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Assessment of Emergency Preparedness and Health Systems Resilience in Middle East and North African Region: The Case of Tunisia

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Abstract

Background: Although COVID-19 is the most recent example of a health emergency in Tunisia, the escalating frequency and complexity of global health threats have elevated the imperative for stronger and more resilient health systems. The objective of this study is to assess the capacity of Tunisia's health system to prevent, detect and respond effectively to health shocks and to generate a practical, actionable list of priorities to strengthen health system resilience and enhance emergency preparedness and response.

Methods: We adapted the Emergency Preparedness and Health System Resilience Assessment (EPSRA) tool—a new and novel instrument [1] to offer a comprehensive and adaptable approach for the self-assessment of health system resilience against health shocks. The tool consists of four components: (1) Financing arrangements; (2) governance and institutional arrangements; (3) health system resources, public health, and service delivery, (4) data and information systems (including surveillance systems). Data collection involved a combination of document reviews and stakeholder meetings, relying on comprehensive and inclusive self-assessment processes, engaging relevant ministries, agencies and stakeholders.

Results: The assessment results reveal substantial variations in progress across the different components. In the financing arrangements component, the country has made significant progress in contingency appropriations for emergencies and social protection mechanisms for vulnerable populations, both rated as "expanding". However, financing arrangements for surge capacity during emergencies and maintaining essential services are lagging, rated as "developing" and "beginning," respectively. The governance and institutional arrangements component presents a mixed picture. Key governance subcomponents, including the presence and maturity of policies and strategies for emergency preparedness, regulatory capacity, and community engagement are rated as "expanding" while informed decision-making processes is rated as "mature”.

Weaknesses are evident in areas such as organizational structures and mechanisms for emergency response, and the socio-political and macroeconomic environment, which are rated as "developing". The health system resources, public health, and service delivery component reveals a concerning picture. Most subcomponents in this category are rated as "developing," highlighting a need for improvement in functional and reserve capacities of human resources and physical resources, training, and infrastructure development that enables both emergency response and the maintenance of essential services. For the data and information systems component, framework and operational procedures for data and information systems, infrastructure to support these systems, and the presence and maturity of key data sources are rated as "expanding” while other areas, such as the presence and maturity of early warning and surveillance systems for timely detection of shocks, the flow of data between stakeholders, and knowledge management are rated as "developing".

Conclusion: The study demonstrated the feasibility of the ESPRA tool to assess a country’s health system resilience, offering key insights for practical implementation. Findings can serve as both a

starting point and a platform for ongoing policy dialogues and health reform efforts at the country level.

BACKGROUND

The COVID-19 pandemic placed immense stress on healthcare systems worldwide, testing their resilience [1]. Even in high-income settings, public health systems were overwhelmed and struggled to cope with the excess demand for care, equipment, staff, life-saving medication, and vaccinations [2]. This pressure resulted in disruptions in the provision of essential health services globally [1]. The pandemic's impacts extended beyond health systems, causing significant economic slowdowns in many countries due to halts in economic activity, job losses, livelihood disruptions [3].

The Middle East and North Africa (MENA) region was one of the most significantly impacted by the COVID-19 pandemic. As of 5 May 2023, when the World Health Organization declared the end of COVID-19 as a public health emergency of international concern [4], the MENA region had reported over 15 million confirmed cases of SARS-CoV-2 and approximately 175,000 deaths, resulting in an average Case Fatality Rate (CFR) of 1.2% [5]. While responses to the pandemic and its impact across the MENA region have been heterogenous, the pandemic revealed common weaknesses in health systems' resilience. It exposed significant gaps in both preparedness and the ability to absorb and manage shocks [6]. These vulnerabilities underscore the urgent need for a renewed focus on making health systems more resilient against future public health threats in the MENA region. To achieve this, it is critical for governments to prioritize the assessment of key health system functions such as financing, governance, institutional arrangements, health resources and service delivery, as well as data and information systems [7, 8].

Although consensus has emerged on the importance of building resilient health systems in the wake of the pandemic, COVID-19 also revealed the inadequacies of existing tools and frameworks designed to help countries prepare for such threats [9]. Moreover, in the MENA region, no frameworks or tools were found in the literature that are specifically developed to assess health system resilience.

In response, the World Bank, in collaboration with a team of experts, developed the Emergency Preparedness and Health System Resilience Assessment (EPSRA) tool—a novel instrument designed to offer a comprehensive and adaptable approach for the self-assessment of health system resilience against health emergencies, using a multisectoral platform that fosters continuous learning and improvement [7]. Based on stakeholder availability and interest, as well as the impact of COVID-19, three contexts were selected for implementation of the tool- Tunisia alongside Jordan and the West Bank and Gaza. In this paper, we focus on the findings from Tunisia.

Tunisian context

Tunisia, a lower-middle income country in northern Africa, has a population of almost 12,000,000 [9, 10].

The health system in Tunisia is characterized by a mix of public and private providers, with the Ministry of Health overseeing the majority of healthcare services, supplemented by a social security system for formal sector employees [12] (Table 1 and Appendix 1).

Tunisia has been among the most affected countries by the COVID-19 pandemic in the MENA region. From the onset of the pandemic until May 5, 2023 [4], the country recorded over 1.14 million confirmed cases and nearly 29,000 deaths attributed to the virus [15]. Tunisia has had one of the highest mortality rates due to COVID-19 in the world (248.26 per 100,000 inhabitants) [15], highlighting weaknesses in its health system as well as gaps in pandemic preparedness and response [16]. Access to essential health services has also been disrupted, with 35% of households facing interruptions to health services in 2020 [17]. As a result, Tunisia's excess mortality rate of 324 per 100,000 is higher than its COVID-19 mortality rate and is the second highest in the MENA region, revealing the limitations of the healthcare system in managing the direct and indirect effects of the pandemic [17, 18]. Despite these constraints, Tunisia has achieved one of the highest COVID-19 vaccination rates in the MENA region, exceeding 50%.

The decline in key health indicators, combined with economic instability, further strained Tunisia's healthcare system, as seen during the COVID-19 pandemic. In 2020, Tunisia's GDP contracted by almost 10% due to the economic shock imposed by COVID-19 and ongoing budgetary difficulties, with slow recovery in 2021 [10, 11], making the country one of the hardest hits in the MENA region.

Although COVID-19 is the most recent example of a health emergency in Tunisia, the escalating frequency and complexity of global health threats – from pandemics like COVID-19 to climate change-induced emergencies – have elevated the imperative for stronger and more resilient health systems in Tunisia, and the world over.

Aim and objectives

The overall aim of this study is to strengthen Tunisia's health system resilience and enhance its preparedness for future public health emergencies. The specific objectives are to:

- Assess the health system's capacity to prevent, detect, and effectively respond to health shocks, including the ability to scale up and mobilize surge capacity.
- Generate a practical, actionable list of priorities for stakeholders and policymakers to strengthen health system resilience, as well as improve emergency preparedness and response.
- Examine the practicality of implementing ESPRA tool to assess a country's health system resilience

METHODOLOGY

Description of tool

We adapted the EPSRA tool for this assessment, with the methodological considerations of its development detailed in the paper by El-Jardali et al, 2025 (7). The EPSRA tool consists of five

components or building blocks: (1) Financing arrangements; (2) governance and institutional arrangements (including government leadership); (3) health system resources, public health, and service delivery, (4) data and information systems (including surveillance systems); and (5) socio-political and cultural environment. Each of the components consists of various subcomponents. Each subcomponent is assessed using a mix of quantitative and qualitative indicators and, on that basis, scored to reflect the maturity of the country's capacity in that specific area. Table 2 provides a brief overview of the EPSRA tool. For the purpose of this assessment, a modified version of the tool was utilized, where the fifth component on 'socio-political and cultural environment' was merged as part of component 2.

We defined health system resilience as the ability of a health system to anticipate and prepare for potential shocks, absorb shocks, including the maintenance of essential functions during shocks, and transform the system in ways that increase its long-term resilience to similar shocks in the future [7].

Implementation process

The modified EPSRA tool was implemented in Tunisia between July 2022 and March 2023, through a collaborative effort between the Ministry of Health and the World Bank team in Tunisia. Data collection involved a combination of document reviews and stakeholder meetings. Data generated from the different sources were collated and analyzed in aggregate form according to the tool's four components. Data triangulation was employed to enhance the reliability and validity of findings by cross-checking of information across different sources.

The completion of the tool relied on a comprehensive and inclusive self-assessment process, engaging relevant ministries, agencies, and stakeholders. It encompassed three phases: preparatory; implementation, and post-implementation [7]. Each phase is described in detail below.

Preparatory phase

The implementation process began with a preparatory phase to secure stakeholder buy-in and national ownership. Key meetings were held with senior officials from the Ministry of Health including the Director General of Health, the Minister's Office and the Directorate of Studies and Planning to establish the implementation plan. The World Bank team provided technical support for the preparation and conduct of the assessment. Following these meetings, a taskforce was created, consisting of four working groups, each focused on one of the tool's components, and coordinated by focal points officially designated by the Minister. A sampling frame was developed for stakeholder selection, which included governments and ministries, civil defense organizations, national regulatory bodies, intergovernmental agencies, health and social sector entities, non-state actors, and academia [7]. Each working group encompassed 6–10 stakeholders, ensuring a cross-sectoral approach to the assessment. A desk review was also conducted to compile relevant background information (including data requirements) to

facilitate completion of the tool and provide an evidence-based foundation for the subsequent discussions.

Implementation phase

The implementation phase was carried in two steps. First, working groups held several meetings to conduct preliminary assessments using the tool. These assessments were conducted iteratively, with a consensus-based approach, ensuring that all perspectives were considered and that the assessment tool accurately reflected the landscape in Tunisia. The focal point for each component facilitated discussions, guiding the group towards a consensus on the current state of preparedness and steering the dialogue from assessment towards initiating an action plan. To support evidence-based decision-making, each stakeholder was provided with a booklet containing the consolidated background information. In the second step, a national workshop was held on September 23, 2022, organized by the Ministry of Health and led by the Director General of Health. The workshop gathered around 60 participants from various governmental sectors, many of whom had been involved in the COVID-19 response, further underscoring the relevance of the assessment. This event enabled the finalization of the assessment through a collaborative process.

Post-implementation phase

The assessment underwent several levels of verification and validation to ensure its accuracy and reliability. These validation exercises served to review the findings and recommendations, foster dialogue among diverse stakeholders, identify synergies across different components and sectors. The ultimate aim is to yield and endorse practical, actionable set of priorities and link them to the priorities already set in the national plan and strategies, as part of efforts to inform future policy discussion in the country. The initially established taskforce was assigned to oversee the implementation of these recommendations, with the goal of enhancing Tunisia’s preparedness and capacity to respond to health emergencies. To monitor progress, a system for periodic follow-up assessments may be established, allowing for continuous evaluation and adjustment of the action plan.

RESULTS

The results section is divided into two parts. Part 1 presents the key overall findings from the capacity assessment conducted using the tool, followed by a component-wise breakdown of these findings. Part 2 highlights the priority areas for action identified for the different components.

PART 1: FINDINGS FROM CAPACITY ASSESSMENT

The assessment results reveal substantial variations in progress across the different components, highlighting key strengths, gaps and areas for improvement (see Table 3). The following sections summarize the main findings for each of the four components.

Component 1: Financing Arrangements

This component focuses on a government’s contingent financial resources planning and its ability to mobilize additional resources in the event of pandemics and other health shocks. It comprises four subcomponents, encompassing a total of 16 indicators. The scorecard shows the ratings for each subcomponent, ranging from “Beginning” to “Mature”. Below, we present the key findings under each subcomponent.

Subcomponent 1.1: Contingency appropriations mobilized for emergencies (maturity level: expanding)

The Tunisian government has established emergency funding provisions detailed in the Finance Act and the medium-term budget framework, accounting for about 1.6% of annual expenditure. These funds, categorized as "Unforeseen and unallocated expenditure," are intended for general emergency use (health sector is not explicitly mentioned), with sectoral allocations made based on need. The Ministry of Health is prohibited by law from maintaining its own emergency fund and instead manages the funds allocated to it. Additionally, two specific emergency funds exist. The Policyholders' Guarantee Fund for compensating insured individuals during insurance insolvency (managed by Tunis-Reinsurance company on the basis of an agreement with the Ministry of Finance) and the Compensation Fund for Agricultural Damage for use in the event of climatic or other natural disasters to protect farmers and fishermen (managed by the CTAMA insurance company). Findings highlight a need to ensure flexibility of budget execution and the incorporation of the health sector and health-related emergencies in emergency funding plan.

Subcomponent 1.2: Funding Arrangements for Surge Capacity during Emergencies (Maturity Level: Developing)

While there are mechanisms for mobilizing emergency funds, public finance management bottlenecks at the Ministry of Health hinder swift responses. During the COVID-19 pandemic, TND 1,200 million (USD 390 million) were reallocated to combat the crisis, but significant procurement delays occurred despite a temporary ministerial decree which was created to facilitate this process. Tunisia participates in credit risk financing mechanisms, like SOTUGAR, to support SMEs and has allocated TND 512 million (around $182 million) in relief during the pandemic. Accountability mechanisms are in place for monitoring emergency financial allocations through annual reviews and audits. Key challenges include integrating surge capacity provisions into health financing strategies, developing flexible emergency supply guidelines, and strengthening direct financing mechanisms for better frontline responsiveness.

Subcomponent 1.3: Financing Arrangements for Maintaining Essential Services (Maturity Level: Developing)

Despite the high level of expenditure on health, the country suffers from fragmented and inefficient financial risk protection schemes that lead to insolvency. A high proportion of the health budget is

devoted to insurance reimbursements and staff salaries, leaving limited funding for the purchase of essential supplies. Furthermore, the absence of price ceilings for Caisse Nationale d'assurance maladie (National Health Insurance Fund) services contributes to late payments to suppliers, including the Pharmacie Centrale de Tunisie (PCT), resulting in stock-outs of essential medicines and supplies, particularly during crises.

Subcomponent 1.4: Social Protection Mechanisms for Vulnerable Populations (Maturity Level: Beginning)

Financial protection schemes are inadequate, leaving many households exposed to healthcare costs. Despite over 80% of the population being covered by a solidarity or contributory health insurance scheme, high out-of-pocket expenses persist, particularly among the poorest. Existing financial risk protection schemes are not well targeted, with 60% of the poorest quintiles not enrolled. During the pandemic, 33% of households reported food insecurity, and 35% faced disruptions in accessing essential care. Findings indicate a need to strengthen targeting mechanisms for better access to protection, and enhance links between the social register and insurance eligibility.

Component 2: Governance and institutional arrangements

This component assesses the governance and institutional arrangements related to emergency preparedness, response, and recovery within the Tunisian health system. It comprises six subcomponents, encompassing a total of 20 indicators. The scorecard shows the ratings for each subcomponent, ranging from 'Developing' to 'Mature'. Below, we present the key findings under each subcomponent

Subcomponent 2.1: Presence and maturity of emergency policies and strategies for emergency preparedness, response and recovery (maturity level: expanding)

Tunisia has annual budget for contingent funding but lacks comprehensive policies for emergency preparedness, with existing policies limited to specific incidents like chemical or radionuclear accidents. The Ministry of Health has signed agreements with 14 other ministries within the framework of the International Health Regulations (IHR), but the focal points of these ministries have no decision-making powers, with collaboration primarily limited to monitoring. Implementation of the IHR in Tunisia has led to the introduction of measures and activities to strengthen health safety. Nonetheless, there are still gaps in the establishment of a coherent policy framework for emergency and disaster response, with clearly defined Clarify the roles and responsibilities.

Subcomponent 2.2: Organizational structures and mechanisms to respond to emergencies (maturity level: Developing)

Although Tunisia has a risk assessment system with well-defined leadership and responsibilities, coordination problems among stakeholders contribute to delays in decision-making, and restrict the

management and institutional capacity required for effective implementation and evaluation. The President's office manages the crisis alert and response system, with the ability to mobilize the army or paramilitary forces when necessary. At the regional level, regional crisis committees are established. The Ministry of Health leads the health sector's response, working collaboratively with other ministries. Despite these structures, the overall response system remains fragmented as depicted during the COVID-19 pandemic. The multitude of decision-makers in the various risk prevention and pandemic preparedness functions without the presence of the necessary coordination mechanisms, prevented effective and timely decision-making during the pandemic, particularly for the management of physical and human resources. Furthermore, the fragmented nature of surveillance and public health missions leads to occasional overlaps in responsibilities and a lack of collaboration among relevant services (HR, logistics, laboratories, donation management, bed management, field hospitals, science). Findings highlight a need to review coordination mechanisms, define roles, and conduct regular risk assessments.

Subcomponent 2.3: Institutional capacity for regulation and oversight (maturity level: expanding)

Although there is regulatory capacity for emergency response oversight, it is handled by several entities, none of which are independent, limiting transparency. The Ministry of Health has regulatory capacity for the approval and oversight of therapeutic products, vaccines and emergency countermeasures, but faces financial, political and legislative constraints to carry out its essential functions and adapt quickly. Areas for improvement include developing a national database for managing stocks of essential supplies at all levels; establishing IT systems and dashboards to facilitate access and decision-making by political decision-makers; and strengthening the country's institutional capacity to oversee public health in the event of an emergency.

Subcomponent 2.4: Informed decision-making processes (maturity level: mature)

This sub-component is rated as "mature" because decision-making is based on up-to-date evidence and data. During emergencies, like the COVID-19 pandemic, decisions were informed by available evidence and global practices, involving multiple ministries. However, political issues and lack of coordination hinder timely action. Clear triggers and guidelines for informed decision-making as well as unification of the various committees (HR, logistics, laboratories, donation management, bed management, field hospitals, science) to centralize coordination and management tasks are needed to further strengthen this process.

Subcomponent 2.5: Management and institutional capacity for Implementation and evaluation (maturity level: expanding)

Training initiatives for various healthcare professionals including for senior executives (regional health directors, general directors and directors of PHCs, doctors, particularly heads of department) have been

implemented before and during the pandemic to improve management capacity (crisis communication, hospital casualty influx plan, field epidemiology, etc.). Additionally, simulation exercises are carried out for various types of disasters and emergencies, albeit they occur irregularly, leading to gaps in preparedness and responsiveness. Assessments have been carried out to take stock of the country's response to COVID-19, including by independent experts (e.g. in November 2020 by WHO); however, the absence of a continuous evaluation framework limits the ability to adapt and improve strategies effectively.

Sub-component 2.6: Community engagement, communication, and outreach capacity (maturity level: expanding)

While civil society, community and voluntary organizations were heavily involved during the COVID-19 pandemic, the government currently lacks an institutionalized communication management system for health risks. During the early phases of the pandemic, communication efforts were comprehensive, targeting different audiences (general public, healthcare professionals and media) and leveraging various channels (SMS, TV, radio, social networks, urban billboards, etc.).. However, these initiatives were not continued in the later phases of the pandemic, particularly during the vaccination campaign. Institutionalizing citizen participation and assessing the government's capacity for health risk communication in the context of new and emerging diseases are recommended.

Component 3: Health system resources, public health and service delivery

This component focuses on the ability of the health system to deliver quality care to respond to health shocks while ensuring maintenance of essential health services. It comprises four sub-components, encompassing a total of 35 indicators. The scorecard shows the ratings for to each sub-component, ranging from 'Developing' to 'Expanding'. Below, we present the key findings under each sub-component.

Subcomponent 3.1: System organization enabling both emergency response and maintenance of essential services (maturity level: developing)

This subcomponent is rated as "developing" due to inadequate organization within the health sector and its coordination with other actors for effective emergency response and maintenance of essential services.

During the COVID-19 pandemic, the Ministry of Health, alongside the army, Ministry of Finance, Ministry of the Interior, MAS, civil society, and the private sector, coordinated the curative response. Key actions included reorienting hospital services to create intensive care units and isolation facilities, designating specific hospitals for COVID-19 patients, and utilizing community locations (e.g. schools) for treatment and quarantine. A sub-committee established within the Ministry of Health coordinated the supply and distribution of PPE and medical equipment. COVID-19 has also seen an increase in the use of telemedicine, with the adoption of decree (no. 2022 – 318) laying down the general conditions for the

practice of telemedicine and its areas of application. Despite these efforts, disruptions to essential health services occurred, varying by region and type of service. Circular No. 10 of 2019 established processes to integrate service delivery to vulnerable populations, but their scope and geographical coverage are limited. Additonally, over-reliance on hospitals for routine care and limited availability of primary healthcare services led to significant disruptions in routine service provision. Furthermore, collaboration with the private sector proved difficult at the national level, partly due to the absence of specific guidelines on engaging with the private sector and purchasing services.

Subcomponent 3.2: Functional and reserve capacities of human resources for health (maturity level: developing)

This subcomponent is classified as "developing" due to insufficient functional and reserve human resources. There is no standardized national human resources plan, and only a few personnel are trained for emergency situations (emergency personnel). A national map of human and physical resources exists, but it is not updated in time to adapt to certain shocks, and data on the private sector is lacking. The country suffers from a general shortage of human resources in the health field, which manifested during the pandemic with increased demand for health workers' working time. Measures to mobilize human resources during COVID-19 included: hiring health professionals to strengthen screening processes; redeploying health personnel according to need; recruiting additional health workers, medical and nursing students and volunteers; returning inactive or retired health professionals; and using the army's medical capacity. While the Ministry of Health was able to allocate staff based on need, there are no standardized emergency plans or regulations for staff reallocation or redeployment of healthcare professionals in the event of a crisis.

Subcomponent 3.3: Functional and reserve capacities of physical resources (maturity level: developing)

This subcomponent is considered "developing" due to limited physical resource capacity which exacerbated the COVID-19 responses. As with human resources, data on physical resources and medical equipment are available, but incomplete. Consequently, stockpiling essential supplies, including PPE and reagents, remains inadequate. The pandemic prompted standards for optimizing resources (e.g. number of staffs per bed) and increased oxygen production and ICU bed capacity. It also expanded testing capacity in the public sector with the integration of laboratories from other ministries (defense, interior) followed by the private sector. Nonetheless, these measures were short-term, with no national plans in place for the use of physical resources during crises to sustain capacities. Furthermore, weak primary healthcare structures led to their unde-utilization to reduce pressure on specialized facilities.

Subcomponent 3.4: Public health functions (maturity level: expanding)

Functional mechanisms for monitoring basic service provision at national level exist; however, capacity to use planning tools to reinforce and deploy reserves of human and financial resources in the event of

service disruption is limited and confined to selected facilities within the public sector. Furthermore, there are no up-to-date records to maintain situational awareness. Existing protocols for testing, contact tracing and surveillance are not comprehensive and primarily implemented in public hospitals. Areas for improvement include the need to develop updated plans for the healthcare system, staggered according to the different levels of the healthcare system, to enhance responsiveness. A coordination plan with the private sector needs to be established, capitalizing on successful local initiatives. Training in psychological care for healthcare professionals and the public should be supported, and the capacities of regional health departments need to be strengthened.

Component 4: Data and information systems

This component focuses on the availability and maturity of data and information systems relevant to the health sector as well as the existence of data-sharing protocols. It comprises six sub-components, encompassing a total of 19 indicators. The scorecard shows the rating for each sub-component, ranging from “Developing” to “Expanding”. Below, we present the key findings under each sub-component.

Subcomponent 4.1: Framework and operating procedures for data and information systems (maturity level: expanding)

This sub-component is rated as "expanding" due to the presence of a framework and operational procedures governing Tunisia’s health information system. While there are implementation gaps, the COVID-19 pandemic has accelerated the transition toward an integrated health information system, demonstrated by the development of a fully digitized COVID-19 vaccine management system (eVax) in a very short space of time. A Health Management Information System (HMIS) is operational at public health facilities, managed by the *Ministry of Health's Computer Center* (CIMS), albeit(primary health centers currently lack connectivity. Efforts are underway to transition from facility-level HMIS to individual-level systems, and to develop a national strategy that will better define the scale and scope of patient-level health information system.

Recognizing the need for improved integration between the public and private sector, there is an ongoing push to align the private sector's HMIS with that of the Ministry of Health. This integration currently focuses only on COVID-19-related initiatives, such as testing platforms and vaccination management. Additionally, while some data management protocols exist in Greater Tunis, they are limited in scope and not standardized across all entities (thus, cannot be optimally used in emergency situations). A legal framework for HMIS is still under development while the protection of personal data is supported by existing legislation (n° 2004-63). Findings highligh the need to improve interoperability between public and private HMIS for routine health information and epidemiological surveillance data; as well as standardizing data management protocols to further support interoperability across systems.

Subcomponent 4.2: Infrastructure and capacity to support information systems (maturity level: expanding)

This sub-component is rated as "expanding" due to existence of the infrastructure and capacity to support information systems, albeit they remain inadequate. The physical infrastructure, particularly in terms of electricity supply is sufficiently available; however, there are deficiencies in computer availability, network capacity and data storage infrastructure. Additionally, the current human resources are insufficient to manage the increasing workload in this area. The Ministry of Health is currently assessing network infrastructure, particularly in low-capacity and disadvantaged areas, in preparation for introducing digital health systems, as part of a project funded by the European Union. Where digital healthcare systems have been introduced, they remain hybrid, with a persistence of paper-based forms and documents.

Subcomponent 4.3: Presence and maturity of key data sources (maturity level: expanding)

This subcomponent is rated as "expanding" due to the existence of reliable data sources, albeit the overall landscape remains fragmented with various information systems managed by different entities. The *National Statistical Institute (INS* is responsible for overseeing capacity building and training in data management and analysis. Population censuses are carried out at regular intervals every ten years, and the vital statistics and civil registration system (CRVS) is robust. There are also registers for diseases including cancer, but data is not collected regularly and the registers are not integrated which limits their effectiveness for disease surveillance. Health surveys exist, but they are infrequent while surveys of health facilities, such as the Service Delivery Indicator (SDI) or the Service Availability and Readiness Survey (SARA), have not been carried out. Additionally, an information system on the logistical management of supplies and human resources exists, but it is neither exhaustive nor updated on a regular basis.

Subcomponent 4.4: Presence and maturity of early warning and surveillance systems for timely detection of shocks (maturity level: developing)

This sub-component is rated as “Developing" because current early warning and disease surveillance systems have very limited surveillance or alert capacity and cover only a small range of diseases.. Although the Early Warning System (EWS) has been established for a priority list of diseases ((defined in the national epidemiological response guide, hosted by the Tunisia Primary Health Care Directorate (DSSB)), its overall capacity is minimal, with implementation limited primarily to influenza surveillance. Additionally, while specific units within the Ministry of Health are responsible for disease-specific monitoring, enhancing coordination among the various units is crucial, as is integrating "One Health" initiatives that integrate animal health monitoring into existing frameworks.

Subcomponent 4.5: Flow of data between stakeholders, data sharing, and data integration mechanisms (maturity level: developing)

This sub-component is rated as "Developing", because data sharing among different information systems is limited. The COVID-19 pandemic provided the impetus needed to enhance interoperability, highlighted by the creation of the Evax online platform for exchanging vaccination information across public and private systems. This platform is currently being extended to become the national database for information on vaccinations, including routine and travel vaccinations. However, broader data exchange protocols and integration across different data sources are still lacking, representing an opportunity for future action.

Subcomponent 4.6: Knowledge management (maturity level: developing)

This subcomponent is rated as "Developing" due to weak real-time knowledge production and management capacity with limited integration of information between sectors and levels of government. Additionally, the absence of standardized protocols across public health institutions leads to fragmented and compartmentalized information with poor aggregation capacity, thus, resulting in delays in information transfer from district to regional and central levels. Key challenges include poor financial resources; poor coordination with stakeholders; and lack of clearly defined roles and responsibilities of key stakeholders in knowledge management.

PART II: PRIORITY AREAS FOR ACTION

The assessment generated key priority recommendations to strengthen the resilience of Tunisia’s health system and enable proactive response to future public health crises and emergencies.

At the governance arrangement level, it is necessary to update national strategies, policies, and protocols, incorporating lessons learned from the COVID-19 pandemic. Coordination among various stakeholders should be institutionalized both within the health sector and across sectors.. Social protection programs must be incorporated into budgeting and health emergency responses. At the financial arrangement level, maintaining a budget line for contingencies while explicitly including the health sector in emergency financing plans as well as defining guidelines for flexible procurement and contracting arrangements, are necessary to facilitate mobilization of funds for health emergencies. Strengthening public financial management through decentralization and facility/regional autonomy can further ensure faster responsiveness. At the delivery arrangement levels, mapping essential services, establishing guidelines for private sector collaboration, creating agreements for human resource deployment, and standardizing stock planning for essential supplies need to be addressed to enable surge capacity while maintaining essential services during emergencies. As for the health information system, it is critical to enhance competencies and structures to support better access to data, transparency, and decision-making, strengthen institutional capacity for integrated disease surveillance

and promote the One Health approach to address the increasingly complex and interconnected health challenges facing the country.

The COVID-19 pandemic has also accelerated the launch of innovative solutions, such as live-data collection and surveillance, integrated HMIS, the strengthening of infection prevention and control, and the establishment of legal framework for telemedicine, all of which need to be further scaled up. Investment in public health functions should not only be at the national level but also at the subnational level, encompassing preparedness and response, capacity building, and training. Operational and implementation research on preparedness and response interventions should be prioritized and institutionalized within the Ministry of Health (MOH), given the contextual challenges and continuous risk of emergencies.

Tables 4–7 outline the prioritized activities/actions for each component (governance, financing, delivery, and information systems), which have been validated by key stakeholders, along with the responsible entities and suggested timeline. A number of activities and projects are already underway or have been included in the Ministry of Health's development plan. These have been highlighted in a different color in the table.

DISCUSSION

The COVID-19 pandemic served as a critical learning experience for countries, including Tunisia, prompting a reevaluation of health system preparedness and resilience [19, 20]. The implementation of the EPSRA tool helped diagnose the country's preparedness and responsiveness to health emergencies and offered a roadmap to enhance the health system resilience to future health emergencies.

In the financing arrangements component, there are notable strengths and weaknesses. The country has made significant progress in contingency appropriations for emergencies and social protection mechanisms for vulnerable populations, both rated as "expanding". However, financing arrangements for surge capacity during emergencies and maintaining essential services are lagging, rated as "developing" and "beginning," respectively. Comparing Tunisia's situation to other countries at the level of financing arrangement, common global challenges include insufficient health financing systems and the need for sustainable financial mobilization during health crises [21, 22]. Countries with advanced strategic purchasing capacities, such as Thailand—building on its experience with SARS-CoV-1 and robust claims management systems—demonstrated a rapid response to the COVID-19 pandemic [23]. In contrast, nations with limited experience struggled to implement effective purchasing arrangements during the emergency [23]. Moving forward, reinforcing health financing systems to build resilience is essential for recovery and future preparedness, balancing both global health security and progress toward universal health coverage [21, 22].

The governance and institutional arrangements component presents a mixed picture. Key governance subcomponents, including the presence and maturity of policies and strategies for emergency preparedness, regulatory capacity, and community engagement are rated as "expanding" while informed

decision-making processes is rated as "mature”. While this suggests well-established systems for preparedness and response, along with strong decision-making capabilities, there are still room for improvements particularly in terms of ensuring the presence of comprehensive policies for emergency preparedness, response, and recovery; strengthening stakeholder coordination for risk assessment systems; minimizing political interferences in decision-making; and establishing a formal system for health risk communication and community engagement. Weaknesses are evident in areas such as organizational structures and mechanisms for emergency response, and the socio-political and macroeconomic environment, which are rated as "developing". Like Tunisia, many countries in the MENA region have established mechanisms for multi-sectoral coordination, yet few embedded explicit indicators for monitoring and evaluation in their response plans [9]. Accountability frameworks, critical for enhancing trust and collaborative effectiveness, are absent in the multi-sectoral plans within the MENA region [9]. The challenge of evidence-informed policymaking and effective civil society engagement also remain prominent [24]. Mirroring the MENA region challenges, insufficient collaboration and coordination and misalignment among governance actors at multiple levels are commonly reported challenges in G20 countries [25].

The health system resources, public health, and service delivery component reveals a concerning picture. Most subcomponents in this category are rated as "developing," including the system organization that enables both emergency response and the maintenance of essential services, as well as the functional and reserve capacities of human resources and physical resources. This suggests that the foundational elements required for an effective health response during emergencies are not fully in place, highlighting a need for improvement in resource allocation, training, and infrastructure development. While public health functions are rated as "expanding," underscoring some progress in this area, existing protocols for testing, contact tracing, and surveillance are limited in scope and do not cover all epidemiological functions for optimal response. Tunisia's experience mirrors that of countries in the MENA and Africa where health systems suffered from insufficient health resources, shortages of skilled health professionals and lack of sufficient medical supplies and equipment, resulting in slow and inadequate responses to the scale of the crisis [26, 27]. The impacts on service access, supply chains, and financing were substantial, revealing the difficulty of balancing pandemic response with maintaining essential health services. A review of LMICs showed that primary healthcare systems' resilience was also strained similarly to Tunisia's situation [1].

The data and information systems component shows a mix of progress and challenges. Subcomponents such as the framework and operational procedures for data and information systems, infrastructure to support these systems, and the presence and maturity of key data sources are rated as "expanding”. This suggests that Tunisia is developing robust data management capabilities that can support emergency response efforts, albeit the pandemic highlighted key gaps in standardization and infrastructure capabilities. Other areas, such as the presence and maturity of early warning and surveillance systems for timely detection of shocks, the flow of data between stakeholders, and knowledge management are rated as "developing", highlighting a critical need for improved mechanisms for data sharing and integration, and integrated surveillance systems to provide timely information

during emergencies. The COVID-19 pandemic has catalyzed advancements in interoperability and knowledge management, driving Tunisia to improve real-time data exchange and system integration. Across European countries, HIS frameworks faced gaps in interoperability, outdated technologies, and insufficient capacity to support rapid data demands during COVID-19. A survey of 19 countries revealed that, although electronic health data transmission was in place, the pandemic's scale required more sophisticated data-sharing mechanisms, highlighting the need for improved digitization and integration of disparate systems [28]. Similarly, LMICs contended with fragmented routine health information systems that disproportionately focused on specific indicators, limiting disease surveillance and the overall scope of health system monitoring, mirroring the situation in Tunisia. The lack of standardized data protocols and the absence of integration between public and private sector data further contributed to data gaps and inconsistencies during the pandemic response [29].

The findings from this initial assessment can inform future policy and programmatic efforts aimed at strengthening Tunisia's health system resilience and enhance preparedness for public health emergencies. Moving forward, these findings provide both a starting point and a platform for ongoing policy dialogue and reforms focused on emergency preparedness and health system resilience. It is essential for responsible parties and partners to coordinate their efforts to address emerging gaps and implement the prioritized actions and activities. Furthermore, the iterative implementation of the EPSRA tool should continue, building on the experiences and lessons learned from this specific iteration.

The successful implementation of the EPSRA tool in Tunisia demonstrates its feasibility and underscores its role as a practical tool to assess a country’s health systems resilience. It offers several key insights for practical implementation. First, by engaging key stakeholders at various levels and tailoring the tool to Tunisia’s specific health system context, we enhanced its relevance and effectiveness. Second, the use of the tool has provided stakeholders in Tunisia with a comprehensive understanding of the health system's strengths and vulnerabilities, allowing for targeted interventions to enhance its overall resilience capacity and capabilities. Third, implementation of the tool has facilitated cross-sectoral collaboration and coordination, bringing together stakeholders from the health sector, as well as other relevant sectors such as finance, education, and transportation. This promotes a more holistic approach to resilience-building, recognizing the interconnected nature of health and these other sectors. Fourth, by promoting a culture of continuous learning and improvement, the tool has helped strengthen the country’s capacity for national-level assessments which is critical for sustainability efforts.

Some of the potential limitations are worth noting, namely the reliance on self-assessment data, which may be subject to bias, and the potential challenges in accessing accurate and comprehensive secondary data sources. Nonetheless, the participatory approach used as a methodology for this assessment helped overcome these constraints and brought several benefits. These include the creation of a platform for frank discussions between stakeholders to reach consensus on responses, the possibility of approaching subcomponents from different angles, the improved relevance and accuracy of the data; and, the presence of a Ministry of Health focal point in each of the four components,

reinforcing the Ministry of Health's leadership status on this process and enhancing their institutional capacity on this subject.

CONCLUSION

The implementation of the EPSRA tool in Tunisia marks a significant step towards strengthening the country’s health system resilience and enhancing its preparedness for future public health emergencies. The study demonstrated the feasibility of the ESPRA tool to assess a country’s health system resilience, offering key insights for practical implementation. The findings from this initial assessment revealed key gaps and generated a practical, actionable list of priorities for stakeholders and policymakers to strengthen health system resilience and enhance future health emergency preparedness. Findings can serve as both a starting point and a platform for ongoing policy dialogues and health reform efforts at the country level.

Abbreviations

EPSRA
Emergency Preparedness and Health Systems Resilience Assessment
HMIS
Health management information system
MENA
Middle East and North Africa

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests" in this section.

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Authors' contributions

HB and IA were the key government counterparts that enabled the implementation of the study in Tunisia PDK lead the study in Tunisia; PDK, DD, YK, HB, IA together validated and interpreted the results; and prepared the matrix of the policy priority actions resulting from the analysis. PKD, FEJ, DD are authors of the main instrument. PKD, FEJ, RF were responsible for the majority of the write-up. All authors provided substantive writing inputs and all authors read and approved the final manuscript.

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Tables

Table 1 to 7 are available in the Supplementary Files section.

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