of viral transmission, during the ninth wave, the number of cases in Japan increased for the 17th consecutive week, spanning from April 3, 2023, to July 30, 2023 [11]. Every week, approximately 5,000 medical facilities in Japan monitor the nationwide trend of new infections. In the week of July 24–30, 2023, 78,502 cases were reported. The tally increased by 9,901 new infections from the previous week. The average number of patients per facility (institution) was 15.91 reported in the previous week, up 14% from the week before (13.91 cases for the week, July 17–23). The daily caseload (average) was worked out to be above 11,000 (11,214), which was a big figure. After the 8th wave receded in Japan, the 9th wave began in the week starting on April 3, 2023 and continued until the week ending on July 30, 2023. After the second consecutive week, the number of cases began to decline, with an average of 15.81 and 14.16 cases per institution for the weeks of July 31-August 6 and August 7–13, respectively. This represents a nearly 11% decline in just two weeks. We have yet to observe if the 9th wave peaked and the infections are on their way to receding, or if the decline is only for a few weeks. It is important to follow the preventive COVID-19 measures, such as ventilation, avoiding crowded places and contacts, and wearing a face mask. The research group of Shervani *et al*. [12]–[32] has published a number of articles and reviews on different aspects of the SARS-CoV-2 virus and COVID-19 disease. As COVID-19 caused deaths all over the world, in this research review, the change in the ALE that occurred during the pandemic years has been worked out for a few high-ranking ALE countries that are rich and democratic. We have specifically compared the changes in LE in Japan with other countries and established a relationship between pandemic awareness (mask usage) and the percentage of GDP spent on healthcare with the changes in LE during the pandemic. ALE is defined as the number of years a child born in a given year is expected to live, assuming that the death rate for each age group remains unchanged.

2. Method

The countries' viral load and mortality tally and ALE data were taken from the "Our World in Data (Coronavirus Pandemic Country Profile)" dashboard [33]. Some ALE data were also taken from Statista, an online platform that specializes in data gathering and visualization [34]. Countries' % GDP to healthcare spending data was taken from the "World Health Organization Global Health Expenditure" database, an online platform ("World Bank Group" data) [35].

3. Results and Discussion

3.1. *Effect of COVID-19 Pandemic on ALE in Japan*

Figs. 1–3 and Tables I and II show the ALE and the change in LE (gradient) in Japan. The gradient for each year the COVID-19 pandemic affected, as well as the overall change that occurred during the pandemic and the non-pandemic (normal) years, were worked out. We used the ALE data from 2017, 2018, and 2019 to understand the pandemic's impact, as 2017 and 2018 were non-pandemic years. The year 2019 was also normal, as the COVID-19 pandemic began with the emergence of pneumonia (SARS-CoV-2 infection)-like symptoms among individuals in Wuhan City (China) on December 31, 2019. Japan detected the first case of the disease COVID-19 in the middle of January 2020 (January 16, 2020), but it did not affect the previous year (2019). A resident of Kanagawa Prefecture who had returned from Wuhan (China) was found to be infected with the virus. This was Japan's first case. Fig. 1 and Table I show the Japanese population's ALE from 2017 to 2022, including the COVID-19 pandemic years. In 2017, the ALE for males was 81.09, and for females, it was 87.27. The ALS gradients shown for every mentioned year in Table I and Fig. 2 were calculated by subtracting the immediate previous year's life span. In 2018, ALE increased by 0.16 and 0.05 years for men and women, respectively, compared to the year before (2017). Until 2020, the long trend of extending LE continued [36] for both men and women. Fig. 1 depicts a part of the long LE lengthening pattern in Japan from 2017 to 2020. In the pandemic year 2020, the COVID-19 disease shortened the LE by 0.03 and 0.02 years for males and females, respectively (Fig. 2 and Table II). Despite the negligible shortening of life span, the overall increase in LE continued, reaching its highest at 87.71 for women and 81.56 for men in 2020. A small decrease in LE, owing to COVID-19, could not lower the overall LE in 2020. The bars in Fig. 2 show an overall increase of 0.15 and 0.26 for males and females, respectively, in 2020, resulting in the highest LS ever reported in the Japanese population in the preceding years. The pandemic in 2021 interrupted the trend of increasing ALE for both men and women in Japan. In 2021, the pandemic resulted in an overall reduction in LE for both sexes, with men decreasing by 0.09 and women by 0.14 years [37]. COVID-19 caused a reduction in LE by 0.1 year for men and 0.07 year for women. Surprisingly, Fig. 2 and Table II show that while COVID-19 reduced the LS by 0.1 year in males in 2021, the overall life span in men only decreased by 0.09 year. This was due to other factors, such as cancer, old age, and kidney failure, that caused the lifespan to decrease less compared to previous years, such as in 2019 and among women in 2021 itself [38]. As the data in Fig. 2 and Table II indicated, the impact of COVID-19 on ALE was greater in 2021 than in 2020, was likely due to a more limited pandemic outbreak in 2020. The outbreak rate in Japan was 1,842 cases per million as of December 31, 2020, which increased to 13,870 cases by December 31, 2021, a 7.5-fold increase [33]. In 2022, the overall LE decreased to a much greater extent of 0.42 and 0.49 year in men and women, respectively. COVID-19's direct contribution to LE shortening was 0.12 for men

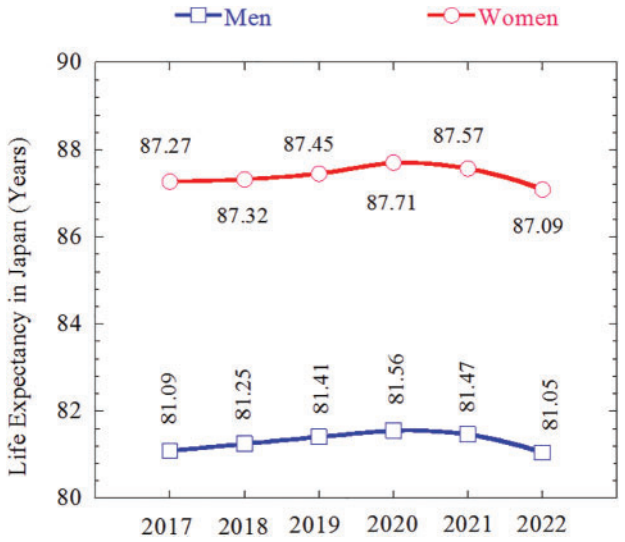

Fig. 1. Effect of COVID-19 pandemic on LE in Japan, LE decreased due to the mortalities the pandemic caused.

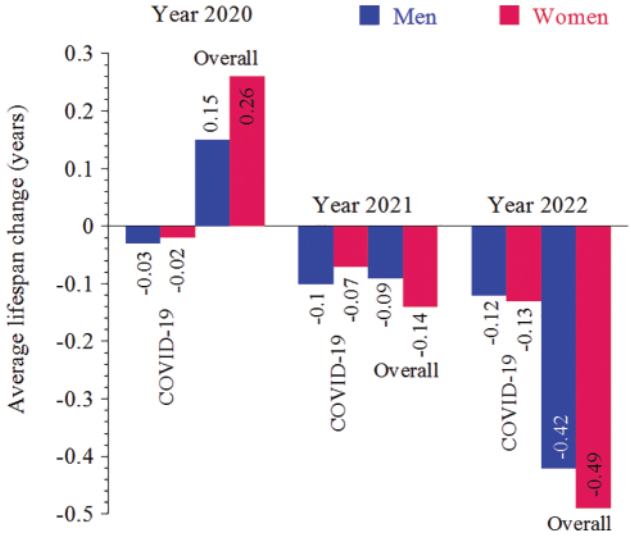

Fig. 2. Effect of the COVID-19 pandemic on LS change in Japan, LS shortened due to the mortalities the pandemic caused. LS change in 2020 was positive as the spread was less.

and 0.13 for women. In 2021, women and men had overall ALE of 87.57 and 81.47 years, respectively. It shortened further in 2022 to 87.09 and 81.05 years for females and males, respectively [39].

Fig. 3 shows the LS gradient that resulted directly from COVID-19 for the pandemic years 2020, 2021, and 2022. We constructed the plots using the data in Table II. The large overall drop in LE in 2022 was due to a higher number of COVID-19-related deaths (47,635 in 2022 compared to 16,766 in 2021). ALE declined in 2021 and 2022 due to additional coronavirus related deaths. Tables I and II have overall ALE data taking into account deaths due to the pandemic and other causes such as cancer, old age, and kidney failure. In 2023, Japanese men and women's life expectancy rose again for the first time in three years after the infection rate decreased to its lowest. Coronavirus related deaths decreased, resulting in a higher LE once again. For women, the ALE at birth was 87.14 years, an increase of 0.05 years over 2022, whereas the ALE for

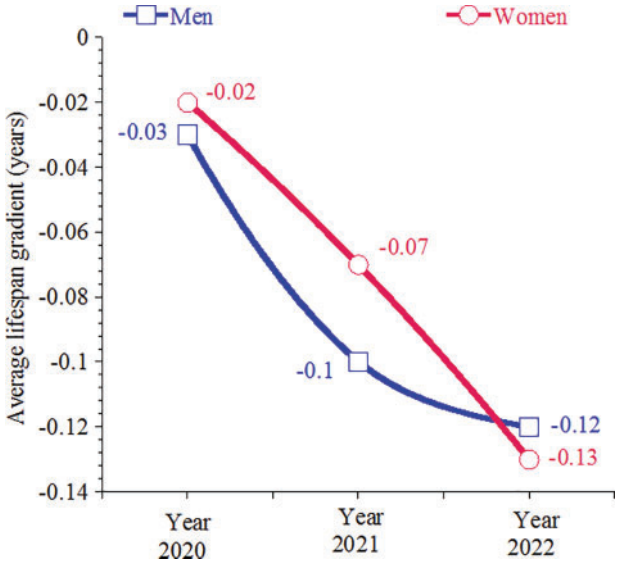

Fig. 3. Year-on-year LS gradient (year) in the Japanese population due to the COVID-19 pandemic. Negative gradients are decreasing LE directly related to the pandemic for 2020, 2021, and 2022.

men was 81.09 years, a rise of 0.04 years [40]. In 2023, the COVID-19 death toll decreased by 9,558 to 38,080.

3.2. Comparison of ALE Change of Japan with Other Top-Ranking Countries During the Pandemic Years

Fig. 4a shows the LE change (gradient) of males of seven rich and democratic countries: Hong Kong, Switzerland, Singapore, Sweden, Norway, and Italy, along with Japan, for the years 2017 to 2023, which include the COVID-19 pandemic years. We calculated the gradients based on the reference LE data of the year 2016. In the non-pandemic year 2017, ALE increased in five countries, whereas Italy and Switzerland reported a marginal decrease of 0.17 and 0.28 year, respectively. In 2018 and 2019, all countries recorded an increase in LS. In the first year of the pandemic 2020, only Italy and Switzerland experienced a decrease in LS of 0.53 and 0.88 year, respectively, while the remaining countries in the group reported an increase in LS for the male population. Five countries continue to report an increase in LS due to the limited global spread in 2020. According to the global tally (per million), the spread was only 10% at the end of 2020, compared to the total cases reported as of August 7, 2024 [33]. In 2021, all the countries reported an increase in the LS except Italy, which showed a slight decrease of 0.15 year. In 2021, the virus spread reached at 36% of the total cases. In 2022, the spread was the most, reaching at 94% of the total outbreak. So, four countries, Hong Kong, Switzerland, Singapore, and Italy, registered a decrease in LS by 0.66, 0.53, 0.4, and 1.14 years, respectively, whereas Japan, Sweden, and Switzerland still increased LS by 0.12, 0.78, and 0.31 year, respectively. The last pandemic year 2023, saw a marginal remaining spread of 6% (5.7%) of the total outbreak, so the pattern of the LS bars returns to the normal non-pandemic years as was noticed in 2019 or 2018. In 2023, no country in the group reported a decrease in LE. The trends for the years 2023, 2019, and 2018 were similar, showing an increase in average LE of their population.

TABLE I: Average LE in Japan During the COVID-19 Pandemic Years

Year	Average age or LE (years)		Fall in ALE (year) due to COVID-19		Overall year-on-year LE change (year) during the COVID-19 outbreak		Remark
	Males	Females	Males	Females	Males	Females	
2017	81.09	87.27			Not worked out	Not worked out	Data worked out from 2018 onward
2018	81.25	87.32			0.16	0.05	Before COVID-19 an increase in LE reported; no separate COVID-19 outbreak data available
2019	81.41	87.45			0.16	0.13	LE Increased; no separate COVID-19 outbreak data available
2020	81.56	87.71	−0.03	−0.02	0.15	0.26	Overall LE increased as COVID-19 was less prevalent in 2020; LE was all-time high in 2020
2021	81.47	87.57	−0.1	−0.07	−0.09	−0.14	Overall LE decreased due to COVID-19 spread
2022	81.05	87.09	−0.12	−0.13	−0.42	−0.49	Overall LE decreased due to COVID-19 spread

Note: The change (gradient) in LE was worked out from the immediate previous year for each year.

TABLE II: Reported LE Change in Japan During COVID-19 Pandemic Years

Year	Fall in LE due to COVID-19 only (year)		Overall change in LE due to COVID-19-related and other issues (year)		Remark
	Males	Females	Males	Females	
2020	−0.03	−0.02	+0.15	+0.26	Overall LE increased as the COVID-19 spread was slow in 2020
2021	−0.1	−0.07	−0.09	−0.14	Overall LE decreased due to more COVID-19 spread
2022	−0.12	−0.13	−0.42	−0.49	Overall LE decreased due to more wide COVID-19 prevalence

Note: The Change (gradient) in LE was worked out from the immediate previous year for each year.

Noticeably, Japan, along with Sweden and Norway, never had a decline in the LS of the male population in the above seven sets of years, 2017 to 2023, including the pandemic years reported among the groups in the male population. Fig. 4a was constructed using data given in Table III.

Fig. 4b shows the bars of ALE change of women living in top-ranking LE countries, Hong Kong, South Korea, Spain, Singapore, Switzerland, and Japan, recorded during the pandemic years. The change was calculated taking the reference LS in 2016 for all the countries, the same as in Table III and Fig. 4a (male population). The bar diagram was constructed from the data in Table IV [33], [34]. In the normal non-COVID year 2017, all the countries in the group showed an increase in the LE of women except Spain, which showed a small decrease of 0.11 year. In 2018 and 2019, the ALS of all six countries increased, with Hong Kong having the highest increase in both 0.68 and 0.98 year, respectively. The bar pattern in the pre-pandemic years 2017, 2018, and 2019 was nearly identical. The pattern changed during the pandemic years 2020, 2021, and 2022 but was restored in 2023, when the cases were negligibly small, just 0.3%, as 99.7% of infections already spread in 2020, 2021, and 2022, taking into account the global infection rate (per million). In the year 2020, Japan, South Korea, and Singapore's LS remained in an increasing domain, while Hong Kong, Spain, and Switzerland showed decrease of 0.31, 0.75, and 0.15 year. In 2021, only Hong Kong and Spain shortened the span by 0.53 and 0.03 year, respectively. Hong Kong shortened largely by 1.14 years in 2022, while South Korea and Spain shortened by 0.32 and 0.45 year, respectively. Noticeably, Japan had the shortest LS decrease by just 0.02 year. In all the reported years from 2017 to 2023, Japan's LS was marginally affected for just one year. After the pandemic was over in 2023 globally, all six countries in the group showed increased LS of the female population.

3.3. Comparison of Healthcare Expenditure of Japan with Other Rich and Democratic Countries in Terms of % GDP

Bars in Fig. 5 illustrate the percentage of GDP contribution to healthcare expenditure of Japan along with the US, Germany, France, the United Kingdom, Canada, Spain, South Korea, and Italy during the pandemic years. The data used were available from the source "current health expenditure (% of GDP)" given on the website "World Health Organization Global Health Expenditure Database". The website was updated on April 15, 2024 [35]. The vertical line in Fig. 5 at the 10% GDP mark shows the countries' domain at ≤ or >10% GDP. The bar diagram illustrates the following features or changes in the percentage of GDP spending in various countries during pandemic and non-pandemic years. The US spent more on healthcare than other countries in the group. It spent

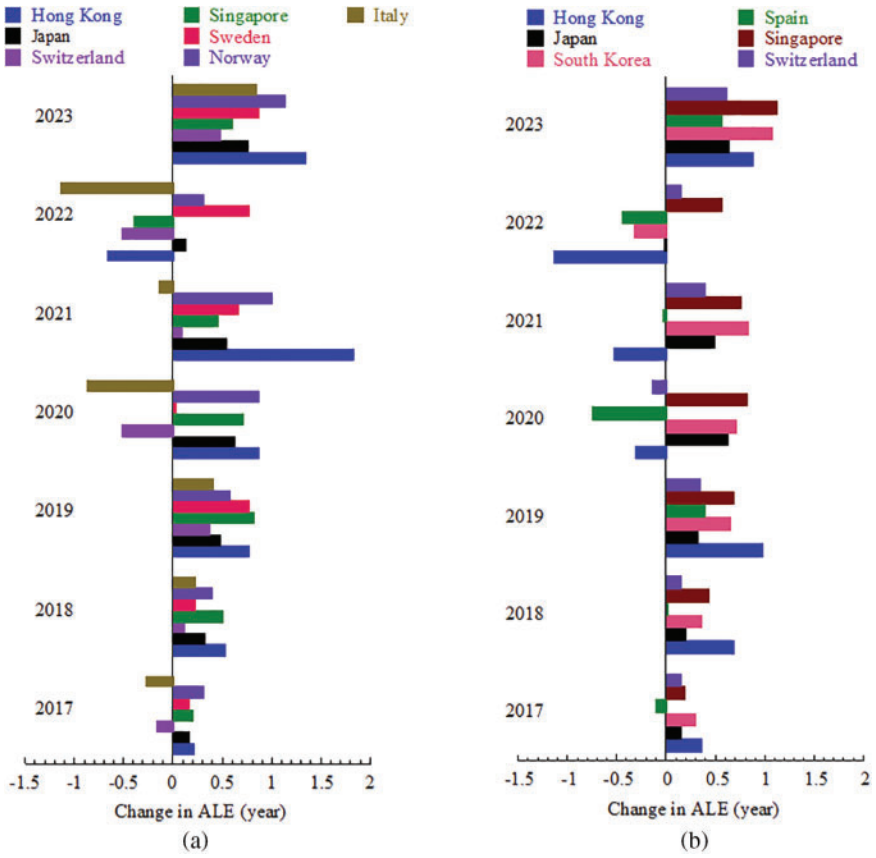

Fig. 4. ALE change (year) in men *(panel a)* and women *(panel b)* of mentioned countries reported during the pandemic years. Right-side bars show an increase, whereas left-side bars decrease in ALE. The changes were computed by taking the ALE of 2016 as the reference value.

TABLE III: ALE Change in Men in Japan During the COVID-19 Pandemic Years Shown Along with Other High LE Countries

Year	Gradient (year) (year-on-year ALS change) for men of seven high-ranking countries around the COVID-19 years							Remark
	Hong Kong	Japan	Switzerland	Singapore	Sweden	Norway	Italy	
2017	0.21	0.16	−0.17	0.20	0.16	0.31	−0.28	Switzerland and Italy decreased
2018	0.53	0.32	0.11	0.50	0.22	0.39	0.22	All increased
2019	0.78	0.48	0.37	0.82	0.78	0.57	0.41	All increased
2020	0.87	0.63	−0.53	0.71	0.03	0.86	−0.88	Switzerland and Italy decreased
2021	1.83	0.54	0.09	0.45	0.66	1.0	−0.15	Italy decreased
2022	−0.66	0.12	−0.53	−0.40	0.78	0.31	−1.14	Hong Kong, Switzerland, Singapore, and Italy decreased
2023	1.34	0.76	0.48	0.60	0.87	1.14	0.84	All increased

Note: The change (gradient) in LE was worked out from the year 2016 as a baseline or reference for all the years.

TABLE IV: ALE Change in Women in Japan During the COVID-19 Pandemic Years Shown Along With Other High LE Countries

Year	Gradient (year) (year-on-year ALS change) for women of six high ranking countries around COVID-19 years						Remark
	Hong Kong	Japan	South Korea	Spain	Singapore	Switzerland	
2017	0.36	0.15	0.30	−0.11	0.18	0.14	Spain decreased
2018	0.68	0.20	0.36	0.02	0.43	0.15	All increased
2019	0.98	0.32	0.65	0.39	0.68	0.34	All increased
2020	−0.31	0.62	0.71	−0.75	0.81	−0.15	Hong Kong, Spain, and Switzerland decreased
2021	−0.53	0.48	0.83	−0.03	0.76	0.39	Hong Kong, Spain decreased
2022	−1.14	−0.02	−0.32	−0.45	0.56	0.15	Hong Kong, Japan, South Korea, and Spain, decreased
2023	0.87	0.63	1.07	0.56	1.13	0.61	All increased

Note: The change (gradient) in LE was worked out from the year 2016 as a baseline or reference for all the years.

more than 16% of the total GDP on health infrastructure, followed by Germany, France, Japan, and the rest of the countries in the set. Germany, France, Japan, the United Kingdom, and Canada spent more than 10% of the total GDP. Among the group, South Korea and Italy made the least contribution, accounting for less than 10%. Spain's spending was below 10% during non-pandemic years, but it rose above 10% during the outbreak in 2020–2022. In

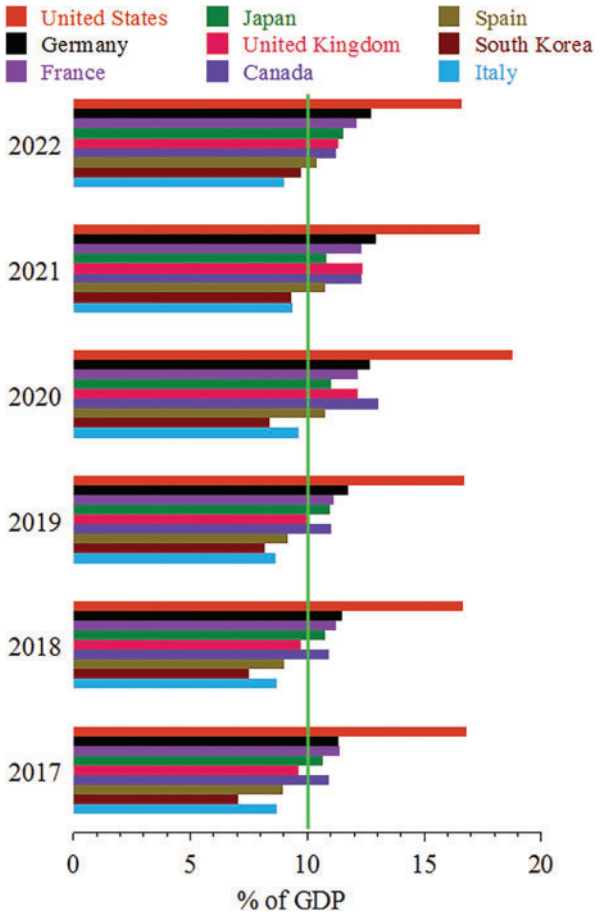

Fig. 5. Health expenditure (% of GDP) of the mentioned countries for 2017–2022, including the COVID-19 years.

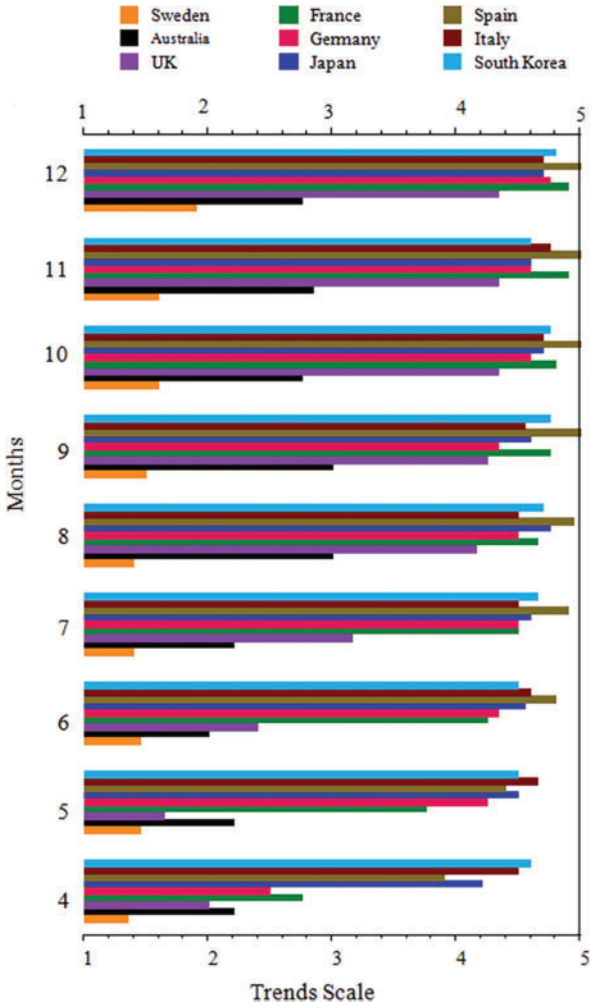

Fig. 6. Bars showing the trend of wearing a face mask in mentioned countries in 2020. The x-axis depicts the trend scale from 1 (not at all) to 5 (always).

non-pandemic years, South Korea's healthcare budget was in the range of 7%–8% of the GDP, but it approached nearly 10% (9.33%–9.7%) during the pandemic years 2021 to 2022. During both pandemic and non-pandemic years, Japan maintained consistent spending in the range of 10.7%–11.5%, no significant change reported. However, in the US, healthcare spending increased in the first year of the pandemic. In 2017, the percentage of healthcare spending was 16.77%, and it increased to 18.76% in 2020, a two-percentage increase. However, later in 2022, it declined to 16.60%.

3.4. Comparison of Mask Awareness in Japan With Other Countries

The bars in Fig. 6 illustrate the trends in mask wearing awareness among the rich and democratic countries, including Japan, in 2020, based on the average monthly response to the statement "wore a face mask when outside the home." The mask-wearing scale ranged from 1 (not at all) to 5 (always). Mask usage was low in the initial months, but it increased later. Sweden reported low levels of awareness. While South Korea, the UK, France, Spain, Germany, Italy, and Japan recorded high levels of mask-wearing awareness, Australia reported a medium level. In the later months, the awareness scale score was higher than 4 in most of the countries. Spain ranked first with 5, followed by the others. At the start of month 4, the mask usage trend in Japan was 4.2, but in the last six months, it reached ≥4.6, indicating a satisfactory level. In month 7, it was 4.6, and then it was reported to be 4.75 in month 8. Between months 9 and 12, it stayed within the range of 4.6 to 4.7. Fig. 6 was constructed based on the study [41] that analyzed the factors influencing mask-wearing behavior in 29 countries using over 400,000 survey responses. Asians were more likely to wear masks than Scandinavian citizens. Citizens in democratic and prosperous countries were less likely to wear masks. Additionally, females were more likely to observe mask usage. Mask usage trends were classified into three categories: (i) countries such as Hong Kong, Indonesia, Malaysia, South Korea, and Thailand consistently had high levels of mask awareness throughout the year, (ii) countries such as Canada, Denmark, Finland, the Netherlands, UK, and, the US had increasing level of awareness, lastly (iii) countries such as Norway and Sweden consistently had low level of awareness. People in the US and Canada, more rich and democratic countries, are less likely to use face mask. In the aforementioned reference, it was reported that the mask usage trend in the US and Canada was initially low but gradually increased over the time. Some other countries (such as Japan and South Korea), as reported in Fig. 6, used mask consistently, which became the reason for low mortality rates in South Korea and Japan compared to the high mortality reported in the US and Canada.

4. Conclusions

ALE in Japan has been analyzed between 2017 and 2022, which included the COVID-19 pandemic years. For males and females, respectively, the pandemic resulted in a marginal shortening of LE in 2020 of 0.03 and 0.02 years. Nonetheless, the overall increase in LE continued in 2020 for both genders as it was in the years before, reaching the highest at 81.56 and 87.71 years for males and females, respectively. In 2021, the pandemic reduced the ALE of men and women by 0.09 and 0.14 years, respectively. The widespread outbreak in 2022 further shortened LE for men and women by 0.42 and 0.49 years, respectively. From 2017 to 2023, the change in male LE (gradient) in six wealthy and democratic countries (Hong Kong, Switzerland, Singapore, Sweden, Norway, and Italy) was compared with Japan. All experienced an increase in LE in 2018 and 2019. Only Italy and Switzerland reported shorter LS in the first year of the pandemic 2020. Except for Italy, which had small decline in LE, every country reported an increase in 2021. By 2022, 94% of the global outbreak had occurred. Four countries Hong Kong, Switzerland, Singapore, and Italy, had seen a decline in LE, whereas Japan, Sweden, and Norway reported no such decline. After the pandemic ended in 2023, every country in the group reported an increase in ALS in the male population. Among the set (Hong Kong, Spain, Switzerland, South Korea, Singapore) along with Japan, in the pandemic year 2020, only Hong Kong, Spain, and Switzerland showed a decrease in ALS in the female population. In 2021, only Hong Kong and Spain (marginally negligible) had a decrease in LS. In 2022, four countries, Hong Kong, South Korea, Japan (marginally), and Spain, saw a decrease in LE, while Singapore and Switzerland continued to experience an increase. In 2023, all countries reported an increase, the same trend as in the male population.

Japan's GDP contribution (%) to healthcare during the pandemic years was compared with those of the US, Germany, France, UK, Canada, Spain, South Korea, and Italy. The US spent over 16% of the total GDP on healthcare. During the pandemic years, Germany, France, Japan, UK, and Canada spent more than 10% (10.4%–12.9%). In the above list of countries, South Korea and Italy contributed the least (below 10%). Throughout the pandemic and non-pandemic years, Japan's spending remained consistent at 10.6%–11.5%. Researchers compared mask-wearing awareness trend of selected countries in 2020. Sweden reported low levels of mask-wearing awareness on a scale below 2, where scale 5 is always and 1 never. In the later months of the survey, South Korea, UK, France, Spain, Germany, Italy, and Japan recorded high mask-wearing awareness above 4. Australia reported a moderate level, between 2 and 3. Spain ranked first with 5. Throughout all of the recorded months, Japan's mask usage remained consistent in the range 4.2 to 4.7. Because of the amount (% GDP) and consistent spending on healthcare, along with the high level of awareness for masks, Japan was the least affected by the pandemic.

5. Statements

The data and results in this article are reproducible. No animal or laboratory experiment was conducted. Only selected high LE countries were included in the article. Author Zameer Shervani (ZS), Ph.D., is the Director General of the Food & Energy Security Research & Product Center, Sendai, Japan. The copyrights of the article belong to the corresponding author (ZS). Coauthors contributed online. Authors have the following qualifications: Aamir A. Khan, BA; Intazam Khan, MD; Abdullah Sherwani, MTech; Parangimalai Diwakar Madan Kumar, BDS, MDS; Akram Mohammad, PhD.; Umair Yaqub Qazi, PhD; Venkata Phani Sai Reddy Vuyyuru MBBS; Adil Ahmed Khan MBBS; Aisha Mahmood MBBS.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Sutandhio S, Furukawa K, Kurahashi Y, Marini MI, Effendi GB, Hasegawa N, *et al.* Fourth mRNA vaccination increases cross-neutralizing antibody titers against SARS-CoV-2 variants, including BQ.1.1 and XBB, in a very elderly population. *J Infect Public Health*. 2023;16:1064–72.

[2] Most People in Canada Now Have Hybrid Immunity Against COVID-19. News Medical. 2023 Aug 14. Available from: https://www.news-medical.net/news/20230814/Most-people-in-Canada-now-have-hybrid-immunity-against-COVID-19.aspx.

[3] Murphy TJ, Swail H, Jain J, Anderson M, Awadalla P, Behl L, *et al.* The evolution of SARS-CoV-2 seroprevalence in Canada: a time-series study, 2020–2023. *Cmaj*. 2023;195(31):E1030–7.

[4] The Protective Effect of Previous Infections and Vaccinations on SARS-CoV-2 Omicron Infection. News Medical. 2023 Aug 14. Available from: https://www.news-medical.net/news/20230814/The-protective-effect-of-previous-infections-and-vaccinations-on-SARS-CoV-2-Omicron-infection.aspx.

[5] de Gier B, Huiberts AJ, Hoeve CE, den Hartog G, van Werkhoven H, van Binnendijk R, *et al.* Effects of COVID-19 vaccination and previous infection on Omicron SARS-CoV-2 infection and relation with serology. *Nat Commun* 2023;14(1):1–7.

[6] Two Men in 30s Die After Getting 2nd Moderna Vaccine Jabs. The Asahi Shimbun. 2021 Aug 29. Available from: https://www.asahi.com/ajw/articles/14428800.

[7] Japan Reports First Death Directly Linked to COVID-19 Vaccine. The Japan Times. 2023 Mar 10. Available from: https://www.japantimes.co.jp/news/2023/03/10/national/japan-first-covid19-vaccine-death.

[8] Mimura W, Ishiguro C, Maeda M, Murata F, Fukuda H. Association between mRNA COVID-19 vaccine boosters and mortality in Japan: the VENUS study. *Human Vacc Immunotherap*. 2024;20(1):1–6.

[9] Two Years After Catching COVID, Patients Still Risk Getting Sick. The Japan Times. 2023 Aug 22. Available from: https://www.japantimes.co.jp/news/2023/08/22/world/science-health/covid-risks-still-persist/.

[10] Bowe B, Xie Y, Al-Aly Z. Postacute sequelae of COVID-19 at 2 years. *Nat Med*. 2023;29:2347–57.

[11] Japan Sees Increase in COVID Cases for 17 Straight Weeks. NHK WORLD-JAPAN. 2023 Aug 4. Available from: https://mainichi.jp/english/covid19.

[12] Shervani Z, Bhardwaj D, Khan MJ, Vuyyuru VPSR, Khan AA, Kumar PDM, *et al.* COVID-19 aftereffects (long COVID) associated with Wuhan, Delta, and Omicron variants reported in Japanese hospitals. *Eur J Med Health Sci*. 2024;6(2):82–9.

[13] Shervani Z, Khan I, Siddiqui NY, Khan T, Qazi UY. Risk of SARS-CoV-2 transmission from humans to pets and vice versa. *Eur J Med Health Sci*. 2021;3(1):34–8.

[14] Shervani Z, Khan I, Khan T, Qazi UY. World's fastest supercomputer picks COVID-19 drug. *Adv Infect Dis*. 2020;10(3):211–25.

[15] Shervani Z, Khan I, Qazi UY. COVID-19 vaccine. *Adv Infect Dis*. 2020;10(3):195–210.

[16] Shervani Z, Khan I, Qazi UY. SARS-CoV-2 delayed Tokyo 2020 Olympics: very recent advances in COVID-19 detection, treatment, and vaccine development useful for conducting the games in 2021. *Adv Infect Dis*. 2020;10(3):56–66.
[17] Shervani Z, Qazi UY, Khan MJ, Fatma K, Siddiquie A, Vuyyuru VP, *et al.* COVID-19 in Karnataka: rise of Omicron. *Eur J Med Health Sci*. 2022;4(6):71–6.
[18] Shervani Z, Jamal N, Qazi UY, Hasan S, Fatma K, Siddiquie A, *et al*. Prevalence and pathogenicity of Omicron variant. *Eur J Med Health Sci*. 2022;4(5):125–32.
[19] Shervani Z, Bhardwaj D, Sherwani A, Khan I, Qazi UY. COVID-19 infection in 8 big cities of India: the dynamics of the spread and seropositivity. *Eur J Med Health Sci*. 2021;3(6):1–5.
[20] Shervani Z, Bhardwaj D, Nikhat R. COVID-19 infection in India: seropositivity versus the dynamics of the spread. *Eur J Med Health Sci*. 2021;3(4):95–9.
[21] Shervani Z, Bhardwaj D, Nikhat R, Ibbrahim A, Hasan S, Khan I, *et al.* Serosurvey of Haryana and Odisha: COVID-19 hybrid immunity. *Eur J Med Health Sci*. 2022;4(2):27–32.
[22] Shervani Z, Bhardwaj D, Nikhat R, Ibbrahim A, Khan I, Qazi UY, *et al.* 4th national sero survey of India: vaccine generated antibodies enhancement. *Eur J Med Health Sci*. 2022;4(1):27–32.
[23] Shervani Z, Bhardwaj D, Nikhat R, Ibbrahim A, Khan I, Hasan S, *et al.* 5th and 6th sero survey of Delhi: vaccine activated antibodies enhancement. *Eur J Med Health Sci*. 2022;4(1):61–6.
[24] Shervani Z. COVID-19 in Kerala: health index theory. *Eur J Med Health Sci*. 2021;3(2):21–4.
[25] Shervani Z. COVID-19 in Kerala: the dynamics of spread and health index theory. *RAS Med Sci*. 2021;1(2):1–3.
[26] Shervani Z, Bhardwaj D, Nikhat R. Dharavi slums (Mumbai, India): the petri dish of COVID-19 herd immunity. *Eur J Med Health Sci*. 2021;3(3):38–41.
[27] Shervani Z, Khan I, Siddiqui NY, Khan T, Qazi UY. Viability of SARS-CoV-2 and sanitization methods. *Eur J Med Health Sci*. 2021;3(1):22–7.
[28] Shervani Z, Fatma K, Hasan S, Siddiquie A, Vuyyuru VP, Jamal N, *et al.* Mild nature of SARS-CoV-2 breakthrough infections in healthcare workers in India. *Eur J Med Health Sci*. 2022;4(4):26–33.
[29] Shervani Z, Nikhat R, Hasan S, Qazi UY, Fatma K, Siddiquie A, *et al.* COVID-19 in India: breakthrough infections in Delta wave. *Eur J Med Health Sci*. 2022;4(4):12–6.
[30] Shervani Z, Bhardwaj D, Purang M, Ibbrahim A, Vuyyuru VP, Hasan S, *et al.* The Omicron variant: prevalence, transmissibility, and pathogenicity. *Eur J Med Health Sci*. 2022;4(3):84–91.
[31] Shervani Z, Jamal N, Qazi UY, Hasan S, Fatma K, Siddiquie A, *et al.* Prevalence and pathogenicity of Omicron variant. *Eur J Med Health Sci*. 2022;4(5):125–32.
[32] Shervani Z, Bhardwaj D, Hasan S, Qazi UY, Purang M, Ibbrahim A, *et al.* The Omicron wave in India, Mumbai, and Delhi: prevalence and pathogenicity. *Eur J Med Health Sci*. 2022;4(3):123–30.
[33] Coronavirus Pandemic Country Profile or Life Expectancy Dashboard. Our World in Data. 2024. Available from: https://ourworldindata.org/coronavirus.
[34] Average Life Expectancy in Selected Countries. Statista. 2024. Available from: https://www.statista.com/statistics/236583/global-life-expectancy-by-country/.
[35] World Health Organization Global Health Expenditure Database. World Bank Group. 2024. Available from: https://apps.who.int/nha/database.
[36] Munira MS, Okada Y, Nishiura H. Life-expectancy changes from 2019 to 2022: a case study of Japan using provisional death count. *J Infect Public Health*. 2024;17:119–21.
[37] Life Expectancy in Japan Sees First Decline in 10 Years Amid Pandemic. Kyodo News. 2022 Jul 29. Available from: https://english.kyodonews.net/news/2022/07/3ee6dba1af9f-japanese-life-expectancy-sees-1st-decline-in-10-years.html.
[38] Life Expectancy in Japan Falls for the First Time in a Decade. Nippon.com. 2022 Aug 17. Available from: https://www.nippon.com/en/japan-data/h01403/.
[39] Japan's Average Life Expectancy Continued to Fall in 2022. The Japan Times. 2023 Jul 28. Available from: https://www.japantimes.co.jp/news/2023/07/28/japan/science-health/japans-average-life-expectancy-continued-to-fall-in-2022/.
[40] Japan's Life Expectancy Rises for First Time in 3 Years. The Japan Times. 2024 Jul 26. Available from: https://www.japantimes.co.jp/news/2024/07/26/japan/society/average-life-expectancy/.
[41] Annaka S. Public awareness of mask usage in 29 countries. *medRxiv*. 2021;2021:1–17.