

A Comparative Study of Non-Communicable Diseases Management During Pandemics in Iran and Selected Countries

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Abstract

Introduction: Maintaining continuity of care for patients with chronic non-communicable diseases (NCDs) is imperative during pandemics. This study evaluates NCD management strategies by conducting a comparative analysis between Iran and seven other nations.

Methods: This comparative qualitative study, conducted in 2023, employed sampling to examine Iran against Germany, Canada, the United States, Singapore, Australia, the United Kingdom, and Turkey. The study focused on five core components: health workforce, health information systems, medical products, health financing, and leadership and governance. Data were extracted from reputable scientific databases and analyzed using the four-stage Adaptive Education Model (description, interpretation, juxtaposition, and comparison).

Results: The comparative analysis identified eleven key components influencing NCD management during pandemics. These included the presence of a comprehensive national strategy, effective inter-sectoral collaboration and coordination across governmental levels, access to sufficient financial resources and appropriate allocation, the efficiency and effectiveness of the financial system, optimal workforce density and distribution, community resilience and welfare, availability and quality of essential products, medications and technologies, integration of COVID-19 related data, data quality and accuracy, and the utilization of telemedicine.

Conclusion: The findings of this study, by pinpointing critical sub-components of NCD management during pandemics, can assist policymakers and health system managers in improving planning and enhancing NCD management in crises. By focusing on the gaps and international lessons learned, this research offers an opportunity to strengthen Iran's healthcare system and reduce inequalities in access to health services.

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Introduction

For over four decades, experts have sounded the alarm about the escalating epidemic of non-communicable diseases (NCDs). Yet, a misguided prioritization has

regrettably left a grim legacy of strategic neglect.¹ Ineffective national and international actions in the management of NCDs have been exacerbated by the emergence of the COVID-19 pandemic, resulting in disruptions to resource allocation, access to healthcare

services, pharmaceutical supply chains, and the continuity of care for affected patients.^{2,3}

The World Health Organization defines non-communicable diseases (NCDs) as non-transmissible conditions with a prolonged course.⁴ Despite similar definitions, various terminologies are used to refer to NCDs—ranging from “long-term conditions” in the United Kingdom and “chronic” in the United States, to “noncommunicable” in global forums. During the COVID-19 pandemic, terms like “underlying conditions” and “co-morbidities” also became common.¹ Crucially, however, NCDs share a common set of characteristics: their global pervasiveness, significant economic repercussions, shared underlying risk factors, and systemic deficiencies in both their management and the research conducted at national and international levels.⁵

NCDs impose substantial economic and social burdens on households, nations, and the global economy.⁶ According to the Centers for Disease Control and Prevention, NCDs account for 86% of healthcare expenditures,⁷ with the United States alone spending approximately 3.8 trillion annually on their management.⁸ In developing and low- and middle-income countries, NCDs place a substantial economic burden due to weak health systems.² They fuel escalating poverty, diminish productivity, and decelerate economic growth, ultimately preventing individuals, families, and entire nations from reaching their full social and economic potential. It is estimated that the failure to effectively control NCDs in low- and middle-income countries could result in over \$7 trillion in economic losses between 2011 and 2025.⁶

Socially speaking, NCDs deepen existing social inequalities by disproportionately affecting vulnerable populations. The prevalence and impact of NCDs are markedly higher among the impoverished, ethnic minorities, refugees, and other marginalized groups.^{2,8} Even with health insurance, individuals living in poverty endure considerable financial and social hardships due to high out-of-pocket expenses, frequent medical visits, and the cost of medications.^{9,10} Moreover, social and economic crises, such as pandemics, further destabilize lifestyles and curtail access to care, complicating the management of NCDs.¹¹

Searches revealed that although various studies have addressed the management of non-communicable diseases (NCDs) during pandemics, they have not yet led to the systematic design of comprehensive, evidence-based models. Karkhi et al. (2021) explored pharmaceutical care management in developing countries;¹² Reira et al. (2021) investigated disruptions in cancer care;¹³ and Ahmed et al. (2020) examined the impact of COVID-19 on access to routine care across

four countries.¹⁴ The majority of existing research was conducted under normal circumstances, with only a handful specifically addressing NCD management during pandemics. Furthermore, most literature originates from high-income countries, with scant representation from developing nations.

The present study was conducted with the aim of identifying the subcomponents influencing the management of NCDs during pandemics, in the context of Iran's health system. The findings may serve as a guide for policymakers and healthcare administrators.

Methods

This applied research was conducted using a descriptive-comparative method with the aim of exploring the components and subcomponents of NCD management during the pandemic in Iran and selected countries. According to the research methodology framework presented in Figure 1, in the first step, the countries to be compared were selected, in the next step, the comparison indicators for the countries were determined; then, through a specific search process, scientific documents were extracted, and finally, based on the qualitative analysis model, the documents were analyzed. The findings were presented and interpreted in the form of a comparative matrix.

Specific criteria were considered for selecting countries to effectively achieve the research objectives, which included the relevance of the countries to the research focus area, diversity in health system structures, socio-economic differences, availability of reliable data, geographical representation, differences

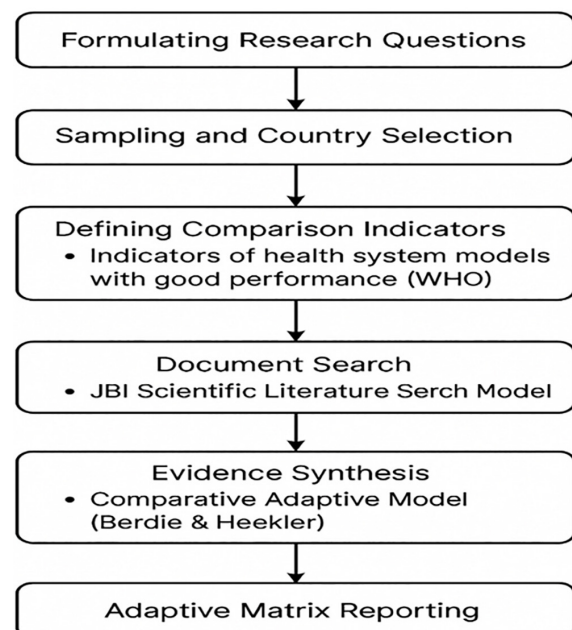


Figure 1: The research methodology framework

in policies and organizational frameworks, and the presence of the evidence of innovative practices. Accordingly, Germany, Canada, the United States, Singapore, Australia, the United Kingdom, and Turkey were purposefully and judiciously selected for comparative analysis.

The WHO framework for well-performing health systems¹⁵ was used to identify the core components. This model, designed to strengthen health systems and achieve fundamental goals, provides a comprehensive framework applicable to the management of non-communicable diseases (NCDs). Its main advantage lies in its capacity to respond in a balanced manner to the needs and expectations of the population including improving the health status of individuals, families, and communities; protecting people from health threats; shielding them from the financial consequences of ill health; and ensuring equitable access to people-centered care.¹⁶ The model is built upon six building blocks: service delivery, health workforce, health information systems, medical products and technologies, financing, and leadership/governance.¹⁵

For the systematic search of documents, the JBI search method was utilized, which is designed based on international standards for qualitative reviews. This method consists of three main stages.¹⁷ First, an initial exploratory search was conducted in the MEDLINE and CINAHL databases and the Google Scholar search engine to identify relevant primary references and extract keywords and indexed terms. In the second step, a comprehensive search strategy based on keywords was conducted. This strategy was translated into other citation databases including Scopus, Web of Science, and PubMed, internal databases including Magiran, SID, IranDoc, and gray literature sources including web pages, government white papers, and prominent think tank reports in databases such as Embase and PsycINFO, as well as gray databases like GreyMatters, GreyNet, CORE, and BASE. In the third step, a supplementary manual and citation search (forward and backward) was conducted.

For data synthesis, the Bardsy and Hecker model, one of the common qualitative methods in comparative studies, was used,¹⁸ which includes four stages: description, interpretation, juxtaposition, and comparison. This study obtained ethical approval from the Research Ethics Committee of Islamic Azad University, Science and Research Branch (IR.IAU.TMU.REC.1401.043).

Results

A total of 252 documents were identified, of which 159 were selected based on their relevance to the research objectives. These included 123 journal articles

(77.36%), 16 government documents (10.06%), 7 WHO publications (4.40%), 5 web pages (3.15%), 2 conference papers (1.26%), 2 World Bank documents (1.26%), 2 book chapters (1.26%), 1 blog post (0.63%), and 1 newspaper article (0.63%).

1. Leadership and Governance

National Strategies for Managing NCDs and Responding to Pandemics

Germany, leveraging its robust infrastructure and preventive strategies, utilized existing protocols to manage non-communicable diseases (NCDs) within the context of pandemic response; however, it did not have a dedicated national program tailored for such circumstances.^{19, 20} Canada and the United States lacked centralized national plans for managing NCDs during the pandemic, and the decentralized nature of their healthcare systems led to fragmented and inconsistent responses.^{19, 21} In contrast, Singapore and Australia implemented comprehensive and well-structured programs for NCD management; nonetheless, these programs were not specifically designed for pandemic settings.^{19, 22, 23} The United Kingdom and Turkey, emphasizing primary care and strategic frameworks, undertook efforts to ensure the continuity of care during the pandemic. However, only Turkey issued specific national guidelines for managing NCDs in the context of the pandemic; however, these too were not part of a comprehensive national program.^{19, 24}

In addition to its national action plan, Iran developed specific guidelines to address chronic diseases during the COVID-19 pandemic. These guidelines primarily focused on precautionary measures, clinical management, and rehabilitation.²⁵

Mechanisms for Intersectoral Collaboration and Policy Coordination at Governmental Levels

Germany, with its federal structure and well-established mechanisms, ensured coordination among ministries and various institutions, utilizing regular meetings of the Coronavirus Cabinet to facilitate intersectoral collaboration during the pandemic. However, challenges were noted in the early stages concerning coordination between federal and state levels.^{20, 26, 27} Canada, despite having strong public health infrastructure and participatory regional processes, faced difficulties in coordinating supply chains and integrating policies due to its federal structure and tensions across levels of government.²⁸ ²⁹ The United States strengthened intersectoral coordination by employing data-sharing frameworks and predictive models to optimize resource allocation. Nevertheless, its decentralized system resulted in inconsistent responses across the states.³⁰⁻³² Singapore, with its centralized governance model and strong leadership, implemented comprehensive strategies

for intersectoral coordination. However, it faced challenges such as limited public acceptance of certain governmental initiatives.³³ Australia improved intersectoral coordination through digital tools and telemedicine; nonetheless, geographical dispersion and weak communication between hospitals and primary care services remained significant challenges.³⁴⁻³⁶ The United Kingdom, relying on the National Health Service, provided a centralized platform for policymaking and coordination and placed strong emphasis on intersectoral collaboration. Yet, gaps in communication and resource allocation were reported.^{27, 37} Iran, through the implementation of an incident command system and the use of a primary healthcare model, sought to strengthen intersectoral coordination in managing the pandemic. Still, it encountered challenges in resource allocation and policy integration, largely due to political and economic constraints.³⁸⁻⁴⁰

2. Health Financing

Availability of Financial Resources to Ensure Service Sustainability and Prioritization of Resource Allocation

Germany, supported by a robust social system, government financial backing, and a well-developed healthcare infrastructure, was able to secure adequate funding to sustain services and demonstrated high flexibility in resource allocation.^{26, 41, 42} Canada, despite its flexibility in reallocating resources and implementing government support programs, faced challenges in ensuring service sustainability due to budget constraints and delays in the provision of non-COVID-19 care. Over time, however, it managed to overcome many of these challenges.^{43, 44} The United States, through federal relief funding, could support hospital financial sustainability. Nevertheless, persistent systemic issues—such as unequal resource distribution, uncontrolled costs, and lack of universal coverage—posed serious challenges.^{45, 46} Singapore, with its efficient financing system based on government subsidies and health savings accounts, secured sufficient resources and strengthened financial resilience through proactive planning.^{33, 47}

Australia, through public funding and preventive measures—including expanded telehealth services and hospital financing—succeeded in maintaining service continuity. However, weak coordination between hospitals and primary care required improvement.^{40, 48, 49} The United Kingdom, despite high levels of allocated funding, faced challenges to financial sustainability due to inflationary pressures, workforce shortages, and rising demand.⁵⁰⁻⁵² Turkey managed to meet some financial needs through government policies and infrastructure investments. Nevertheless, budget limitations and disparities in service provision adversely affected financial sustainability.^{53, 54} Iran,

facing severe financial constraints—including limited budgets, international sanctions, and high out-of-pocket expenditures—was unable to secure adequate resources for crisis response and service continuity. This exposed the vulnerability of the healthcare system in future emergencies.⁵⁵⁻⁵⁸

Efficiency and Effectiveness of the Health Financing System

Germany, with its social health system and strong financial reserves, was able to efficiently allocate resources for the simultaneous management of COVID-19 and NCDs. However, challenges such as disparities among vulnerable groups, including patients with NCDs, remained.^{42, 59, 60} Canada, through federal and provincial funding mechanisms, managed to maintain NCD services relatively efficiently. Still, economic pressures and resource diversion toward pandemic management negatively impacted service continuity.^{29, 61} The United States, due to its fragmented and inefficient financing structure, experienced major disruptions in NCD service delivery and inequality in access, highlighting the urgent need for structural reforms.⁶² Singapore, with an efficient financing system and preventive planning, continued NCD services without significant disruption although more attention to vulnerable populations was necessary.^{33, 63} Australia, using a mixed public–private funding model, demonstrated high flexibility. Nonetheless, service disruptions in NCD care and the need for systemic reforms to strengthen primary care became evident.^{48, 64, 65} The United Kingdom, despite extensive financial support, struggled to maintain NCD service continuity amid routine service disruptions and persistent health inequalities, which undermined the efficiency and effectiveness of its financing system.^{66, 67} Turkey, through a hybrid financing model, was able to support hospitals, but declining revenues and rising costs negatively affected financing efficiency, underlining the need for more effective policies.⁶⁸ Iran, due to financial constraints and sanctions, faced serious challenges in financing NCD services. However, efforts were made to maintain essential services by leveraging the primary healthcare system and expanding diagnostic infrastructure.⁶⁹

3. Health Workforce

Density and Equitable Distribution of the Workforce

Germany, despite having a high workforce density, encountered disruptions in care delivery—including for NCDs—due to inequitable distribution and decentralized management of human resources.^{70, 71} Canada faced workforce distribution disparities, particularly in rural areas, along with challenges such as staff burnout and shortages. However, the country attempted to mitigate the crisis impacts through innovative strategies and supportive measures for health workers.^{72, 73} In the United States, pre-existing

workforce shortages and maldistribution were exacerbated during the pandemic. These issues were particularly acute in underserved areas, where access to services diminished significantly, severely affecting NCD management.⁷⁴⁻⁷⁶ Singapore, benefiting from a well-structured health system and relatively balanced workforce distribution, managed to maintain service delivery under pandemic pressure although staff burnout remained a notable challenge.^{33, 77} Australia and the United Kingdom experienced severe workforce shortages, and regional disparities negatively impacted care quality. Both countries made efforts to recruit international professionals and utilize emerging technologies to support the workforce.⁷⁸ Turkey encountered similar challenges, especially in rural and underdeveloped areas, which led to service disruptions in NCD management.^{79, 80} In Iran, workforce shortages and inequitable distribution—particularly in rural regions—disrupted the continuity of care for NCDs.⁸¹⁻⁸³

Workforce Resilience and Well-being

Germany sought to improve staff resilience and well-being through psychological support, financial incentives, and task reallocation.⁸⁴⁻⁸⁶ Canada enhanced workforce welfare by implementing mental health programs, financial incentives, and supportive coalitions. Nevertheless, high workloads and burnout remained major concerns.^{73, 87, 88} In the United States, support measures such as mental health programs and financial incentives were implemented, but regional disparities and frontline staff burnout had detrimental effects.⁸⁹⁻⁹¹ Singapore employed comprehensive mental health strategies, financial and non-financial incentives, and workload reduction to strengthen workforce resilience. Nonetheless, stress and burnout persisted.^{26, 33} Australia supported its health workforce through mental health services, financial backing, and modifications to work environments. However, mental illness stigma and misalignment between programs and staff needs posed significant challenges.^{92, 93} The United Kingdom aimed to improve staff welfare through mental health services, financial incentives, and increased funding. Still, overall workforce well-being declined during the pandemic.^{78, 94, 95} Turkey attempted to enhance workforce welfare by offering psychological support, financial incentives, and free welfare services. However, harsh working conditions and widespread burnout were major problems.^{96, 97} Iran implemented mental health programs, financial and non-financial incentives, and welfare services to support healthcare workers. Yet, due to resource shortages, workload pressure, and burnout, these efforts were partial and insufficient.^{55, 98, 99}

4. Essential Medicines, Vaccines, Products, and Technologies *Availability of Essential Medicines, Vaccines,*

Products, and Technologies

Germany, Canada, Singapore, and Australia, benefiting from robust health infrastructures and domestic manufacturing capacities, maintained favorable conditions in securing essential medicines and medical technologies. Germany and Canada, through a focus on domestic production and strategic stockpiling, were largely able to prevent disruptions in supply chains.^{70, 84, 100} Singapore, leveraging its past experiences, engaged in stockpiling and the utilization of advanced technologies to ensure stable access to pharmaceuticals and medical equipment.^{26, 101} Despite initial challenges in supply chain management, the United States and the United Kingdom, owing to substantial investments in infrastructure and medical innovation, succeeded in adequately meeting the needs of patients with chronic conditions.^{26, 102} Turkey, through expansion of domestic production and increased hospital capacity, demonstrated moderate performance; however, it continued to face challenges in supply chain continuity.¹⁰³ Iran, due to international sanctions and infrastructural limitations, encountered significant difficulties in securing medicines and medical technologies for noncommunicable diseases (NCDs).¹⁰⁴

Quality and Safety of Essential Products, Medicines, and Technologies

Germany, Canada, and the United States stood at the forefront in ensuring the quality and safety of medical products, backed by strong regulatory frameworks and stringent standards. Germany maintained high standards through rigorous quality controls, post-marketing surveillance, and a prioritization of domestic production.¹⁰⁵ Canada successfully implemented expedited approval processes and meticulous oversight through sustained international collaboration and continuous monitoring of the supply chain.^{61, 106} The United States, under the comprehensive oversight of the Food and Drug Administration (FDA) and the issuance of emergency use authorizations, swiftly responded to urgent needs while upholding quality standards.¹⁰⁷ Singapore guaranteed the quality and safety of products through strict regulation of manufacturing and distribution, as well as the implementation of price controls.¹⁰⁸ Australia and the United Kingdom, relying on robust legal frameworks and international partnerships, ensured safe and rapid access to essential medicines and technologies.^{109, 110} Turkey, while advancing domestic manufacturing and striving to enhance its regulatory framework, exhibited moderate performance, yet faced challenges in adherence to international standards.¹¹¹ Despite domestic efforts and regulatory initiatives, Iran struggled with quality control and safety assurance of medical products due to sanctions and resource constraints.¹¹²

5. Health Information Systems

Integration of COVID-19 Data with NCD Management Systems

Singapore, through its national electronic health record system and centralized data repositories,¹¹³ and Australia, via its My Health Record system, ensured comprehensive and coordinated care during the pandemic.¹¹⁴ In contrast, countries like Germany and Canada, despite having strong infrastructures, encountered obstacles in fully integrating data due to the fragmentation of health information systems and cultural or legal barriers.^{115, 116} The United States, due to its fragmented structure and lack of national coordination, failed to achieve full data integration although federal initiatives led to partial advancements.¹¹⁷ Turkey and Iran, constrained by infrastructural limitations, insufficient resources, and a lack of standardization, faced significant challenges in data integration, which contributed to ineffective management of NCDs alongside COVID-19.^{118, 119}

Timeliness, Accessibility, Quality, and Accuracy of Data

Singapore, with its integrated and advanced health system, provided timely and accurate data for comprehensive disease management.¹²⁰⁻¹²² Australia ensured high-quality and reliable data through coordination between federal and state governments and the deployment of a robust health informatics system.¹²³⁻¹²⁵ Germany and Canada, despite strong infrastructures, faced limitations in delivering timely and comprehensive data due to decentralized structures and coordination challenges.¹²⁶⁻¹²⁸ The United States, due to the fragmentation of health information systems across various states, failed to

uniformly ensure data quality and coordination.^{7, 129, 130} Turkey, through efforts to implement digital tools and health registries, provided relatively reliable data though occasional inconsistencies and delays were observed.^{131, 132} Iran faced serious challenges regarding the timeliness, quality, and accuracy of data, which complicated the management of NCDs.^{81, 133}

Utilization of Telemedicine and Digital Health Technologies

Singapore, by leveraging its national electronic health record system and standardized telehealth frameworks, delivered comprehensive and coordinated care.^{26, 134, 135} Australia ensured continuity of care by expanding Medicare-supported telehealth services and integrating digital technologies.¹³⁶⁻¹³⁸ In Germany, despite progress in telemedicine and the enactment of legislation such as the Digital Healthcare Act, regional disparities and limited acceptance posed challenges.¹³⁹⁻¹⁴¹ Canada made significant advances through investments in digital health infrastructure and the provision of virtual services though barriers such as limited Internet access and low digital literacy among certain patients were noted.^{142, 143} The United States, supported by both public and private sectors, experienced widespread adoption of telehealth although disparities in access across regions and population groups remained.^{26, 144} In Turkey, efforts to expand digital health and telemedicine faced obstacles including limited infrastructure, unequal access, cybersecurity concerns, and low levels of e-health literacy. Additionally, high costs, lack of transparent regulatory frameworks for data protection, interoperability, and reimbursement policies hindered widespread adoption, highlighting

Table 1: Results of Comparative Analysis of NCDs Management during Pandemics

Component	Subcomponent	Turkey	UK	Australia	Singapore	USA	Canada	Germany	Iran
Governance and Leadership	Existence of a National Strategy for Non-Communicable Diseases (NCDs) and Pandemic Response	✓	×	×	×	×	×	×	×
	Mechanisms for Intersectoral Collaboration and Policy Coordination Across Governmental Levels	Fair	Good	Good	Excellent	Fair	Good	Excellent	Poor
Health Financing	Financial Resources Required to Ensure Service Sustainability	Fair	Good	Good	Excellent	Fair	Good	Excellent	Poor
	Efficiency and Effectiveness	Fair	Excellent	Good	Excellent	Poor	Good	Excellent	Fair
Health Workforce	Density and Equitable Distribution	Fair to Good	Fair to Good	Fair	Excellent	Fair to Poor	Fair	Good	Fair to Poor
	Resilience and Well-being	Fair	Fair to Good	Good	Excellent	Fair to Poor	Good to Excellent	Excellent	Very Poor
Products, Medicines, and Technologies	Availability	Fair	Good	Good	Excellent	Good	Good	Excellent	Poor
	Quality, Safety, and Regulatory and Legal Environment	Fair	Excellent	Excellent	Good	Good	Excellent	Excellent	Fair
Health Information System	Integration of COVID-19 Data into NCD Management Systems	Poor	Excellent	Excellent	Excellent	Fair	Good	Fair	Poor
	Timeliness, Accessibility, Quality, and Accuracy of Data	Good	Excellent	Excellent	Excellent	Fair	Excellent	Good	Poor
	Telemedicine and Digital Health Technologies	Fair	Good	Excellent	Excellent	Excellent	Excellent	Good	Poor

the need for structural reforms,^{103, 145, 146} Iran, despite efforts to develop digital health services, encountered infrastructural, regulatory, and cultural barriers that prevented the effective adoption and utilization of telehealth services.^{147, 148} A summary of the assessments conducted on NCDs management components is presented in Table 1.

Discussion and Conclusion

The management of non-communicable diseases (NCDs) is of critical importance, as these conditions not only impact quality of life but also impose a significant economic and social burden on health systems and societies. During the COVID-19 pandemic, NCD management in Iran faced multiple challenges that disrupted service delivery to affected patients. This study aimed to conduct a comparative analysis of NCD management components in Iran and selected countries during the pandemic. A total of 11 subcomponents related to five health system building blocks, as defined by the WHO, were identified. These subcomponents can enhance planning and management of NCDs during health emergencies. The findings, particularly in identifying existing gaps and drawing on international lessons, provide valuable opportunities to strengthen health systems and reduce disparities in access to care.

This study, by analyzing key components of NCD management in Iran and comparing them with selected countries, offers strategies to improve health system performance in times of crisis. In this context, the study by Ezzati et al. (2023) highlighted the resilience challenges faced by Iranian health centers during the COVID-19 pandemic, showing that the absence of a comprehensive national plan for NCD management negatively affected the efficiency of the health system.¹⁴⁹ The research by Goya et al. (2023) emphasized the importance of leveraging primary health care capacity and examined Iran's response measures during the pandemic.¹⁵⁰ Salamah et al. (2023) in Indonesia examined the impact of COVID-19 on NCD program outcomes, demonstrating that patients' metabolic control parameters were significantly affected.¹⁵¹ Similarly, Di Sarro et al. (2023) explored access barriers faced by patients with NCDs in Italy during the pandemic.¹⁵² This study addressed a key research gap by identifying shortcomings in NCD management and proposing comprehensive, evidence-based models, especially in times of crisis—an area inadequately explored in previous literature.

Effective governance and leadership during public health emergencies play a fundamental role in maintaining continuity of services and meeting the needs of NCD patients. This study identified key subcomponents of leadership and governance, including the presence of a national strategy,

intersectoral collaboration, and policy coordination across government levels. Intersectoral collaboration mechanisms improve communication and coordination among agencies, enhance service quality, and reduce access inequalities.²⁸ Strengthening these subcomponents can improve Iran's health system performance in managing NCDs and ensure continued services for vulnerable populations during future emergencies.

Health financing plays a crucial role in NCD management, particularly during crises, where funding shortages can severely disrupt service delivery. In this study, the health financing-related subcomponents identified were availability of financial resources, prioritization of allocations, and the efficiency and effectiveness of financing systems. The pandemic underscored the need for sustainable financing to preserve the health systems and maintain continuity of care.¹⁵³ Efficient and effective financing mechanisms reduce resource wastage and improve access in times of disruption.¹⁵⁴ The findings suggest that strengthening financial infrastructure, prioritizing resources, and establishing efficient and effective financing mechanisms can enhance NCD management and bolster the resilience of the health system in future crises.

The health workforce, as the backbone of any health system, plays a pivotal role in managing NCDs during emergencies. The quality, continuity, and effectiveness of services are closely linked to workforce capacity and equitable distribution. The three subcomponents identified under this pillar were workforce density and distribution, workforce competencies, and resilience and well-being. Adequate and equitable distribution of health personnel across regions contributes to reducing disparities in service access.^{155, 156} Finally, workforce resilience and well-being ensure service sustainability by preventing burnout and boosting motivation.¹⁵⁷ The findings highlight that strengthening these subcomponents can improve service quality and enhance the ability of the health system to cope with crises.

Access to essential medical products, medicines, and technologies is fundamental for NCD management, as it ensures treatment continuity and minimizes disease-related complications. The identified subcomponents included availability, quality and safety of products, and the regulatory and legal environment. Ensuring availability of essential medicines and technologies—particularly in emergencies like pandemics—enables uninterrupted service delivery.^{152, 158} An efficient regulatory environment expedites the approval of new drugs and technologies, facilitating timely access to essential treatments and enhancing NCD management.¹⁵¹ The

findings indicate that strengthening infrastructure for medical products and establishing advanced regulatory mechanisms can improve the service quality and increase the system resilience.

Health information systems play a central role in NCD management by providing timely, accurate, and comprehensive data, which supports strategic decision-making during crises. The three subcomponents identified were data integration, timeliness and data quality, and the use of digital health and telemedicine technologies. Integration of COVID-19 data facilitates identification of high-risk populations, optimizes resource allocation, and improves treatment strategies.^{159, 160} Accurate and timely data allow policymakers to make evidence-based decisions and optimize care strategies.^{161, 162} Digital health technologies and telemedicine enhance access and enable continuous monitoring, especially when physical access is limited.¹⁶³ Strengthening these subcomponents can transform the health system into an intelligent and flexible structure that is better equipped to face future challenges.

This research adopted a comprehensive and systematic approach to the comparative analysis of NCD management components during pandemics, identifying key gaps in Iran's health system compared to selected countries. A notable strength of this study was the inclusion of countries with diverse health system structures and socio-economic conditions, increasing the generalizability of the findings and providing valuable insights for improving Iran's health system.

However, this study faced several limitations. Intrinsic challenges of comparative studies included variations in data availability, inconsistencies in definitions and indicators across countries, and the influence of cultural and political contexts on analysis. Furthermore, reliance on existing data and secondary sources may have overlooked some undocumented or less visible aspects of NCD management. These limitations underscore the need for future research using mixed methods and primary data collection to provide a more comprehensive understanding.

The findings of this study can serve as a foundation for designing comprehensive models applicable to managing other diseases. Future studies could focus on analyzing interrelationships among the identified components, assessing the impact of financial and governance policies on health outcomes, and evaluating successful country experiences under similar conditions. This synthesis of applications can facilitate meaningful interactions between policymakers and researchers, supporting the development of innovative strategies to improve public health management.

By conducting a comparative analysis of NCD management during pandemics, this study identified the strengths and weaknesses in Iran's health system and those of selected countries. The findings demonstrated that effective NCD management under crisis conditions requires strategic planning, intersectoral coordination, adoption of innovative technologies, strengthening of health infrastructure, sustainable financing, and equitable workforce distribution. This research provides an evidence-based model and draws on international best practices, offering a valuable opportunity to enhance the resilience of health systems and promote equity in access to health services. The results can not only improve NCD management in Iran but also serve as a model for other countries facing similar crises. It is hoped that this study will inform more effective actions and comprehensive planning for public health management in future emergencies.

Ethics Statement

This article forms an integral part of a thesis with the code of 123246089323221400162456365, which has been registered at the Islamic Azad University with the ethical code of IR.IAU.SRB.REC.1401.043.

Authors Contributions

TZ wrote the initial draft of the manuscript assisted by RL, LN, and KH. TZ designed the study with input from RL and LN. KH and RL conducted the statistical analyses under the supervision of LN. All authors contributed to revising the manuscript and approved the final version. TZ and RL are the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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