

ORGANIZATIONAL CONSEQUENCES OF THE COVID-19 PANDEMIC AND HEALTH SYSTEM PREPAREDNESS FOR FUTURE PUBLIC HEALTH EMERGENCIES

L. Zh. Orakbay¹, T. B. Tolegen^{*1}, O. T. Kasymov²

¹ NEI «Kazakh-Russian Medical University», Kazakhstan, Almaty

² I. K. Akhunbaev Kyrgyz State Medical Academy, Kyrgyzstan, Bishkek

*Corresponding author

Abstract

Relevance: The COVID-19 pandemic exposed organizational weaknesses in health systems, disrupting workforce capacity, hospital services, supply chains, and routine care. Lessons from these disruptions may inform preparedness for future public health emergencies in Kazakhstan.

Objective: To synthesize evidence on the organizational consequences of COVID-19, distinguish emergency adaptations from persistent gaps, and consider the applicability of international preparedness lessons to Kazakhstan.

Methods: The main evidence base comprised journal publications first published between 1 January 2020 and 26 May 2026 that addressed organizational consequences of COVID-19 or health-system preparedness and resilience. Citation searching, targeted searches, and institutional reports supplemented the database searches. The review drew on 90 publications, including three conference abstracts, and five additional institutional reports. Findings were synthesized by thematic domain.

Results: A meta-analysis estimated burnout prevalence among healthcare workers at 52 % (95 % CI 40–63 %). Burnout was associated with intention to leave, whereas actual workforce departures were reported mainly in national surveys. A global modelling study projected that 28.4 million elective operations would be cancelled or postponed during 12 weeks of peak disruption in 2020. Supply-chain studies identified concentrated manufacturing, low contingency stocks, and limited supply-chain knowledge as potential contributors to shortages. Organizations adapted through staff redeployment, bed conversion, centralized supply coordination, and telemedicine, but evidence on the long-term sustainability of these measures was limited.

Conclusion: The evidence supports considering workforce protection, surge-capacity planning, supply-chain diversification, and institutional learning within routine health-system operations. The comparative effectiveness and long-term sustainability of specific measures remain uncertain. Evidence from Kazakhstan is limited, and proposed measures require local evaluation.

Keywords: COVID-19, pandemics, health services administration, health workforce, hospital bed capacity, health resources, disaster Planning.

Introduction

COVID-19 placed pressure on both clinical capacity and the organizational structures of health systems, exposing weaknesses in workforce sustainability, surge capacity, and governance [1]. Successive waves required ward conversion, staff reassignment, and disruption of routine services under severe time pressure, with some effects persisting beyond the acute phase [2]. A 2025 meta-review spanning clinical, immunological, and

health-services research described the broad consequences of the pandemic for service provision [3]. Understanding these organizational consequences can help identify preparedness needs that extend beyond clinical readiness.

Workforce strain was a recurrent finding. A 2025 review described high levels of burnout before and during the pandemic and identified long working hours, limited clinical autonomy, and insufficient institutional support as contributing factors [4]. A

2022 narrative review discussed earlier projections of US physician shortages and the potential effects of attrition and early retirement; these projections should not be interpreted as observed post-pandemic deficits [5]. Public health personnel were also affected. A Canadian cross-sectional study reported burnout in 63.6 % of public health physicians and residents and threats or bullying during the crisis in 41.2 % [6]. Another Canadian survey reported burnout in more than 60 % of public health workers and an association with intention to leave [7]. These findings raise concerns about workforce sustainability, although cross-sectional surveys cannot establish individual trajectories or attribute all observed problems to COVID-19.

The pandemic also exposed gaps in surge infrastructure and international governance. A 2026 review of reviews, organized around the 4S surge-capacity framework, identified staff reallocation, resource shortages, and repurposing of space as recurrent challenges in healthcare responses to COVID-19, H1N1, and mpox [2]. A 2025 review of pandemic prevention, preparedness, and response identified weaknesses in implementation of the International Health Regulations (IHR), constraints on WHO capacity, and unresolved questions concerning pathogen access and benefit-sharing [1]. An analysis of 43 political manifestos from 16 countries during 2024 found relevant preparedness pledges in only four, suggesting limited political attention in the documents examined [8].

Existing reviews address workforce well-being, surge capacity, governance, or broad health-system resilience [1-4]. This review brings these domains together by distinguishing acute disruption, emergency adaptation, and persistent gaps. It also separates findings supported by evidence from Kazakhstan from international approaches that require local evaluation.

The aim was to synthesize evidence on the organizational consequences of COVID-19, distinguish emergency adaptations from persistent gaps, and assess the relevance of international preparedness lessons to Kazakhstan.

Materials and methods

A narrative review was undertaken to integrate evidence from heterogeneous study designs and organizational settings. The review did not aim to produce a pooled effect estimate or to claim exhaustive coverage of the literature.

Literature search

PubMed/MEDLINE, Web of Science Core Collection, and Google Scholar were searched for

publications first published from 1 January 2020 to 26 May 2026. The last search was performed on 26 May 2026; eligibility was based on the first publication date, including early online publication. Three concept blocks were combined using AND, with synonyms within each block linked by OR: (1) “COVID-19” and “SARS-CoV-2”; (2) “health system”, “health service”, “hospital”, and “health workforce”; and (3) “organizational consequences”, “health system resilience”, “health service disruption”, “surge capacity”, “essential health services”, “pandemic preparedness”, “public health emergency”, “emergency response”, “governance”, “surveillance”, “supply chain”, and “health system recovery”. Search syntax was adapted to each platform, including title, abstract, and MeSH fields in PubMed and the Topic field in Web of Science. Several simplified keyword queries were used in Google Scholar. Only English-language publications were considered. Reference lists were screened to identify additional sources.

Eligibility criteria

The main evidence base comprised journal publications first published between January 2020 and July 2026 that addressed organizational consequences of COVID-19 or health-system preparedness and resilience. Eligible designs included primary quantitative and qualitative studies, systematic and other reviews, comparative health-system studies, policy and implementation analyses, and conceptual frameworks. Conference abstracts and institutional reports were treated as supplementary source types rather than as equivalent to full peer-reviewed articles.

The thematic scope covered the health workforce, hospital capacity, medical and pharmaceutical supply chains, continuity and adaptation of service delivery, and health-system resilience and governance. Digital tools, financing, surveillance, and emergency coordination were considered where they informed these domains. Selected contextual sources were used to describe baseline resource constraints and barriers to care relevant to Kazakhstan.

Publications were excluded from the main evidence base if they lacked a relevant organizational or health-system component, concerned animal research, were protocols without results or preprints, duplicated another report of the same study, or did not provide sufficient information to interpret the relevant findings. Where multiple versions of a study were identified, the most complete eligible version was retained.

Supplementary sources. Five reports from WHO, OECD, and the US National Academies

of Sciences, Engineering, and Medicine provided contextual indicators and policy analyses concerning hospital beds, workforce capacity, and medical-product supply chains [9-13]. These reports were identified through targeted searches of the organizations' websites. Three conference abstracts containing extractable quantitative information were also retained [14-16]; their limited reporting and review procedures were considered when interpreting their findings.

Selection and synthesis

Search records were managed in Zotero. Duplicates were identified using the software and manual checks. One author (T. B. Tolegen) screened titles, abstracts, and full texts; uncertain eligibility decisions were discussed with L. Zh. Orakbay and resolved by consensus. Additional versions of the same study identified during full-text assessment were checked to avoid duplicate inclusion. Publications were considered insufficiently informative when the relevant organizational outcome could not be identified or separated from clinical outcomes, the design or setting was unclear, or sampling and analytical methods were inadequately described. No formal risk-of-bias assessment was conducted.

Two further publications were identified through supplementary targeted searches to address digital innovations in healthcare supply chains and contextual evidence on tuberculosis diagnostic barriers in Eastern Europe and Central Asia, including Kazakhstan [17; 18]. The latter study was used as contextual evidence and not as a direct estimate of pandemic effects.

Data extraction. T.B. Tolegen extracted the author, year, country or region, study design, setting and population, data-collection period, organizational domain, main findings, and reported limitations. For reviews, the number and types of primary studies and the review period were also recorded to consider potential overlap between sources.

Thematic synthesis. Findings were organized into five domains informed by the review scope and the 4S framework (staff, stuff, structure, and systems) [2]: health workforce; hospital and bed capacity; medical and pharmaceutical resources and supply chains; service delivery and care models; and resilience, governance, and preparedness. Within these domains, findings were grouped into acute disruption, adaptation, and persistent gaps or recovery. Quantitative pooling was not performed

because designs, settings, populations, and outcomes differed substantially. Primary findings, review conclusions, model projections, and the authors' interpretation were distinguished in the narrative synthesis.

Results

Characteristics of the sources. The review drew on 90 publications and five institutional reports [9-13]. The 90 publications comprised 44 primary studies with observational, qualitative, quasi-experimental, or modelling designs, including two conference abstracts [15; 16]; 28 systematic and other evidence reviews, including one conference abstract of a systematic review [14]; and 18 narrative reviews and policy- or practice-oriented publications. Not all included publications were full peer-reviewed research articles. Much of the evidence came from high-income settings. Four publications included information from Kazakhstan [16; 18-20]; one of these [18] was used only as contextual evidence because it did not address pandemic-specific outcomes. Reviews may contain overlapping primary studies and were therefore not treated as independent confirmations of the same findings.

Health workforce

The pandemic intensified occupational stress and exposed pre-existing workforce vulnerabilities. Reported consequences included burnout, staffing pressures, redeployment, and concerns about retention across hospitals, long-term care, and primary care. These outcomes need to be distinguished because they measure different aspects of workforce capacity [21-28].

Burnout and mental health

A meta-analysis of 30 observational studies estimated overall burnout prevalence at 52 % (95 % CI 40-63 %) and emotional exhaustion at 51 % (95 % CI 42-61 %) [21]. A conference abstract published in 2025 summarized studies published from January 2020 to December 2022 and reported burnout prevalence of 75 % in Saudi Arabia and 76.9 % in Kuwait [14]. These regional estimates do not establish an increase over time. An updated meta-analysis of burnout symptoms among nurses reported substantial burden and associated risk factors [22]. Differences in populations, measurement instruments, and cut-offs limit comparisons across reviews. Predominantly cross-sectional evidence describes prevalence and associations rather than within-person changes or causal effects of the pandemic.

Staffing and retention

The pandemic intensified concerns about a pre-existing nursing shortage. An analysis of data from 29,472 registered nurses (hereinafter – RNs) and 24,061 licensed practical or vocational nurses in the 2022 US National Nursing Workforce Survey estimated that approximately 100,000 RNs had left the workforce during the preceding two years and that a further 610,388 RNs intended to leave the workforce by 2027 [23]. Survey estimates of past departures and future intentions are distinct outcomes. An integrative review identified burnout, moral distress, and understaffing as factors associated with intention to leave [24]. Reviews of care-home staff well-being and nurse retention identified gaps in the evidence on sustained support and retention strategies across settings [25; 26]. A systematic review linked turnover intention to organizational factors, caring for patients with COVID-19, low job control, and moral distress [27]. A subsequent narrative review framed shortages, burnout, and attrition as mutually reinforcing problems [28]; this

is an interpretive model rather than an established causal mechanism.

Leadership and organizational support

A systematic review of 86 studies reported associations between supportive leadership, adequate personal protective equipment (PPE), and better mental health outcomes, but few initiatives had been evaluated for effectiveness [29]. A scoping review identified telephone helplines, peer support, and psychological first aid among institutional support approaches [30]. Another systematic review found associations between social support, resilience, coping, and psychological outcomes [31]. In Kazakhstan, a longitudinal qualitative study of 30 physicians and nurses, interviewed three times between May 2021 and May 2022, identified professional duty, sacrifice, and spiritual and interpersonal coping as important features of frontline experience [19]. These findings support attention to organizational context but do not establish the superiority of organizational over individual support programmes.

Table 1. Selected studies of workforce interventions and factors associated with burnout and retention

Study and design	Intervention or exposure	Reported findings	Main limitations
Cohen et al., 2023 [32] Systematic review; 33 studies	Workplace interventions: mindfulness, coaching, workload changes, job crafting, and peer support. Most targeted individuals.	Most studies reported improved well-being or reduced burnout, stress, anxiety, or depression.	Many studies lacked controls and follow-up; causal conclusions are limited.
Rotenstein et al., 2023 [33] Cross-sectional survey	Work overload among 43,026 respondents from 206 organizations; no intervention tested.	Burnout: 49.9 %; intention to leave: 28.7 %. Both were associated with work overload across occupational groups.	Voluntary participation and cross-sectional design limit generalizability and causal inference.
James et al., 2023 [34] Two-site quasi-experimental comparison	Organizational pandemic-support programme for hospitalists at one intervention and one comparison hospital.	Burnout decreased at the intervention hospital relative to the comparison hospital.	Only two hospitals; baseline and site-level differences may confound findings.
De Vries et al., 2023 [35] Systematic review; 55 studies	Retention strategies including onboarding, staffing, social support, professional development, and technology.	The review identified multiple strategies associated with retention; effects were not pooled.	Heterogeneous evidence does not support ranking strategies by effectiveness.
Frias et al., 2025 [36] Rapid review of 50 reviews	Organizational and individual approaches to workforce mental health and well-being.	Workload management, staffing, leadership, and psychological support were recurring organizational approaches.	Rapid-review methods and variation in source quality limit certainty.

Study and design	Intervention or exposure	Reported findings	Main limitations
Sidiq et al., 2024 [37] Cross-sectional survey	Professional role and workload; no intervention tested.	Burnout was reported in 68.1 % of respondents; nurses had higher scores.	Single-region, self-reported data from Jaipur, India; no causal inference.

Source: compiled by the authors based on [32-37]

Hospital and bed capacity

Acute capacity pressures

During pandemic waves, demand for general and intensive care unit (hereinafter – ICU) beds exceeded available capacity in several settings. A systematic review examined models used to inform hospital surge-capacity planning and their assumptions [38]. A report from a New York City medical centre described converting operating rooms and post-anaesthesia care units into critical care areas [39]. A modelling study projected that Saudi Arabia would require 4,372 additional general beds and 1,600 additional ICU beds under a six-month scenario [40]. A Ugandan conference abstract reported that 48 of 132 districts had ICU beds and estimated additional needs of 2,247 beds and 2,756 ventilators over a twelve-month surge [15]. These are setting-specific reports or projections. A European country-level analysis found that national acute-bed occupancy by patients with COVID-19 did not exceed 38.3 % in the countries examined, while noting that national averages could conceal severe regional pressures [41].

Capacity adaptation

Adaptations included repurposing existing space, redeploying staff, and coordinating resources across departments. A systematic review of 142 studies identified adaptability, demand forecasting,

and governance as relevant to capacity planning [42]. In Tokyo, nine temporary hospitals with 842 beds admitted 11,572 patients between 2022 and 2024, with a maximum occupancy of 68.5 %; the authors interpreted this arrangement as helping to relieve pressure on acute hospitals [43]. A review of reviews using the 4S framework similarly identified staffing, supplies, and space as recurrent challenges [2]. No directly comparable evaluation from Kazakhstan was identified in the included literature.

Surgical disruption and recovery

Disruption extended to non-COVID surgical care. A global model projected 28.4 million cancelled or postponed elective operations during 12 weeks of peak disruption in 2020, including cancellation rates of 81.7 % for benign conditions and 37.7 % for cancer surgery. Assuming a 20 % increase in baseline surgical output, the model estimated a median of 45 weeks to clear the backlog [44]. These figures are projections, not counts of recorded cancellations. Dutch registry data documented a reduction in surgical procedures extending beyond the first wave [45]. Together, these sources indicate the need to consider both surge capacity and continuity of routine care, without establishing the effectiveness of a particular protective strategy. Figure 1 summarizes disruption, adaptation, and possible persistent gaps in hospital capacity.

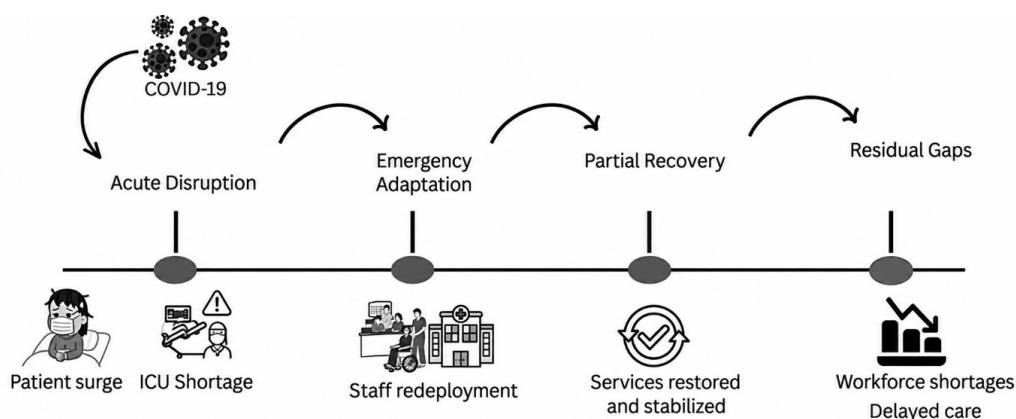


Figure 1. Conceptual summary of hospital-capacity disruption, adaptation, and persistent gaps

Source: compiled by the authors based on [46-48]

*Medical supplies and supply chains**Shortages and organizational responses*

PPE shortages were widely reported during the first wave, alongside production disruption, export restrictions, and stockpiling [49]. A British Columbia case study identified leadership, shared objectives, digital information systems, and real-time monitoring as capabilities supporting the supply-chain response [50]. A Swedish mixed-methods study linked shortages to low contingency stocks and limited supply-chain knowledge and described agreements between logistics and clinical teams to prioritize supplies [51]. A Nova Scotia case study described centralized coordination within a provincial health authority as a response to disrupted distribution [52]. In Zimbabwe, currency instability and donor-dependent procurement were associated with medicine shortages [53]. These studies illustrate different responses but do not establish that one procurement model is universally preferable.

Diversification and reserve capacity

A systematic review of 35 studies identified artificial intelligence, blockchain, big-data analytics, and simulation among digital approaches to

healthcare supply-chain disruption management [17]. A modelling study estimated that protecting health workers in low- and middle-income countries would cost approximately US\$9.6 billion and could avert about 2.3 million deaths, with an estimated societal return of US\$755 billion; these outputs depend on the model assumptions [54]. Studies and reviews also discussed supplier redundancy, manufacturing diversification, and regional production as potential resilience strategies [55; 56]. A 5P strategic medical-stockpile model has been proposed [57]. Evidence describing these approaches is more extensive than evidence comparing their effectiveness or long-term costs.

Persistent supply vulnerabilities

Persistent vulnerabilities include concentration of manufacturing, complex production processes, and low profitability of some essential generic medicines [55; 56; 58]. The Zimbabwe case study additionally illustrates how donor dependence and currency instability may constrain procurement [53]. Such problems can predate a pandemic and persist after its acute phase; temporal coexistence alone does not establish that COVID-19 caused them.

Table 2. Selected indicators of hospital capacity, medical and pharmaceutical resources, and health workforce, with data year, geographic coverage and indicator definitions

Indicator (definition, unit)	Geographic coverage	Year(s)	Reported values	Ref.	Comparability notes
General hospital beds (all hospital beds), per 100,000 population	Global, 183 countries; high-income regions	Latest pre-pandemic year available per country	Mean 402.3 per 100,000 in high-income regions	[59]	Country data years vary; not comparable with acute-care bed density (next row)
Acute-care beds, per 100,000 population	Global, 183 countries; upper-middle-income regions	Latest pre-pandemic year available per country	Mean 424.8 per 100,000 in upper-middle-income regions (highest of the income groups); distribution highly uneven across countries	[59]	Acute-care beds are a subset of all hospital beds; cannot be compared with the previous row
Total hospital beds, per 1,000 population	OECD countries	2021	OECD average 4.3 per 1,000; Korea and Japan 12–13 per 1,000; relatively few beds in Mexico, Costa Rica and Colombia	[9]	Same OECD indicator as the next row, but from a different report edition; small differences may reflect data revisions and country coverage

Indicator (definition, unit)	Geographic coverage	Year(s)	Reported values	Ref.	Comparability notes
Total hospital beds, per 1,000 population; occupancy of curative (acute) care beds, %	OECD countries (occupancy: 29 countries with comparable data)	2023	OECD average 4.2 beds per 1,000 (Korea 12.6; Japan 12.5; lowest in Mexico, Costa Rica and Sweden); mean occupancy 72 %, above 85 % in 2 of 29 countries (Ireland and Canada)	[10]	See previous row
ICU/critical care beds, per 100,000 population	19 Asian countries and regions (7 high-income, 12 middle-income economies)	2017 and 2022	High-income: median 11.4 (IQR 7.3–22.8) in 2017 and 13.9 (IQR 10.7–21.7) in 2022. Middle-income: 2.6 (IQR 1.7–7.8) and 6.6 (IQR 2.2–13.3). In 2022, 10.9 % of critical care beds were in single rooms and 5.3 % had negative pressure	[60]	Same countries measured at two time points, so change can be assessed; Asian countries only; ICU beds are not comparable with general or acute-care beds
ICU beds, per 100,000 population	31 OECD countries	2023	Average 17 per 100,000; from about 40 or more in Czechia and Estonia to below 5 in New Zealand and Sweden; most countries increased ICU capacity compared with the pre-pandemic period	[10]	National ICU definitions differ; not directly comparable with the Asian data in the previous row
Facilities with a complete WHO-recommended PPE set on the survey day, %	7 low- and middle-income countries; 1,554 health facilities	2020–2021 (repeated survey rounds)	43 % had a complete set; 46 % lacked respirator masks; 16 % lacked gloves; negligible improvement across rounds	[61]	Low- and middle-income settings only; no comparable high-income facility estimate in the included sources
Active drug shortages, number	USA	2023–2024	277 active shortages as of September 2024, down slightly from the historic high of 323; above 275 for two consecutive years	[58]	Single-country count based on ASHP / University of Utah Drug Information Service surveillance definitions
Government measures against medicine shortages (qualitative)	38 countries, mostly high-income	2020–2023	Stockholding obligations, export restrictions, and collaborative procurement mechanisms adopted	[62]	Policy inventory; no outcome data
Causes of essential-medicine shortages (qualitative)	OECD countries; Saudi Arabia	Before and during the pandemic	Concentrated generic manufacturing and thin margins (OECD); centralized procurement and registration bottlenecks (Saudi Arabia)	[11; 63]	Qualitative; different settings and methods

Table continued

Indicator (definition, unit)	Geographic coverage	Year(s)	Reported values	Ref.	Comparability notes
Disruption of essential health commodities (systematic review of 13 studies)	Low- and middle-income countries	Pandemic period	Disrupted supply of antiretroviral, tuberculosis, and malaria medicines; lockdowns and reduced manufacturing capacity cited as main drivers	[64]	Data years vary across included studies
Health-workforce thresholds and shortage	Global, 204 countries and territories	2019	Thresholds of 20.7 physicians and 70.6 nurses and midwives per 10,000 population for UHC; estimated shortage of 6.4 million physicians, 30.6 million nurses and midwives, 3.3 million dental personnel and 2.9 million pharmaceutical personnel	[65]	Pre-pandemic baseline; model-based estimates (GBD 2019)
Health-workforce density by income group	Global	2020	6.5-fold difference in density between high-income and low-income countries	[66]	WHO National Health Workforce Accounts data
Nursing workforce, number	Global	2018 and 2023	27.9 million (2018) and 29.8 million (2023); internationally trained nurses account for about 23 % of nurses in some high-income settings	[12]	Same data system at two time points
Mechanical ventilators, number	USA	Pre-pandemic stock (estimate published in 2021)	About 62,000 full-featured and about 98,000 non-full-featured or non-invasive devices	[67]	Single-country stock estimate
Hospital beds in facilities with oxygen supply, %	Kenya	2020	58 %	[68]	Single country
Use of respiratory support among hospitalized COVID-19 patients	23 low- and middle-income countries; >66,000 patients	Pandemic period (prospective cohort)	Invasive ventilation used more often and high-flow nasal oxygen less often than reported in high-income settings	[69]	Comparison with high-income settings is indirect

Indicator (definition, unit)	Geographic coverage	Year(s)	Reported values	Ref.	Comparability notes
Mechanical ventilation capacity (narrative evidence)	Low- and middle-income countries	Before and during the pandemic	Capacity insufficient in most low- and middle-income countries, limiting access to critical care and surgery	[70]	Commentary; no pooled data

Source: compiled by the authors from [9-12; 58-70]. Values refer to different settings, years, and definitions. Cross-row comparisons should not be interpreted as temporal changes. Within-source comparisons are shown for repeated measurements of critical-care capacity in Asia [60] and the global nursing workforce [12]

Service delivery and care models

Disrupted services and delayed diagnosis

Beyond the surgical backlog described above [44], a meta-analysis of 245 studies from 46 countries reported reductions of 39.0 % in cancer-screening participation, 23.0 % in new diagnoses, 24.0 % in diagnostic tests, and 28.0 % in treatment provision; reductions were larger in medium-Human Development Index settings for some outcomes [71]. A US cancer-database study also found fewer diagnoses of screenable cancers than predicted for 2020 [72]. This suggests delayed detection, but does not by itself establish subsequent stage shifts or long-term outcomes. For regional context, a qualitative study including Kazakhstan described financial, household, stigma-related, and provider-related barriers to tuberculosis diagnosis [18]. That study does not isolate the effect of COVID-19 and should not be interpreted as a measure of pandemic-related diagnostic delay.

Maintaining essential services

An interrupted time-series analysis of 31 health services in ten countries reported declines of 9-40 % in outpatient visits and 26-96 % in cancer screening, tuberculosis screening, and HIV testing. Substantial disruption remained in half of the countries at the end of 2020 [73]. A Nigerian qualitative study described appointment rescheduling, prioritization of maternal and child health services, staff redeployment, and incentives, while documenting continued pressures on essential services [74]. In a US national survey, 69 % of Medicare-certified home health agencies used some form of telehealth, including care coordination, virtual visits, and monitoring [75]. These examples show that service adaptation involved both changes to staffing and care processes

and the use of digital tools; they do not allow the relative contribution of each to be ranked.

Sustainability of adaptations

Evidence on sustainability varied by setting. The US home health survey reported that some agencies discontinued telehealth after adopting it during the pandemic [75]. The Nigerian study described adaptations that contributed to the recovery of essential services, particularly in local government areas classified as highly resilient [74]. These findings suggest that some practices persisted while others were discontinued. The included evidence does not establish how commonly emergency adaptations became routine practice across health systems or isolate the effects of financing, infrastructure, and organizational learning on their continuation.

Resilience and governance

Conceptual frameworks

A systematic review of hospital resilience used resource and capability perspectives to examine how organizations respond to disruption [76]. A surge-management framework identified four interacting functions: preserving existing capacity, expanding capacity, moderating demand, and enabling coordination [77]. A systematic review of workforce surge capacity described emergency hiring, task-shifting, and redeployment as common responses [78]. Another review identified regulatory flexibility and psychological and financial support among workforce interventions, while noting limited evidence on comparative and long-term effectiveness [79]. An Indonesian qualitative study described hospital shocks and organizational responses relevant to resilience [80]. These frameworks help organize reported experience, but should not

be treated as validated predictions of performance in future emergencies.

Coordination and policy learning

A study of South Korea described a whole-of-nation response involving coordinated testing, surveillance, legal powers, and participation by private and civil-society actors [81]. Interviews with policy-makers in India, Indonesia, and Nigeria identified multisectoral cooperation as important for maintaining tuberculosis services [82]. A comparative analysis of 28 countries highlighted governance clarity, coordination, and links between surveillance and decision-making as features of national responses [83]. These observations support examining how coordination operates in different settings; they do not establish that a single governance model

is superior after accounting for epidemic conditions and baseline resources.

Preparedness gaps

A scoping review identified gaps in empirically tested, implementable strategies for resilient health systems [84]. Sources concerning Kazakhstan included a geospatial conference abstract on workforce and infrastructure distribution [16] and a descriptive account of public health response measures [20]. In the literature retrieved for this review, direct evidence on workforce departures, elective-care backlogs, and supply-chain disruption in Kazakhstan was limited. This finding reflects the scope and language restrictions of the search and is not evidence that no national data exist. Figure 2 presents an author-developed conceptual synthesis of organizational resilience and preparedness.

MULTI-LEVEL ORGANIZATIONAL RESILIENCE FRAMEWORK

Organizational resilience during the COVID-19 response and preparedness for future emergencies.

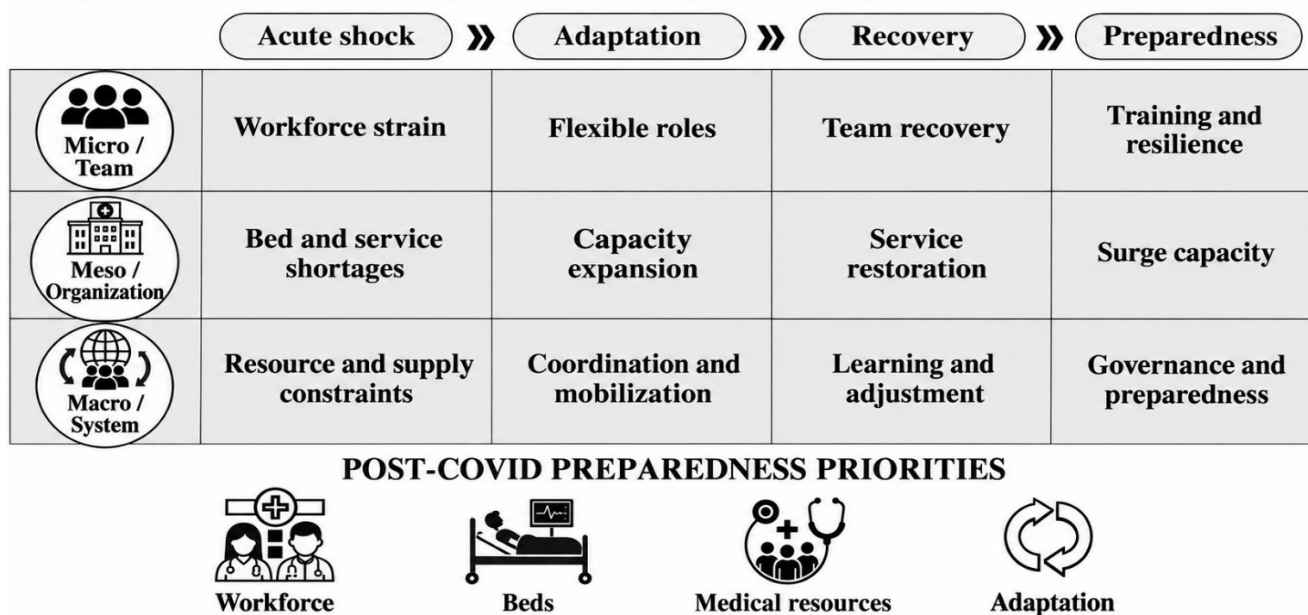


Figure 2. Conceptual framework linking organizational levels, pandemic-response phases, and preparedness priorities

Source: compiled by the authors based on [83; 85; 86].

The figure is a conceptual illustration and not an empirically validated model.

Discussion

Organizational priorities for preparedness

Workforce capacity

Workforce planning should consider persistent staffing shortages and the potential contribution of long-COVID-related absence [87]. Reviews describe task-shifting, regulatory flexibility, and rapid mobilization as approaches to increasing short-term workforce availability, while evidence on long-term

effectiveness remains limited [79]. Burnout and staffing pressures are associated with turnover intention [88]. Reviews of workforce support also describe workload management, peer support, and leadership alongside individual interventions [36]. The comparative effectiveness, feasibility, and sustainability of these approaches require evaluation in the settings where they are implemented.

Hospital and supply capacity. Hospital preparedness requires coordination across staff, supplies, space, and systems [2; 77]. The literature describes reserve physical capacity, cross-training, and adaptable space as potentially relevant resources [76]. The US National Academies proposed measures to improve supply-chain resilience through inventory management and information exchange among hospitals, suppliers, and public authorities [13]. Decisions about reserves and redundancy should account for maintenance costs, staffing requirements, and local patterns of demand.

Governance and learning. The Lancet Commission identified failures of coordination and delayed institutional responses and recommended stronger health systems and international cooperation [89]. A subsequent analysis of global health governance discussed reforms associated with the WHO Pandemic Agreement [90]. For organizational planning, these sources support attention to clear responsibilities, information exchange, and mechanisms for learning from emergency responses. They do not establish that resources or formal preparedness plans alone are sufficient to ensure effective performance.

Table 3. Priority organizational and resource-capacity needs for future preparedness and corresponding recommendations

Domain	Proposed preparedness need	Evidence informing the proposal	Implementation considerations
Workforce	Pre-agreed surge staffing, flexible skill mix, and staff protection.	Reviews describe increasing worker numbers, expanding roles, and supporting existing staff; shortages constrained response capacity [20; 79; 91].	Specify responsibilities, scope-of-practice arrangements, financing, training, and staff support before a crisis. Evaluate safety and sustainability locally.
Hospital capacity	Plans to expand staffed ICU and general-bed capacity while maintaining essential care.	Practice reports describe coordinated planning for beds, staffing, supplies, isolation, and communication; a US survey documented hospital surge actions [92–94].	Identify convertible spaces, staffing and supply requirements, coordination arrangements, and procedures for reviewing performance after an emergency.
Medical supplies	Diversified procurement, contingency stocks, and coordination of distribution.	A conceptual analysis proposed stronger supply-chain governance [95]. Swedish hospitals reported low reserves and described agreements to prioritize scarce supplies [51].	Assess reserve requirements, storage and maintenance costs, supplier dependence, and allocation procedures. Compare feasibility and outcomes across local settings.

Source: compiled by the authors based on [20; 51; 79; 91-95]

Strength and nature of the evidence

The evidence differed substantially across domains. Burnout has been examined in meta-analyses, but variation in measurement and possible overlap of primary studies limit comparisons between pooled estimates [21; 22]. Actual workforce departures were documented less often than intention to leave [23; 24; 27; 88]. Surgical-backlog and bed-capacity estimates depended on model assumptions [15; 40; 44]; registry and service-use studies supported the direction of disruption without

confirming the projected global magnitude [45; 71]. Supply-chain evidence consisted largely of case studies, policy analyses, and narrative reviews [50-53; 56; 95]. It describes plausible mechanisms and organizational responses but offers limited grounds for causal attribution or ranking interventions.

Most empirical evidence was observational. Associations between burnout and intention to leave, or between governance features and national response performance, should therefore not be interpreted as causal effects. Epidemic intensity, baseline

resources, financing, political decisions, and population characteristics may all influence organizational outcomes [83]. The central implication of this synthesis is the need to distinguish documented disruption, reported adaptations, and evidence that those adaptations remained effective over time.

Applicability to Kazakhstan

The retrieved sources concerning Kazakhstan comprised a qualitative study of frontline professionals [19], a descriptive account of public health

responses [20], a geospatial conference abstract [16], and contextual qualitative evidence on tuberculosis diagnostic barriers [18]. They provide different types of information and do not collectively establish national estimates of pandemic-related organizational harm. Table 4 distinguishes proposed measures with some local support from those derived mainly from international experience. Local-language and administrative sources would be needed for a more comprehensive national assessment.

Table 4. Proposed preparedness measures for Kazakhstan: international evidence, national evidence, and status

Proposed measure	Supporting international evidence	Evidence from Kazakhstan	Status for Kazakhstan
Organizational support for health-worker well-being and retention (workload management, peer support, visible leadership)	[29; 32; 35; 36]	Qualitative evidence on frontline professionals [19]; the included sources do not provide national estimates of burnout or actual departures.	Partly supported (qualitative); prevalence and attrition require national monitoring
Pre-agreed regulatory flexibility for surge staffing (scope of practice, redeployment, rapid licensing)	[78; 79; 91]	Public health response measures described [20]; effectiveness not evaluated	Transfer of international experience; requires local evaluation
Pre-established protocols for ICU and general bed expansion; regional surge planning	[2; 38; 42; 92-94]	Regional differences in workforce and infrastructure density [16]	Need partly indicated by national data; protocols require local testing
Protection of elective and diagnostic capacity (cancer, tuberculosis) during surges	[44; 45; 71; 72]	Contextual evidence on tuberculosis diagnostic barriers [18]; no direct estimate of COVID-19 effects on diagnostic delay.	Contextual support only; pandemic-specific national service data are needed.
Diversified procurement, contingency stockpiles and supply-chain visibility	[13; 17; 51; 55; 56; 95]	No directly relevant national study was identified in this English-language review.	Transfer of international experience; requires local evaluation
Governance: multisectoral coordination, after-action reviews, IHR accountability	[81-83; 89; 90]	Response measures described [20]; governance effectiveness not evaluated	Transfer of international experience; requires local evaluation

Source: compiled by the authors based on the reviewed literature

Authors' recommendations. On the basis of this synthesis, priorities for evaluation in Kazakhstan include monitoring burnout and actual workforce departures; examining elective, diagnostic, and cancer-care volumes during 2020–2022; assessing regulatory arrangements for surge staffing; testing

regional ICU and general-bed surge plans; and reviewing medical-product supply-chain resilience. These are proposed directions for national assessment rather than interventions whose effectiveness in Kazakhstan has been demonstrated by this review.

Limitations

This narrative review was not based on a registered protocol and did not include formal risk-of-bias assessment or quantitative pooling. Screening and extraction were conducted by one author, with uncertain cases discussed with the second author; this may increase selection and extraction errors. Searches were restricted to three platforms and English-language publications. Google Scholar searches are difficult to reproduce, and the omission of regional databases and Russian- and Kazakh-language literature may have limited identification of evidence from Central Asia. The included sources varied in design, population, observation period, and outcome definitions. Many relied on voluntary participation and self-report. Burnout instruments and thresholds differed, and turnover intention was not equivalent to observed departure. Resource indicators referred to different years and settings and cannot be combined into a single temporal trend. Overlap between reviews may give some primary findings disproportionate weight. Conference abstracts and institutional reports provided supplementary information but differed from full research articles in reporting detail and review procedures. Finally, the predominance of observational evidence and high-income settings limits causal inference and transferability to Kazakhstan.

Conclusion

COVID-19 exposed and intensified organizational pressures involving the health workforce, hospital capacity, medical supplies, and continuity of care. Reported adaptations included staff redeployment, hospital reconfiguration, procurement changes, and telemedicine. Evidence on their comparative effectiveness and long-term sustainability remains limited. The review supports considering workforce protection, coordinated surge planning, supply-chain resilience, and institutional learning within routine preparedness, while distinguishing these priorities from proven intervention effects. For Kazakhstan, the available evidence is insufficient to determine which combination of measures will be most effective. Local assessment of workforce retention, service recovery, resource capacity, and implementation outcomes is therefore needed.

References

1. Miyamoto T., Fujita M., Hachiya M. et al. Overview of global governance, capacity, and health systems implication of pandemic prevention, preparedness, and response: a narrative review and descriptive analysis of open-source data // *Global Health & Medicine*. – 2025. – Vol. 7(2). – P. 112-126. – DOI: 10.35772/ghm.2025.01018.
2. Rubini E., Trentin M., Maffi P. et al. Challenges in healthcare facilities' response to past outbreaks: a systematic review of reviews // *BMC Health Services Research*. – 2026. – Vol. 26(1). – Article No. 141. – DOI: 10.1186/s12913-025-13934-9.
3. Wang R., Naeem M. A. COVID-19 pandemic: a comprehensive meta-review of global impacts, responses, and future preparedness // *The Clinical Respiratory Journal*. – 2025. – Vol. 19(11). – Article No. e70134. – DOI: 10.1111/crj.70134.
4. Moss M. Mitigating burnout: the role of healthcare organizations // *ATS Scholar*. – 2025. – Vol. 6(3). – P. 267-279. – DOI: 10.34197/ats-scholar.2024-0153PS.
5. Bhardwaj A. COVID-19 pandemic and physician burnout: ramifications for healthcare workforce in the United States // *Journal of Healthcare Leadership*. – 2022. – Vol. 14. – P. 91-97. – DOI: 10.2147/JHL.S360163.
6. Fatima S. A., Hao X. Y., Sun D. et al. Burnout among public health physicians and residents in Canada following the COVID-19 pandemic: a cross-sectional study // *PLOS Mental Health*. – 2025. – Vol. 2(12). – Article No. e0000527. – DOI: 10.1371/journal.pmen.0000527.
7. Singh J., Poon D. E.-O., Alvarez E. et al. Burnout among public health workers in Canada: a cross-sectional study // *BMC Public Health*. – 2024. – Vol. 24(1). – Article No. 48. – DOI: 10.1186/s12889-023-17572-w.
8. Wenham C., Potluru A. Analysing the engagement with pandemic preparedness, prevention and response in selected English language political manifestoes in 2024 // *Global Health Action*. – 2025. – Vol. 18(1). – Article No. 2559453. – DOI: 10.1080/16549716.2025.2559453.
9. OECD. Health at a Glance 2023: OECD Indicators. – Paris: OECD Publishing, 2023. – DOI: 10.1787/7a7afb35-en.
10. OECD. Health at a Glance 2025: OECD Indicators. – Paris: OECD Publishing, 2025. – DOI: 10.1787/8f9e3f98-en.
11. OECD. Securing Medical Supply Chains in a Post-Pandemic World: OECD Health Policy Studies. – Paris: OECD Publishing, 2024.
12. World Health Organization. State of the world's nursing 2025: investing in education, jobs,

- leadership and service delivery. – Geneva: World Health Organization, 2025.
13. National Academies of Sciences, Engineering, and Medicine. Building resilience into the nation's medical product supply chains. – Washington, DC: The National Academies Press, 2022.
 14. Jan B. Z. M. M., Keenoo S. B. Prevalence of burnout among healthcare workers during the COVID-19 pandemic: a systematic literature review: abstract // *BJPsych Open*. – 2025. – Vol. 11, Suppl. 1. – P. S58. – DOI: 10.1192/bjo.2025.10204.
 15. Jephthah D., Ddumba I. Assessing the surge capacity of hospitals in Ugandan health care systems in managing the COVID-19 pandemic: abstract // *European Psychiatry*. – 2023. – Vol. 66, Suppl. 1. – P. S785–S786. – DOI: 10.1192/j.eurpsy.2023.1658.
 16. Glushkova N., Semenova Y., Jobalayeva B. et al. Geospatial characteristics of medical workforce and infrastructure to combat COVID-19 in Kazakhstan: abstract // *European Journal of Public Health*. – 2022. – Vol. 32, Suppl. 3. – Article No. ckac130.023. – DOI: 10.1093/eurpub/ckac130.023.
 17. Arji G., Ahmadi H., Avazpoor P., Hemmat M. Identifying resilience strategies for disruption management in the healthcare supply chain during COVID-19 by digital innovations: a systematic literature review // *Informatics in Medicine Unlocked*. – 2023. – Vol. 38. – Article No. 101199. – DOI: 10.1016/j.imu.2023.101199.
 18. Turusbekova N., Celan C., Caraulan L. et al. Gender-related factors associated with delayed diagnosis of tuberculosis in Eastern Europe and Central Asia // *BMC Public Health*. – 2022. – Vol. 22(1). – Article No. 1999. – DOI: 10.1186/s12889-022-14419-8.
 19. Foster F., Kanderzhanova A., Umbetkulova S. et al. “Who else if not us”: an exploratory-descriptive qualitative study of Kazakhstani frontline professionals' experience and perceptions during the coronavirus disease 2019 pandemic // *Qualitative Health Research*. – 2024. – Vol. 34(6). – P. 507-516. – DOI: 10.1177/10497323231216363.
 20. Battakova Z., Imasheva B., Slazhneva T. et al. Public health response measures for COVID-19 in Kazakhstan // *Disaster Medicine and Public Health Preparedness*. – 2023. – Vol. 17. – Article No. e524. – DOI: 10.1017/dmp.2023.181.
 21. Ghahramani S., Lankarani K. B., Yousefi M. et al. A systematic review and meta-analysis of burnout among healthcare workers during COVID-19 // *Frontiers in Psychiatry*. – 2021. – Vol. 12. – Article No. 758849. – DOI: 10.3389/fpsy.2021.758849.
 22. Fekih-Romdhane F., Harb F., Al Banna S. et al. Prevalence and risk factors of burnout symptoms among nurses during the COVID-19 pandemic: an updated systematic review and meta-analysis // *Human Resources for Health*. – 2025. – Vol. 23(1). – Article No. 48. – DOI: 10.1186/s12960-025-01012-4.
 23. Martin B., Kaminski-Ozturk N., O'Hara C., Smiley R. Examining the impact of the COVID-19 pandemic on burnout and stress among U.S. nurses // *Journal of Nursing Regulation*. – 2023. – Vol. 14(1). – P. 4-12. – DOI: 10.1016/S2155-8256(23)00063-7.
 24. Leep-Lazar K., Ma C., Stimpfel A. W. Factors associated with intent to leave the nursing profession in the United States: an integrative review // *Research in Nursing & Health*. – 2025. – Vol. 48(4). – P. 429-440. – DOI: 10.1002/nur.22465.
 25. Johnston L., Malcolm C., Rambabu L. et al. Practice based approaches to supporting the work related wellbeing of frontline care workers in care homes: a scoping review // *Journal of Long-Term Care*. – 2021. – P. 230-240. – DOI: 10.31389/jltc.66.
 26. Buckley L., McGillis Hall L., Price S. et al. Nurse retention in peri- and post-COVID-19 work environments: a scoping review of factors, strategies and interventions // *BMJ Open*. – 2025. – Vol. 15(3). – Article No. e096333. – DOI: 10.1136/bmjopen-2024-096333.
 27. Tolksdorf K. H., Tischler U., Heinrichs K. Correlates of turnover intention among nursing staff in the COVID-19 pandemic: a systematic review // *BMC Nursing*. – 2022. – Vol. 21(1). – Article No. 174. – DOI: 10.1186/s12912-022-00949-4.
 28. Amini Rarani S. Nursing workforce in collapse: a narrative review of global shortages, burnout, and the future of health system resilience // *International Journal of Africa Nursing Sciences*. – 2025. – Article No. 100938. – DOI: 10.1016/j.ijans.2025.100938.
 29. Belita E., Neil-Sztramko S. E., Seale C. et al. Organizational interventions to support and promote the mental health of healthcare workers during pandemics and epidemics: a systematic review // *BMC Health Services Research*. – 2025. – Vol. 25(1). – Article No. 731. – DOI: 10.1186/s12913-025-12888-2.
 30. Amarsanaa J., Batsaikhan O., Jargalsaikhan B. et al. Impact of the COVID-19 pandemic on health emergency and disaster risk management systems: a scoping review of mental health support provided

- to health care workers // *Journal of Occupational Health*. – 2025. – Vol. 67(1). – Article No. uiaf020. – DOI: 10.1093/joccuh/uiaf020.
31. Labrague L. J. Psychological resilience, coping behaviours and social support among health care workers during the COVID-19 pandemic: a systematic review of quantitative studies // *Journal of Nursing Management*. – 2021. – Vol. 29(7). – P. 1893-1905. – DOI: 10.1111/jonm.13336.
32. Cohen C., Pignata S., Bezak E. et al. Workplace interventions to improve well-being and reduce burnout for nurses, physicians and allied healthcare professionals: a systematic review // *BMJ Open*. – 2023. – Vol. 13(6). – Article No. e071203. – DOI: 10.1136/bmjopen-2022-071203.
33. Rotenstein L. S., Brown R., Sinsky C., Linzer M. The association of work overload with burnout and intent to leave the job across the healthcare workforce during COVID-19 // *Journal of General Internal Medicine*. – 2023. – Vol. 38(8). – P. 1920-1927. – DOI: 10.1007/s11606-023-08153-z.
34. James T. T., Hudon R., Merrick T. et al. Creating a comprehensive pandemic response to decrease hospitalist burnout during COVID-19: intervention vs control results in 2 comparable hospitals (HOSP-CPR) // *Journal of General Internal Medicine*. – 2023. – Vol. 38(5). – P. 1256-1263. – DOI: 10.1007/s11606-023-08041-6.
35. De Vries N., Lavreysen O., Boone A. et al. Retaining healthcare workers: a systematic review of strategies for sustaining power in the workplace // *Healthcare*. – 2023. – Vol. 11(13). – Article No. 1887. – DOI: 10.3390/healthcare11131887.
36. Frias C. E., Samarasinghe N., Cuzco C. et al. Strategies to support the mental health and well-being of health and care workforce: a rapid review of reviews // *Frontiers in Medicine*. – 2025. – Vol. 12. – Article No. 1530287. – DOI: 10.3389/fmed.2025.1530287.
37. Sidiq M., Ch S. J. P., Janakiraman B. et al. Burnout experience among healthcare workers post third COVID-19 wave in India; findings of a cross-sectional study // *PeerJ*. – 2024. – Vol. 12. – Article No. e18039. – DOI: 10.7717/peerj.18039.
38. Klein M. G., Cheng C. J., Lii E. et al. COVID-19 models for hospital surge capacity planning: a systematic review // *Disaster Medicine and Public Health Preparedness*. – 2022. – Vol. 16(1). – P. 390-397. – DOI: 10.1017/dmp.2020.332.
39. Peters A. W., Chawla K. S., Turnbull Z. A. Transforming ORs into ICUs // *New England Journal of Medicine*. – 2020. – Vol. 382(19). – Article No. e52. – DOI: 10.1056/NEJMc2010853.
40. Alqahtani F., Khan A., Alowais J. et al. Bed surge capacity in Saudi hospitals during the COVID-19 pandemic // *Disaster Medicine and Public Health Preparedness*. – 2022. – Vol. 16(6). – P. 2446-2452. – DOI: 10.1017/dmp.2021.117.
41. Berger E., Winkelmann J., Eckhardt H. et al. A country-level analysis comparing hospital capacity and utilisation during the first COVID-19 wave across Europe // *Health Policy*. – 2022. – Vol. 126(5). – P. 373-381. – DOI: 10.1016/j.healthpol.2021.11.009.
42. Petanidis S., Chandramouli K., Floros G. et al. Optimizing emergency response in hospitals: a systematic review of surge capacity planning and crisis resource management // *Healthcare*. – 2025. – Vol. 13(21). – Article No. 2819. – DOI: 10.3390/healthcare13212819.
43. Kodaira Y., Inokuchi M., Omomo T. et al. A stratified approach to hospital surge capacity during the COVID-19 pandemic in Tokyo // *Acute Medicine & Surgery*. – 2025. – Vol. 12(1). – Article No. e70076. – DOI: 10.1002/ams2.70076.
44. COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans // *British Journal of Surgery*. – 2020. – Vol. 107(11). – P. 1440-1449. – DOI: 10.1002/bjs.11746.
45. de Graaff M. R., Hogenbirk R. N. M., Janssen Y. F. et al. Impact of the COVID-19 pandemic on surgical care in the Netherlands // *British Journal of Surgery*. – 2022. – Vol. 109(12). – P. 1282-1292. – DOI: 10.1093/bjs/znac301.
46. McCabe R., Schmit N., Christen P. et al. Adapting hospital capacity to meet changing demands during the COVID-19 pandemic // *BMC Medicine*. – 2020. – Vol. 18(1). – Article No. 329. – DOI: 10.1186/s12916-020-01781-w.
47. Rosenbäck R. G., Svensson A. Resilience in keeping the balance between demand and capacity in the COVID-19 pandemic, a case study at a Swedish middle-sized hospital // *BMC Health Services Research*. – 2023. – Vol. 23. – Article No. 202. – DOI: 10.1186/s12913-023-09182-4.
48. Dichter J. R., Devereaux A. V., Sprung C. L. et al. Mass critical care surge response during COVID-19: implementation of contingency strategies – a preliminary report of findings from the Task Force for Mass Critical Care // *Chest*. – 2022.

- Vol. 161(2). – P. 429–447. – DOI: 10.1016/j.chest.2021.08.072.
49. Burki T. Global shortage of personal protective equipment // *The Lancet Infectious Diseases*. – 2020. – Vol. 20(7). – P. 785. – DOI: 10.1016/S1473-3099(20)30501-6.
50. Zhang J., Mitchell C., Kushniruk A., Guitouni A. Facing disruption: learning from the healthcare supply chain responses in British Columbia during the COVID-19 pandemic // *Healthcare Management Forum*. – 2022. – Vol. 35(2). – P. 80–85. – DOI: 10.1177/08404704211058968.
51. Rosenbäck R., Lantz B., Rosén P. Managing disrupted supply chains in Swedish hospitals during the COVID-19 pandemic // *Health Systems*. – 2025. – Vol. 14(1). – P. 58–68. – DOI: 10.1080/20476965.2024.2349816.
52. Snowdon A. W., Saunders M. J. Supply chain integration as a strategy to strengthen pandemic responsiveness in Nova Scotia // *Healthcare Management Forum*. – 2022. – Vol. 35(2). – P. 62–70. – DOI: 10.1177/08404704211061223.
53. Yemeke T. T., Umaru F. A., Ferrand R. A., Ozawa S. Impact of the COVID-19 pandemic on medical product procurement, prices, and supply chain in Zimbabwe: lessons for supply chain resiliency // *Global Health: Science and Practice*. – 2023. – Vol. 11(5). – Article No. e2200424. – DOI: 10.9745/GHSP-D-22-00424.
54. Risko N., Werner K., Offorjebe O. A. et al. Cost-effectiveness and return on investment of protecting health workers in low- and middle-income countries during the COVID-19 pandemic // *PLoS ONE*. – 2020. – Vol. 15(10). – Article No. e0240503. – DOI: 10.1371/journal.pone.0240503.
55. Callaway Kim K., Rothenberger S. D., Tadrous M. et al. Drug shortages prior to and during the COVID-19 pandemic // *JAMA Network Open*. – 2024. – Vol. 7(4). – Article No. e244246. – DOI: 10.1001/jamanetworkopen.2024.4246.
56. Aivazi M. A., Rasekh H. R., Peikanpour M. et al. The COVID-19 pandemic and the resilience of the pharmaceutical supply chain: lessons from past experiences and strategies for the future // *Iranian Journal of Pharmaceutical Research*. – 2024. – Vol. 23(1). – Article No. e152723. – DOI: 10.5812/ijpr-152723.
57. Vats K., Sharif Y. Using a 5P strategic medical stockpile model to build an optimal and resilient supply chain in health emergencies // *Saudi Journal of Emergency Medicine*. – 2024. – Vol. 5. – P. 73–80. – DOI: 10.24911/SJEMed/72-1703414327.
58. Serchen J., Hilden D., Silberger J. R. Health and Public Policy Committee of the American College of Physicians. Bolstering the medication supply chain and ameliorating medication shortages: a position paper from the American College of Physicians // *Annals of Internal Medicine*. – 2025. – Vol. 178(10). – P. 1464–1468. – DOI: 10.7326/ANNALS-25-00607.
59. Sen-Crowe B., Sutherland M., McKenney M., Elkbuli A. A closer look into global hospital beds capacity and resource shortages during the COVID-19 pandemic // *Journal of Surgical Research*. – 2021. – Vol. 260. – P. 56–63. – DOI: 10.1016/j.jss.2020.11.062.
60. Phua J., Kulkarni A. P., Mizota T. et al. Critical care bed capacity in Asian countries and regions before and during the COVID-19 pandemic: an observational study // *The Lancet Regional Health – Western Pacific*. – 2024. – Vol. 44. – Article No. 100982. – DOI: 10.1016/j.lanwpc.2023.100982.
61. Drouard S. H. P., Ahmed T., Amor Fernandez P. et al. Availability and use of personal protective equipment in low- and middle-income countries during the COVID-19 pandemic // *PLoS ONE*. – 2023. – Vol. 18(7). – Article No. e0288465. – DOI: 10.1371/journal.pone.0288465.
62. Vogler S. Tackling medicine shortages during and after the COVID-19 pandemic: compilation of governmental policy measures and developments in 38 countries // *Health Policy*. – 2024. – Vol. 143. – Article No. 105030. – DOI: 10.1016/j.healthpol.2024.105030.
63. AlRuthia Y., Almutiri N. M., Almutairi R. M. et al. Local causes of essential medicines shortages from the perspective of supply chain professionals in Saudi Arabia // *Saudi Pharmaceutical Journal*. – 2023. – Vol. 31(6). – P. 948–954. – DOI: 10.1016/j.jsps.2023.04.019.
64. Mekonen Z. T., Fenta T. G., Nadeem S. P., Cho D. J. Global health commodities supply chain in the era of COVID-19 pandemic: challenges, impacts, and prospects: a systematic review // *Journal of Multidisciplinary Healthcare*. – 2024. – Vol. 17. – P. 1523–1539. – DOI: 10.2147/JMDH.S448654.
65. Haakenstad A., Irvine C. M. S., Knight M. et al. Measuring the availability of human resources for health and its relationship to universal health coverage for 204 countries and territories from 1990 to 2019: a systematic analysis for the Global Burden

- of Disease Study 2019 // *The Lancet*. – 2022. – Vol. 399(10341). – P. 2129-2154. – DOI: 10.1016/S0140-6736(22)00532-3.
66. Boniol M., Kunjumen T., Nair T. S. et al. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and ‘universal’ health coverage? // *BMJ Global Health*. – 2022. – Vol. 7(6). – Article No. e009316. – DOI: 10.1136/bmjgh-2022-009316.
67. Dar M., Swamy L., Gavin D., Theodore A. Mechanical-ventilation supply and options for the COVID-19 pandemic: leveraging all available resources for a limited resource in a crisis // *Annals of the American Thoracic Society*. – 2021. – Vol. 18(3). – P. 408-416. – DOI: 10.1513/AnnalsATS.202004-317CME.
68. Barasa E. W., Ouma P. O., Okiro E. A. Assessing the hospital surge capacity of the Kenyan health system in the face of the COVID-19 pandemic // *PLoS ONE*. – 2020. – Vol. 15(7). – Article No. e0236308. – DOI: 10.1371/journal.pone.0236308.
69. Relan P., Rylance J., Arabi Y. M. et al. Medical oxygen and respiratory support requirements for patients hospitalised with COVID-19 in 23 low-income and middle-income countries: a prospective, observational cohort study // *The Lancet Global Health*. – 2026. – Vol. 14(2). – P. e233–e241. – DOI: 10.1016/S2214-109X(25)00480-2.
70. Gallifant J., Sharell D., Hashmi M. et al. Mechanical ventilators for low- and middle-income countries: informing a context-specific and sustainable design // *British Journal of Anaesthesia*. – 2022. – Vol. 128(4). – P. e279–e281. – DOI: 10.1016/j.bja.2022.01.007.
71. Shah R., Hanna N. M., Loo C. E. et al. The global impact of the COVID-19 pandemic on delays and disruptions in cancer care services: a systematic review and meta-analysis // *Nature Cancer*. – 2025. – Vol. 6(1). – P. 194-204. – DOI: 10.1038/s43018-024-00880-4.
72. Romatoski K. S., Chung S. H., Kenzik K. et al. Delay and disparity in observed vs predicted incidence rate of screenable cancer during the COVID-19 pandemic // *Journal of the American College of Surgeons*. – 2023. – Vol. 237(3). – P. 420-430. – DOI: 10.1097/XCS.0000000000000772.
73. Arsenault C., Gage A., Kim M. K. et al. COVID-19 and resilience of healthcare systems in ten countries // *Nature Medicine*. – 2022. – Vol. 28(6). – P. 1314-1324. – DOI: 10.1038/s41591-022-01750-1.
74. Bello S., Neill R., Jegede A. S. et al. Health systems challenges, mitigation strategies and adaptations to maintain essential health services during the COVID-19 pandemic: learnings from the six geopolitical regions in Nigeria // *BMC Health Services Research*. – 2024. – Vol. 24(1). – Article No. 625. – DOI: 10.1186/s12913-024-11072-2.
75. Perera U. G., Chastain A. M., Dick A. W. et al. Transforming care: the impact of COVID-19 on telehealth adoption in US home health care agencies // *Telemedicine and e-Health*. – 2025. – Vol. 31(12). – P. 1503-1507. – DOI: 10.1177/15305627251382456.
76. Carbonara N., Pellegrino R., De Luca C. Resilience of hospitals in an age of disruptions: a systematic literature review on resources and capabilities // *Health Systems*. – 2024. – Vol. 13(3). – P. 192-228. – DOI: 10.1080/20476965.2024.2365144.
77. Larson J. D., Lai A. Y., DePuccio M. J., Hilligoss B. Managing surges in demand: a grounded conceptual framework of surge management capability // *Medical Care Research and Review*. – 2024. – Vol. 81(3). – P. 245-258. – DOI: 10.1177/10775587241226485.
78. Gupta N., Balcom S. A., Gulliver A., Witherspoon R. L. Health workforce surge capacity during the COVID-19 pandemic and other global respiratory disease outbreaks: a systematic review of health system requirements and responses // *International Journal of Health Planning and Management*. – 2021. – Vol. 36, Suppl. 1. – P. 26-41. – DOI: 10.1002/hpm.3137.
79. Cavalcante de Oliveira A. P., Galante M. L., Maia L. S. et al. Implementation of policy and management interventions to improve health and care workforce capacity to address the COVID-19 pandemic response: a systematic review // *Human Resources for Health*. – 2023. – Vol. 21(1). – Article No. 80. – DOI: 10.1186/s12960-023-00856-y.
80. Sari N., Omar M., Pasinringi S. A. et al. Toward hospital resilience: a qualitative study on the identification of hospital shocks during disruption era in Indonesia // *BMC Health Services Research*. – 2024. – Vol. 24(1). – Article No. 1185. – DOI: 10.1186/s12913-024-11385-2.
81. Hong S. A. Toward better pandemic governance and preparedness: South Korea’s whole-of-nation approach to COVID-19 // *BMC Public Health*. – 2024. – Vol. 24(1). – Article No. 2126. – DOI: 10.1186/s12889-024-19655-8.
82. Brubacher L. J., Yellappa V., Lestari B. W. et al. Health and tuberculosis systems resilience, the

- role of the private sector and pandemic preparedness: insights from a cross-country qualitative study with policy-makers in India, Indonesia and Nigeria // *BMJ Global Health*. – 2025. – Vol. 10(1). – Article No. e016180. – DOI: 10.1136/bmjgh-2024-016180.
83. Haldane V., De Foo C., Abdalla S. M. et al. Health systems resilience in managing the COVID-19 pandemic: lessons from 28 countries // *Nature Medicine*. – 2021. – Vol. 27(6). – P. 964-980. – DOI: 10.1038/s41591-021-01381-y.
84. Bishai D., Saleh B. M., Huda M. et al. Practical strategies to achieve resilient health systems: results from a scoping review // *BMC Health Services Research*. – 2024. – Vol. 24(1). – Article No. 297. – DOI: 10.1186/s12913-024-10650-8.
85. Tan M. Z. Y., Prager G., McClelland A., Dark P. Healthcare resilience: a meta-narrative systematic review and synthesis of reviews // *BMJ Open*. – 2023. – Vol. 13(9). – Article No. e072136. – DOI: 10.1136/bmjopen-2023-072136.
86. Burau V., Falkenbach M., Neri S. et al. Health system resilience and health workforce capacities: comparing health system responses during the COVID-19 pandemic in six European countries // *International Journal of Health Planning and Management*. – 2022. – Vol. 37(4). – P. 2032-2048. – DOI: 10.1002/hpm.3446.
87. Armstrong D. Health workforce issues and challenges in the post-pandemic era // *Health Affairs Scholar*. – 2025. – Vol. 3(1). – Article No. qxae168. – DOI: 10.1093/haschl/qxae168.
88. Poon Y. S., Lin Y. P., Griffiths P. et al. A global overview of healthcare workers' turnover intention amid COVID-19 pandemic: a systematic review with future directions // *Human Resources for Health*. – 2022. – Vol. 20(1). – Article No. 70. – DOI: 10.1186/s12960-022-00764-7.
89. Sachs J. D., Karim S. S. A., Akinin L. et al. The Lancet Commission on lessons for the future from the COVID-19 pandemic // *The Lancet*. – 2022. – Vol. 400(10359). – P. 1224-1280. – DOI: 10.1016/S0140-6736(22)01585-9.
90. Abdel-Motaal K. A., El Kheir-Mataria W. A., Chun S. Global health governance and the WHO pandemic agreement: a scoping review of challenges and analysis of reforms // *International Journal of Environmental Research and Public Health*. – 2025. – Vol. 22(12). – Article No. 1807. – DOI: 10.3390/ijerph22121807.
91. Coates A., Fuad A. O., Hodgson A., Bourgeault I. L. Health workforce strategies in response to major health events: a rapid scoping review with lessons learned for the response to the COVID-19 pandemic // *Human Resources for Health*. – 2021. – Vol. 19(1). – Article No. 154. – DOI: 10.1186/s12960-021-00698-6.
92. Goh K. J., Wong J., Tien J. C. et al. Preparing your intensive care unit for the COVID-19 pandemic: practical considerations and strategies // *Critical Care*. – 2020. – Vol. 24(1). – Article No. 215. – DOI: 10.1186/s13054-020-02916-4.
93. Griffin K. M., Karas M. G., Ivascu N. S., Lief L. Hospital preparedness for COVID-19: a practical guide from a critical care perspective // *American Journal of Respiratory and Critical Care Medicine*. – 2020. – Vol. 201(11). – P. 1337-1344. – DOI: 10.1164/rccm.202004-1037CP.
94. Kerlin M. P., Costa D. K., Davis B. S. et al. Actions taken by US hospitals to prepare for increased demand for intensive care during the first wave of COVID-19: a national survey // *Chest*. – 2021. – Vol. 160(2). – P. 519-528. – DOI: 10.1016/j.chest.2021.03.005.
95. Bhaskar S., Tan J., Bogers M. L. et al. At the epicenter of COVID-19 – the tragic failure of the global supply chain for medical supplies // *Frontiers in Public Health*. – 2020. – Vol. 8. – Article No. 562882. – DOI: 10.3389/fpubh.2020.562882.

References

1. Miyamoto, T., Fujita, M., Hachiya, M., et al. (2025). Overview of global governance, capacity, and health systems implication of pandemic prevention, preparedness, and response: A narrative review and descriptive analysis of open-source data. *Global Health & Medicine*, 7(2), 112-126. DOI: <https://doi.org/10.35772/ghm.2025.01018>
2. Rubini, E., Trentin, M., Maffi, P., et al. (2026). Challenges in healthcare facilities' response to past outbreaks: A systematic review of reviews. *BMC Health Services Research*, 26(1), 141. DOI: <https://doi.org/10.1186/s12913-025-13934-9>
3. Wang, R., & Naeem, M. A. (2025). COVID-19 pandemic: A comprehensive meta-review of global impacts, responses, and future preparedness. *The Clinical Respiratory Journal*, 19(11), e70134. DOI: <https://doi.org/10.1111/crj.70134>
4. Moss, M. (2025). Mitigating burnout: The role of healthcare organizations. *ATS Scholar*, 6(3), 267-279. DOI: <https://doi.org/10.34197/ats-scholar.2024-0153PS>

5. Bhardwaj, A. (2022). COVID-19 pandemic and physician burnout: Ramifications for health-care workforce in the United States. *Journal of Healthcare Leadership*, 14, 91-97. DOI: <https://doi.org/10.2147/JHL.S360163>
6. Fatima, S. A., Hao, X. Y., Sun, D., et al. (2025). Burnout among public health physicians and residents in Canada following the COVID-19 pandemic: A cross-sectional study. *PLOS Mental Health*, 2(12), e0000527. DOI: <https://doi.org/10.1371/journal.pmen.0000527>
7. Singh, J., Poon, D. E.-O., Alvarez, E., et al. (2024). Burnout among public health workers in Canada: A cross-sectional study. *BMC Public Health*, 24(1), 48. DOI: <https://doi.org/10.1186/s12889-023-17572-w>
8. Wenham, C., & Potluru, A. (2025). Analysing the engagement with pandemic preparedness, prevention and response in selected English language political manifestoes in 2024. *Global Health Action*, 18(1), 2559453. DOI: <https://doi.org/10.1080/16549716.2025.2559453>
9. OECD. (2023). Health at a glance 2023: OECD indicators. OECD Publishing. DOI: <https://doi.org/10.1787/7a7afb35-en>
10. OECD. (2025). Health at a glance 2025: OECD indicators. OECD Publishing. DOI: <https://doi.org/10.1787/8f9e3f98-en>
11. OECD. (2024). Securing Medical Supply Chains in a Post-Pandemic World: OECD Health Policy Studies. OECD Publishing.
12. World Health Organization. (2025). State of the world's nursing 2025: Investing in education, jobs, leadership and service delivery.
13. National Academies of Sciences, Engineering, and Medicine. (2022). Building resilience into the nation's medical product supply chains. The National Academies Press.
14. Jan, B. Z. M. M., & Keenoo, S. B. (2025). Prevalence of burnout among healthcare workers during the COVID-19 pandemic: A systematic literature review: Abstract. *BJPsych Open*, 11(Suppl. 1), S58. DOI: <https://doi.org/10.1192/bjo.2025.10204>
15. Jephthah, D., & Ddumba, I. (2023). Assessing the surge capacity of hospitals in Ugandan health care systems in managing the COVID-19 pandemic: Abstract. *European Psychiatry*, 66(Suppl. 1), S785–S786. DOI: <https://doi.org/10.1192/j.eurpsy.2023.1658>
16. Glushkova, N., Semenova, Y., Jobalayeva, B., et al. (2022). Geospatial characteristics of medical workforce and infrastructure to combat COVID-19 in Kazakhstan: Abstract. *European Journal of Public Health*, 32(Suppl. 3), ckac130.023. DOI: <https://doi.org/10.1093/eurpub/ckac130.023>
17. Arji, G., Ahmadi, H., Avazpoor, P., & Hemmat, M. (2023). Identifying resilience strategies for disruption management in the healthcare supply chain during COVID-19 by digital innovations: A systematic literature review. *Informatics in Medicine Unlocked*, 38, 101199. DOI: <https://doi.org/10.1016/j.imu.2023.101199>
18. Turusbekova, N., Celan, C., Caraulan, L., et al. (2022). Gender-related factors associated with delayed diagnosis of tuberculosis in Eastern Europe and Central Asia. *BMC Public Health*, 22(1), 1999. DOI: <https://doi.org/10.1186/s12889-022-14419-8>
19. Foster, F., Kanderzhanova, A., Umbetkulova, S., et al. (2024). “Who else if not us”: An exploratory-descriptive qualitative study of Kazakhstani frontline professionals’ experience and perceptions during the coronavirus disease 2019 pandemic. *Qualitative Health Research*, 34(6), 507-516. DOI: <https://doi.org/10.1177/10497323231216363>
20. Battakova, Z., Imasheva, B., Slazhneva, T., et al. (2023). Public health response measures for COVID-19 in Kazakhstan. *Disaster Medicine and Public Health Preparedness*, 17, e524. DOI: <https://doi.org/10.1017/dmp.2023.181>
21. Ghahramani, S., Lankarani, K. B., Yousefi, M., et al. (2021). A systematic review and meta-analysis of burnout among healthcare workers during COVID-19. *Frontiers in Psychiatry*, 12, 758849. DOI: <https://doi.org/10.3389/fpsy.2021.758849>
22. Fekih-Romdhane, F., Harb, F., Al Banna, S., et al. (2025). Prevalence and risk factors of burnout symptoms among nurses during the COVID-19 pandemic: An updated systematic review and meta-analysis. *Human Resources for Health*, 23(1), 48. DOI: <https://doi.org/10.1186/s12960-025-01012-4>
23. Martin, B., Kaminski-Ozturk, N., O'Hara, C., & Smiley, R. (2023). Examining the impact of the COVID-19 pandemic on burnout and stress among U.S. nurses. *Journal of Nursing Regulation*, 14(1), 4-12. DOI: [https://doi.org/10.1016/S2155-8256\(23\)00063-7](https://doi.org/10.1016/S2155-8256(23)00063-7)
24. Leep-Lazar, K., Ma, C., & Stimpfel, A. W. (2025). Factors associated with intent to leave the nursing profession in the United States: An integrative review. *Research in Nursing & Health*, 48(4), 429-440. DOI: <https://doi.org/10.1002/nur.22465>

25. Johnston, L., Malcolm, C., Rambabu, L., et al. (2021). Practice based approaches to supporting the work related wellbeing of frontline care workers in care homes: A scoping review. *Journal of Long-Term Care*, 230-240. DOI: <https://doi.org/10.31389/jltc.66>
26. Buckley, L., McGillis Hall, L., Price, S., et al. (2025). Nurse retention in peri- and post-COVID-19 work environments: A scoping review of factors, strategies and interventions. *BMJ Open*, 15(3), e096333. DOI: <https://doi.org/10.1136/bmjopen-2024-096333>
27. Tolksdorf, K. H., Tischler, U., & Heinrichs, K. (2022). Correlates of turnover intention among nursing staff in the COVID-19 pandemic: A systematic review. *BMC Nursing*, 21(1), 174. DOI: <https://doi.org/10.1186/s12912-022-00949-4>
28. Amini Rarani, S. (2025). Nursing workforce in collapse: A narrative review of global shortages, burnout, and the future of health system resilience. *International Journal of Africa Nursing Sciences*, 100938. DOI: <https://doi.org/10.1016/j.ijans.2025.100938>
29. Belita, E., Neil-Sztramko, S. E., Seale, C., et al. (2025). Organizational interventions to support and promote the mental health of healthcare workers during pandemics and epidemics: A systematic review. *BMC Health Services Research*, 25(1), 731. DOI: <https://doi.org/10.1186/s12913-025-12888-2>
30. Amarsanaa, J., Batsaikhan, O., Jargalsaikhan, B., et al. (2025). Impact of the COVID-19 pandemic on health emergency and disaster risk management systems: A scoping review of mental health support provided to health care workers. *Journal of Occupational Health*, 67(1), uiaf020. DOI: <https://doi.org/10.1093/joccuh/uiaf020>
31. Labrague, L. J. (2021). Psychological resilience, coping behaviours and social support among health care workers during the COVID-19 pandemic: A systematic review of quantitative studies. *Journal of Nursing Management*, 29(7), 1893-1905. DOI: <https://doi.org/10.1111/jonm.13336>
32. Cohen, C., Pignata, S., Bezak, E., et al. (2023). Workplace interventions to improve well-being and reduce burnout for nurses, physicians and allied healthcare professionals: A systematic review. *BMJ Open*, 13(6), e071203. DOI: <https://doi.org/10.1136/bmjopen-2022-071203>
33. Rotenstein, L. S., Brown, R., Sinsky, C., & Linzer, M. (2023). The association of work overload with burnout and intent to leave the job across the healthcare workforce during COVID-19. *Journal of General Internal Medicine*, 38(8), 1920-1927. DOI: <https://doi.org/10.1007/s11606-023-08153-z>
34. James, T. T., Hudon, R., Merrick, T., et al. (2023). Creating a comprehensive pandemic response to decrease hospitalist burnout during COVID-19: Intervention vs control results in 2 comparable hospitals (HOSP-CPR). *Journal of General Internal Medicine*, 38(5), 1256-1263. DOI: <https://doi.org/10.1007/s11606-023-08041-6>
35. De Vries, N., Lavreysen, O., Boone, A., et al. (2023). Retaining healthcare workers: A systematic review of strategies for sustaining power in the workplace. *Healthcare*, 11(13), 1887. DOI: <https://doi.org/10.3390/healthcare11131887>
36. Frias, C. E., Samarasinghe, N., Cuzco, C., et al. (2025). Strategies to support the mental health and well-being of health and care workforce: A rapid review of reviews. *Frontiers in Medicine*, 12, 1530287. DOI: <https://doi.org/10.3389/fmed.2025.1530287>
37. Sidiq, M., Ch, S. J. P., Janakiraman, B., et al. (2024). Burnout experience among healthcare workers post third COVID-19 wave in India; findings of a cross-sectional study. *PeerJ*, 12, e18039. DOI: <https://doi.org/10.7717/peerj.18039>
38. Klein, M. G., Cheng, C. J., Lii, E., et al. (2022). COVID-19 models for hospital surge capacity planning: A systematic review. *Disaster Medicine and Public Health Preparedness*, 16(1), 390-397. DOI: <https://doi.org/10.1017/dmp.2020.332>
39. Peters, A. W., Chawla, K. S., & Turnbull, Z. A. (2020). Transforming ORs into ICUs. *New England Journal of Medicine*, 382(19), e52. DOI: <https://doi.org/10.1056/NEJMc2010853>
40. Alqahtani, F., Khan, A., Alowais, J., et al. (2022). Bed surge capacity in Saudi hospitals during the COVID-19 pandemic. *Disaster Medicine and Public Health Preparedness*, 16(6), 2446-2452. DOI: <https://doi.org/10.1017/dmp.2021.117>
41. Berger, E., Winkelmann, J., Eckhardt, H., et al. (2022). A country-level analysis comparing hospital capacity and utilisation during the first COVID-19 wave across Europe. *Health Policy*, 126(5), 373-381. DOI: <https://doi.org/10.1016/j.healthpol.2021.11.009>
42. Petanidis, S., Chandramouli, K., Floros, G., et al. (2025). Optimizing emergency response in hospitals: A systematic review of surge capacity planning and crisis resource management. *Healthcare*, 13(21), 2819. DOI: <https://doi.org/10.3390/healthcare13212819>

43. Kodaira, Y., Inokuchi, M., Omomo, T., et al. (2025). A stratified approach to hospital surge capacity during the COVID-19 pandemic in Tokyo. *Acute Medicine & Surgery*, 12(1), e70076. DOI: <https://doi.org/10.1002/ams2.70076>
44. COVIDSurg Collaborative. (2020). Elective surgery cancellations due to the COVID-19 pandemic: Global predictive modelling to inform surgical recovery plans. *British Journal of Surgery*, 107(11), 1440-1449. DOI: <https://doi.org/10.1002/bjs.11746>
45. de Graaff, M. R., Hogenbirk, R. N. M., Janssen, Y. F., et al. (2022). Impact of the COVID-19 pandemic on surgical care in the Netherlands. *British Journal of Surgery*, 109(12), 1282-1292. DOI: <https://doi.org/10.1093/bjs/znac301>
46. McCabe, R., Schmit, N., Christen, P., et al. (2020). Adapting hospital capacity to meet changing demands during the COVID-19 pandemic. *BMC Medicine*, 18(1), 329. DOI: <https://doi.org/10.1186/s12916-020-01781-w>
47. Rosenbäck, R. G., & Svensson, A. (2023). Resilience in keeping the balance between demand and capacity in the COVID-19 pandemic, a case study at a Swedish middle-sized hospital. *BMC Health Services Research*, 23, 202. DOI: <https://doi.org/10.1186/s12913-023-09182-4>
48. Dichter, J. R., Devereaux, A. V., Sprung, C. L., et al. (2022). Mass critical care surge response during COVID-19: Implementation of contingency strategies – a preliminary report of findings from the Task Force for Mass Critical Care. *Chest*, 161(2), 429-447. DOI: <https://doi.org/10.1016/j.chest.2021.08.072>
49. Burki, T. (2020). Global shortage of personal protective equipment. *The Lancet Infectious Diseases*, 20(7), 785. DOI: [https://doi.org/10.1016/S1473-3099\(20\)30501-6](https://doi.org/10.1016/S1473-3099(20)30501-6)
50. Zhang, J., Mitchell, C., Kushniruk, A., & Guitouni, A. (2022). Facing disruption: Learning from the healthcare supply chain responses in British Columbia during the COVID-19 pandemic. *Healthcare Management Forum*, 35(2), 80-85. DOI: <https://doi.org/10.1177/08404704211058968>
51. Rosenbäck, R., Lantz, B., & Rosén, P. (2025). Managing disrupted supply chains in Swedish hospitals during the COVID-19 pandemic. *Health Systems*, 14(1), 58-68. DOI: <https://doi.org/10.1080/20476965.2024.2349816>
52. Snowdon, A. W., & Saunders, M. J. (2022). Supply chain integration as a strategy to strengthen pandemic responsiveness in Nova Scotia. *Healthcare Management Forum*, 35(2), 62-70. DOI: <https://doi.org/10.1177/08404704211061223>
53. Yemeke, T. T., Umaru, F. A., Ferrand, R. A., & Ozawa, S. (2023). Impact of the COVID-19 pandemic on medical product procurement, prices, and supply chain in Zimbabwe: Lessons for supply chain resiliency. *Global Health: Science and Practice*, 11(5), e2200424. DOI: <https://doi.org/10.9745/GHSP-D-22-00424>
54. Risko, N., Werner, K., Offorjebe, O. A., et al. (2020). Cost-effectiveness and return on investment of protecting health workers in low- and middle-income countries during the COVID-19 pandemic. *PLoS ONE*, 15(10), e0240503. DOI: <https://doi.org/10.1371/journal.pone.0240503>
55. Callaway Kim, K., Rothenberger, S. D., Tadrous, M., et al. (2024). Drug shortages prior to and during the COVID-19 pandemic. *JAMA Network Open*, 7(4), e244246. DOI: <https://doi.org/10.1001/jamanetworkopen.2024.4246>
56. Aivazi, M. A., Rasekh, H. R., Peikanpour, M., et al. (2024). The COVID-19 pandemic and the resilience of the pharmaceutical supply chain: Lessons from past experiences and strategies for the future. *Iranian Journal of Pharmaceutical Research*, 23(1), e152723. DOI: <https://doi.org/10.5812/ijpr-152723>
57. Vats, K., & Sharif, Y. (2024). Using a 5P strategic medical stockpile model to build an optimal and resilient supply chain in health emergencies. *Saudi Journal of Emergency Medicine*, 5, 73-80. DOI: <https://doi.org/10.24911/SJEMed/72-1703414327>
58. Serchen, J., Hilden, D., Silberger, J. R., & Health and Public Policy Committee of the American College of Physicians. (2025). Bolstering the medication supply chain and ameliorating medication shortages: A position paper from the American College of Physicians. *Annals of Internal Medicine*, 178(10), 1464-1468. DOI: <https://doi.org/10.7326/ANNALS-25-00607>
59. Sen-Crowe, B., Sutherland, M., McKenney, M., & Elkbuli, A. (2021). A closer look into global hospital beds capacity and resource shortages during the COVID-19 pandemic. *Journal of Surgical Research*, 260, 56-63. DOI: <https://doi.org/10.1016/j.jss.2020.11.062>
60. Phua, J., Kulkarni, A. P., Mizota, T., et al. (2024). Critical care bed capacity in Asian countries and regions before and during the COVID-19 pandemic: An observational study. *The Lancet Regional*

- Health – Western Pacific, 44, 100982. DOI: <https://doi.org/10.1016/j.lanwpc.2023.100982>
61. Drouard, S. H. P., Ahmed, T., Amor Fernandez, P., et al. (2023). Availability and use of personal protective equipment in low- and middle-income countries during the COVID-19 pandemic. *PLoS ONE*, 18(7), e0288465. DOI: <https://doi.org/10.1371/journal.pone.0288465>
62. Vogler, S. (2024). Tackling medicine shortages during and after the COVID-19 pandemic: Compilation of governmental policy measures and developments in 38 countries. *Health Policy*, 143, 105030. DOI: <https://doi.org/10.1016/j.healthpol.2024.105030>
63. AlRuthia, Y., Almutiri, N. M., Almutairi, R. M., et al. (2023). Local causes of essential medicines shortages from the perspective of supply chain professionals in Saudi Arabia. *Saudi Pharmaceutical Journal*, 31(6), 948-954. DOI: <https://doi.org/10.1016/j.jsps.2023.04.019>
64. Mekonen, Z. T., Fenta, T. G., Nadeem, S. P., & Cho, D. J. (2024). Global health commodities supply chain in the era of COVID-19 pandemic: Challenges, impacts, and prospects: A systematic review. *Journal of Multidisciplinary Healthcare*, 17, 1523-1539. DOI: <https://doi.org/10.2147/JMDH.S448654>
65. Haakenstad, A., Irvine, C. M. S., Knight, M., et al. (2022). Measuring the availability of human resources for health and its relationship to universal health coverage for 204 countries and territories from 1990 to 2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, 399(10341), 2129-2154. DOI: [https://doi.org/10.1016/S0140-6736\(22\)00532-3](https://doi.org/10.1016/S0140-6736(22)00532-3)
66. Boniol, M., Kunjumen, T., Nair, T. S., et al. (2022). The global health workforce stock and distribution in 2020 and 2030: A threat to equity and 'universal' health coverage? *BMJ Global Health*, 7(6), e009316. DOI: <https://doi.org/10.1136/bmjgh-2022-009316>
67. Dar, M., Swamy, L., Gavin, D., & Theodore, A. (2021). Mechanical-ventilation supply and options for the COVID-19 pandemic: Leveraging all available resources for a limited resource in a crisis. *Annals of the American Thoracic Society*, 18(3), 408-416. DOI: <https://doi.org/10.1513/AnnalsATS.202004-317CME>
68. Barasa, E. W., Ouma, P. O., & Okiro, E. A. (2020). Assessing the hospital surge capacity of the Kenyan health system in the face of the COVID-19 pandemic. *PLoS ONE*, 15(7), e0236308. DOI: <https://doi.org/10.1371/journal.pone.0236308>
69. Relan, P., Rylance, J., Arabi, Y. M., et al. (2026). Medical oxygen and respiratory support requirements for patients hospitalised with COVID-19 in 23 low-income and middle-income countries: A prospective, observational cohort study. *The Lancet Global Health*, 14(2), e233–e241. DOI: [https://doi.org/10.1016/S2214-109X\(25\)00480-2](https://doi.org/10.1016/S2214-109X(25)00480-2)
70. Gallifant, J., Sharell, D., Hashmi, M., et al. (2022). Mechanical ventilators for low- and middle-income countries: Informing a context-specific and sustainable design. *British Journal of Anaesthesia*, 128(4), e279–e281. DOI: <https://doi.org/10.1016/j.bja.2022.01.007>
71. Shah, R., Hanna, N. M., Loo, C. E., et al. (2025). The global impact of the COVID-19 pandemic on delays and disruptions in cancer care services: A systematic review and meta-analysis. *Nature Cancer*, 6(1), 194-204. DOI: <https://doi.org/10.1038/s43018-024-00880-4>
72. Romatoski, K. S., Chung, S. H., Kenzik, K., et al. (2023). Delay and disparity in observed vs predicted incidence rate of screenable cancer during the COVID-19 pandemic. *Journal of the American College of Surgeons*, 237(3), 420-430. DOI: <https://doi.org/10.1097/XCS.0000000000000772>
73. Arsenault, C., Gage, A., Kim, M. K., et al. (2022). COVID-19 and resilience of healthcare systems in ten countries. *Nature Medicine*, 28(6), 1314-1324. DOI: <https://doi.org/10.1038/s41591-022-01750-1>
74. Bello, S., Neill, R., Jegede, A. S., et al. (2024). Health systems challenges, mitigation strategies and adaptations to maintain essential health services during the COVID-19 pandemic: Learnings from the six geopolitical regions in Nigeria. *BMC Health Services Research*, 24(1), 625. DOI: <https://doi.org/10.1186/s12913-024-11072-2>
75. Perera, U. G., Chastain, A. M., Dick, A. W., et al. (2025). Transforming care: The impact of COVID-19 on telehealth adoption in US home health care agencies. *Telemedicine and e-Health*, 31(12), 1503-1507. DOI: <https://doi.org/10.1177/15305627251382456>
76. Carbonara, N., Pellegrino, R., & De Luca, C. (2024). Resilience of hospitals in an age of disruptions: A systematic literature review on resources and capabilities. *Health Systems*, 13(3), 192-228. DOI: <https://doi.org/10.1080/20476965.2024.2365144>

77. Larson, J. D., Lai, A. Y., DePuccio, M. J., & Hilligoss, B. (2024). Managing surges in demand: A grounded conceptual framework of surge management capability. *Medical Care Research and Review*, 81(3), 245-258. DOI: <https://doi.org/10.1177/10775587241226485>
78. Gupta, N., Balcom, S. A., Gulliver, A., & Witherspoon, R. L. (2021). Health workforce surge capacity during the COVID-19 pandemic and other global respiratory disease outbreaks: A systematic review of health system requirements and responses. *International Journal of Health Planning and Management*, 36(Suppl. 1), 26-41. DOI: <https://doi.org/10.1002/hpm.3137>
79. Cavalcante de Oliveira, A. P., Galante, M. L., Maia, L. S., et al. (2023). Implementation of policy and management interventions to improve health and care workforce capacity to address the COVID-19 pandemic response: A systematic review. *Human Resources for Health*, 21(1), 80. DOI: <https://doi.org/10.1186/s12960-023-00856-y>
80. Sari, N., Omar, M., Pasinringi, S. A., et al. (2024). Toward hospital resilience: A qualitative study on the identification of hospital shocks during disruption era in Indonesia. *BMC Health Services Research*, 24(1), 1185. DOI: <https://doi.org/10.1186/s12913-024-11385-2>
81. Hong, S. A. (2024). Toward better pandemic governance and preparedness: South Korea's whole-of-nation approach to COVID-19. *BMC Public Health*, 24(1), 2126. DOI: <https://doi.org/10.1186/s12889-024-19655-8>
82. Brubacher, L. J., Yellappa, V., Lestari, B. W., et al. (2025). Health and tuberculosis systems resilience, the role of the private sector and pandemic preparedness: Insights from a cross-country qualitative study with policy-makers in India, Indonesia and Nigeria. *BMJ Global Health*, 10(1), e016180. DOI: <https://doi.org/10.1136/bmjgh-2024-016180>
83. Haldane, V., De Foo, C., Abdalla, S. M., et al. (2021). Health systems resilience in managing the COVID-19 pandemic: Lessons from 28 countries. *Nature Medicine*, 27(6), 964-980. DOI: <https://doi.org/10.1038/s41591-021-01381-y>
84. Bishai, D., Saleh, B. M., Huda, M., et al. (2024). Practical strategies to achieve resilient health systems: Results from a scoping review. *BMC Health Services Research*, 24(1), 297. DOI: <https://doi.org/10.1186/s12913-024-10650-8>
85. Tan, M. Z. Y., Prager, G., McClelland, A., & Dark, P. (2023). Healthcare resilience: A meta-narrative systematic review and synthesis of reviews. *BMJ Open*, 13(9), e072136. DOI: <https://doi.org/10.1136/bmjopen-2023-072136>
86. Burau, V., Falkenbach, M., Neri, S., et al. (2022). Health system resilience and health workforce capacities: Comparing health system responses during the COVID-19 pandemic in six European countries. *International Journal of Health Planning and Management*, 37(4), 2032-2048. DOI: <https://doi.org/10.1002/hpm.3446>
87. Armstrong, D. (2025). Health workforce issues and challenges in the post-pandemic era. *Health Affairs Scholar*, 3(1), qxae168. DOI: <https://doi.org/10.1093/haschl/qxae168>
88. Poon, Y. S., Lin, Y. P., Griffiths, P., et al. (2022). A global overview of healthcare workers' turnover intention amid COVID-19 pandemic: A systematic review with future directions. *Human Resources for Health*, 20(1), 70. DOI: <https://doi.org/10.1186/s12960-022-00764-7>
89. Sachs, J. D., Karim, S. S. A., Akin, L., et al. (2022). The Lancet Commission on lessons for the future from the COVID-19 pandemic. *The Lancet*, 400(10359), 1224-1280. DOI: [https://doi.org/10.1016/S0140-6736\(22\)01585-9](https://doi.org/10.1016/S0140-6736(22)01585-9)
90. Abdel-Motaal, K. A., El Kheir-Mataria, W. A., & Chun, S. (2025). Global health governance and the WHO pandemic agreement: A scoping review of challenges and analysis of reforms. *International Journal of Environmental Research and Public Health*, 22(12), 1807. DOI: <https://doi.org/10.3390/ijerph22121807>
91. Coates, A., Fuad, A. O., Hodgson, A., & Bourgeault, I. L. (2021). Health workforce strategies in response to major health events: A rapid scoping review with lessons learned for the response to the COVID-19 pandemic. *Human Resources for Health*, 19(1), 154. DOI: <https://doi.org/10.1186/s12960-021-00698-6>
92. Goh, K. J., Wong, J., Tien, J. C., et al. (2020). Preparing your intensive care unit for the COVID-19 pandemic: Practical considerations and strategies. *Critical Care*, 24(1), 215. DOI: <https://doi.org/10.1186/s13054-020-02916-4>
93. Griffin, K. M., Karas, M. G., Ivascu, N. S., & Lief, L. (2020). Hospital preparedness for COVID-19: A practical guide from a critical care perspective. *American Journal of Respiratory and Critical Care Medicine*, 201(11), 1337-1344. DOI: <https://doi.org/10.1164/rccm.202004-1037CP>

94. Kerlin, M. P., Costa, D. K., Davis, B. S., et al. (2021). Actions taken by US hospitals to prepare for increased demand for intensive care during the first wave of COVID-19: A national survey. *Chest*, 160(2), 519-528. DOI: <https://doi.org/10.1016/j.chest.2021.03.005>
95. Bhaskar, S., Tan, J., Bogers, M. L., et al. (2020). At the epicenter of COVID-19 – the tragic failure of the global supply chain for medical supplies. *Frontiers in Public Health*, 8, 562882. DOI: <https://doi.org/10.3389/fpubh.2020.562882>

COVID-19 ПАНДЕМИЯСЫНЫҢ ҰЙЫМДАСТЫРУШЫЛЫҚ САЛДАРЛАРЫ ЖӘНЕ ДЕНСАУЛЫҚ САҚТАУ ЖҮЙЕСІНІҢ ҚОҒАМДЫҚ ДЕНСАУЛЫҚ САЛАСЫНДАҒЫ БОЛАШАҚ ТӨТЕНШЕ ЖАҒДАЙЛАРҒА ДАЙЫНДЫҒЫ

Л. Ж. Оракбай¹, Т. Б. Төлеген^{*1}, О. Т. Касымов²

¹«Қазақстан-Ресей медициналық университеті» МЕББМ, Қазақстан, Алматы

² И. К. Ахунбаев атындағы Қырғыз мемлекеттік медицина академиясы, Қырғызстан, Бішкек

**Корреспондент автор*

Андатпа

Өзектілігі: COVID-19 пандемиясы денсаулық сақтау жүйелерінің ұйымдастырушылық осал тұстарын анықтап, кадрлармен қамтамасыз етудің тұрақтылығын, ауруханалардың жұмысын, жеткізу тізбектерін және жоспарлы медициналық көмек көрсетуді бұзды. Персоналдың тұрақтылығы, ауруханалардың резервтік қуаттары, жеткізу тізбектерінің сенімділігі және басқару саласындағы сабақтар Қазақстанның денсаулық сақтау жүйесінің болашақ пандемияларға және қоғамдық денсаулық сақтау саласындағы басқа да төтенше жағдайларға дайындығын нығайту үшін маңызды.

Мақсаты: COVID-19 пандемиясының ұйымдастырушылық салдарлары туралы деректерді қорытындылау, шұғыл бейімделу шараларын сақталып қалған мәселелерден ажырату және дайындық жөніндегі халықаралық тәжірибенің Қазақстанға қолданылуын қарастыру.

Материалдар мен әдістер: Нарративтік шолу жүргізілді. PubMed/MEDLINE, Web of Science және Google Scholar платформаларында 2020 жылғы қаңтардан 2026 жылғы шілдеге дейін алғаш жарияланған жұмыстар ізделді; соңғы іздеу 2026 жылғы 26 мамырда орындалды. Іздеу әдебиеттер тізімдері, нысаналы іздеу және ұйымдардың есептері арқылы толықтырылды. Шолуда үш конференция тезисін қамтитын 90 жарияланым және қосымша бес институционалдық есеп пайдаланылды. Деректер тақырыптық бағыттар бойынша қорытындыланды.

Нәтижелер: PubMed/MEDLINE, Web of Science және Google Scholar платформаларында 2020 жылғы 1 қаңтардан 2026 жылғы 26 мамырға дейін алғаш жарияланған жұмыстар ізделді; соңғы іздеу 2026 жылғы 26 мамырда жүргізілді. Жаһандық модель 2020 жылғы ең ауыр кезеңнің 12 аптасында 28,4 миллион жоспарлы операцияның тоқтатылуы немесе кейінге шегерілуі мүмкін екенін болжады. Жеткізу тізбектері туралы зерттеулерде өндірістің географиялық шоғырлануы, резервтік қорлардың жеткіліксіздігі және жеткізу тізбектері туралы білімнің шектеулілігі тапшылыққа ықпал етуі мүмкін факторлар ретінде қарастырылды. Бейімделу шараларына персоналды қайта бөлу, төсек қорын қайта бейіндеу, жабдықтауды орталықтандырылған үйлестіру және телемедицина кірді, алайда олардың ұзақ мерзімді тұрақтылығы жөніндегі деректер шектеулі болды.

Қорытынды: Деректер персоналды қорғауды, резервтік қуаттарды жоспарлауды, жеткізу тізбектерін әртараптандыруды және ден қою тәжірибесінен институционалдық сабақ алуды денсаулық сақтау жүйесінің күнделікті жұмысына енгізу мүмкіндігін қарастыруды қолдайды. Жекелеген шаралардың салыстырмалы тиімділігі мен ұзақ мерзімді тұрақтылығы жеткілікті анықталмаған. Қазақстан бойынша деректер шектеулі, сондықтан ұсынылған шаралар жергілікті бағалауды қажет етеді.

Түйін сөздер: COVID-19; пандемиялар; денсаулық сақтауды басқару; денсаулық сақтаудың кадрлық ресурстары; ауруханалардың төсек қоры; денсаулық сақтау ресурстары; төтенше жағдайлар кезіндегі іс-қимылдарды жоспарлау.

ОРГАНИЗАЦИОННЫЕ ПОСЛЕДСТВИЯ ПАНДЕМИИ COVID-19 И ГОТОВНОСТЬ СИСТЕМЫ ЗДРАВООХРАНЕНИЯ К БУДУЩИМ ЧРЕЗВЫЧАЙНЫМ СИТУАЦИЯМ В ОБЛАСТИ ОБЩЕСТВЕННОГО ЗДРАВООХРАНЕНИЯ

Л. Ж. Оракбай¹, Т. Б. Толеген^{*1}, О. Т. Касымов²

¹ НУО «Казахстанско-Российский медицинский университет», Казахстан, Алматы

² Кыргызская государственная медицинская академия

имени И.К. Ахунбаева, Кыргызстан, Бишкек

**Корреспондирующий автор*

Аннотация

Актуальность: Пандемия COVID-19 выявила организационные уязвимости систем здравоохранения, нарушив устойчивость кадрового обеспечения, работу больниц, цепочки поставок и оказание плановой помощи. Уроки в области устойчивости персонала, резервных мощностей больниц, надёжности цепочек поставок и управления важны для укрепления готовности системы здравоохранения Казахстана к будущим пандемиям и другим чрезвычайным ситуациям в области общественного здравоохранения.

Цель: обобщить данные об организационных последствиях COVID-19, разграничить экстренные адаптационные меры и сохраняющиеся проблемы, а также рассмотреть применимость международного опыта обеспечения готовности к условиям Казахстана.

Материалы и методы. Поиск в PubMed/MEDLINE, Web of Science и Google Scholar охватывал работы, впервые опубликованные с 1 января 2020 г. по 26 мая 2026 г.; последний поиск выполнен 26 мая 2026 г. Дополнительно использованы поиск по спискам литературы, целевой поиск и отчёты организаций. В обзор вошли 90 публикаций, включая три конференционных тезиса, и пять дополнительных институциональных отчётов. Данные обобщены по тематическим направлениям.

Результаты: В метаанализе распространённость профессионального выгорания среди медицинских работников составила 52 % (95 % ДИ 40–63 %). Выгорание было связано с намерением покинуть работу, тогда как фактический уход кадров описывался преимущественно в национальных обследованиях. Глобальная модель прогнозировала отмену или перенос 28,4 млн плановых операций за 12 недель пиковых нарушений в 2020 г. В исследованиях цепочек поставок географическая концентрация производства, недостаточные резервы и ограниченные знания о цепочках поставок рассматривались как возможные факторы дефицита. Организации адаптировались за счёт перераспределения персонала, перепрофилирования коек, централизованной координации поставок и телемедицины, однако данных о долгосрочной устойчивости этих мер было недостаточно.

Выводы: Имеющиеся данные поддерживают рассмотрение мер по защите персонала, планированию резервных мощностей, диверсификации поставок и институциональному обучению на опыте реагирования в рамках повседневной работы системы здравоохранения. Сравнительная эффективность и долгосрочная устойчивость конкретных мер остаются недостаточно изученными. Данные по Казахстану ограничены; предложенные меры требуют локальной оценки.

Ключевые слова: COVID-19; пандемии; управление здравоохранением; кадровые ресурсы здравоохранения; больничный коечный фонд; ресурсы здравоохранения; планирование действий при чрезвычайных ситуациях.

АВТОРЛАР ТУРАЛЫ

Оракбай Лязат Жадигеровна – медицина ғылымдарының докторы, «Қазақстан-Ресей медициналық университеті» МЕМБМ қауымдастырылған профессоры, Қазақстан, Алматы; e-mail: l.orakbai@medkrmu.kz; ORCID: <https://orcid.org/0009-0001-9367-0884>.

Төлеген Тогжан Бауыржанқызы – «Қазақстан-Ресей медициналық университеті» МЕМБМ «Қоғамдық денсаулық сақтау» білім беру бағдарламасы бойынша докторант, Қазақстан, Алматы; e-mail: togzhans.tolegen@gmail.com; ORCID: <https://orcid.org/0000-0003-1140-1064>.

Касымов Омор Тилегенович – медицина ғылымдарының докторы, профессор, Ресей жаратылыстану ғылымдары академиясының академигі, Ресей ғылым академиясының шетелдік мүшесі, И. К. Ахунбаев атындағы Қырғыз мемлекеттік медицина академиясының менеджмент кафедрасының профессоры, Қырғыз Республикасы Денсаулық сақтау министрлігінің «Профилактикалық медицина» ғылыми-өндірістік бірлестігінің директоры, Қырғызстан, Бішкек; e-mail: npopm@mail.ru; ORCID: <https://orcid.org/0000-0002-3304-7409>.

ОБ АВТОРАХ

Оракбай Лязат Жадигеровна – доктор медицинских наук, ассоциированный профессор НУО «Казахстанско-Российский медицинский университет», Казахстан, Алматы; e-mail: l.orakbai@medkrmu.kz; ORCID: <https://orcid.org/0009-0001-9367-0884>.

Төлеген Тогжан Бауыржанқызы – докторант по образовательной программе «Общественное здравоохранение» НУО «Казахстанско-Российский медицинский университет», Казахстан, Алматы; e-mail: togzhans.tolegen@gmail.com; ORCID: <https://orcid.org/0000-0003-1140-1064>.

Касымов Омор Тилегенович – доктор медицинских наук, профессор, академик РАЕН, иностранный член РАН, профессор кафедры менеджмента Кыргызской государственной медицинской академии им. И.К. Ахунбаева (КГМА), директор Научно-производственного объединения «Профилактическая медицина» МЗ Кыргызской Республики, Кыргызстан, Бишкек; e-mail: npopm@mail.ru; ORCID: <https://orcid.org/0000-0002-3304-7409>.

ABOUT THE AUTHORS

Orakbay Lyazat Zhadigerovna – Doctor of Medical Sciences, Associate Professor, Kazakh-Russian Medical University, Kazakhstan, Almaty; e-mail: l.orakbai@medkrmu.kz; ORCID: <https://orcid.org/0009-0001-9367-0884>.

Tolegen Togzhan Bauyrzhankyzy – doctoral student in Public Health, Kazakh-Russian Medical University, Almaty, Kazakhstan; e-mail: togzhans.tolegen@gmail.com; ORCID: <https://orcid.org/0000-0003-1140-1064>.

Kasymov Omor Tilegenovich – Doctor of Medical Sciences, Professor, Academician of the Russian Academy of Natural Sciences, Foreign Member of the Russian Academy of Sciences, Professor at the Department of Management, I. K. Akhunbaev Kyrgyz State Medical Academy, Director of the Scientific and Production Association «Preventive Medicine» of the Ministry of Health of the Kyrgyz Republic, Kyrgyzstan, Bishkek; e-mail: npopm@mail.ru; ORCID: <https://orcid.org/0000-0002-3304-7409>.

Authors' contributions: Orakbay L. Zh., Kasymov O. T. – conceptualization, methodology, supervision, critical revision of the manuscript; Tolegen T. B. – literature search, study selection, data extraction, formal analysis, writing of the original draft.

Conflict of interest. The authors declare no conflict of interest.

Funding: This work was supported by the Ministry of Healthcare of the Republic of Kazakhstan through programme-targeted funding (Programme No. BR27310319, “Development of preventive and rehabilitation programmes to improve the population’s quality of life in the post-COVID period”).

All authors have approved the final version of the manuscript and are responsible for its content.

Article received: 23.06. 2026.

Accepted for publication: 21. 08. 2026.