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RESEARCH ARTICLE

Factors Explaining Japan's Low COVID-19 Mortality: Comparison with Rich and Democratic Countries

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ABSTRACT

The novel coronavirus (SARS-CoV-2) caused a large number of deaths during the COVID-19 pandemic. The pandemic had a greater impact on wealthy and developed countries. Considering the per capita deaths and fatality-to-case ratio, also known as the case fatality ratio (CFR), Japan was among the least affected countries. The CFR of Japan was compared with nine other democratic and wealthy countries: the US, Italy, Spain, France, Austria, Germany, Canada, Australia, and South Korea. Japan's CFR was the second lowest at 0.2%, only behind South Korea with 0.1%. The highest rates were recorded by the US and Canada, each at 1.1%. The per capita (per 100,000 people) fatality rate of Japan was 57.72 deaths, whereas the US had six times more deaths compared to Japan. We calculated the mortality (fatality) rates based on the cumulative deaths as of March 16, 2023, when the pandemic was mostly over. The amount of GDP spent on healthcare in Japan, mask awareness, the stringency index (SI), vaccinations, urbanization, life expectancy (LE), and the age cohorts of the population were examined to determine the factors that resulted in a low mortality rate in Japan during the pandemic.

Keywords: Case fatality ratio (CFR), COVID-19 mortality, fatality-to-case ratio, mask wearing trend.

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1. Introduction

Researchers [1] cited the physiological and genetic factors of the human body to explain the varying virulence and pathogenicity of the SARS-CoV-2 virus across different countries. The connection between skin flushing in East Asians after alcohol consumption and the rs671 variant of aldehyde dehydrogenase 2 (ALDH2) was examined. Takashima *et al*. [1] established a link between the above genetic polymorphism rs671 and the COVID-19-infected Japanese individuals hospitalized using a web-based survey. The study revealed that rs671 exhibited a protective effect against the COVID-19 infection. The survey included 807 infected individuals who responded to the queries, of which 362 were non-flushers, and 445 were flushers. The study period was 42 months, from December 2019 to May 2023. A ratio of 40.6% of non-flushers and 35.7% of flushers had COVID-19. The hospitalization rate among non-flushers was higher (2.5%) compared with flushers (0.5%). The risk ratio for flushers compared to non-flushers was calculated to be 0.2. The research has linked the flushing to a lower incidence of COVID-19 morbidity and hospitalization. The finding is useful in understanding the distinctive human body physiological variability of East Asians and offers useful information to control the infection. The vaccine immunogenicity among flushers was predicted [2]. The findings suggest a possible link between weakened immunity and rs671, the most common polymorphism of the aldehyde dehydrogenase 2 gene (ALDH2). There is an inverse relationship between rs671 and the production of antibodies resulting from the COVID-19 vaccination. The level of anti-SARS-CoV-2 spike protein IgG in 88 Japanese students and workers was repeatedly checked for four months before and after they received the BNT162b2 or mRNA-1273 (mRNA) vaccine. Two weeks after the second dose of the vaccine, the IgG levels were 3090, 1843, and 1098 BAU/mL for people with

the GG-, GA-, and AA-type alleles of rs671, respectively. Three months after the second vaccination, titers dropped to 706 and 467 BAU/mL for the GG- and AA-type alleles, respectively. The study reported the diminishing immunogenicity of the COVID-19 mRNA vaccine. The finding is useful in understanding vaccination strategies for cohorts with specific genetic makeup, in this case, Japanese or East Asians. Bogahawaththa *et al*. [3] reported that the Asian flush gene variant made the COVID-19 mRNA vaccine work better in the Japanese population as a whole. This was in contrast to the reduction in vaccine effectiveness reported among flushers [2]. Researchers hypothesized [3] that the rs671 variant enhanced cellular immunity against COVID-19. The IFN-γ ELISPOT assay was used to find out how many T cells were making IFN-γ in response to antigens specific to SARS-CoV-2. The variant carriers had higher counts than wild-type carriers. The wild and variant types had median counts of 0.5 and 5.5 spot-forming cells per 2×10^5 PBMC, respectively. One month after the second dose, the medians reached 139.5 and 196, respectively. However, six months after the second dose, the number decreased to 36 in the wild-type group, whereas 116 in the variant-type group. Cellular immunogenicity remained substantially detectable six months after the second dose in the rs671 variant group. The lower level of humoral immunity (anti-S1 IgG) seen in rs671 carriers [2] was not backed up by the cellular immunity found in the study above [3]. The study showed that the rs671 variant had a positive effect against SARS-CoV-2 infection by improving the immune system in cells. The decreased humoral immunity (anti-S1 IgG) reported in rs671 carriers [2] was not supported by the cellular immunity mentioned in the above [3] study. The study shows that the rs671 variant has a positive effect against SARS-CoV-2 infection by improving the immune system in cells. This could lead to the development of new medicines and better ways to prevent the disease.

The following text discusses the development of immunity against the infection, an essential aspect of the pandemic. Multiple and early exposures to the coronavirus resulted in herd (mass) immunity in the Pakistani population [4]. As reported on June 27, 2020, the test positivity rate in Pakistan was 20.4%, resulting from the original Wuhan wave. However, only 7.1% of the total scanned samples in neighboring India tested positive on the above date. After the peak infection rate (positivity rate) of 20.4% reported in Pakistan, the number of cases began to decline, reaching its lowest baseline rate (1.5%) on September 19, 2020. In India, it was 8.5% on the above date. The virus spread late in India. The rate in India continued to rise and peaked at the rate of 10.4% positivity on July 30, 2020, also caused by the Wuhan wave. Considering the daily confirmed cases (per million), the original Wuhan wave reached the plateau (23.0 cases per million) on June 21, 2020, in Pakistan. On the other hand, in India, the above wave peaked late on September 20, 2020, with a significantly higher caseload of 64.7 cases per million. Early generation of herd immunity in Pakistan led to a lower infection rate during the Delta and Omicron surges, with only 23.36 cases per million on April 29, 2021, and 29.3 cases per million on February 5, 2022. In India, the infection rate was significantly higher during the Delta wave, 274.5 per million on May 12, 2021, and the Omicron surge, 212.0 per million on January 27, 2022. The low infections reported in Pakistan, which slowed down the spread, resulted from the high exposure of the population to the SARS-CoV-2 virus at the start of the pandemic, not from other factors like "non-specific immunity," humid weather, or shifts in the season, as suggested [4]. Non-specific immunity is also known as innate immunity or general immunity. There is no evidence that other vaccines like BCG and oral polio vaccine can slow down the spread of SARS-CoV-2. The slowing down of the pandemic in Pakistan in the month of July 2020 was due to the receding of the Wuhan wave, not because of any special immunity. In July 2020, the cases were on the rise in India as no mass immunity was developed, and the spread remained limited in this period. Only 10.4% of the scanned samples in India tested positive for the virus on July 30, 2020. Another possible explanation, as proposed, could be that the pathogen lost its virulence due to mutations it underwent after spreading among a large number of people. Despite extensive worldwide research, the behavior of novel coronavirus remained elusive.

Pakistan conducted a cross-sectional countrywide cluster survey [5]. It was the largest community-based seroprevalence data for SARS-CoV-2 collected between July 15 and 31, 2020, from seven randomly selected cities (clusters) located in the three most populous provinces (Khyber Pakhtunkhwa, Sindh, and Punjab) of Pakistan. The study was conducted from 15th to 31st July 2020. Serum samples of 15,390 participants were tested for SARS-CoV-2 antibodies. The overall seroprevalence of 42.4% was registered. It showed a large number of people already infected with the virus. As a result, the cases kept falling in Pakistan after the original Wuhan wave and remained low during subsequent Delta and Omicron waves. On May 14, 2021, India reported 274.5 cases per million during the Delta surge at the peak, whereas in Pakistan, it was much lower, just 23.3 cases per million on April 29, 2021. Daily new cases were 212.0 per million reported on January 24, 2022, in India during the Omicron spurt. The number of daily new cases remained surprisingly low to just 29.3 cases per million on February 2, 2022, during the peak of the Omicron surge in Pakistan. The data demonstrated that the Pakistani population developed mass immunity as early as mid-2020, leading to a decrease in new infections compared to India and other parts of the world.

Masood *et al*. [6] demonstrated that humoral and T cell responses mediated the protection against SARS-CoV-2, considering Pakistan's relatively low morbidity and mortality from COVID-19. The authors looked at the IgG antibody response level, virus neutralizing activity, and T cell reactivity to the spike protein in a healthy control group (HCG) and compared it with COVID-19 cases and people from the pre-pandemic period (PPP) to see if the population already had immunity. It was concluded that antibody and T cell responses to spike protein in individuals from the pre-pandemic period suggested prior immunity against SARS-CoV-2, most likely from cross-reactive responses. The activation of adaptive immunity from cross-reactive

memory B and T cells might have led to a low infection rate and mortality in the Pakistani population, in contrast to the high infection rate in neighboring India, which has similar geolocation and population racial background. In addition to India, Pakistan's infection rate was significantly lower than that of other global regions like the US, Japan, South Korea, Australia, and Europe. HCG and COVID-19-infected individuals were recruited between October 2020 and May 2021 (study period) when the original Wuhan wave was over and the Delta wave receded in Pakistan. These two surges appeared as three consecutive waves of 23.0, 12.7, and 23.4 cases per million, indicating extremely low infection rates in comparison to the other countries mentioned above. Overall, the IgG (anti-spike) antibody level was highest in COVID-19 cases (90%), followed by HCG (39.8%) and PPP (12.2%). IgG levels increased from 10.6% reported in October-November 2020 to 83.3% in April–May 2021. Surprisingly, there was no significant change in antibody levels among COVID-19 confirmed cases from 1 week to 24 weeks (six months). Mostly, it remained in the range of 100%–90%. However, there was a slight reduction after 25 weeks and beyond. The study used pre-pandemic sera that were banked before the pandemic in the periods 2008–2009 and 2016–2018. The above banked samples were also used to prepare PBMCs for the T cell ELISpot assay. IgG antibodies against spike protein and its RBD were determined by ELISA. Virus neutralization activity was determined using a PCR-based micro-neutralization assay. T cell-IFN-γ activation was assessed by ELISpot. Another survey [7] in Pakistan tested antibodies on 2162 HCPs (healthcare personnel). Out of them, 857 (39.6%) tested positive. Pakistan crossed the first peak of the pandemic on June 14, 2020. The healthcare personnel belonged to the Shaukat Khanum Memorial Cancer Hospital (Lahore, Pakistan). The testing was done from July 29 to July 31, 2020. The initial surge (first wave) in Pakistan was declining during this period. The positivity rate of 39.5% was similar to the study evaluating samples from healthy blood donors in Pakistan in July 2020. In the third week of June 2020, researchers [8] checked the seroprevalence (IgG) for COVID-19 antibodies in a cohort of healthy blood donors in the city of Karachi (Pakistan). The results confirmed that 21.4% of the samples tested positive for IgG. Around mid-June 2020, the first (a part of the original Wuhan) wave was at its peak after it started receding in July 2020. Soon, in July 2020, out of the 300 healthy blood donors, 113 (37.7%) were found to be reactive to IgG. From June to July, the seropositivity jumped to almost 40.0% from about 20%, a twofold rise in just one month. By July 2020, nearly 40% of blood donors had COVID-19 reactivity. The finding showed that the Pakistani population had widespread infections in an earlier stage of the outbreak, surpassing global patterns.

In this article, we used the current socioeconomic, demographic, and extent of vaccination to explore the reasons behind the substantial disparities in infection and mortality rates among wealthy democratic countries, specifically focusing on Japan. Robust repeated vaccination and other well-established factors contributed to Japan's low mortality rate. We will analyze serological data and spread dynamics from India and Pakistan to explain why infection and mortality rates differ in each country.

2. Materials and Methods

We took the fatality-to-case or case fatality ratio (CFR) and mortality per 100,000 population in the countries mentioned in the database [9]. The data was updated on March 16, 2023. The "Our World in Data" website was used to determine the percentage of the population that received various vaccination regimens, as given in *Section 3.2.4. (Role of Vaccination)*. The data included the share of people who received at least one dose of the COVID-19 vaccine, the share of individuals who completed the initial COVID-19 vaccination protocol, and COVID-19 vaccine boosters administered per 100 people. References [10], [11] were used to construct the healthcare spending plots of Japan. To report the percentage share of urban populations in the countries mentioned, an online database [12] was used.

3. Results and Discussion

3.1. Mortality Trend of Japan in the Group of Rich and Developed Countries (Japan Among Least Affected)

Bars in Fig. 1 compare the cumulative COVID-19 death rate of the group of ten countries (US, Italy, Spain, France, Austria, Germany, Canada, Australia, South Korea, and Japan), normalized per 100,000 people, until March 16, 2023, when the pandemic was nearly over (94%). They are in the group of richest and most developed countries. But the pandemic affected them differently. Fig. 1 illustrates how Japan's health outcomes differed from those of other countries. Since we normalized the reported deaths to the population, the variable countries' size became redundant. Mortality rates (per 100,000) varied widely, with Japan (57.72) and the US (341.11) at the extremes. Japan is the lowest, and the US is the highest. The death rates of the other countries in the set were between these extremes. Italy, Spain, France, Austria, Germany, Canada, Australia, and South Korea reported a decreasing order of mortality: 311.47, 255.54, 254.68, 243.94, 203.16, 135.23, 76.88, and 66.50, respectively. The COVID-19 death rate in the US was nearly 6 times (5.9) that of Japan.

Fig. 2 shows the fatality-to-case ratio of the above set of countries. The sequence of the bars is not the same as the per 100,000 population plot (Fig. 1). Though South Korea, Australia, and Japan (0.1%, 0.2%, and 0.2%, respectively) were among the three lowest fatalities, the same three countries appeared among the last three in the per 100,000 people plot. The countries that followed the decreasing or similar fatality-to-case ratio order were Canada, the US, Spain, Italy, Germany, France, and Austria, with respective rates of 1.1%, 1.1%, 0.9%, 0.7%, 0.4%, 0.4%, and 0.4%. The US had a higher rate of fatality, 5.5 times compared to Japan, nearly the same (5.9 times) as reported in Fig. 1 (per 100,000 population plot). In the group, the US fatality rate stood out and was much higher than elsewhere. The evolution of the Japanese fatality rate plot over time was notably smoother and more consistent without the spikes observed in all other countries in the set [13].

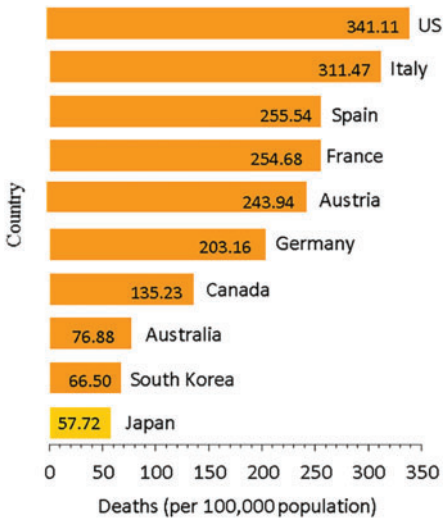

Fig. 1. COVID-19 fatality rate of mentioned countries (updated as of March 16, 2023).

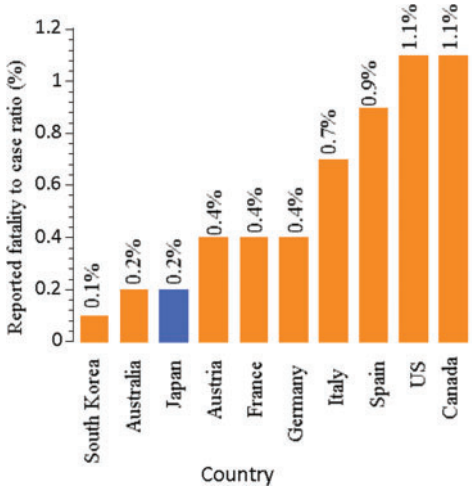

Fig. 2. COVID-19 fatality rates (fatality to case ratio (%)) of mentioned countries (updated as of March 16, 2023).

3.2. *Reasons Why Japan Least Affected by the COVID-19 Pandemic*

3.2.1. *Reasonable Amount and Consistent Increase in Healthcare Spending*

Fig. 3 shows the percentage of GDP that Japan spent annually on healthcare during the pandemic years. The spending on health infrastructure kept rising year-over-year for the pre-pandemic years 2017–2019, approaching nearly 11% (10.9%) in 2019. The percentage of GDP spent on health infrastructure increased from 11.0% in the pandemic year 2020 to 11.50% in 2022, after a slight dip in 2021 (10.82%). Compared with the other developed countries, the US, Germany, France, UK, Spain, Canada, South Korea, and Italy, Japan was among the countries' club that contributed nearly ≥10% (9.0%–18.0%) of the GDP to healthcare, with Italy being the lowest (9.0%) and the US the highest (nearly 18.0%) [14].

Fig. 4 shows the annual spending (trillion yen) for the fiscal years (FY) 2017 to 2022. From 2017 to 2019, the yearly medical expenditure grew from 43.07 trillion to 44.39 trillion yen. The year 2020 saw a slight decrease to 42.97 trillion yen, but spending in 2021 and 2022 rose to 45.04 and 46.0 trillion yen, respectively. In 2018, the

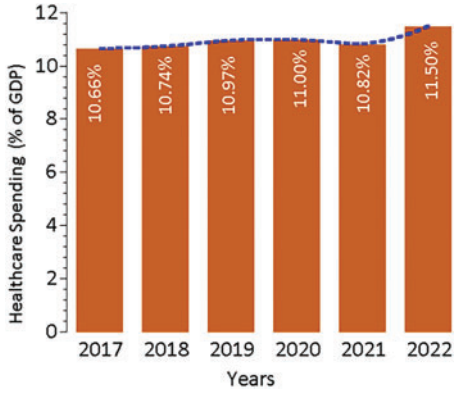

Fig. 3. Percent share of GDP to healthcare expenditures of Japan for the mentioned years including COVID-19 pandemic years.

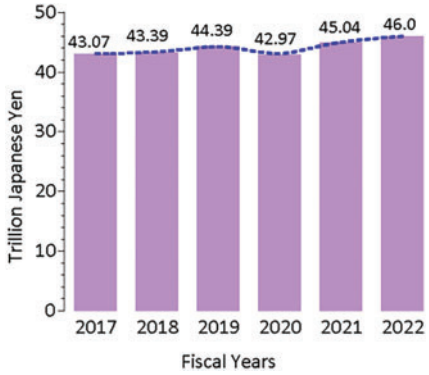

Fig. 4. Annual national medical expenditures in Japan for fiscal years mentioned including COVID-19 pandemic years.

total spending increased by 320 billion yen from the year before, reaching 43.39 trillion with a growth rate of 0.74%. In COVID-19 year 2022, there was a nearly 2% (2.1%) increase in spending compared to the previous year. The yearly increase remained almost unchanged in the non-pandemic FY 2019, at 2.3%. These figures represent 98% of officially confirmed expenditures, which may exclude expenses related to occupational injury cases and other personal spending by patients. In both non-pandemic and pandemic years, Japan's healthcare expenditures have been steadily rising, a trend that could persist as the country's aging population demands more funding for medical technological advancements.

Fig. 5 shows per capita healthcare expenditure for FY 2017–2022 in Japan. From FY 2017 to 2019, the per capita healthcare expenditure steadily increased from 334,660 yen to 346,610 yen. In 2020, the per capita healthcare expenditure marginally decreased to 338,240 yen but then increased in 2021 and 2022, reaching 356,170 and 368,000 yen, respectively. In 2018, the estimated per capita spending amounted to 339,440 yen, indicating a 4,780 yen increase from the previous year.

3.2.2. *Mask Usage Awareness for COVID-19 Disease (SARS-CoV-2 Virus) in Japanese, the US, and Canadian Population*

Bars in Fig. 6 illustrate the trends in mask-wearing awareness in the Japanese population reported in 2020. Figure was constructed from the survey [15] based on the average monthly response to the statement "wore a face mask when outside home." The mask-wearing scale ranged

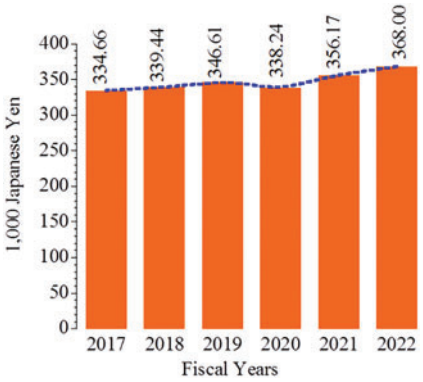

Fig. 5. Estimated per capita healthcare expenditures (thousand Japanese Yen) in Japan for fiscal years mentioned including COVID-19 pandemic years.

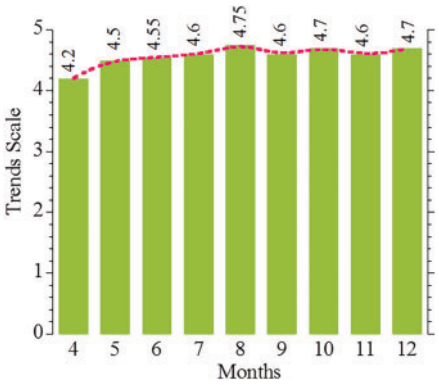

Fig. 6. Bars showing the trend of wearing a face mask in Japan in 2020. Figure has response months versus the trend scale 1 (not at all) to 5 (always).

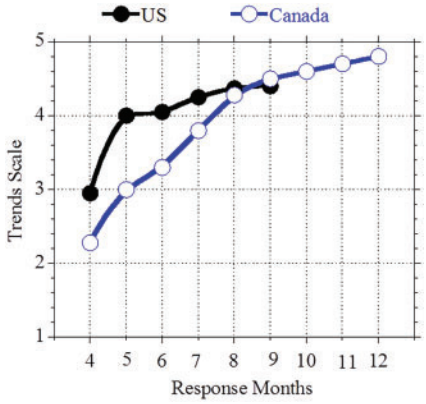

Fig. 7. Trend of wearing a face mask in the US and Canada in 2020, trend scale 1 (not at all) to 5 (always).

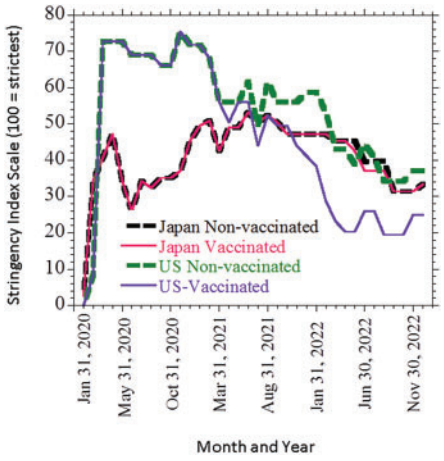

Fig. 8. Comparison of COVID-19 stringency index (closure of schools, workplaces, travel bans, etc.) of Japan and the US of vaccinated and non-vaccinated individuals.

from 1 (not at all) to 5 (always). The usage of masks was relatively low in the initial months, reaching a level of 4.2 in month 4, but it gradually increased and reached a level of 4.75 in month 8. In month 12, it stabilized and reached a record high of 4.7.

On the other hand, the US and Canada had low mask usage trends (Fig. 7), in contrast to Japan. At the beginning of month 4, the trends for Canada and the US were approximately 2 and 3, respectively. The trend increased to 3 and 4 in the following month. In month 8, the trend rose to nearly 4.4 for both the US and Canada. In the last recorded month (8), Canada saw an increase in the trend to a scale of 4.8. Compared to the US and Canada, mask awareness was much higher and uniform in Japan. As a long-established tradition, the Japanese wear masks to prevent the spread of diseases (flu and common cold). Despite the absence of an official mask mandate, reports indicated that at least half of the population planned to continue wearing masks even after the pandemic ended. The Japanese government distributed masks to the population early on and launched during spring 2020 the "Avoid the three Cs" (closed spaces, crowded places, and close-contact settings) public awareness campaign.

3.2.3. Stringency Index of Japan and Comparison with the US

Fig. 8 compares the COVID-19 pandemic stringency index (SI) implemented in the US and Japan. The nine metrics used [16], [17] to calculate the SI were school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closures of public transport, stay-at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls. Japan maintained strict border controls throughout the pandemic, which helped reduce infection rates. As individual behavior in Japan had been conducive to controlling the infection, Fig. 8 suggests a reduced need to impose stringent government measures in Japan.

The US implemented interventions during the early stages of the pandemic, while Japan's government response (SI) is relatively low and stable. In the US, the measures implemented in April 2021 separated vaccinated and non-vaccinated individuals, reporting SI 56.02 and 50.46, respectively. The restriction for vaccinated citizens consistently decreased throughout the pandemic, reaching its lowest point at 19.44 in August 2022. In December 2022, it increased slightly to 25.00. The restriction for those not vaccinated remained high (58.80) until January 2022, after which it dropped to 37.04 in December 2022. On the contrary, in Japan, stringency remained more stable throughout the pandemic, as shown in Fig. 8. Also, vaccinated and non-vaccinated separated very shortly. The difference in restrictions between vaccinated and non-vaccinated people in the US was longer, starting approximately in the middle of the pandemic (April 2021). The SI in Japan was 2.78 in January 2020. It shot up to

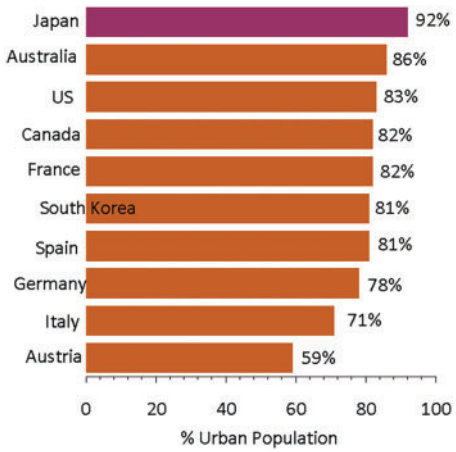

Fig. 9. Percent share of urban population in total population of selected wealthy and democratic countries as reported in year 2022.

34.26 in February, a month later. After reaching 47.22 in April 2020, it fell to 25.93 in June and then rose again to a peak (53.24) in June 2021. After that, it steadily declined, reaching a low of 31.48 in November 2022.

3.2.4. Role of Urbanization

Fig. 9 shows the percentage of the population living in urban areas (urbanization) for the listed countries, including Japan. Urbanization played an important role based on the concept of the "Avoid the three Cs" (3Cs) protocol explained in *Section 3.2.2*. The low mortality rate in Japan was more remarkable or noticeable given the high Japanese urbanization rate as compared to the other nine countries: the US, Italy, Spain, France, Austria, Germany, Canada, Australia, and South Korea. Japan has the highest urbanization rate, with 92% of the population living in urban areas, followed by Australia (86%) and the US (83%). The other countries have the urbanization rates arranged in decreasing order: Canada (82%), France (82%), South Korea (81%), Spain (81%), Germany (78%), Italy (71%), and Austria (59%).

3.2.5. Role of Vaccination

The COVID-19 vaccination in the US began on December 14, 2020. In Japan, however, it started in March 2021. Fig. 10 compares the percentage of individuals in Japan and the US who have received at least one dose. As of January 2021, 8.8% of the US population received at least one dose. Over the course of four months, the vaccination drive accelerated, resulting in 50.80% of the population receiving at least one dose by May 2021. As of March 2022, nearly three-quarters (74.9%) of Americans received one dose or more in the following ten months. Eventually, the vaccination rate slowed down, with only a little over 4% (4.1%) receiving vaccinations in the next 13 months, reaching about 80% (79.1%). Vaccination in Japan started late, but the pace was fast. In March 2021, the vaccination rate was less than 1% (0.7%), but by October 2021, it increased to about 80% (79.7%) in just ten months. Out of the total 84% (83.8%) of the population who received the regimen, a little more than 4.0% (4.1%) received the dose in the remaining 18 months.

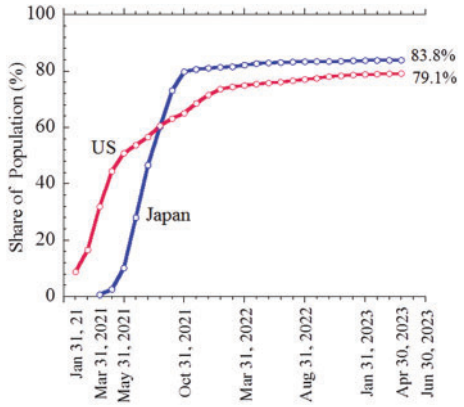

Fig. 10. Comparison of % share of people who received at least one dose of COVID-19 vaccine in Japan and the US.

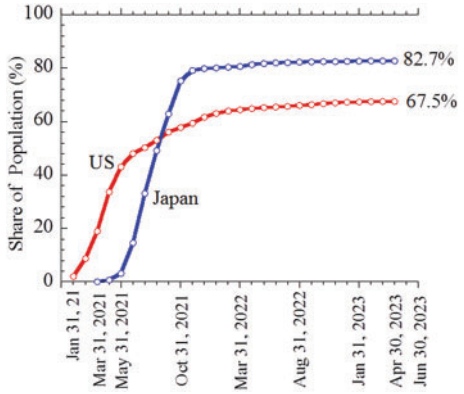

Fig. 11. Comparison of % share of people who were fully vaccinated for COVID-19 in Japan and the US.

The second dose regimen in the US started in January 2021, as depicted in Fig. 11. As of January 2021, 2.20% of the population had a second dose. By May 2021, 43.10% had completed the vaccination. In four months, nearly 41.0% of the population was vaccinated. The immunization slowed, and by March 2022 (next ten months), 21.30% had received the full dose, reaching 64.40% of the population receiving full vaccination. In 13 months (as of April 2023), only 3.10% of the remaining 67.5% (total) received the second dose. In contrast, Japan initiated the second dose of vaccination late (March 2021) but completed it quickly. As of November 2021 (in 9 months), nearly 80.00% (79.10%) of Japan's population had a second dose. As of April 2023, the remaining 2.7% of 82.70% (total) had undergone a second dose of vaccination, as shown in Fig. 11.

Fig. 12 compares the percentage of the population that received boosters in Japan and the US. The booster regimens in the US began in September 2021, earlier than Japan (December 2021). A ratio of 1.9% of the population received the booster dose in September, which steadily increased until January 2022. In five months, 27.60% of the population received the booster dose. In the following 8 months (August 2023), only 11.4% of the population received the booster dose, bringing the total to 39.0%. Japan launched its booster vaccination program late in December 2021. But the inoculation was rapid and robust. As of January 2023, 137.80% (multiple doses) of the Japanese population had received booster doses. By April

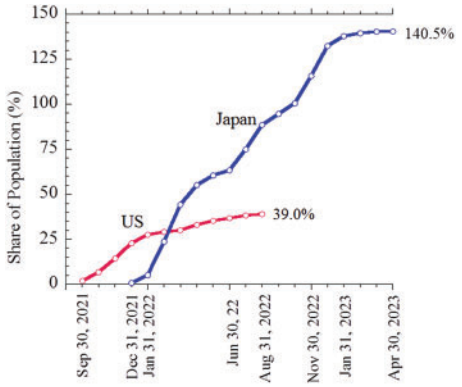

Fig. 12. Comparison of % share of people who received boosters of the COVID-19 vaccine in Japan and the US.

2023, in the following three months, nearly 3% (2.7%) of the 140.5% population had received booster doses.

3.2.6. *Role of Health Profile (Life Expectancy)*

Fig. 13 compares Japan's life expectancy (LE) with those of the US, Australia, Canada, France, South Korea, Spain, Germany, Italy, and Austria. We constructed the LE bars diagram using the database of the "World Bank Group" [18]. Japan has the highest LE (85 years), followed by Spain (84 years). Italy, South Korea, France, and Australia all had 83 years each. Canada and Austria both reported LE of 82 years, while Germany and the US came in last with 81 and 79 years, respectively. In the set of wealthy and high LE countries in the entire world, the Japanese population has the highest LE, whereas the US citizens ranked last in the group. The highest LE of Japan illustrates the overall health profile of the Japanese population, which played an important role in determining the low COVID-19 mortality rate. The LE of the population depends on the frequency of pre-existing diseases. The low rate of obesity, the low consumption of red meat (particularly saturated fatty acids), the high consumption of fish (especially n − 3 polyunsaturated fatty acids), the consumption of plant foods (like soybeans), and the consumption of non-sugary drinks (like green tea) are likely factors that have greatly increased the LE of the Japanese population. In contrast, the American population, along with those from Australia, Canada, France, South Korea, Spain, Germany, Italy, and Austria, is more likely to suffer from obesity, diabetes, hypertension, and heart failure. These common underlying diseases increase the risk of developing severe COVID-19 symptoms and subsequent high mortality.

3.2.7. *The Role of Demography (Age Cohort)*

Another factor that might have contributed to Japan's lower mortality rate could have been the country's demography, specifically its age structure. Given that COVID-19 affected different age groups differently, the country's aged population looked to have an important role in low deaths resulting from SARS-CoV-2 infection. Fig. 14 provides the percentage population of the age cohorts (60+ and 70+) in the mentioned countries. We have compared Japan's age cohorts with those of the US, Canada, France, Germany, and Italy. Japan has the highest percentage of 60+ and 70+ cohorts, followed by Italy, Germany, France, Canada, and

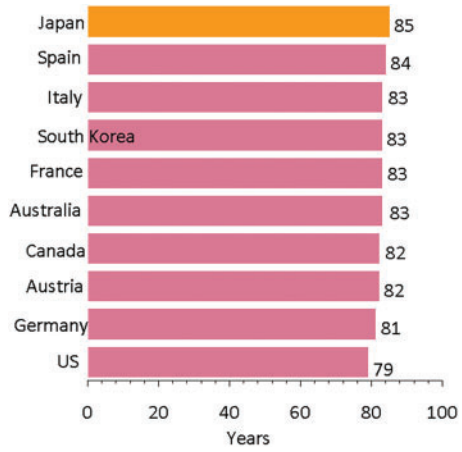

Fig. 13. Life expectancy of selected wealthy and democratic countries (Japan reported in 2020 and the rest 2019).

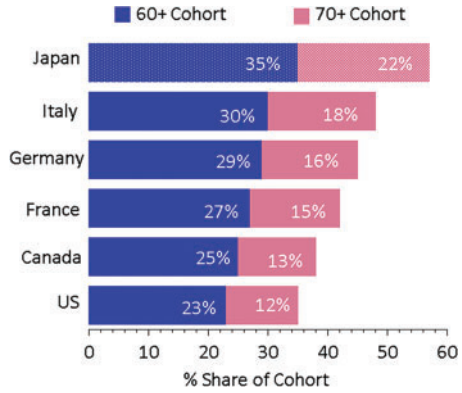

Fig. 14. Percent share of cohort of selected wealthy and democratic countries.

the US. Japan has a 35% 60+ cohort, followed by Italy (30%), Germany (29%), France (27%), Canada (25%), and the US (23%). Regarding the 70+ cohort, Japan leads with 22%, followed by Italy (18%), Germany (16%), France (15%), Canada (13%), and the US (12%). Japanese have the largest share of 60+ and 70+ cohorts, while Americans have the lowest. Given that Japan has the highest percentage of elderly people in its population globally, it was expected to fare better, maintaining a low pandemic mortality rate.

4. Conclusion

We compared the COVID-19 death rates in ten countries: the US, Italy, Spain, France, Austria, Germany, Canada, Australia, South Korea, and Japan. The updated cumulative deaths as of March 16, 2023, were considered when the pandemic was almost over. With 57.72 deaths per 100,000 people, Japan had the lowest death rate, whereas the US had a rate of 341.11. The following mortality rates were reported in terms of CFR: Canada (same as the US) with 1.1%, followed by Spain, Italy, Germany, France, Austria, Japan, Australia, and South Korea with respective rates of 0.9%, 0.7%, 0.4%, 0.4%, and 0.4%, 0.2%, 0.2%, and 0.1%, respectively. In comparison with other countries in the group, the fatality rate was highest in the US along with Canada. Japan had the second lowest mortality rate, the same as Australia. Japan's CFR was lower than that

of other parts of the world due to several positive social (public awareness), economic (healthcare spending), and infrastructure (vaccination drive) factors, among others, as detailed below.

Japan's healthcare spending has been steadily increasing, reaching nearly 11.0% of its GDP in 2019, the year before the pandemic. By 2022, the amount rose to 11.5%. Japan allocates over 10% of its GDP to healthcare, which is a reasonable amount among developed countries. In 2021, total healthcare spending amounted to 45.04 trillion yen. It increased to 46.0 trillion yen in 2022. From 2017 to 2019, per capita healthcare expenditure rose from 334,660 yen to 346,610 yen. The spending kept increasing from 2021 to 2022. It rose from 356,170 yen to 368,000 yen.

The data collected in 2020 found mask-wearing awareness among the Japanese population to be significantly high, 4.7 on a scale from 1 (not at all) to 5 (always). Mask-wearing awareness was higher and more uniform in Japan than in the US and Canada. The Japanese government's efforts to promote the use of masks played a crucial role in encouraging the population to adopt this practice, which helped control the spread of the pandemic. The COVID-19 pandemic stringency index (SI) implemented in the US and Japan was compared. The SI was worked out using nine metrics (restrictions imposed) as given in *Section 3.2.3*. Throughout the pandemic, Japan maintained strict border controls, which contributed to lower infection rates. Additionally, the individual's behavior in Japan was favorable for controlling the spread of the virus, suggesting a reduced need for stringent government measures compared to the US. While the US implemented various interventions during the early stages of the pandemic, Japan's government response reflected a relatively low and stable stringency measure. In Japan, the separation of stringency measures for vaccinated and unvaccinated individuals occurred relatively briefly due to self-awareness among the people, unlike in the US, where it lasted longer. In *Section 3.2.2*, urbanization is discussed. It is an important factor in the outbreak, particularly in relation to the "Avoid the three Cs" (3Cs) protocol. Japan's low mortality rate is especially notable given its high urbanization rate compared to the other nine countries: the US, Italy, Spain, France, Austria, Germany, Canada, Australia, and South Korea. Japan has the highest urbanization rate, with 92% of its population living in urban areas, whereas Austria has the lowest at 59%.

The COVID-19 vaccination campaign in the US began on December 14, 2020. By January 2021, 8.8% of the population had received at least one dose. By May 2021, this figure rose to 50.8%. As of March 2022, nearly three-fourths (74.9%) of the population had completed their vaccination regimen. However, the vaccination rate slowed down later, reaching 80% by April 2023. In contrast, Japan's vaccination rate swiftly reached 80% within ten months and approached nearly 84.0% by April 2023, more than the US.

The US launched a second dose vaccination program in January 2021, and by May of that year, above 43.0% of the population had received their second dose. By March 2022, this number rose to 64.4%. In contrast, Japan initiated its second dose of vaccine slightly later, but it progressed swiftly. By November 2021, 80% of the population was vaccinated. As of April 2023, the number had gone up to 83%. As of this date, only about 68.0% of people in the US have received the second dose. Both countries also implemented booster vaccination programs. By April 2023, over 140% of Japan's population had boosters, including those with multiple booster doses. As of August 2022, the US could only vaccinate booster doses to 39%. After that, data were not available.

Japan has the highest LE among the US, Australia, Canada, France, South Korea, Spain, Germany, Italy, and Austria, with an ALS of 85 years. The impressive LE is attributed to the country's overall health profile, which has improved significantly over the years. Contributing factors for higher LS include low obesity, reduced consumption of red meat, and a high intake of fish, plant-based foods, and non-sugary beverages. In contrast, the US population, along with other countries, faces higher risks of obesity, diabetes, hypertension, and heart failure, which lead to severe COVID-19 symptoms and increased mortality rates. Japan has the highest percentage of individuals aged 60+ and 70+ cohorts, followed by Italy, Germany, France, Canada, and the US. The large proportion of Japan's elderly population might have contributed to a lower mortality rate during the pandemic.

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), PhD, 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 Akbar Khan, BA; Intazam Khan, MD; Shagufta Nazneen Ansari, PhD; Deepali Bhardwaj MBBS, MD, DVDL, MPhil; Parangimalai Diwakar Madan Kumar, BDS, MDS; Akram Mohammad, PhD.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

[1] Takashima S, Tokiya M, Izui K, Miyamoto H, Matsumoto A. Asian flush is a potential protective factor against COVID-19: a web-based retrospective survey in Japan. *Environ Health Prev Med*. 2024;29:14.

[2] Matsumoto A, Hara M, Ashenagar MS, Tokiya M, Sawada T, Iwasaka C, *et al.* Variant allele of ALDH2, rs671, associates with attenuated post-vaccination response in anti-SARS-CoV-2 spike protein IgG: a prospective study in the Japanese general population. *Vaccines*. 2022;10:1035.

[3] Bogahawaththa S, Hara M, Furukawa T, Iwasaka C, Sawada T, Yamada G, *et al.* Asian flush gene variant enhances cellular immunogenicity of COVID-19 vaccine: prospective observation in the Japanese general population. *Vaccines*. 2024;12:1015.

[4] The News International. Unexplained decline in COVID-19 cases in Pakistan puzzles health experts and policymakers. *Thenews.com.pk*. 2020. Available from: https://www.thenews.com.pk.

[5] Haq M, Rehman A, Ahmad J, Zafar U, Ahmed S, Khan MA, *et al.* SARS CoV-2: big seroprevalence data from Pakistan—is herd immunity at hand? *Infection*. 2021;49:983–8.
[6] Masood KI, Qaiser S, Abidi SH, Khan E, Mahmood SF, Hussain A, *et al.* Humoral and T cell responses to SARS-CoV-2 reveal insights into immunity during the early pandemic period in Pakistan. *BMC Infect Dis*. 2023;23:846.
[7] Abbas S, Raza A, Iftikhar A, Khan A, Khan S, Yusuf MA. Seroprevalence of SARS-CoV-2 antibodies among health care personnel at a health care system in Pakistan. *Asia Pac J Public Health*. 2021;33(5):632–4.
[8] Younas A, Waheed S, Khawaja S, Imam M, Borhany M, Shamsi T. Seroprevalence of SARS-CoV-2 antibodies among healthy blood donors in Karachi. *Pakistan Transfus Apher Sci*. 2020;59:102923.
[9] Johns Hopkins University & Medicine. Coronavirus resource center [Internet]. 2023 March 16.
[10] Nipponcom. Healthcare expenditures rise to record ¥42.6 trillion. 2019. Available from: Nippon.com.
[11] World Health Organization. *Current Health Expenditure (% of GDP)-Japan*. WHO Global Health Expenditure Database.
[12] Our World in Data. Share of the population living in urban areas. 2022. https://ourworldindata.org/grapher/share-of-population-urban.
[13] Pandem-iccom. Japan and US are worlds apart on pandemic mortality. 2024. Available from: Pandem-ic.com.
[14] Shervani Z, Khan AA, Khan I, Sherwani A, Kumar PDM, Mohammad A, *et al.* Marginal shortening of life expectancy in Japan during COVID-19: a low pandemic impact country due to improved health infrastructure and awareness. *Eur J Med Health Sci*. 2024;6(6):9–17.
[15] Annaka S. Public awareness of mask usage in 29 countries. *medRxiv*. 2021. 10.1101/2021.03.06.21253037.
[16] Hale T, Angrist N, Goldszmidt R, Kira B, Petherick A, Phillips T, *et al.* A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nat Hum Behav*. 2021;5:529–38.
[17] Our World in Data. COVID-19: stringency index. 2022 December 31. https://ourworldindata.org/metrics-explained-covid19-stringency-index.
[18] World Bank Group. Life expectancy at birth, total (years). 2022.