Assessment of the impact of integrated disease surveillance and response system on surveillance management at healthcare facilities in Pakistan

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Abstract

Background: Disease surveillance is very crucial especially in high vulnerability settings like Pakistan. However, surveillance and outbreak response management are still evolving in the country and research studies are needed to assess the existing system.

Aim: To assess the impact of integrated disease surveillance and response system (IDSRS) implemented by the provincial government to strengthen infectious disease surveillance and reporting in 6 districts of Pakistan in 2016.

Methods: A baseline cross-sectional assessment of health facilities and the healthcare workforce was conducted in 2016 to identify needs and gaps in public sector health facilities and the health system of 6 selected districts of Khyber Pakhtunkhwa Province, Pakistan. This was followed by a 2018 endline survey of the same facilities using the same variables.

Results: Overall, there was improvement in district management and facility level performance ($\chi^2_{(1, 314)}$ = 21.19, P <0.001, V = 0.26). District level management improved significantly in areas with relatively lower Gross Domestic Product (GDP)? $\chi^2(1, 154)$ = 30.41, P <0.001, V = 0.44). Facilitation domain variables improved in the lower GDP districts ($\chi^2_{(1, 74)}$ = 5.76, P =0.016, V = 0.28) and showed counterintuitive deterioration ($\chi^2_{(1, 74)}$ = 4.80, P = 0.028, V = 0.25) in relatively higher GDP areas.

Conclusion: IDSRS is effective in improving surveillance and response systems, however, its effectiveness appears to depend on locale-specific economies and can be enhanced by modifying the implementation approach. Better empowerment of the local workforce can contribute to such improvement.

Keywords: Disease surveillance, outbreak response, healthcare facility, IDSRS, Pakistan

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Introduction

The global burden of noncommunicable diseases increased from 61% of deaths in 2000 to 79% in 2019 and communicable diseases continue to have a negative effect, affecting mostly low- and middle-income countries (*1*). As a low- and middle-income country, Pakistan has to deal with the dual burden of communicable and noncommunicable diseases, therefore, surveillance, detection and response for both groups of diseases need to be agile. Without a sensitive surveillance and reporting system, timely action cannot be initiated to address disease occurrence and without a timely coordinated response, disease control and prevention measures cannot be effective (*2*). Khyber Pakhtunkhwa has experienced repeated outbreaks of communicable diseases like dengue and Crimean-Congo hemorrhagic fevers, and it is a known endemic area for malaria (*3-6*). Due to the sociopolitical and environmental conditions of Khyber Pakhtunkhwa, the risk of such outbreaks will continue to exist for the foreseeable future. Under such circumstances, effective surveillance and response systems become critically important. The development of surveillance capacities is necessary to meet national and international control and eradication targets, which place the surveillance of communicable diseases high among national priorities.

Periodic assessments of a surveillance system enable it to reveal evolving national disease control priorities, remain efficient, and take advantage of emerging opportunities for the integration of activities. New surveillance methods and techniques should be considered and incorporated into the existing system.

The Government of Khyber Pakhtunkhwa started the health management information system (HMIS) in 1990 as part of the United States-supported Women's Health Project which was implemented until 1996. Four years later, in 2002, the Japan International Cooperation Agency (JICA) piloted the District Health Information System (DHIS) in 4 districts of Pakistan, including Swabi from Khyber Pakhtunkhwa. The provincial government was invited to submit proposals for initiating the system in other districts, after which the Khyber Pakhtunkhwa

government received a grant of 90 million rupees to introduce the DHIS in 12 districts over 3 years. The United States Agency for International Development (USAID) funded the implementation of DHIS in another 7 districts (7). After the 2005 earthquake in northwest Pakistan, the Disease Early Warning System (DEWS)—for detecting disease outbreaks through analysing data collated from government and private healthcare facilities— was deployed and managed by WHO from 2005 to 2009. DEWS was further strengthened in 2008 with the heavy influx of internally displaced persons (IDPs) in different cities of Khyber Pakhtunkhwa and federally administered tribal areas (FATAs) (8). Unfortunately, WHO withdrew its support from DEWS in 2009 and it could not be adopted by the Khyber Pakhtunkhwa health department.

The integrated disease surveillance and response system (IDSRS) is a WHO strategy for improving epidemiologic surveillance and response. It coordinates and integrates surveillance activities by improving the integration of surveillance, laboratory, and response functions of the provincial disease surveillance system (9).

In 2016, as a pre-inception survey before the implementation of IDSRS, the provincial government decided to assess the existing surveillance and outbreak response system in 6 high-risk districts of Khyber Pakhtunkhwa The system was to be reassessed after implementation. The findings of the reassessment could then be used to inform existing or new health policies. Surveillance and outbreak response management in Pakistan are still evolving and there are currently no research studies exploring the existing system, especially in Khyber Pakhtunkhwa.

Objective

To assess the impact of IDSRS implementation on the surveillance and response components of the existing health system in Khyber Pakhtunkhwa, highlighting the characteristics and covariates of change.

Ethical approval

Ethical approval for this study was granted by the Khyber Medical University. For district offices and facilities, the approving authority—the Khyber Pakhtunkhwa health department—initiated the study.

Methods

A baseline cross-sectional assessment of health facilities and the healthcare workforce was conducted in 2016 to identify needs and gaps in public sector health facilities and the health system of 6 selected districts of Khyber Pakhtunkhwa Province. Data was collected using a comprehensive and standard model questionnaire developed by WHO for the assessment of a surveillance and outbreak response management system (10). There were 3 sets of questions; for provincial, district, and facility-level assessments. This was followed by a 2018 endline survey of the same facilities using the same variables.

A census was used for data collection from the offices of the Director General Health Services, District Health Officers and District Headquarters Hospitals, while stratified random sampling was used to select 12 healthcare facilities from the 6 identified districts.

The data collection team comprised public health students; 3–4 data collectors were allocated for each district. Data supervisors and monitors were recruited to ensure data validity and accuracy during fieldwork. Data collectors were trained on the WHO tool for 2 consecutive days. The training was classroom-based using audiovisual aids and interactive information sharing on the first day, and fieldwork using the tool on the second day. Data from the questionnaires were entered into Microsoft Excel® and checked for validity, consistency, and accuracy by 2 independent data entry specialists.

STATA, version 14.2, was used for data analysis (11). The data being paired, nominal dichotomous in nature, asymptotic symmetry and marginal homogeneity (Stuart-Maxwell) tests were used to compare pre-post discordance of indicator variables. STATA symmetry command was used for the purpose. Cramér's V is reported as an effect size for chi square (χ^2) tests, with 0.1 to 0.3 denoting small, 0.4 to 0.5 medium, and values above 0.5 representing large effect size. All tests of significance are 2-tailed at an alpha of 0.05.

Results

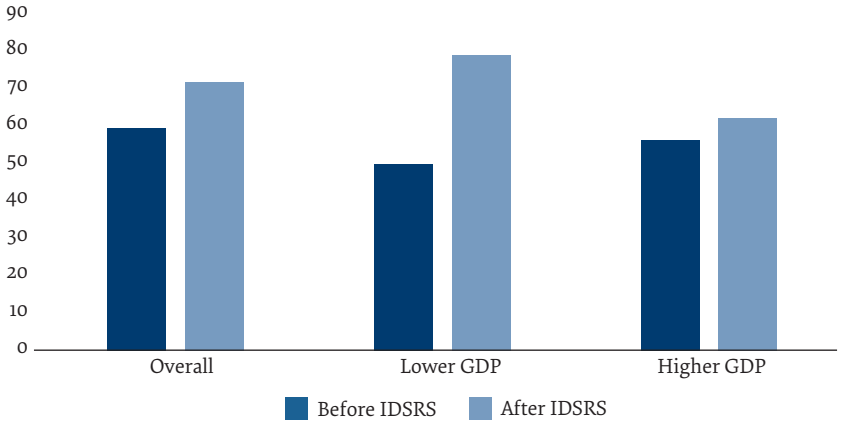
Five percent of the facility and 3% of the district data were missing. Three of the 6 districts—Nowshera, Dera Ismail Khan, and Haripur—had a higher Gross Domestic Product (GDP) than the other 3—Buner, Karak, and Lakki Marwat (12,13,14). The information collected was classifiable under 2 domains, function and facilitation, which had 10 and 6 subdomains, respectively.

District level data

Overall district level improvement

Overall, at district level, there were significant improvements (Figure 1) in the surveillance and outbreak response system (SORS) during the period; 84 (71%) of the discordant indicators changed from nonconforming to conforming status, while only 34 (29%) changed from conforming to nonconforming; asymptotic symmetry and marginal homogeneity $\chi^2_{(1, 314)} = 21.19$, $P < 0.001$, $V = 0.26$. This improvement was significant only in the districts with lower GDP ($\chi^2_{(1, 154)}$ 30.41, $P < 0.001$, $V = 0.44$). In the higher GDP districts, overall improvement was not significant ($\chi^2_{(1, 160)} = 1.07$, $P < 0.302$); where 34 (57%) of the discordant indicators converted from nonconforming to conforming, while 26 (43%) converted from conforming to nonconforming. Compared with conformity during the pre-inception survey, proportions conforming to IDSRS recommendations during the post-inception period showed a trend of worsening conformity in higher GDP

Figure 1 Distric level conformity with WHO recommendations, overall and by local economy



districts (test for linear trend $\chi^2_{(5, 325)}$ = 13.5, P < 0.001, V = 0.2).

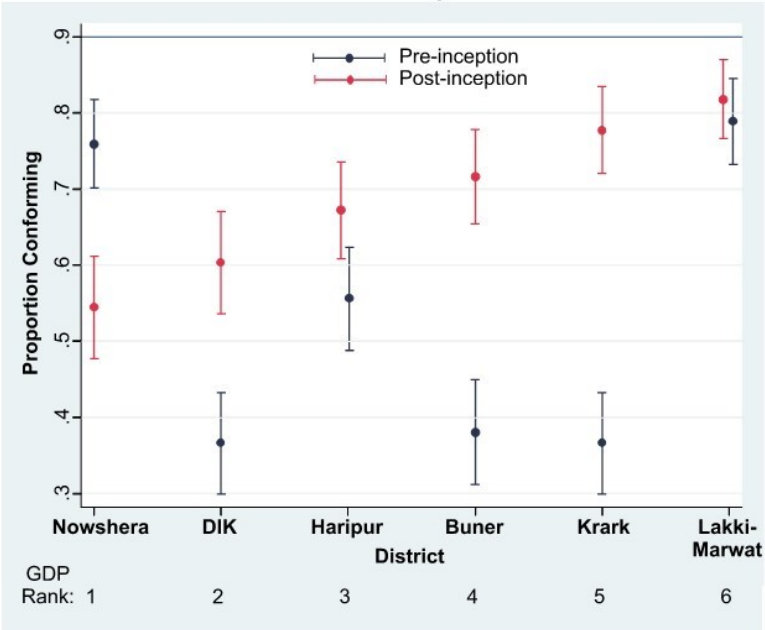
Domain level impact in districts

District level indicators were classifiable under 2 major domains: surveillance related activities were aspects of 'function', while logistic and other support for such activities was classifiable under 'facilitation'.

In the function domain, improvement was significant with a medium effect size; 59 (88%) of the discordant indicators converted from nonconforming to conforming, while only 8 (12%) changed from conforming to nonconforming ($\chi^2_{(1, 166)}$ = 38.82, P < 0.001, V = 0.48). This significance of improvement in the function domain had no association with the GDP of the districts.

In contrast, in the facilitation domain at district level, there was an overall trend—albeit statistically nonsignificant—towards deterioration in the post-compared with the pre-initiation period; 26 (51%) of the discordant indicators changed from compliant to noncompliant, while 25 (49%) changed from noncompliant in the pre-inception period to compliant $\chi^2_{(1, 148)}$ = 0.02, P = 0.889). Stratified by GDP ranking, districts with relatively lower GDP showed significant improvement; 16 (76%) of the discordant indicators changed from noncompliant to compliant, while only 5 (24%) changed from compliant to noncompliant ($\chi^2_{(1, 74)}$ = 5.76, P = 0.016, V = 0.28). In comparison, districts with relative affluence showed a significant *deterioration*, with 21 (70%) changing from compliant to noncompliant, while 9 (30%) converted from noncompliant to compliant status ($\chi^2_{(1, 74)}$ = 4.80, P = 0.028, V = 0.25). This modification of the intervention's effects by GDP ranking could explain the nonsignificant overall change in the facilitation domain (Figure 2).

Figure 2 Proportions with 95% confidence intervals of indicators conforming to IDSRS recommendations before and after programme inception (districts sorted by GDP)



Subdomain level impact in districts

In the function domain, there were 10 subdomains: surveillance manual availability, case confirmation ability, data reporting ability, data analysis ability, outbreak investigations performance, preparedness for outbreak investigations, outbreak control measures implementation, feedback activity, supervisory process functionality, and training in outbreak investigation. Out of the 10, 4 showed improvements: manual availability ($\chi^2_{(1, 6)}$ = 4.0, P = 0.045, V = 0.82), outbreak investigations performance ($\chi^2_{(1, 23)}$ = 10.0, P = 0.002, V = 0.66), preparedness for outbreak investigation ($\chi^2_{(1, 42)}$ = 7.12, P = 0.008, V = 0.41), and outbreak control measures implementation ($\chi^2_{(1, 30)}$ = 10.0, P = 0.002, V = 0.58). All of these 4 indicators were related to the employee's work routine choices, while the indicators that did not improve (case confirmation at higher level, case reporting process to higher levels, feedback from higher levels, supervision, training, and data analysis) involved higher levels of hierarchy, except data analysis which basically reflects on the training process, again a higher hierarchical level activity.

There were 6 subdomains in the facilitation domain: logistic support, data management materials, communication technology aids, educational aids availability, hygiene and sanitation materials availability, and surveillance coordination. The only subdomain that showed significant improvement was the surveillance coordination process, where all 8 of the discordant indicators changed from noncompliance to compliance ($\chi^2_{(1, 12)}$ = 8.0, P = 0.005, V = 0.82). This subdomain was also related to the employees' workplace management.

Structure process impact in districts

At district level, 178 (56%) of the variables were classifiable as indicators of structure elements, 134 (42%) as process elements, and 6 (2%) as equivocal in stance. Regarding structure components, there was no significant improvement between the pre- and post-implementation periods ($\chi^2_{(1, 174)}$ = 0.15, P = 0.696). In the process class indicator, there was a highly significant improvement; 48 (91%) of the discordant indicators changed from nonconforming to conforming, while only 5 (9%) changed from conforming to nonconforming ($\chi^2_{(1, 128)}$ = 34.89, p <.001, V = 0.52).

Facility level data

Overall facility level improvement

Overall, at facility level, there were significant improvements in the SORS; 480 (62%) of the discordant indicators changed from nonconforming to conforming status, while only 299 (38%) changed from conforming to nonconforming ($\chi^2_{(1, 2290)}$ = 42.06, P < 0.001, V = 0.14). The improvement was consistent in facilities from relatively weaker economies ($\chi^2_{(1, 978)}$ 27.20, P < 0.001, V = 0.17) and those from more affluent areas ($\chi^2_{(1, 1312)}$ 15.84, P < 0.001, V = 0.11).

Domain level impact in facilities

Facility level indicators were classifiable under 2 domains: function domain for surveillance activities, and facilitation domain for logistic and other support processes from higher levels.

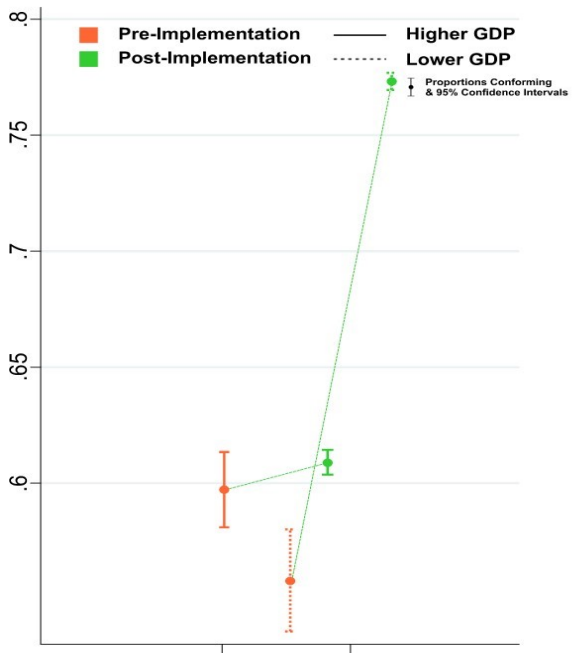
In the function domain at facility level, there was significant overall improvement in the post-initiation assessment; 425 (67%) of the discordant indicators converted from nonconforming to conforming, while 206 (33%) changed from conforming to nonconforming ($\chi^2_{(1, 1602)}$ = 76.01, P < 0.001, V = 0.22). This significance of improvement in the function domain was consistent across both strata of the economy.

In contrast, there was significant overall *deterioration* in the facilitation domain at facility level; 93 (63%) of the discordant indicators changed from complaint to noncompliant, while 55 (37%) converted from noncompliant in the pre- to compliant in the post-initiation assessment ($\chi^2_{(1, 688)}$ = 9.76, P = 0.002, V = 0.12).

Most of this deterioration was accounted for by facilities from more affluent districts, where 46 (74%) of the discordant indicators changed from compliant in the pre- to noncompliant in the post-initiation assessment, while only 16 (26%) improved ($\chi^2_{(1, 389)}$ = 14.52, P < 0.001, V = 0.19). In the facilities from relatively weaker economies, the change from pre- to post-initiation assessment was not significant ($\chi^2_{(1, 299)}$ = 0.74, P = 0.388), although the direction of the change was still deterioration; 47 (55%) of the concordant indicators changed for the worse while 39 (45%) changed for the better.

This difference in the impact of intervention stratified by GDP ranking (Figure 3), although not not amounting to effect modification as much as in the district level data,

Figure 3 Pre-to-post-IDSRS implementation change in conformity with the guidelines at the 2 levels of the economy



was still consistent with the pattern of a relatively poor response in the locales with stronger economies.

Subdomain level impact in facilities

In the function domain in facilities data, there were 8 subdomains: case detection and registration, case confirmation, data reporting, data analysis, epidemic preparedness, feedback, supervision, and training.

Out of these 8 subdomains, 3 did not show improvement: data reporting, feedback to higher levels, and supervision; all components dependent on higher tier collaboration. Only 1, arguably, higher-tier-dependent component—training—showed significant improvement with 22 (82%) of the discordant indicators showing improvement, while only 5 (18%) deteriorated ($\chi^2_{(1, 53)}$ = 10.70, $P < 0.001$, $V = 0.45$).

The subdomains that showed improvement were all those representing employees' workplace activity. Case detection and registration: 74 (84%) of discordant indicators improved while only 14 (16%) deteriorated ($\chi^2_{(1, 261)}$ = 40.91, $P < 0.001$, $V = 0.40$). Case confirmation: 112 (63%) improved, 65 (37%) deteriorated ($\chi^2_{(1, 515)}$ = 12.48, $P < 0.001$, $V = 0.16$). Data analysis: 77 (67%) improved, 38 (33%) deteriorated ($\chi^2_{(1, 302)}$ = 13.23, $P < 0.001$, $V = 0.21$). Epidemic preparedness: 21 (88%) improved, 3 (12%) deteriorated ($\chi^2_{(1, 44)}$ = 13.50, $P < 0.001$, $V = 0.55$).

There were 3 subdomains in the facilitation domain in facility data: logistic support, data management materials, and communication technology aids. The first 2, although both showing a trend towards deterioration, did not achieve statistical significance in pre- to post-initiation assessment. Logistics: 23 (59%) deteriorated while 16 (41%) improved ($\chi^2_{(1, 212)}$ = 1.26, $P = 0.262$). Data management aids: 41 (61%) deteriorated while 26 (39%) improved ($\chi^2_{(1, 265)}$ = 3.36, $P = 0.067$). Deterioration in communication technology aids was statistically significant; 29 (69%) of the 42 discordant indicators changed from conforming to nonconforming, while 13 (31%) converted from nonconforming to conforming ($\chi^2_{(1, 211)}$ = 6.10, $P = 0.014$, V = 0.17). All the indicators in these subdomains were related to higher tier support and collaboration.

Structure process impact in facilities

In contrast to district management level, there were significant improvements in both structure and process-related indicators at the facility level. In the structure components indicators, 215 (60%) of the discordant indicators changed from nonconforming to conforming, while 144 (40%) converted from conforming to nonconforming ($\chi^2_{(1, 1271)}$ = 14.04, $P < 0.001$, $V = 0.10$). In the process component, 264 (63%) improved, while 155 (37%) changed for the worse ($\chi^2_{(1, 1015)}$ = 28.36, $P < 0.001$, $V = 0.17$).

Discussion

This study offers a unique insight into the data management and usage mechanisms of the health system in Khyber Pakhtunkhwa, a province characterised by high vulnerability and relatively low resources. Although province-wide economic comparisons for Pakistan are not readily available, unverified estimates of GDP have consistently placed Khyber Pakhtunkhwa third among the 4 provinces, with only Baluchistan being lower (*13*). From a broader perspective, Pakistan itself ranks 131st and 133rd on susceptibility and vulnerability, respectively, and 39th and 40th on adaptive capability and coping indices, respectively, among 180 countries (*15*). Higher risk and lower coping potential constitute the very definition of vulnerability. In such localities, the surveillance of communicable and noncommunicable diseases, an important component of the practice of public health globally, becomes even more important.

Overall, there was significant improvement in the reporting of communicable diseases, as well as in outbreak response and investigation at the district management level. However, this district level improvement in surveillance and outbreak response was significant only in the districts with lower GDP; the districts with relatively better economies showed significant deterioration. This surprising finding, after multiple analytical double-takes, has proved to be real, systematic, and beyond chance within the context of this dataset. While the lack of any legacy data and covariate information in this respect precludes any comparisons—and comments on its reasons would fall in the domain of unsubstantiated conjecture—it certainly invites further exploration, as economy-related systematic differences in performance are also liable to carry pointers to leverage for improvement; a promising opportunity for improving the overall effectiveness of the system.

Improvements in the function domain indicators were observed in the subdomains relating to an employee's work, with system-related indicators showing no such improvement. Facilitation domain indicators showed overall deterioration over the 2-year period, albeit statistically nonsignificant. Stratified by GDP, the affluent districts showed significant deterioration while less affluent districts showed significant improvement. This improvement in function, even with the lack of facilitation, may be an indicator of an employee's motivation for workplace improvement, but the function–facilitation divide is another aspect in need of further exploration. The same idea of a relative lack of system-level support is apparent in the process vs. structure indicators at the district level, where process aspect indicators showed improvement, without any improvement in structure aspect indicators. Process is a more workforce-related activity, while structure denotes higher tier, system support.

The pattern was consistent at the facilities' level, except for 1 main difference: structure as well as process components showed an improvement.

The pattern that has emerged from the analysis of these data tells a story: performance in poorer economies is relatively more improvable; employees' managed indicators are more sensitive and responsive to change; and resource management is better at the facilities level, where, unlike at the district management level, locally

managed aspects of structure showed improvement as well.

Conclusion

IDSRS is a valuable addition to the healthcare data management systems. District level response monitoring may further improve SORS, as may the optimization of resource allocation and provision, with more empowerment of the local workforce. The study and consideration of organizational cultures and dynamics in the context of socioeconomic realities should be made a prerequisite for the implementation of all real-time responsive processes.

Further studies are recommended to assess the effect of local economies on the effectiveness of programmes.

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Competing interest: None declared.

Évaluation de l'impact du système de surveillance intégrée des maladies et de riposte sur la gestion de la surveillance au sein des établissements de santé au Pakistan

Résumé

Contexte : La surveillance des maladies constitue un enjeu crucial, en particulier dans les régions à forte vulnérabilité comme le Pakistan. Toutefois, la surveillance et la gestion de la riposte aux flambées épidémiques sont encore en évolution dans le pays et des études de recherche sont nécessaires pour évaluer le système existant.

Objectif : Déterminer l'impact du système de surveillance intégrée des maladies et de riposte mis en place par le gouvernement provincial pour renforcer la surveillance et la notification des maladies infectieuses dans six districts du Pakistan au cours de l'année 2016.

Méthodes : Une évaluation transversale initiale des établissements et des personnels de santé a été réalisée en 2016 pour identifier les besoins et les lacunes des établissements sanitaires du secteur public et du système de santé de six districts sélectionnés de la province de Khyber Pakhtunkhwa (Pakistan). Cette évaluation a été suivie d'une enquête finale en 2018 auprès des mêmes établissements en utilisant les mêmes variables.

Résultats : Dans l'ensemble, une amélioration a été constatée en ce qui concerne la gestion des districts et la performance des établissements ($\chi^2_{(1,314)} = 21{,}19$, $p < 0{,}001$, $v = 0{,}26$). La gestion au niveau des districts s'est nettement améliorée dans les zones où le produit intérieur brut (PIB) est relativement plus faible ($\chi^2_{(1,154)} = 30{,}41$, $p < 0{,}001$, $v = 0{,}44$). Les variables du domaine de facilitation ont affiché une amélioration dans les districts où le PIB est plus faible ($\chi^2_{(1,74)} = 5{,}76$, $p = 0{,}016$, $v = 0{,}28$), mais elles se sont paradoxalement dégradées ($\chi^2_{(1,74)} = 4{,}80$, $p = 0{,}028$, $v = 0{,}25$) dans les zones où le PIB est relativement plus élevé.

Conclusion : Le système de surveillance intégrée des maladies et de riposte est efficace pour renforcer les systèmes de ce genre. Toutefois, son efficacité semble dépendre des économies spécifiques locales et peut être améliorée en modifiant la méthode de mise en œuvre. Une meilleure autonomisation du personnel local peut y contribuer.

تقييم أثر النظام المتكامل لترصُّد الأمراض والاستجابة لها على إدارة الترصُّد في مرافق الرعاية الصحية في باكستان

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الخلاصة

الخلفية: يُعَدُّ ترصُّد الأمراض أمر بالغ الأهمية، لا سيَّما في الأماكن المعرضة بشدة للخطر، مثل باكستان.

الأهداف: هدفت هذه الدراسة الى تقييم النظام المتكامل لترصُّد الأمراض والاستجابة لها الذي تنفذه حكومة الإقليم بهدف تعزيز ترصُّد الأمراض المُعْدية والإبلاغ عنها في 6 مناطق في باكستان في عام 2016.

طرق البحث: استُخدم الإحْصاء لجمع البيانات على مستوى المناطق، في حين استُخدم أسلوب أخذ العينات العشوائية الطبقية لاختيار 12 مرفقًا صحيًّا لتقييمها. واستُخدمَت أداة منظمة الصحة العالمية لجمع البيانات. وأدخلت البيانات ببرنامج Microsoft Excel وحُلِّلت بالإصدار 14,2 من برنامج STATA. واستُخدم التناظر التقريبي والتجانس الهامشي (ستيوارت–ماكسويل) لتقييم عدم التوافق بين متغيرات المؤشرات ما قبل تطبيقها وما بعده.

النتائج: بشكل عام، كان هناك تحسُّن في أداء إدارة المناطق الصحية والأداء على مستوى المرافق ($\chi^2_{(1، 314)} = 21{,}19$، القيمة الاحتمالية <001 ، التباين = 0,26). وتحسَّنت الإدارة على مستوى المناطق تحسنًا كبيرًا في المناطق ذات الناتج المحلي الإجمالي الأقل نسبيًّا ($\chi^2_{(1، 154)} 30{,}41$، القيمة الاحتمالية <0,001، التباين = 0,44). وتحسَّنت متغيرات مجال التيسير في المناطق ذات الناتج المحلي الإجمالي الأدنى ($\chi^2_{(1، 74)} = 5{,}76$، القيمة

الاحتمالية =016,، التباين = 0,28) وأظهرت تراجعًا غير متوقع ($\chi^2_{(1، 74)}$ = 4,80، القيمة الاحتمالية =028,، التباين = 0,25) في المناطق ذات الناتج المحلي الإجمالي الأعلى نسبيًّا.

الاستنتاجات: يُعَد النظام المتكامل لترصُّد الأمراض والاستجابة لها فعَّالًا في تحسين نُظُم الترصُّد والاستجابة، ولكن يبدو أن فعاليته تتوقف على الاقتصادات الخاصة بكل موقع، ويمكن تعزيزها بتعديل نهج التنفيذ. ويمكن أن تسهم زيادة تمكين القوى العاملة المحلية في هذا التحسين.

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