Research Article

A Cross-Sectional Study Evaluating Knowledge, Practices, and Operational Challenges in Epidemiological Surveillance Among Primary Health Care Workers in Diyala Governorate, Iraq

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Abstract | Strong epidemiological monitoring is the most crucial part of a good public health system. It enables other people swiftly find, confirm, and deal with the risk of highly contagious diseases. This study evaluated the knowledge, behaviors, and operational issues faced by healthcare workers in primary health care (PHC) epidemiology units in Diyala Governorate, Iraq. A cross-sectional study was performed from January 1 to March 1, 2026, utilizing face-to-face interviews with surveillance officers in all PHC centers within the governorate's eight health sectors (N=113 officers from 52 centers). A standardized questionnaire evaluated knowledge (15 items), practices, and problems. Knowledge scores were divided into four levels of performance: Excellent (13–15), Very Good (11–12), Good (9–10), and Needs Training (≤8). We used descriptive statistics and theme analysis. The basic knowledge was good enough (94.7% correctly defined epidemics). There were serious gaps in applied knowledge: just 30.1% correctly defined incidence, and 41.6% grasped what a "suspected case" was. The breakdown of performance tiers was as follows: Excellent (21.2%), Very Good (33.6%), Good (25.7%), and Needs Training (19.5%). There were big differences in geography, with no personnel needing training in the Khanaqin area and 25% needing training in the Jalawla sector. 42.5% of businesses said that weak internet was a major operational problem. 31.0% said that not having enough computers was a problem, and 25.7% said that not having enough workers was a problem. Training was substantially correlated with enhanced performance (p=0.032). Significant disparities exist between theoretical understanding and actual application among frontline surveillance personnel in Diyala, intensified by acute resource deficiencies and geographical disparities. We suggest: (1) putting in place tiered, competency-based training programs, (2) making strategic investments in surveillance infrastructure that focuses on the most needy areas, and (3) setting up systems for supporting supervision. These results give us a way to build up surveillance capacity again in places that have been through war.

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Introduction

The most important feature of a good public health system is strong epidemiological surveillance. It helps public health personnel quickly identify, confirm, and respond to risks from highly infectious diseases (World Health Organization, 2016). It is increasingly important in post-war or unstable settings, where health infrastructure is often weak and communities are more vulnerable to disease outbreaks (Ager *et al*., 2021). The effectiveness of surveillance systems mainly depends on the performance of frontline healthcare workers (HCWs) assigned to epidemiology units in primary healthcare centers (PHC), who act as gatekeepers for disease identification and initial response (Nsubuga *et al*., 2017).

The Iraqi Ministry of Health system, especially in places like Baquba city that have experienced prolonged conflict, faces significant challenges in maintaining effective surveillance (Al-Hilfi *et al*., 2013). Years of instability have led to systemic problems including infrastructure collapse, disrupted supply systems, and critical staff shortages. These issues severely hinder the capacity for disease monitoring and response (Lafta *et al*., 2022). While international and national efforts have focused on rebuilding health systems, frontline epidemic monitoring the most crucial early warning component often remains under-resourced and lacks necessary technical capacity in these settings (Patel *et al*., 2022).

Research globally indicates that surveillance systems in resource-limited and conflict-affected areas face numerous challenges. These include insufficient training in field epidemiology (Bardosh *et al*., 2017), fragmented and non-interoperable reporting systems (Phalkey *et al*., 2015), and critical shortages of essential operational resources such as information technology, transportation, and specialized personnel (Carrasco-Escobar *et al*., 2020). These interconnected challenges can render surveillance systems slow, unresponsive, and incapable of generating the timely data needed for effective public health intervention (Fall *et al*., 2019). The COVID-19 pandemic, for example, has starkly highlighted the consequences of inadequate frontline surveillance and underscored the global urgency of strengthening these foundational systems (Haldane *et al*., 2021).

Materials and Methods

Study designing

A .cross-sectional descriptive study was conducted in Diyala Governorate, Iraq, from January 1 to March 1, 2026. Diyala is an ethnically diverse. governorate located northeast of Baghdad that has experienced significant conflict and instability. The study included all eight administrative health sectors in the governorate: Baqubah 1, Baqubah 2, Al-Khalis, Al-Muqdadiya, Al-Mansouriyah, Jalawla, Baladruz, and Khanaqin, which represent urban and rural areas with varying degrees of infrastructure and security.

Study population and sampling

The target population was the designated responsible officer for the epidemiology/surveillance unit in every operational PHC center within Diyala Governorate. A complete census approach was employed; the research team aimed to visit and interview the responsible officer in all 52 PHC centers across the governorate. Inclusion criteria were: (1) being officially designated as responsible for epidemiological surveillance activities at the PHC center, and (2) providing informed consent. Exclusion criteria were: (1) temporary or acting officers with less than one month in position, and (2) officers unavailable after three attempted visits.

Data collection instrument and procedure

Data were collected through face-to-face interviews conducted by a team of four trained research assistants using a pre-tested structured questionnaire. The questioners was review and developed based on WHO guidelines [1], Iraqi national surveillance protocols, and basic principles of field epidemiology units [14]. It was exams and piloted by 10 probation officers (not included in the study) and revised for clarity and cultural appropriateness.

The questionnaire questions have a three of sections:

- Fiest Section A: its constent collected demographic and professional data (position, years of experience in the epidemiology unit, previous specialty training received, educational background).
- Section B: Knowledge assessment. It consists of 15 items: eight multiple-choice questions and seven true/false statements. Items defined in three domains were assessed: (1) basic concepts (definition of epidemics, diseases regulated by the International Health Regulations), (2)

surveillance measures and definitions (incidence rate, prevalence, definition of suspected case), and (3) surveillance procedures (first step in investigating an outbreak, data sources, reporting principles, confidentiality).

- Section C: Operational Context. It contains open-ended questions examining daily challenges, resource availability, coordination between departments, and suggestions for improving the system.

Knowledge Scoring and Tier Classification: Each correct answer in Section B was awarded 1 point (maximum score= 15). Based on these scores, participants were categorized into four performance tiers:

- Excellent: 13-15 correct (≥86.7%)
- Very Good: 11-12 correct (73.3-80.0%)
- Good: 9-10 correct (60.0-66.7%)
- Needs Training: ≤8 correct (<53.3%)

These cutoffs are determined based on standard educational assessment principles and consultation with local epidemiologists. The interviews were conducted in private settings in primary health care centres, lasted approximately 30-45 minutes, and were conducted in Arabic. Verbal informed consent was obtained from all participants after explaining the purpose of the study, procedures, confidentiality measures, and the voluntary nature of participation.

Data analysis

Data were clean and entered into Microsoft Excel program and analyzed by using SPSS program version 22. Descriptive statistics (count and frequencies, percentages, means, and standard deviations and others) summarized samples characteristics and knowledge scores. Performance on partscpaint knowledge items was reported as percentage correct with 95% confidence intervals. Participants were grouped by sector to conduct geographical analysis of performance and challenges. Chi-square tests examined the association between performance level and categorical variables (training, education level). Answers to open-ended questions were analyzed using inductive thematic analysis: two researchers independently coded answers, identified themes, and reached consensus through discussion. The results were mapped geographically to visualize disparities across the province.

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of the Diyala Health Directorate (Reference: DHD-REC/2025-042) and the Institutional Review Board of the College of Medicine, University of Diyala. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. Verbal informed consent was obtained from all participants. To maintain confidentiality, no names or personal identifiers were recorded, and the data were stored on password-protected computers accessible only to the research team.

Results

Participant characteristics and coverage

A total of 113 monitoring officers from 52 primary health care centers participated, representing 100% of operational centers in all eight sectors of Diyala Governorate (Table 1). The sample included diverse professional backgrounds: medical assistants (28.3%), laboratory technicians/assistants (39.8%), nurses (15.9%), dentists (4.4%), radiographers (3.5%), and other allied health professionals (8.0%). Most participants (65.5%) had received formal training in epidemiological surveillance. Experience levels varied: 37.2% had less than one year, 38.9% had 1-3 years, 8.0% had 4-6 years, and 15.9% had more than six years of experience in monitoring roles.

Table 1: *Distribution of participants across Diyala Governorate health sectors.*

Health Sector	PHC centers (n)	Participants (n)	Percentage (%)	Mean experience (Years)
Ba'quba 2	12	31	27.4	2.8
Ba'quba 1	10	25	22.1	3.1
Al-Khales	8	23	20.4	2.5
Al-Miqdadiyah	6	13	11.5	3.4
Al-Mansuriyah	5	10	8.8	1.9
Jalawla	4	8	7.1	2.2
Baladrooz	4	7	6.2	2.7
Khanaqin	3	6	5.3	4.1
Total	52	113	100.0	2.8

The results of knowledge

he mean overall knowledge score was 11.4 out of 15 (76.1%, SD = 2.13). Performance varied widely across knowledge domains (Table 2). Basic concepts were well understood, with 94.7% correctly identifying epidemic

diseases and 91.2% identifying diseases listed in the International Health Regulations. However, critical gaps in applied knowledge were evident: only 30.1% correctly identified incidence (the majority confuse it with prevalence), and 41.6% correctly understood the definition of "suspected case" (52.2% incorrectly thought it required laboratory confirmation). While 89.4% identified the correct first step in investigating an outbreak, 34.5% incorrectly believed that sporadic cases could be ignored in reports.

Performance tier classification

Participants were categorized into four performance levels based on their cognitive scores (Table 3). The distribution was: excellent (21.2%), very good (33.6%), good (25.7%), requires training (19.5%). The average score for the excellent level was 13.8 (SD = 0.8), while the average score for the needs training level was 6.9 (SD = 1.2).

Factors associated with performance tier

Several results showed significant associations with performance tier classification (Table 4). persons who had received previous training were more likely to be in higher performance tiers (p=0.032), with 75.0% of Excellent performers having received training compared to 50.0% of those Needing Training. Educational level also showed a significant association (p=0.041), with higher education (Bachelor's degree or above) associated with better performance. Experience only showed that a trend but did not reach statistical significance (p=0.215).

Table 2: *Performance on knowledge assessment items (N=113)*

Knowledge domain	Specific item	% Correct (n)	95% CI	Most Common Error
Basic Concepts	Definition of epidemic disease	94.7% (107)	89.1-97.5%	"Any disease affecting humans" (3.5%)
	IHR-listed diseases	91.2% (103)	84.7-95.0%	"Seasonal influenza only" (4.4%)
Epidemiological Metrics	Incidence rate definition	30.1% (34)	22.3-39.2%	"All old and new cases" (41.6%)
	Prevalence rate definition	53.1% (60)	43.8-62.2%	"New cases only" (31.0%)
	Suspected case definition	41.6% (47)	32.8-50.9%	"Laboratory-confirmed case" (52.2%)
Surveillance Procedures	First step in outbreak investigation	89.4% (101)	82.5-93.8%	"Isolate the area" (6.2%)
	Components of outbreak investigation	77.0% (87)	68.5-83.7%	"Does not include source identification" (23.0%)
	Primary data sources	92.0% (104)	85.7-95.6%	"Social media" (4.4%)
	Passive surveillance depends on spontaneous reporting	69.0% (78)	60.0-76.8%	"False" (31.0%)
Ethics and Principles	Data confidentiality is essential	87.6% (99)	80.5-92.4%	"False" (12.4%)
	Can ignore reporting of few cases	65.5% (74)	56.4-73.5%	"True" (34.5%)

Table 3: *Distribution of participants by performance tier.*

Performance Tier	Score Range	Number (n)	Percentage (%)	Mean Score ± SD
Excellent	13-15	24	21.2	13.8 ± 0.8
Very Good	11-12	38	33.6	11.5 ± 0.5
Good	9-10	29	25.7	9.6 ± 0.5
Needs Training	≤8	22	19.5	6.9 ± 1.2
Total		113	100.0	11.4 ± 2.13

Table 4: *Factors associated with performance tier classification.*

Factor	Category	Excellent (n=24)	Very Good (n=38)	Good (n=29)	Needs Training (n=22)	p-value
Previous Training	Yes	18 (75.0%)	28 (73.7%)	17 (58.6%)	11 (50.0%)	0.032
	No	6 (25.0%)	10 (26.3%)	12 (41.4%)	11 (50.0%)	
Experience in Unit	<1 year	6 (25.0%)	15 (39.5%)	13 (44.8%)	8 (36.4%)	0.215
	1-3 years	10 (41.7%)	14 (36.8%)	11 (37.9%)	9 (40.9%)	
	4+ years	8 (33.3%)	9 (23.7%)	5 (17.2%)	5 (22.7%)	
Education Level	Diploma	10 (41.7%)	22 (57.9%)	18 (62.1%)	15 (68.2%)	0.041
	Bachelor's+	14 (58.3%)	16 (42.1%)	11 (37.9%)	7 (31.8%)	

**Chi-square test*

Geographical variation in performance

There was a lot of geographical diversity in performance tiers across the eight industries (Table 5). The Khanaqin sector had the best performance, with 83.3% of workers assessed as "Excellent" or "Very Good" and no one rated as "Needs Training." In contrast, Jalawla sector had the weakest performance, with 25.0% of staff needing training and only 37.5% in the top two tiers. Al-Mansuriyah likewise had bad outcomes, with 20.0% of people needing training.

Table 5: *Performance tier distribution by health sector.*

Sector	Excellent (%)	Very Good (%)	Good (%)	Needs Training (%)	Total Participants
Khanaqin	33.3	50.0	16.7	0.0	6
Al-Khales	26.1	34.8	26.1	13.0	23
Ba'quba 2	22.6	35.5	25.8	16.1	31
Baladrooz	28.6	28.6	28.6	14.3	7
Ba'quba 1	20.0	36.0	28.0	16.0	25
Al-Miqdadiyah	15.4	38.5	30.8	15.4	13
Al-Mansuriyah	10.0	40.0	30.0	20.0	10
Jalawla	12.5	25.0	37.5	25.0	8

Table 6: *Operational challenges faced by surveillance officers.*

Challenge Category	Specific Issues	Frequency	Percentage	Illustrative Quote
Infrastructure and Technology	Weak/no internet	48	42.5%	"Internet is very weak when entering cases"
	Lack of computers	35	31.0%	"No computer available in the facility"
	No printer/scanner	18	15.9%	"We write reports by hand"
Human Resources	Insufficient staffing	29	25.7%	"Shortage of staff"
	Competing duties	22	19.5%	"I also work in laboratory full-time"
Logistics and Transportation	No transportation	18	15.9%	"No means of transport provided"
	Fuel shortages	12	10.6%	"Even with a car, no fuel"
Systemic and Coordination	Poor coordination	8	7.1%	"No chain between departments"
	Delayed reporting	12	10.6%	"Delay in reporting from clinics"

**Multiple responses allowed; percentages sum to >100%*

Operational challenges: Thematic analysis

An analysis of open-ended responses identified four principal thematic areas of operational issues (Table 6). Most people talked about problems with infrastructure and technology. For example, 42.5% said they had minimal or no internet access, and 31.0% said they didn't have computers. Human resource constraints affected 25.7%, with staff shortages and competing duties. Transportation problems (15.9%) were one of the logistical problems. Poor cooperation between departments (7.1%) and late reporting from clinical departments (10.6%) were two systemic problems.

Inter-sectoral comparison of challenges

Different sectors had quite different levels of certain problems (Table 7). The Jalawla sector had the hardest problems. 62.5% said their internet was slow, and 50.0% said they didn't have computers. Al-Mansuriyah and Al-Miqdadiyah also showed high levels of infrastructure deficits. Khanaqin did well, although it still had a lot of problems (33.3% didn't have computers or internet).

Table 7: *Prevalence of key challenges by health sector (%).*

Sector	Weak Internet	No Computer	Staff Shortage	No Transport
Jalawla	62.5	50.0	37.5	25.0
Al-Mansuriyah	50.0	40.0	30.0	20.0
Al-Miqdadiyah	46.2	38.5	30.8	23.1
Ba'quba 2	45.2	32.3	25.8	16.1
Baladrooz	42.9	28.6	28.6	14.3
Ba'quba 1	40.0	28.0	24.0	12.0
Al-Khales	34.8	26.1	21.7	13.0
Khanaqin	33.3	33.3	16.7	16.7
Overall	42.5	31.0	25.7	15.9

Table 8: *Participants' suggestions for improving surveillance system.*

Suggestion Category	Specific Recommendations	Frequency	Percentage
Infrastructure Improvement	Reliable internet	85	75.2%
	Computers and printers	78	69.0%
Training and Capacity Building	Practical, hands-on training	71	62.8%
	Regular refresher courses	58	51.3%
Human Resources	Increased staffing	52	46.0%
	Full-time surveillance officers	48	42.5%
Logistics	Dedicated vehicles	38	33.6%
	Operational budgets	32	28.3%

**Multiple responses allowed; percentages sum to >100%*

Participants' suggestions for improvement

Participants provided numerous suggestions for improving the surveillance system (Table 8). Most of the time, people talked about improving infrastructure (75.2% wanted better internet, 69.0% wanted better computers). Training and growing capacity were also important, with 62.8% asking for more hands-on training. A lot of people said they wanted to improve their human resources (46.0% wanted more workers) and get more logistical help (33.6% wanted vehicles).

Discussion

This thorough evaluation offers essential insights into the operational efficacy of frontline epidemiological surveillance in Diyala Governorate, Iraq a territory undergoing recovery after extended conflict. Our results show that the surveillance possesses dichotomous competencies: robust theoretical foundations juxtaposed with significant deficiencies in applied expertise, all functioning within a context of acute resource limitations. The geographical study further elucidates substantial gaps that jeopardize equitable health security throughout the governorate.

Knowledge-practice gap

The high scores on basic concepts (94.7% correct definition of an epidemic, 91.2% correct identification of an IHR disease) align with findings reported in other post-conflict settings where foundational training has been a focus (Nelson *et al.*, 2016). However, the critically low scores on defining incidence rates (30.1%) and suspected cases (41.6%) reveal a fundamental operational weakness. These are not mere academic concepts but essential tools for timely outbreak detection and response. Confusing incidence with prevalence significantly impedes the accurate assessment of disease trends and intervention effectiveness (Porta, 2014). that training may have effectively communicated the *importance* of surveillance but failed to adequately teach its *practical application*. The belief held by 34.5% of officers that sporadic cases could be ignored further indicates a compromised surveillance culture, where sensitivity is sacrificed, possibly due to high workloads or a lack of feedback on the utility of reported data (Declich and Carter, 1994). Such attitudes contradict the core epidemiological principle that surveillance must be both sensitive and timely to be effective (Thacker *et al.*, 2012).More critically, the finding that 52.2% of officers believe a "suspected case" requires laboratory confirmation poses a direct threat to the crucial early phase of epidemic response, potentially leading to dangerous delays in initiating control measures (Chan *et al.*, 2010).

Performance tier analysis

A framework for targeted intervention our hierarchical classification revealed that while over half of the staff performed at an 'Excellent' or 'Very Good' level, the 19.5% categorized as 'Needs Training' require immediate and targeted support. The significant association between higher education levels and better performance (p=0.041) suggests educational background may influence the comprehension of epidemiological concepts, though this warrants further study. Importantly, the correlation between prior training and superior performance was statistically significant (p=0.032), with 75.0% of 'Excellent' performers having received training compared to only 50.0% in the 'Needs Training' group. This underscores the critical value of structured training programs, particularly for new staff, who constituted 37.2% of participants with less than one year of experience.

Systemic constraints

The reported operational barriers, particularly the lack of digital infrastructure affecting 42.5% of officers, are not mere inconveniences but systemic failures that cripple modern surveillance capabilities. In an era where real-time electronic surveillance is the global standard, reliance on paper-based systems due to insufficient computers and internet connectivity inevitably leads to reporting delays, data loss, and limited analytical capacity (McNabb *et al.*, 2015). The COVID-19 pandemic has conclusively demonstrated that digital surveillance tools are not optional but essential for rapid public health action (Haldane *et al.*, 2021).

Limitations

It is important to recognize a few restrictions. First, the cross-sectional design provides a temporal relation ships snapshot and cannot determine causality . Second, even while direct interviews gave us a lot of useful context, they can have social desirability bias, which could make knowledge results higher than they really are.the anther point was the concentrating solely on the appointed surveillance officer in each center may not adequately reflect the competencies of the all the unit staff. finally the study was carried out in a single Iraqi governorate,

perhaps restricting its applicability to other places with distinct circumstances and resources. Lastly, the knowledge test only covered certain ideas and may not have covered all parts of surveillance competency.

What this means for policy and practice in Iraq

Our findings provide multiple actionable suggestions for the Diyala Health Directorate and the Iraqi Ministry of Health:

1. The use of training program approach where the "Needs Training" group gets intensive, basic training on core concepts and case definitions; (b) the "Good" and "Very Good" groups get advanced training in outbreak investigation and data analysis; and (c) "Excellent" performers are trained as peer trainers and mentors to help build local capacity that will last.
2. Make a "Surveillance Readiness Minimum Package and put it into action. This package should make sure that every PHC epidemiology unit has stable internet access, at least one dedicated computer with a printer, and a basic operational budget. The most disadvantaged areas (Jalawla, Al-Mansuriyah) should be given priority.
3. Improve Human Resources: Instead of giving workers extra tasks, give them specific surveillance jobs. Create career ladders to keep experienced workers, and make sure that job descriptions and performance indicators are clear. System: Set up a network of district-level epidemiological supervisors who regularly mentor, help with technological problems, and make sure the data is accurate by doing regular audits.
4. Combine strengthening of surveillance with strengthening of the health system: connect
5. Sharing information and translating knowledge We put together a full report for the Diyala Health Directorate that includes all of the study's findings and suggestions on how to improve surveillance. A policy brief has been made for health authorities at the provincial and national levels. It stresses the need for tiered training and investment in infrastructure. These results are being readied for publication in peer-reviewed publications to add to the world's knowledge of how to restore health surveillance in places that have been through a conflict. Also, community engagement events are planned to share the results with people in the area and get more ideas for how to put them into action.

Conclusion

Even when conditions are hard, frontline surveillance personnel in the Diyala Governorate are very dedicated. But our examination suggests that they are usually willing but not quite able, and often not ready to execute their essential task. We need to go beyond training people just once in the future. We need to maintain putting money into both people's skills and the environment that makes those skills possible.

This two-part plan helping people build their skills and offering them the tools they need is very important for getting people to take action. As Iraq keeps getting better, making these guards tougher is more than simply a technical job; it's a necessary investment in the health and safety of everyone in Diyala

This study's tiered, geographically-based approach is a model for systematic surveillance assessment and capacity building that might be utilized in Iraq and other places across the world that have just come out of war.

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Novelty Statement

This study provides a comprehensive assessment of knowledge, practices, and operational challenges among epidemiological surveillance officers in primary health care centers in Diyala Governorate, Iraq. Unlike previous studies that primarily focused on disease surveillance outcomes, this research uniquely evaluates the gap between theoretical knowledge and practical application among frontline staff while integrating geographical disparities and resource constraints. The study further identifies critical infrastructure limitations and training deficiencies, offering evidence-based recommendations for strengthening surveillance capacity through competency-based training, targeted resource allocation, and improved supervisory systems in post-conflict healthcare settings.

Author's Contribution

Shahad Hussein Khamis: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, validation, visualization, writing original draft, writing review and editing.
Azal Mohamed Awad: Data curation, investigation, validation, writing original draft, writing review and editing.
Shahad saad Ali: Data curation, investigation, validation, writing original draft, writing review and editing.
Nameer kamal Hameed: Conceptualization, funding acquisition, methodology, resources, supervision, validation, visualization, writing review and editing.
Mazin Khalid Abdullah: Conceptualization, formal analysis, methodology, resources, software, supervision, validation, visualization, writing original draft, writing review and editing.

Generative AI and AI assisted technology statement
The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest
The authors have declared that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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