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Review Article

Learning from the pandemic: A critical review of public health system evolution in China, India, and Japan

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Abstract: The COVID-19 pandemic has highlighted both the strengths and vulnerabilities of global public health systems (PHSs) and international cooperation. To identify key strategies for enhancing global health security, this research seeks to reveal crucial factors needed for resilient and integrated global health systems. In the absence of overseeing agencies in Asia, constructive policy recommendations for respective governments are required, with a combination of centralized policy directives and localized implementation strategies being the key. The sheer demographic size of China and India, shared challenges of depopulation of China and Japan, and the current or future issue of aging between China, India and Japan, make it necessary to have a comparative analysis of public health responses in China, India, and Japan. The novelty of the study lies in this comparative study on the evolution of PHSs in these countries since the 1990s using the WHO health indicators and their COVID-19 responses. Political economy must ensure public trust through equitable access to health care and transparent communication, while balancing public health needs with economic imperatives. The findings underscore the need for coordinated governance, preventive healthcare and livelihood efforts to prepare for future health crises and identify directions for international collaborative efforts to combat them.

Keywords: Public Health Systems, COVID-19, Public health preparedness, Critical care, Resilience

Introduction

The global impact of the COVID-19 pandemic on the public health system (PHS) has been so profound and it has revealed both strengths and vulnerabilities, urging all the countries to focus on resilience strategies against health hazards. Since COVID-19 served as an unprecedented litmus test for the preparedness and resilience of PHS, it is high time to work on remedial policy directions since the World Health Organization declared the end of the COVID-19 health emergency on 5 March 2023 [1].

In the 28th edition of the World Population Prospects (WPP) of the UN Department of Economic and Social Affairs (DESA), the following two trends were identified: 1) Lower fertility and aging populations in almost a fifth of all countries and areas: China, Italy, the Republic of Korea and Spain have "ultra-low fertility" with fewer than 1.4 live births per woman over her lifetime, and 2) Population size reaching the peak in 63 countries: the total

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population group will decline by 14% over the next 30 years. China, Germany, Japan and the Russian Federation are the major countries and areas in this group. By mid-2024, the global population reached close to 8.2 billion, and it is expected to grow by another 2 billion over the next 60 years to peak in the mid-2080s with a projected population of 10.3 billion [2]. As shown in Figure 1, the Asian region currently has four of the most populous countries in the world, namely India, China, Indonesia and Pakistan. In the coming decades, the world is expected to witness the acute population decline in China and the enormous population increase in India [2].

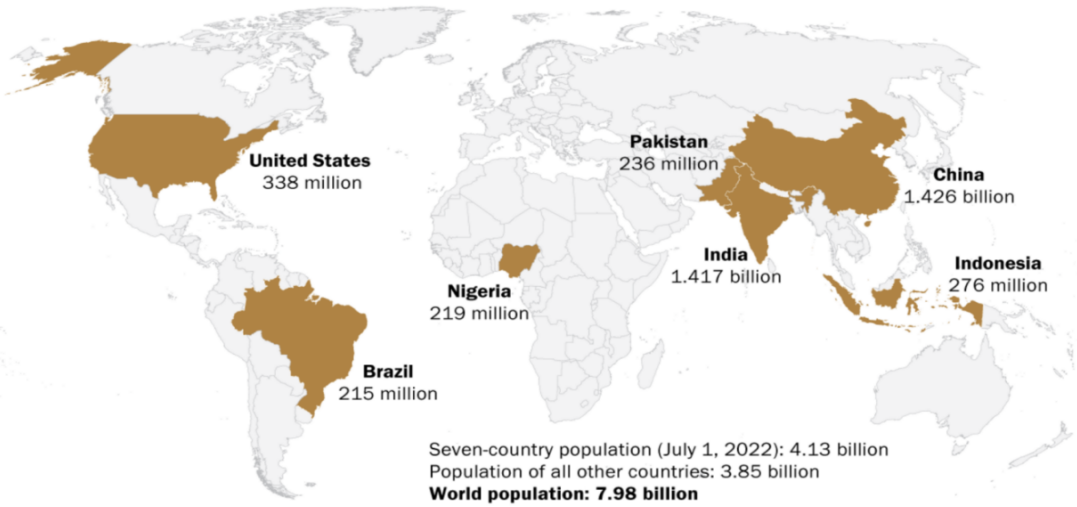

Figure 1. The distribution of world's population: half the world's population lives in seven countries [4]

India and China, with a population of more than 1.4 billion (2022) respectively, are the two most populous countries in Asia and the world, followed by the United States (343 million), Indonesia (281 million), Pakistan (248 million), Nigeria (228 million) and Brazil (211 million) [3], which together have fewer people than India or China. The population of India or China is larger than the entire population of Europe (744 million) or the Americas (1.04 billion) and is roughly equivalent to that of all African nations (1.427 billion) [4].

Urbanization, wealth, population age and population density are significant spatial determinants of COVID-19 incidence. The inclusion of geographical variations in social, economic and infrastructural dimensions with the knowledge of the inter-urban characteristics across human settlements is valuable in addition to an intra-urban understanding [5].

The COVID-19 pandemic has impacted different social groups in various local settings, making inherent vulnerabilities manifest within a country. The public health system faces the challenge of adopting an egalitarian approach while addressing the issues arising from demographic challenges. To evaluate these challenges, it is vital to consider the intersections of both demographic and social issues, such as an aging society, population density, and the urban–rural divide. Ohta, Yakabe & Sano (2024) [6] acknowledged that "social isolation, heightened by privacy concerns and diminishing community intimacy" necessitates a balance between individual privacy and communal support, encouraging the establishment of collaborative relationships between rural communities and medical institutions where the role of physicians is emphasized.

The need of the study

Regarding public health, Asia is currently not fully regulated by any overseeing agencies. Furthermore, it is important to remember that South Asia has the highest number of excess deaths out of seven world regions with 5.27 million, followed by Latin America (2.86 million excess deaths) [7]. Being the two most populous countries in the world, it is imperative to study on China and India, with a reflection upon the case of Japan, where universal health for all has been propagated as the gist of the public health policy of the country.

In United States, there was a storage of staff and a prevalent lack of access to healthcare, which had detrimental consequences for chronically ill patients. The challenge for referral cases came up with the task

of providing preventive care while managing long COVID and its complications. The US experience led to a realization of the importance of collaborative work with government entities and community-based agencies for fighting against adverse impact of COVID-19 while ensuring approved antiviral medications to all communities [8].

The unprecedented severity of the COVID-19 pandemic led to the phenomenal rise of the European Centre for Disease Prevention and Control (ECDC) [9] as the focal point for monitoring, analysing and interpreting data from EU countries on 52 communicable diseases and conditions with the use of the European Surveillance System (TESSy), to coordinate the European Programme for Intervention Epidemiology Training (EPIET) and the European Programme for Public Health Microbiology Training (EUPHEM).

Latin America represented 25.1% (1.7 million) COVID-19-attributed deaths of the global reported deaths (6.9 million) by May 2023, drawing urgent attention to manage the grave impact of global health hazard. Lizárraga et al [7] believe that stakeholder involvement in coordination with the government is the key, while considering pre-existing inequalities. The 5 points of their policy recommendations focus on 1) strengthening zoonotic disease-pathogen surverillance systems, 2) robust infection and prevention control programmes, 3) indicator- and event-based monitoring and reporting systems, 4) community-based surveillance, including in remote areas, and 5) reviving and improving national strategic plans for emerging and re-emerging pathogens as policy recommendations.

While China and India are highly populated countries, Japan has long faced the issue of depopulation. However, certain challenges are common to the three countries despite the different size of their respective populations. The sheer demographic size of China and India, the shared challenges of depopulation in China and Japan, and the issue of an aging society, manifesting progressive in China, futuristic in India, and pressing in Japan, make a comparative analysis of public health responses of these three countries unique and indicative regarding possible remedial policy suggestions.

Objectives of the study

This study employed a comparative analysis of public health systems using secondary indicators from globally standardized datasets. The objectives of the study are summarized as below:

- To provide insights into the complexities of managing health crises in diverse political and economic contexts in Asia.
- To highlight the lessons learned by critically evaluating the responses to the COVID-19 pandemic in China, India, and Japan and to offer resilience strategies for health crises.

The study intends to make recommendations to ensure more resilient and effective public health strategies.

The novelty of the study

Because China, India, and Japan have distinct political, economic, and social frameworks and there are no mechanisms for collective action. This is a threat to humanity, as the COVID-19 pandemic has exemplified that the challenges for health-centric coordinated governance go beyond the necessary policy areas. The novelty of this study therefore lies in the comparative examination of the evolution of PHSs of these three countries since the 1990s using the WHO health indicators and their COVID-19 responses, aiming to identify key strategies for enhancing global health security.

2. Literature review

2.1 Disparities of health care due to aging

China: The societal issue of aging also affects by China, whose population is more than 10 times that of Japan. It is expected to adversely impact China's economy in the coming years. In China, 20% of the population is already aged 60 and over, and this proportion is expected to increase to 30% or more than 400 million people [10]. In China, the rising cost of living and shifting attitudes among younger generations have led to a decreasing interest in starting a family. Furthermore, with the decreasing number of women of childbearing age, even though its one-child policy has been relaxed, allowing a couple to have two children in 2011 and three in 2021, depopulation and aging are the two major issues. The year 2023 was the seventh consecutive year with a declining birth rate, while in 2024, it was 6.77 per 1000 people, whereas it was 6.39 per 1000 people in 2023, and a mortality rate of 7.76 per 1000 resulted in an overall population decline [11].

India: It is expected that India will have 193 million elderly people, approximately 13% of the total population of the country by 2030. As reported by the data from Longitudinal Ageing Study in India (LASI), 59% of the elderly population sought outpatient services in 2023. While the 75th round of the National Sample Survey 2017-18 recorded that one-third of the elderly used PHS, only one-fourth of the elderly sought outpatient care from public health services in India [12, 13].

Japan: The concept of universal health for all was realized in Japan long before the COVID-19 pandemic. However, Japan is facing the challenges of emergency medical situations due to its aging society and depopulation [14]. Japan, with its population of 124.4 million [15], has emerged in recent decades as the most prominent country labelled as a "super-aging society" by Muramatsu and Akiyama (2011), who termed this

population division because of the staggering rate of 90% of earthquake-related deaths of people aged 65 and over –541 deaths in 241 hospitals in Miyagi, Fukushima and Iwate prefectures two months after the Great East Japan Disaster of 2011 [16].

2.2 Disparities of health care due to urban-rural divide

In early 2020, COVID-19 mortality occurred in densely populated areas due to urbanization. In the second half of 2020 and 2021, however, during the outbreaks of the Alpha, Delta and Omicron variants, people in non-metropolitan communities were more likely to die from the disease. The high population density in urban areas put pressure on overall PHSs in the country, while policy and planning of health services need to be inclusive in certain depopulated regions so that people in remote areas are not neglected. Disparities in health care availability between urban and rural areas caused the following phenomena:

Higher mortality rates in rural communities: Mortality rates due to COVID-19 remained higher in rural communities during variant-related fluctuations in 2021 [17]. China, for example, recorded a mortality rate of 15.5 per 100,000 live births in urban areas and 19.9 in rural areas in 2018 [18].

Lesser vaccination outreach and critical care in rural communities: Among non-metropolitan communities, the aged population in rural areas may be more affected by higher mortality rates than those in urban areas. There is less access to critical care services, worsening care due to overwhelmed capacity of hospitals, or a combination of these factors impacting rural communities [17].

China: Centralized response with mixed outcomes

Historically, China's public healthcare system has evolved in parallel with its economic and political development. The economic reforms of 1978 marked a shift towards privatization, which drastically weakened healthcare [19]. Following the outbreak of SARS in 2002, China established a new emergency management system based on the "One Plan, Three Mechanisms" framework. This system includes a comprehensive emergency plan and three mechanisms: emergency management, management and legal. By 2007, most provinces, cities and counties had developed their own emergency plans. This framework has helped to streamline and improve crisis management during public health emergencies [20]. China's public health response to the COVID-19 pandemic was thus shaped by its centralized, one-party political system, which enabled rapid and decisive action. It should be noted that there was the China-WHO Country Cooperation Strategy (CCS) 2016-2020, and this strategy of the WHO's five-year plan saw the COVID-19 pandemic [18]. The National Health Commission (NHC) of China and the World Health Organization jointly reviewed its implementation and created a new CCS for the years from 2022 and 2026. Chinese government's ability to implement large-scale testing, contact tracing and quarantine measures demonstrates the advantages of a centralized approach. However, centralization has become a cause of disparities in regional settings. In their quantitative study on the accessibility of national PHCs in China, Jia et al (2022) [21] revealed inequalities of accessibility to PHCs at both province and city levels. About 44% of communities claimed that 30% of them had no access to PHCs within 6 km, while 78% of communities claimed that 68.4% of them had no access to PHCs within 1.5 km, which signified that the overview of primary healthcare delivery and national mapping of primary healthcare accessibility is a crucial benchmark in the pre-COVID-19 era. There are also issues related to transparency and data management.

India: Decentralized governance with public surveillance, yet the outcome of health disparities

Since health is the responsibility of the state in India, the first National Health Policy (NHP) in 1983 focused on primary healthcare, health volunteers, and specialty facilities. NHP 2002 emphasized decentralization, private sector involvement, and increased public health expenditures [22]. India's federal structure, characterized by decentralization of power between the central and state governments, resulted in varied public health responses during the COVID-19 pandemic. Most union territories exceptionally performed well despite of their dense population and states such as Punjab, Mizoram and Arunachal Pradesh effectively managed the crisis, whereas other states such as Meghalaya, Nagaland and Sikkim ranked poorly [23]. Health system decentralization indicates that strengthening local-level decision making, ensuring equitable allocation of resources by reflecting needs and preferences of the local population, and leading to public satisfaction and enhanced effectiveness, experimentation, and innovation [24], but India witnessed inequality and inequity of delivery of health care due to socio-cultural characteristics, access to resources, and economic status of the beneficiaries [25]. These disparities are partly due to the differences in state government actions, such as travel restrictions and large-scale emergency measures.

The COVID-19 pandemic exposed weaknesses, such as inactive crisis committees, inadequate systems for organizing medical personnel, poor adoption of new technologies, and shortages of both human resources and medical equipment. As a result, approximately 50% (16) of the states struggled to manage the crisis effectively [23]. States such as Kerala and Tamil Nadu, which had stronger healthcare systems and better socioeconomic conditions, were better at managing crises than those states such as Bihar and Uttar Pradesh, which lacked healthcare professionals and the return of migrant workers

[26]. Negative media portraying on the infectors based on their religion (Muslims), region (North-East India) and their professions (biomedical waste sanitation/ cremation related) aggravated already existing prejudices [25] (Acharya 2022:214-215). The severity of the second wave in India, due to less stringent lockdown with more transmissible viral variants, urged India to consider disease surveillance across districts for epidemiological incidents [5].

Japan: Stability and universal healthcare

Japan's political stability and strong regulatory frameworks have fostered the development of an efficient and equitable PHS over the past several decades. The country's Universal Healthcare Coverage (UHC), coupled with a focus on preventive care and integrated community care, has contributed to Japan's effective response to the COVID-19 pandemic. While facing challenges related to an aging population, Japan's response has mixed views.

The historical developments of health policy in Japan, such as the introduction of the diagnosis-related groups system in 1983 and the long-term care insurance systems in 2000, have maintained the quality and sustainability of healthcare services. The 2013 Health Care Reform Act further emphasized the importance of preventive care, reflecting Japan's proactive approach to public health. Regionalized public health delivery has been the focus, and local public health centers (PHCs), hokenjyo, with more than 460 such centers scattered across Japan, serve exceptionally well [27]. The pandemic reinforced the strengths of Japan's healthcare system but also showed vulnerabilities during the threshold.

2.3 Identification of key areas for improvement in each country's public health system

2.3.1 China: Enhancing transparency and decentralization

Improving data transparency and timeliness: China's initial response highlighted issues with information transparency and data sharing [28]. Its PHS must improve the collection, analysis and dissemination of real-time data. A transparent health system framework that allows for timely and accurate reporting of health information is essential to build trust among the public and the international community [29].

Strengthening decentralized decision-making: Rapid policy implementation and bottlenecks may delay local responses to critical healthcare needs, particularly in underserved rural areas. Addressing disparities in primary health centers requires enhancing local governance and empowering regional authorities to make context-specific decisions for both routine operations and emergency preparedness [30].

Increasing investment in public health infrastructure: Investment in healthcare infrastructure, especially in rural and underserved areas, is crucial for reducing disparities in access to healthcare, including building new facilities, upgrading existing facilities and ensuring equitable resource distribution [31].

2.3.2 India: Addressing healthcare inequities and strengthening federal coordination

Reducing regional disparities in healthcare access: India's public healthcare system is characterised by significant regional disparities. To ensure equitable healthcare access, enhancing supply chains for essential medicines and recruiting and training more healthcare professionals could be promoted to ameliorate healthcare disparities. The prevalence and mortality rate of COVID-19 was reported to be much higher in slum areas where poor people live [32].

Improving coordination between central and state governments: India's decentralized structure has caused a lack of coordination between the central and state governments, leading to fragmented health responses. Strengthening intergovernmental coordination through clear policy guidelines, improved resource allocation and integrated health management systems is essential for a unified national response to future health emergencies.

Enhancing health data management systems (HDMS): India's current health data management systems are often fragmented and lack interoperability. There is a need to develop a robust, centralized health information system that integrates data from various sources, improves real-time surveillance, and facilitates evidence-based decision making [33].

2.3.3 Japan: Accelerating digital integration and addressing demographic challenges

Accelerating digital transformation in healthcare: Japan's PHS needs digital adoption to efficiently track and manage the rapid increase in emergency health situations. Investment in digital infrastructure, including electronic health records, telemedicine and AI-driven analytics, will improve healthcare delivery and preparedness for future health crises. A comprehensive digital health strategy that prioritizes interoperability and data security is essential.

Addressing the aging population and workforce shortages: Japan faces significant challenges due to its rapidly aging population and declining workforce. The healthcare system needs to increase the number of healthcare workers through targeted training programmes and utilise technology such as robotics and AI to compensate for the labor shortages [31]. Japan lacks an expert-led body with autonomous decision-making authority similar to the Centers for Disease Control and Prevention (CDC) in the United States or the Korean Centers for Disease Control and Prevention (KCDC) in

Korea. Instead, there are advisory bodies that provide guidance rather than making independent decisions, which may delay decision making [34].

Strengthening public–private partnerships in healthcare innovation: To enhance the healthcare delivery system, a stronger collaboration among the government, private sector, and academic institutions is needed. Innovations, such as advanced diagnostics, personalized medicine and preventive care solutions should be encouraged.

Healthcare for the next generation: The Japanese government is committed to preventive medical care in order to achieve a 100-year life expectancy. It encourages data utilization to offer services related to health, medical care and nursing by sharing medical information and medications via My Number Card as a health insurance card and Big Data. Technologies such as ICT robots and AI are promoted for scaling up the system of medical care and nursing, and the development of medicines and medical equipment has also been encouraged. The government of Japan is keen to introduce technological innovations such as data and ICT and promote their economic usage to improve the quality and productivity of medical and nursing care, which could contribute to reforming the work style throughout Japan [35]. It is acknowledged that the rapid data analysis is vital for the examination and treatment of affected individuals [35].

3. Methodology

Parameters for evaluating public health systems

Due to the lack of comparable primary data and the challenge of overcoming data inconsistencies across borders and differences in interpretation depending on context, the authors conducted an internationally standardized comparative data analysis. Globally comparable health indicators reveal the effectiveness of political systems and reflect the quality of governance and overall performance of a nation. The data on the health indicator data were sourced from the WHO World Health Indicator data [36, 37]. The study examined PHS in its entirety, considering human factor, chronic disease management, environmental factors and universal health care as a sign of equity.

This study examines the following health indicators:

Human resources for healthcare: The presence of healthcare professionals—physicians, nurses and dental personnel—reflects the availability of medical professionals and access to healthcare facilities for the population, as well as the government's investment in developing the workforce [38]. The densities of physicians, nurses, and dental personnel per 10,000 people are individually sourced from the WHO health indicators for each country. A higher density generally ensures better access to medical care, a higher quality of care and a more responsive healthcare system.

Chronic disease burden: The incidence of chronic diseases, such as hypertension and tobacco use, indicates a country's success in managing noncommunicable diseases. This reflects the effectiveness of preventive healthcare and efforts for health promotion. Patients with chronic diseases are often the users of PHC, and chronic disease management is crucial for public health [39]. The age-standardized prevalence rates of hypertension and tobacco use considered for this study were 30-79 years for hypertension and 15 years and older for tobacco use.

Environmental health: The indicators for sanitation and air pollution assess the government's role in fostering a healthy environment [40, 41]. These indicators reveal how environmental factors impact public health and reflect the effectiveness of government policies aimed at improving environmental conditions. Changes in the physical, chemical or biological constituents of the environment (air masses, temperature, climate, etc.) cause environmental pollution [41]. The proportion of the population using safely managed sanitation services and the age-standardized mortality rate from air pollution per 100,000 people are considered.

Universal health coverage (UHC): UHC measures the accessibility and affordability of essential health services for all people in a country. This indicates a nation's commitment to equitable healthcare and ensures that economic barriers do not limit access to necessary care for any individual. A higher index of UHC service indicates better equity in accessing healthcare and domonstrates that the system is successful in reaching all segments of the population. The focus is "not merely to improve clinical services, but to achieve equitable improvements in health outcomes through genuine integration of individual and population-level health promotion and preventative efforts with curative services" [42]. The UHC index measures equitable access to essential services and reflects a system’s ability to maintain care during crises—a core feature of resilience [43]. It emphasizes the outcomes of services such as immunization or chronic disease treatment over financial input.

States parties’ self-assessment annual reporting tool (SPAR): This tool consists of 35 indicators for the 15 International Health Regulation capacities needed to detect, assess, notify, report and respond to public health risks and acute events of domestic and international concern. Countries and projects can use SPAR to demonstrate the broad impact of their approaches with the aim of increasing compliance with the international health regulation (IHR) [44]. SPAR evaluates national capacities in areas such as surveillance, laboratories, and emergency response. Despite being self-reported, it offers broad and timely insights into the resilience of the national health system [45].

Global health security index (GHS): A comprehensive assessment of a country's capabilities to prevent, detect and respond to epidemic threats. It measures the technical, financial, socioeconomic and political capacities of all

countries to effectively manage health emergencies. Prasiska et al (2025) [46] researched COVID-19 detection, mortality, transmission, deaths and recovery and acknowledged the GHSI as a valuable tool for identifying gaps in pandemic preparedness, although they did not fully capture a country's capacity for an effective response to COVID-19. The GHS Index complements the UHC Index and SPAR by providing an external, comparative assessment across six key domains: prevention, detection, rapid response, health system, compliance with international norms, and risk environment. Furthermore, it also includes the dimensions of risk communication and governance, providing a holistic view of national readiness [45].

Health expenditure: Government spending enables better training for healthcare professionals, improved access to medical services and the provision of essential resources for emergencies [47]. It also fosters long-term resilience and ensures that healthcare systems can respond effectively to future outbreaks and reduce mortality.

COVID-19 cases and fatality rate: This rate is calculated by dividing the number of confirmed deaths by the number of confirmed cases and reflects the effectiveness of the country's healthcare infrastructure and disease management capabilities [48]. Low rates indicate that robust healthcare systems can cope with severe cases. The data is sourced from the WHO's Covid-19 dashboard, and the data ranges from November 2019 to May 5, 2023 (this date marks the end of the COVID-19 health emergency).

$$\text{Fatality rate} = (\text{number of deaths}/\text{number of cases detected})*100$$

The use of health indicators helps to identify best practices and highlight areas for improvement. By tracking changes in these indicators over time, trends can be observed and progress or setbacks in the performance of health systems can be measured [49]. The COVID-19 pandemic has highlighted the topmost priority for universal health coverage (UHC), with a focus on the Sustainable Development Goals (SDGs), especially SDG 3: good health and well-being, where PHC is the focus and focal point to achieve global health equity. Constrained by "a lack of methodological standardization and fragmented literature", the relationship between these indicators and the outcomes of the pandemic provides insights [49] for guiding policymaking, ultimately assists in the development of more effective health policies and strategies. The UHC, SPAR, and GHS Index were selected for their distinct yet complementary roles in assessing health system resilience and preparedness. Together, these indicators offer a well-rounded framework for evaluating national health security and response strength that fits for the study seeking for resilience strategies for health crises.

There are several limitations and considerations that should be taken into consideration when comparing indicators. The quality of data can vary significantly among countries, which affects the reliability and comparability of results. Additionally, contextual factors such as socioeconomic conditions, cultural differences and geographical characteristics may influence health outcomes and need to be considered in further analyses with the required field inputs. Climate change and its impact on human health are causes of concern for public health [50], but this topic will not be discussed in this study.

Criteria for selecting the countries analysed in the study

The study examined demographic trends, urbanization, and aging issues through comparative analyses of standardized international parameters that are applicable to all three countries. The neglect of routine diagnostics, screening programmes and elective procedures for chronic diseases, infectious conditions and certain neoplasms is a major problem during the COVID-19 pandemic [51] (Nascimento et al. 2025). In the case of Latin America and the Caribbean, the COVID-19 pandemic strained all resources and exposed disparities in cancer control that were persistent barriers even before the COVID-19 pandemic. Resource crunches in cancer control with non-universal health coverage led to fragmented health care and unequal cancer services characterized by inadequate registries, delays in diagnosis or initiation of treatment and insufficient palliative care services [52] (Barrios et al 2021).

4. Case studies

In this section, three countries' case studies are elaborated regarding their respective responses to the COVID-19 pandemic.

4.1 Case study 1: China

Initial outbreak and response

In December 2019, there was an unexplained outbreak of COVID-19 in Wuhan, the capital of Hubei province in China. It took more than a month for the pandemic to spread throughout China. On January 16, 2020, China officially classified COVID-19 as a serious infectious disease and initiated a "first-level" public health emergency response. From January 23 to April 8, 2020, the city of Wuhan was under lockdown, all public transportation was halted and the access to the city was restricted. Between December 31, 2019 and March 22, 2020, which was considered the first wave of COVID-19, China recorded 80,695 confirmed cases [53]. Wuhan classified management into four categories as of February 2, 2020: confirmed cases, suspected cases, febrile patients

and close contacts. All individuals in need were tested, isolated, hospitalized or treated. Mass screenings were conducted to identify and hospitalize infected individuals, and accurate case data were collected [54].

To support Hubei province, the Chinese government mobilized 346 national medical teams, including 42,600 medical personnel and over 900 public health workers, from January 24 to March 8, 2020. Rapidly established makeshift hospitals include 16 Fangcang shelter hospitals with over 14,000 beds, and a 1,000-bed Huoshenshan Hospital was built in 10 days [55].

However, China received criticism from countries such as the United States. and Australia for delays in information sharing and lack of transparency. In the initial phase of the outbreak, there were considerable delays in information sharing and attempts to minimize the number of reported cases within the country, which facilitated the spread of the virus. Although new facilities were built quickly, the existing healthcare system encountered serious difficulties [56, 57]. Later, the Chinese government strengthened cooperation with the WHO and other countries, sharing viral genome sequences and experience in prevention and control [58]. Domestically, the Chinese government sought the support from homeowners' associations and local leaders in charge of food procurement and distribution during lockdown periods to sustain the informal economy and provide food for residents of Wuhan, Shangha, and other cities from 2020—2022 [59].

The country utilized big data, artificial intelligence and 5G technology for outbreak surveillance, contact tracing and resource allocation. The Health Code System, which tracks personal health status and travel history through mobile applications, helps the government to quickly identify and isolate potentially infected individuals [60]. Itinerary codes were used to track domestic travel within China [61]. Additionally, vaccine production capabilities helped to achieve the vaccination program to commence in December 2020. By June 2021, over 1 billion doses had been administered [62] and 3 billion by January 2022 [63].

Economic impact

China's economy has been affected by the zero-COVID-19 policy. In 2020, China's GDP growth decreased to 2.2% from the prepandemic level of approximately 6%. The service sector and small and medium–sized enterprises (SMEs) were hit hard particularly [64, 65]. The recovery measures involved arranging special funds to ensure epidemic prevention and control; rolling out various macroeconomic policies, including fiscal, monetary, industrial, and employment policies; and stabilizing the economy, employment and financial market expectations. Tax and fee reductions, financial support and employment guarantee measures were introduced to ease the economic pressure on enterprises and residents. These stimulus policies help facilitate economic recovery to a certain extent [64, 65].

4.2 Case study 2: India

Initial outbreak and response

In India, the outbreak of COVID-19 began in early 2020. India's early lockdown, imposed on March 24, 2020, was one of the strictest globally and initially succeeded in slowing the spread of the virus. The socioeconomic fabric of the country is characterized by high population density and widespread poverty poses unique challenges. The sudden lockdown led to mass migration, as millions of daily wage workers returned to their villages, inadvertently contributing to the spread of the virus in rural areas.

Under the ICMR recommendation, "Pool Testing" was adopted initially to increase the testing capacity and reduce costs. Only high-risk candidates with possible symptoms, close contacts and travel histories were tested. The government launched the Aarogya Setu app for contact tracing and quarantine measures. India's healthcare system struggled to cope with the surge in cases, and the relaxation of social distancing measures led to a rapid increase in infections in the later stages [54].

Healthcare measures taken by the government include banning the export of personal protective equipment (PPE), including face masks and protective clothing. By March 4, 2020, the export of 26 active pharmaceutical ingredients (APIs) and medicines was restricted. In March, nearly 60,000 isolation beds were established nationwide, and approximately 20,000 train carriages were modified for patient isolation. The testing capacity was increased and make-shift shelter hospitals were constructed in the major cities. On August 1, the Sanjivan mobile app was launched to register home quarantines, check hospital bed availability, request ambulances and provide remote consultations [55]. India was not prepared for the health crisis with poor public health infrastructure, but it had the ability to manufacture vaccines.

India began to provide free COVID-19 vaccinations on January 16, 2021, after the drug regulator approved the emergency use of Covishield (the Oxford-AstraZeneca vaccine) and Covaxin (developed by Bharat Biotech in collaboration with the National Institute of Virology). Pre-existing manpower and cold-chain infrastructure were initially sufficient to vaccinate 30 million healthcare workers. The government has also taken swift steps to expand vaccine production capacity and developed a digital system to monitor vaccine administration [66].

Economic impact

India has experienced its worst economic performance since independence, with a contraction of 7.3% from 2020--2021. The economy decreased by 23.9% in the April–June quarter of 2020 [67]. Many micro, small,

and medium enterprises (MSMEs) were forced to shut down, with surveys indicating that approximately 35% of these businesses were at risk of permanent closure [68]. The Indian government announced a 20 trillion Indian Rupee stimulus package, which was equivalent to 10% of the Gross Domestic Product (GDP), with 1700 billion Indian Ruppees aimed at serving various sectors, such as micro, small and medium enterprises (MSMEs), for credit guarantees and liquidity support. At the onset of the pandemic, the unemployment rate in India soared to 23.5%, but with government intervention, it was reduced to 8.5% by mid-June 2020. The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) scheme guarantees 100 days of work for rural adults, playing a vital role in mitigating unemployment, with 40 million people seeking work in June 2020. The government also supported 800 million people with 500 billion rupees in cash transfers and subsidized food grains [69].

4.3 Case study 3: Japan

Initial outbreak and response

On February 25, 2020, Japan's Ministry of Health, Labour and Welfare established the Cluster Response Team to identify and contain small COVID-19 clusters. This team, comprising epidemiologists and infection control specialists, conducted epidemiological surveys and contact tracing when new clusters were confirmed. Business and events were restricted [69]. The Japanese government initially declared a state of emergency in April 2020 for specific prefectures, which was later expanded to the entire country. The state of emergency was lifted in late May 2020 as the number of daily cases decreased to 20-30.

Compared with the United States, Europe, and other countries, Japan's management of the COVID-19 pandemic is considered more effective as the number of deaths was relatively low. However, among Asian nations, Japan has been identified as one of the countries struggling the most to control the spread of the virus [70]. The Japanese government initially downplayed the need for PCR tests and rejected extensive testing, which was later increased in July 2020. The focus was on early detection, isolation and treatment of highly contagious individuals within clusters. On June 19, 2020, the government launched a tracing app called "COCOA"[54].

During the second wave, the PHCs could not cope with many cases, resulting in a system collapse. Many facilities turned away non-COVID-19 patients, while non-designated hospitals refused admissions. This lack of resources, space and coordination led to COVID-19 patients overflowing, creating situations where one hospital faced critical bed shortages while a neighboring facility had empty wards [71]. Furthermore, it is also vital to note that such a situation irked cancer patients to avoid getting proper screening in time. For example, the suspension of breast cancer screening due to the COVID-19 pandemic impacted long-term clinical outcomes of bread cancer patients who had more aggressive and advanced disease, leading to the development of breast cancers, which was likely to adversely affect the outcomes of those patients [72].

The vaccination campaign was coordinated with local medical associations, with a particular focus on vaccinating youth in crowded areas. To reach the younger population, the government used a lottery-based approach via platforms such as LINE and Twitter, which target residents aged 16-39 years [73, 74]. Japan was disrupted by a lack of digitalization, leading to a delay in the online provision of services by government administrators and educational institutions, as well as the adoption to flexible work style such as remote work. While awareness about internet security and privacy risk among Japanese could be a factor, the main reasons were derived from rigid bureaucratic regulations and interest group politics, as well as the stagnant political environment of one-party rule, which leaves fewer opportunities [75]. However, these opportunities are mostly discussed from the perspective of clients and workforce access to digital services, rather than in terms of enhancing digital usage of data exchange and digital monitoring of emergency situations.

The demographic challenges of a declining birth rate and an aging population have raised concerns about increasing staff shortages in the healthcare sector [35]. The pandemic has exposed two more concerns related to the lack of preventive medical care and the utilization of data for the provision of services in health, medical care and nursing.

Economic impact

Without exception, Japan's economy was also affected by COVID-19, with GDP contracting from April to June 2020. In response, the government announced 108 trillion yen in emergency economic measures in April 2020 [70]. To promote recovery, the Ministry of Economy, Trade and Industry (METI) supported startups through initiatives such as the "Shibuya New Normal Lab" [76].

The above observations are summarized in Table 1.

5. Results

Importantly, the underlying societal challenges and policy directions have affected the management of the primary healthcare system of each country. Table 2 summarizes the health indicators and their progress since the 1990s.

The data presented in Table 1 were analysed as follows:

Human resources for healthcare: As shown in Table 1, India has experienced contrasting trends in its healthcare workforce over the years. The physician density has alarmingly declined from 12.24 per 10,000 people in the

Table 1. Comparisons of the responses of China, India, and Japan to the COVID-19 pandemic

Country	Initial Outbreak and Response	Economic Impact
China	-Unexplained outbreak of COVID-19 in Wuhan in December 2019. -Classified COVID-19 as a serious infectious disease on January 16, 2020. -Implemented a "First-Level" public health emergency response. -Lockdown in Wuhan from January 23 to April 8, 2020. -Mobilized 346 national medical teams and established makeshift hospitals. Utilized big data, AI, and 5G technology for outbreak surveillance and contact tracing. -Launched Health Code system for tracking personal health status and travel history. -Vaccination programme commenced in December 2020.	-GDP growth dropped to 2.2% in 2020 from the pre-pandemic level of 6%. -The service sector and SMEs were hit hard. -Introduced tax and fee reductions, financial support, and employment guarantee measures. -Stimulus policies helped facilitate economic recovery to a certain extent.
India	-Outbreak of COVID-19 began in early 2020. -Imposed strict lockdown on March 24, 2020. -Adopted "Pool Testing" to increase testing capacity. -Launched Aarogya Setu app for contact tracing and quarantine measures. -Banned export of PPE and restricted export of APIs and medicines. -Established isolation beds and modified train carriages for patient isolation. -Launched Sanjivan mobile app for home quarantines and remote consultations. -Free COVID-19 vaccinations began on January 16, 2021.	-Experienced worst economic performance since independence, with a contraction of 7.3% in the fiscal year 2020-2021. -The economy shrank by 23.9% in the April-June quarter of 2020. -Announced a 20 trillion Indian Rupees stimulus package. -The unemployment rate soared to 23.5% but reduced to 8.5% by mid-June 2020. -Supported 800 million people with cash transfers and subsidized food grains. -35% of closed MSMEs feared to permanent closure.
Japan	-Established Cluster Response Team on February 25, 2020. -Declared state of emergency in April 2020. -Launched COCOA tracing app on June 19, 2020. -Faced a system collapse during the second wave. -Coordinated vaccination drive with local medical associations. - Used a lottery-based approach for vaccinating youth.	-GDP contracted from April to June 2020. -Announced 108 trillion yen in emergency economic measures in April 2020. -Supported startups through initiatives like the "Shibuya New Normal Lab".

1990s to 7.27 per 10,000 people in 2020, highlighting a growing gap in healthcare professionals' accessibility and quality, especially as the population continues to surge. Little progress has been made in expanding the nursing and midwifery workforce, with density increasing from 3.76 per 10,000 in the 1990s to 17.3 currently, which still trails behind global leaders in this field such as Finland and Belgium, with more than 200 personnel per 10,000. This emphasizes the need for continued investment in this critical segment to meet growing demand and improve service delivery. Additionally, while there have been successful expansions in dental education and practice, further efforts are necessary to increase the density of dentistry personnel to meet global standards. The overall increasing trends in healthcare professionals in China and Japan are impressive. However, the higher density of physicians in China is not evenly distributed across the country: it is much lower in rural areas, indicating regional disparities regarding accessible and affordable healthcare. On the other hand, the decline in physician density in India, combined with the rising prevalence of chronic diseases, indicates a widening gap in healthcare access that weakens the ability to respond to pandemic.

Chronic disease burden: There was no significant reduction in hypertension. This finding points to limited progress in tackling risk factors such as obesity and diabetes, necessitating targeted public health interventions to reduce the burden of cardiovascular diseases. All countries made commendable progress in reducing tobacco consumption.

Sanitation services and air pollution mortality: China and India are far behind Japan in providing a safe public

Table 2. Health indicators and their progress (1990-2020)

Sl. No.	Health Indicator	Country	Year		
			1990-1999	2000-2009	2010-2020
A	Density of Physicians (per 10,000 population)	China	12.4	14.2	25.2
		India	12.2	-	7.3
		Japan	17	22.1	25.4
B	Density of nursing and midwifery personnel (per 10 000 population)	China	8	13.4	33
		India	3.76	16	17.3
		Japan	59.2	100	124.5
C	Density of dentistry personnel (per 10 000 population)	China	-	0.9	5.5
		India	0.4	0.9	1.6
		Japan	6.9	7.6	8.3
D	Age-standardized prevalence of hypertension among adults aged 30 to 79 years (%)	China	26.1	29.6	27.3
		India	30.5	31.7	31.1
		Japan	34.1	32.7	31.4
E	Age-standardized prevalence of tobacco use among persons 15 years and older (%)	China	30	30	20
		India	60	40	30
		Japan	30	30	20
F	Proportion of population using managed sanitation services (%)	China	13.4	31.2	64.6
		India	6.1	23.4	47.9
		Japan	96.4	97.7	99
G	Age-standardized mortality rate attributed to household and ambient air pollution (per 100 000 population)	China	-	-	95.3
		India	-	-	139.3
		Japan	-	-	11.8
H	UHC service coverage index (out of 100)	China	47	66	81
		India	30	49	63
		Japan	70	80	83

(Source: WHO World Health Indicator Data. A, B, C, D, G, and H: https://data.who.int/indicators E: https://extranet.who.int/e-spar; and F: https://ghsindex.org/).

environment. In times of a pandemic, poor sanitation and poor air quality are clearly threats to public health. Continued and aggressive environmental interventions are necessary to reduce this threat to public health and align with sustainable development goals.

SPAR, GHS and UHC indexes: The State Parties Self-Assessment Annual Reporting (SPAR) and Global Health Security (GHS) values show that China and India are very poorly prepared for health crises. India has shown significant improvement in Universal Health Coverage (UHC) over the last decade, but compared to China (which has a similar population), UHC has fallen far behind that of China. Figure 2 helps us understand the state of health infrastructure in each country and essentially provides information about the preparedness of a country in any health crisis. Figure 2 shows the index scores for SPAR, the GHS and the UHC, highlighting the differences in preparedness among the three countries.

Health expenditure: Health spending as a share of GDP remained higher in 2021 in low-, lower-, middle-, upper- and higher-income countries than before the COVID-19 pandemic. In the context of China, India and Japan, there has been an interesting trend in the spread of COVID-19 and in countries' health expenditures over the years. While Japan's health expenditure consistently exceeded 10% of its GDP, it reached 4–5% of GDP in China and 3–4% in India over the last decade [77].

COVID-19 cases and fatality rates

Figure 3 shows the fatality rates of China, India and Japan in a time interval of 6 months between May 2020 and May 2023.

As shown in Figure 3, Japan's fatality rate steadily declined, reflecting effective health system capacity and early intervention strategies.

Figure 4 depicts the three countries' cumulative cases and fatality rates in a time interval of 6 months from the beginning of the COVID-19 pandemic between May 2020 and May 2023.

The initial months could be categorized as a 'Panic Phase' in which all countries did not have any idea about the disease. China experienced significant spread, whereas India experienced consistent growth of cases. Japan tried to balance the economy and restrictions, and the growth of the cases was significant in later waves due to the size of its population. China reported an enormous number of cases in the month of January 2023, even after the

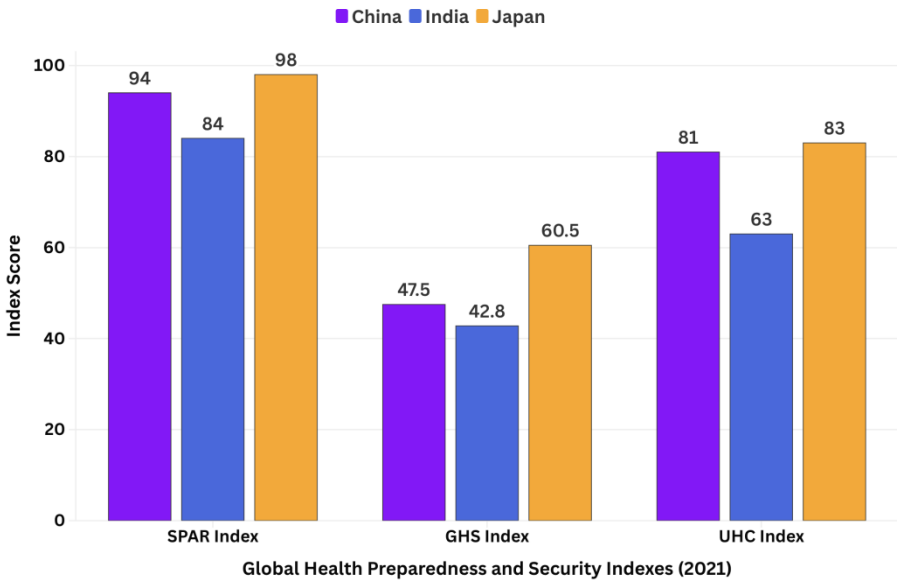

Figure 2. The Comparison of Index scores from the State Parties Self-Assessment Annual Reporting Tool (SPAR), the Global Health Security Index (GHS), and the Universal Health Coverage (UHC) for China, India, and Japan (Year 2021)

Source: Compiled by the authors from SPAR index (https://extranet.who.int/e-spar/); GHS index (India: https://ghsindex.org/country/india/; China: https://ghsindex.org/country/china/; Japan: https://ghsindex.org/country/japan/); Universal Health Coverage (UHC) progress/UHC service coverage index: https://data.who.int/indicators/i/3805B1E/9A706FD

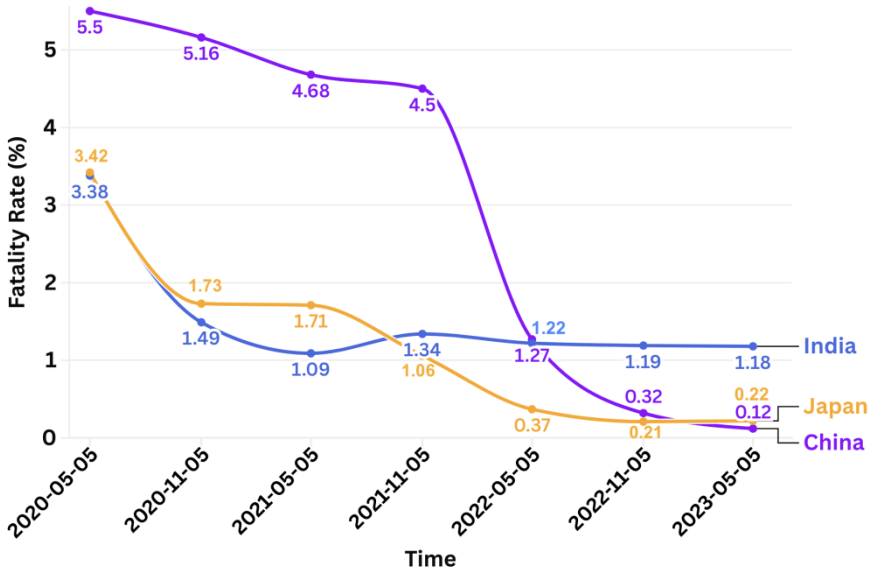

Figure 3. Transition of the fatality rates due to COVID-19 in China, India, and Japan.

Source: Compiled by the authors from the data presented in WHO COVID-19 dashboard (https://data.who.int/dashboards/covid19/cases)

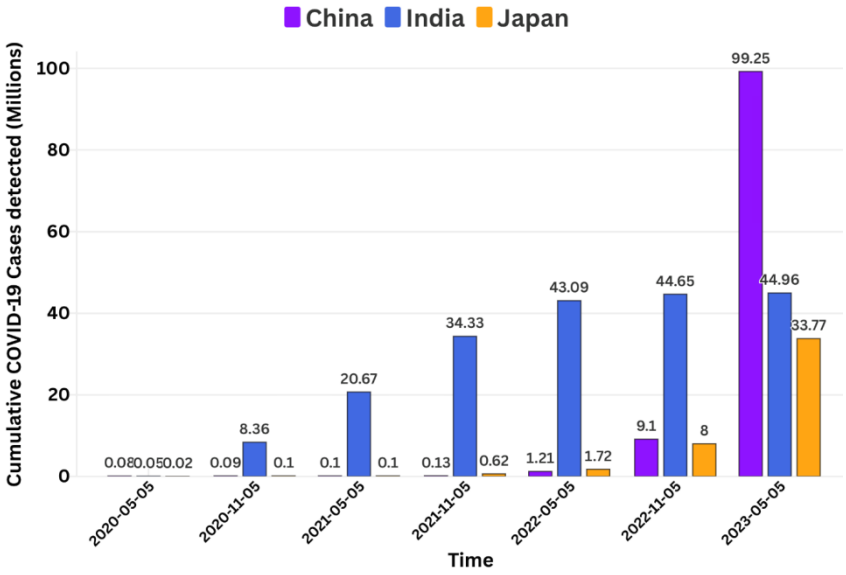

Figure 4. Cumulative COVID-19 cases detected in China, India, and Japan.

Source: Compiled by the authors from the data presented in WHO COVID-19 dashboard (https://data.who.int/dashboards/covid19/cases)

Table 3. Thematic summary table of the findings on China, India, and Japan

Country	China	India	Japan
Key Indicators	-Density of physicians (25.2/10,000) equivalent to Japan -Reproductive care needs more personnel (33/10,000) -Sanitation level could improve (64.6%) -Mortarity rate could be reduced (95.3/100,000) -UHC coverage (81%), almost equivalent to Japan	-Density of physicians extremely low (7.3/10,000) -Stagnant care for reproductive health (17.3/10,000) -Poor sanitation record (47.9%) -High mortarity rate (139.3/100,000) -Low UHC coverage (63%)	-Density of physicians (25.4/10,000) equivalent to China -Reproductive care professinoals were in good number (124.5/10,000) -Sanitation level was extremely good (99%). -Low mortality rate (11.8/100,000) -UHC coverage (83%)
Observed Policy Trends	Centralization and urbanization left vulnerable groups in rural areas and low-income section of population in urban areas	Lack of egalitarian encompassing health system for all communities and regions. Integration of the centre and the state policies needs to be reviewed.	Univeral health for all approach and good sanitation contributed to low mortality rate. Lack of digitalization caused overall monitoring of medical facilities challenging.
Potential Policy Implications	Sanitation and reproductive health care could improve by paying more attention to rural and remote areas.	Serious review of the working of decentralized health care needs to be taken	Best facilities and personnels could be utilized and maneuvered better with digital application of surveillance and monitoring of medical emergencies.

majority of the population had been vaccinated. The ability of a country's health system to manage COVID-19 can be assessed through its fatality rate. However, COVID-19 mortality can also be affected by environmental and socioeconomic factors. The fatality rates during the initial months are very high for all three countries. Compared to the other countries, the fatality rate in Japan has drastically decreased. The flat line of India's fatality rate reflects the poor state of healthcare infrastructure, which indicates that drastic measures must be taken in the coming years.

Table 3 summarizes the findings of key indicators, observed trends, and potential policy implications of China, India, and Japan.

6. Discussions

The public health responses of these three countries were strongly influenced by their political economy. This section aims to 1) compare the effectiveness of different public health strategies and interventions; 2) analyse how political, economic and social factors influence public health responses; and 3) identify common challenges and successful practices.

6.1 Effectiveness of public health strategies and interventions

The COVID-19 pandemic overwhelmed healthcare systems and forced many countries to reduce or halt essential health services. Such disruptions impacted essential health services and affected routine diagnoses, screenings and elective procedures, leading to delayed treatment of chronic diseases and other conditions. As a result, complications and mortality rates for preventable diseases increased [51] (Nascimento 2025:2). This study conducted a comparative analysis of public health strategies in China, India, and Japan during pandemics to reveal the healthcare outcomes were impacted by their respective governance structures.

China's centralized single-party system enabled rapid mobilization of resources, and decisive actions effectively mitigated the initial spread of the virus [78]. However, the lack of transparency and coordination across regions exposed systemic vulnerabilities [56].

India's decentralized governance enabled regional responses, resulting in varied state-level strategies and varied public health system goals. However, disparities in local capabilities and resources present challenges.

Japan's efficient public health infrastructure, community-based initiatives, widespread compliance coupled with a stable bureaucracy and parliamentary system effectively balance stringent health measures with economic considerations [79]. The regionalized PHC model is a powerful tool for future outbreaks of infectious disease with the approach of rapid, coordinated, and locally responsive pivots.

These practices demonstrate that a combination of centralized policy directives and localized implementation strategies can enhance public health responsiveness. Despite these differences, common challenges include ensuring equitable access to healthcare, maintaining public trust through transparent communication, and balancing public health needs with economic imperatives.

6.2 Key elements for resilient PHS

The comparative strengths and weaknesses of the PHSs of China, India, and Japan have revealed perspectives on informed future policy decision-making processes. Enhancing global health security starts with engaging regional stakeholders at the centre stage of the public health system of the country. Coordinated efforts in governance, preventive health care, and livelihood security to prepare against health hazards make PHSs resilient against vulnerabilities. The diagram in Figure 5 summarizes key the elements for enhancing the public health system with resilient elements. The crucial role of digitalization in governance needs to be further reflected to ensure active engagement of regional stakeholders in preventive healthcare and to ensure livelihood security.

6.3 Remedial measures

As remedial measures, effective PHS should swiftly focus on overcoming emergency situations caused by the COVID-19 pandemic. Figure 4 shows how systematic preparedness against vulnerability could be achieved through remedial measures and further research directions with the following crucial elements to revitalize the public health system to ensure health for all.

- Social institutions as agents of change (both public and private)
- Government to facilitate stakeholder engagement
- Media for enhanced disaster communication
- Political economy that can function to ensure sustainable livelihoods

The active engagement of stakeholders is the key to materializing systematic preparedness against vulnerability. For this purpose, preventive health cure should be ensured by securing the livelihoods of people in every country.

6.4 Recommendations for enhancing global health security

To ensure global health security, we need to develop a collaborative, adaptive approach. Lessons from China, India and Japan during the COVID-19 pandemic highlight strengths and weaknesses in our journey to build resilient global health systems. We recommend the following steps

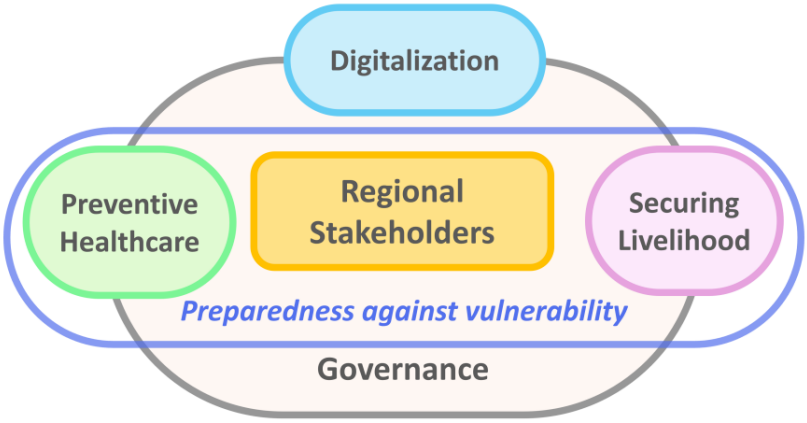

Figure 5. Diagram dipicting key elements for enhancing public health systems

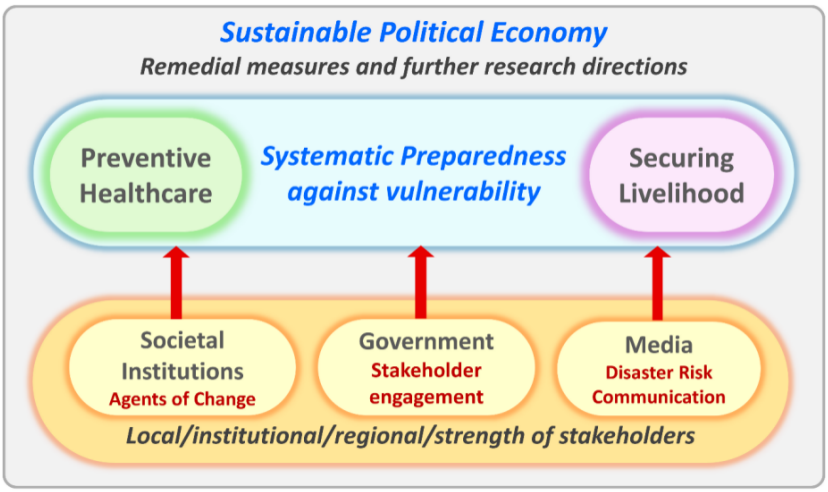

Figure 6. A Framework for sustainable political economy with systemic preparedness against vulnerability

to enhance global health security.

Strengthening international cooperation and data governance

Establishing a robust global health surveillance system: The COVID-19 pandemic highlighted the need for a global health surveillance network for real-time data exchange and early warning of emerging threats. Countries should advocate for an integrated platform under international organizations such as the WHO, to standardise data collection, improve interoperability, and ensure compliance with health regulations for timely interventions [18].

Promoting multilateral research collaboration and resource sharing: The rapid development of vaccines exemplifies the effectiveness of international scientific collaboration [80]. To build on this success, global health actors should expand joint research initiatives to develop vaccines, therapeutics, diagnostics and public health interventions, and establish cross-border research consortia and multilateral funding mechanisms. Such collaborations could foster equitable access to innovations by ensuring that lower-income countries benefit from the advances made by wealthier countries [31]. For vaccine distribution systems such as COVAX, which is led by Gavi, CEPI, WHO, and UNICEF, COVAX is a multilateral initiative aimed at accelerating the development and equitable distribution of COVID-19 vaccines worldwide, ensuring that lower-income countries also benefit from the advancements made by wealthier nations.

Fostering adaptive and resilient public health governance

Governance model of enhanced centralized coordination and local flexibility: Central authorities should provide strategic guidance, resources, and policies. Local health

authorities should have the autonomy to implement context-specific measures. This approach ensures adaptability, accountability, and alignment with national goals [29].

Strengthening local health systems and community-based interventions: Local health systems and community engagement are crucial for effective public health responses. Countries should invest in building local health capacities through community-based networks, surveillance systems, and empowered health workers. Decentralized capacity building should be supported by national frameworks for coherence and coordination.

Accelerating digital transformation and health technology integration

Development of a global digital health strategy: Digital health technologies, including electronic health records (EHRs), telemedicine, and artificial intelligence (AI)-driven analytics, are critical tools for modernizing PHS. A global digital health strategy should be developed to harmonize digital health standards, promote data interoperability, and ensure data privacy and security to facilitate cross-border data exchange and collaborative health surveillance. Investments in digital health tools and capacity building initiatives should be prioritized.

Leveraging technological innovations to improve health outcomes: AI, machine learning, and big data analytics can enhance public health decision making. For example, AI can predict outbreaks, optimize resources, and improve patient outcomes. Integrating digital tools with traditional measures can provide a more dynamic, responsive, and data-driven approach to managing health emergencies [81].

Addressing health inequalities and promoting inclusive heath

Implementing equity-centred health policies: The COVID-19 pandemic exposed health inequities. To build resilient systems, governments should adopt equity-centered policies by prioritizing marginalized populations to provide full support to vulnerable parts of our society. This includes expanding UHC, investing in the social determinants of health, ensuring accessible, affordable, and culturally appropriate services, and using disaggregated data to inform policy [31].

Enhance community engagement and participatory governance: Effective public health strategies require community participation. Countries should foster participatory governance models that empower communities to take ownership of health interventions. This involves building trust, engaging local leaders and civil society, and utilizing community networks. Community-driven approaches can enhance public trust, improve health literacy, and increase the effectiveness of public health interventions. Health issues are increasingly varied and demand collaborative relationships between communities and medical institutions in rural areas, with physicians playing a key role in modelling healthy behaviours while impacting community health practices [6].

7. Conclusions

The study focused on the three healthcare systems of China, India, and Japan to explore the elements of resilience that helped them to tide through the challenges of the COVID-19 pandemic. The key characteristics and challenges drove the countries to prioritize saving vulnerable sections of their societies: rescuing the aging population, rehabilitating impacted enterprises, addressing existing healthcare issues, while rushing to improve public health preparedness to match the enormity of the pandemic. Our findings reveal that all three healthcare systems were not fully ready to face the COVID-19 pandemic. The next pandemic will not wait. Now is the time to reform, invest, and collaborate. Based on our study, we recommend the following four crucial focal points for policy making to enhance resilience of PHS:

- Establishing dedicated teams/departments for infectious diseases control
- Ensuring well-coordinated stakeholder involvement
- Harnessing the regionalized focus with the vision of economic recovery
- Paying attention to the involvement of local entities with proper risk communication

We should establish and invest in regional regulatory systems in Asia, including China, India, and Japan, to ensure access to safe, effective, and high-quality medical products. The responses by PHS highlight varied presence or lack of adequate leadership, resources, and financial arrangements which are vital determinants for local population going through life-or-death eventualities. Policy makers should consolidate efforts by prioritizing the focal points of policy making. Our efforts should prioritize to value and save the lives of people with egalitarian approaches.

Supplementary data

The supplementary date of this study is available at: https://file.luminescience.cn/JDH-412%20Supplementary.pdf.

Authors' contributions

TK, CG, SS, YG made initial investigation, data collection, literature review, analysis and preliminary

writing. TK did data visualization, compiled references, and drafted the manuscript. TK made revision incorporating the reviewer comments. RS supervised the research process and critically reviewed the initial draft. All authors contributed to the final version of the manuscript and approved it for the publication.

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Conflict of interests

The authors declare that there are no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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