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# "Comparing Healthcare Worker Density and Distribution in KPK, Punjab, and Sindh: Implications for Polio Eradication"

**Bilawal Khan[1] Farzana Shahin[2] Iqra Asif[3]**

[1,2,3] Department of Biological Sciences, Superior University Lahore, Pakistan

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**Abstract**

Polio remains a significant health concern in Pakistan, one of the few countries where the disease is still widespread. The major determinant necessary to polio eradication is the distribution and density of healthcare workers because these are the personnel who have to mobilize the population and ensure children are immunized. This paper therefore seeks to determine the distribution of healthcare workers in KPK, Punjab and Sindh with specific reference to polio immunization. Therefore, both the quantitative secondary data is collected from the government and global health sources and qualitative data collected from health care professionals and community members. In relation to the workforce distribution, it was found that KPK has had challenges in terms of security, Punjab has a relatively stable health system and Sindh has variation in the immunization between urban and rural settings. It emphasizes the value in workforce plans for delivery, the protection of health workers and policies to improve immunization Programme. Examination of these barriers is important in the sight of offering equal access to health care and sustenance of polio eradication in Pakistan.

**Keywords:** Polio eradication, healthcare workforce, immunization, Pakistan, Khyber Pakhtunkhwa, Punjab, Sindh, public health, vaccination coverage.

## Introduction

In many regions of Pakistan, primarily in the FATA region, polio continues to remain an alarming public menace, one of the few internationally recognized bile threats. Although there have been improvements regarding administration of vaccines, more work still needs to be done in terms of eliminating diseases, which depends on proper personnel in health centers. There is also increasing concern in achieving high rate of immunizations especially in eligible groups which may reach high risks in immunization unique challenges hindering access due to geographic, political and or socio-economic status [1]. Contact with the healthcare facilities is a key factor, which directly defines the rate of immunization coverage, ability to react adequately to emergence of outbreaks, and involving community members in the process. However, Pakistan has inequality of distribution of workers where some provinces are lacking enough of them such as (KPK), Punjab, Sindh in order to attain polio free target. These disparities lead to interruptions in the coverage and could lead to outbreaks in specific regions that need special attention from policy makers [2].

In the last few decades, polio eradication has been a very hot topic on the agenda of global health, and mass immunization campaigns have resulted in a true public health success story. The Global Polio Eradication Initiative (GPEI), initiated in 1988, has helped reduce the polio occurrences worldwide to

over 99% from previous levels. Since polio has been eradicated from the United States and United Kingdom, efforts to contain the virus within communities were based on the efforts of the healthcare workforce that mobilizes extensively, working with communities, and activating robust disease surveillance systems [4]. With continued effort, people reap dividends as, for example in India, in the polio eradication program, which is reflected in door-to-door vaccination campaign, community awareness and high healthcare worker density to able to reach underserved populations. However, recent events in Pakistan and Afghanistan indicate that polio actually continues to be transmitted because many challenges such as inadequate healthcare workers, logistical problems, security threats, or vaccine hesitance are hindering complete eradication [5].

Eradication of polio was greatly possible based on global partnership efforts against this disease mostly instituted by the WHO, GPEI, and national governments. Studies reveal that the countries with efficient healthcare institutions and workforce distribution, which established strict immunization policies, eradicate polio [9]. On the other hand, India is subject to evidence regarding how effective workforce allocation, community health engagement, and strategic immunization programs accomplished eradication. However, the last parochial hotspots of polio in Pakistan and Afghanistan are hampered by many hurdles some of which include different densities of health workers per area, insecurity and political instability, and "vaccine confidence" which add to the evidence provided in the study. As access to healthcare through infrastructure is also poorly provided in remote and conflict-prone communities, this complicates eradication measures as well. [3].

**Healthcare workforce and immunization coverage**

Density of the healthcare workforce is a key variable for effective immunization programs. One study has elucidated the connection between healthcare worker density and immunization coverage and disease prevalence [8]. Sadly, the acute shortage of healthcare workers in Pakistan, particularly in rural and conflict-ridden areas, worsens its already troubled path toward polio eradication. Besides, cultural norms in KPK and Sindh restrict male HWs from vaccinating children, which further aggravates the shortage of female healthcare workers in conservative regions, thereby rendering adverse effects on vaccination campaigns [21] Studies prove that the interplay of these dilemmas with weak training, limited resources, all sorts of vaccine misinformation, and political instability has aggravated the problem. It has been shown conclusively that the number of trained health care workers in underserved areas, their safety, and ongoing professional development are the ticket to better vaccine coverage and immunization efforts. Moreover, engaging community health workers and exploring digital health technologies for monitoring the workforce and tracking vaccines can potentially alleviate logistical problems and enhance immunization outreach [22].

This is a study from experts regarding the status of polio case bursts and the eradication efforts in the world but also a tribute to the appreciated support from the Pakistani nation that we have had in the past, and what we continue to receive in the current scenario in the Federal Administered Tribal Areas of the country before their merger in KPK. The elimination of polio is a public health strategy that demands a review of the literature relating to previous attempts to eliminate poliovirus from this society, in conjunction with individuals at the local level, the provincial government, state government, and health world officials in the society of the global level [20]. The ongoing and planned strategies of WHO and GPEI for the next years are also discussed. Lastly, this part describes the work of the Pakistan Health institute and comments on some of its initiatives like the National Emergency Action Plan [NEAP] to eradicate polio in the country until the year 2023 [7]. As explains, the [GPEI] in Pakistan has been responsible for an astonishing budget of 5.5 billion dollars in a bid to wipe out all types of viral health issues found in Pakistan, critics have even found reports stating that they aimed to immunize more than 250 million needy children in Pakistan with the assistance of health care workers; going door to door

immunizing children under the age of 5. conducted a research survey in Federal administered tribal areas to assess the potential of people availing the vaccination provided by a polio health worker & government and reported wowing statistics & results with only 25% of the residents having faith in polio health workers and availing the vaccine [6]. The negativity against vaccination campaigns are also developed among the people of tribal areas from KPK, they assume polio eradication campaign as the foreign propaganda and so there is Haram composition in the vaccine as described. Under such spring conditions and undesirable timings, however, the ranking of polioviruses took a drastic turn in 2014 in the federally administered tribal areas [10].

Children below five years old experience substantial risk from the highly infectious polio virus which produces this disease. The virus enters the nervous system to result in paralysis and possible fatal outcomes [17]. The best means of safeguarding children from this disabling disease is through vaccination even though polio remains without cure. The vaccination process for children under five years old steadily builds their resistance levels to the virus. Multiple immunization rounds have safeguarded many millions of children from polio thus leading to almost complete polio elimination worldwide [16].

Polio Eradication also known as polio represents a major public health problem in Pakistan because it continues to exist across the nation alongside Afghanistan as the only two endemic countries. Pakistan continues to observe polio cases although global communities make efforts to eradicate the disease with ongoing reports primarily from KPK, Punjab and Sindh provinces. The review about spreading have pattern of polio across these provinces during the time period from 2010 through present while vaccination coverage and regional responses together with government intervention [19].

**Research Methodology**

We employ a mixed-method approach to analyze the effect of healthcare workforce distribution on polio eradication efforts in Pakistan. Hence, since this specific research's data included both qualitative and quantitative data, it, therefore, provides a complete picture of workforce distribution patterns in KPK, Punjab, and Sindh. These mixed-methods approaches that repose upon the analyses of both quantitative data and qualitative narrative allow for the holistic exploration of impediments against polio eradication efforts and barriers faced by the stakeholders while having evidence-based potential pathways for elimination.

**Research Design**

This is a comparative case study design to examine the differences in the distribution of healthcare workforce and its impact on polio immunization. It allows for a nuanced system by which province-specific factors such as availability of health systems and personnel, insecurity, socio-economic access, and effectiveness of policies impact vaccination coverage. Using multiple perspectives, this study attempts to develop a thorough understanding of the systemic barriers against Pakistan's polio eradication efforts [18].

**Data Collection Methods**

The data collection for this study combines quantitative and qualitative data collection methods to provide a holistic view of distribution of healthcare workforce and its effects on polio eradication in Pakistan. Q. D. Secondary (government health, (WHO), and (GPEI) reports and datasets will be the backbone of our quantitative approach to ana- lyzing statistical trends in both healthcare worker density and vaccination coverage. Furthermore, demographic and socio-economic data will be explored to identify any correlations between the distribution of the workforce and accessibility of employees to immunization [15].

In Sindh, in particular in high-risk districts of Karachi, Punjab, however, has seen only one or two instances of security threats and, by and large, vaccination continued without interruptions. Polio teams some times are threatened by criminal groups as well as extremist factions [23].

On the qualitative side, semi-structured interviews would be done with health care staff, policymakers, and front-line polio workers to flesh out issues around workforce constraints, security issues, and logistical barriers to immunization programmes. Latest vaccine hesitancy data, cultural barriers and local perceptions of polio eradications efforts will be garnered as focus group discussions will be held at 11 areas of concern and high risk with parents and community leaders [25]. In addition, a content analysis of policy documents, news articles, and government strategies for intervention will be conducted to assess the impact of previous and current efforts to address shortages in the health workforce and improve immunization outreach. The combination of each of these diverse data collection methods will provide a comprehensive and evidencebased breakdown of healthcare workforce distribution in KPK, Punjab and Sindh, as focusing on relevant factors that affect successful vaccination rates, and allowing for policy recommendations to be made targeted towards sustainable polio eradication strategies within Pakistan [27].

**Quantitative Data**

Data will be collected from secondary sources for quantitative data, such as government reports, and (WHO) publications, and (GPEI) datasets. These data sources in KPK, Punjab and Sindh provide essential information on healthcare worker density, vaccination coverage rates, and reported polio cases across these provinces. More specifically, these statistics indicate trends in polio eradication, specifically, including the ratio of healthcare workers to the population, immunization outreach, and geographical workforce disparities. Additionally, demographic and socio-economic data will be analysed through national surveys to identify patterns in the distribution of the workforce; examine how this relates to immunisation efforts; and elucidate differences in access to the vaccine [26]

However, area-targeted interventions are still needed, especially for regions under heavy migrant movement and tough terrains. Some inroads have been made in this respect: strategies in Pakistan to enhance accessibility have included sending motorcycle-mounted vaccinators into remote hinterlands and opening transitory vaccination points at transit nodes [28].

**Results**

Quantitative data analysis uses statistical techniques to explore the distribution of health care workers and its association with polio immunisation coverage in KPK, Punjab and Sindh. Healthcare worker density per 10,000 people will be examined in each region using descriptive statistics of mean, median and standard deviation. It is also aimed to analyse the correlation of workforce availability leading to immunisation success rate x 5 (successrate). Using geospatial mapping techniques, disparities in the distribution of the workforce will also be visualized, noting areas of critical shortage and correlating with the prevalence of polio.

**Table 1 shows a summary of healthcare worker distribution and polio immunization coverage across the three provinces.**

| Province | Healthcare Workers per 10,000 People | Polio Immunization Coverage (%) |
|---|---|---|
| KPK | 8 | 85 |
| Punjab | 12 | 92 |
| Sindh | 10 | 88 |

The table shown above indicates Punjab has the highest density of healthcare worker and immunization coverage, and KPK has the least available workforce who might be the reason of lower immunization coverage. The polio eradication initiatives of KPK, Punjab, and Sindh, this research have to give certain policy recommendations for total poliovirus eradication for Pakistan. The following chapter is thus a comparative analysis of polio expansion and eradication efforts from 2013 to 2023,

**Table 2: Healthcare worker Analysis of Key Factors (2013–2023)**

| Factor | KPK | Punjab | Sindh |
|---|---|---|---|
| Misinformation Impact | High – Social media rumors, religious opposition | Low – Strong counter-misinformation strategies | Moderate – Resistance in rural areas, religious myths |
| Policy Implementation | Weak – Security threats, lack of coordination | Strong – Digital tracking, strict enforcement | Moderate – Administrative delays, incentives |
| Security Threats | Severe – Attacks on polio workers | Minimal – No major security concerns | Moderate – Resistance in high-risk areas |
| Geographical Challenges | High – Mountainous terrain, remote areas | Low – Easy accessibility | High – Migrant populations, urban slums |
| Vaccine Coverage (%) | 67% (in 2023) | 98% (in 2023) | 76% (in 2023) |
| Government Support | Moderate – Security efforts but inconsistent policies | High – Strong digital monitoring & law enforcement | Moderate – Incentives but weak administration |

Punjab's digital monitoring and governance ensured high vaccination rates. KPK faced severe security threats, leading to a lower vaccination rate (67%). Sindh struggled with high-risk urban slums and migrant populations, affecting vaccine coverage.

**Table 3: Polio Eradication Cases in Pakistan (2013–2023)**

To define table 4.2 polio cases was experienced in 2013 to 2023 as a result of political unrest and, lack of vaccinations in Pakistan. Key observation table 4.3 Province cases report, the following table shows reported polio cases per year in each province:

| Year | Total Cases (Pakistan) | KPK | Punjab | Sindh |
|---|---|---|---|---|
| 2013 | 93 | 20 | 3 | 29 |
| 2014 | 306 | 68 | 4 | 30 |
| 2015 | 54 | 17 | 2 | 12 |
| 2016 | 20 | 8 | 0 | 8 |
| 2017 | 8 | 2 | 0 | 4 |
| 2018 | 12 | 3 | 0 | 6 |
| 2019 | 147 | 91 | 0 | 25 |
| 2020 | 84 | 22 | 0 | 24 |
| 2021 | 1 | 1 | 0 | 0 |
| 2022 | 20 | 20 | 0 | 0 |
| 2023 | 6 | 6 | 0 | 0 |

**Government of Pakistan Healthcare workers Polio Eradication Reports**

The highest number of the Healthcare workers polio cases was experienced in 2014 as a result of political unrest and, lack of vaccinations. As highlighted above, Punjab depicted Zero incidence from year 2016, meaning that through good governance other incidence could be contained. In KPK, there was an increased activity in 2019, and most of it was related to anti-vaccine content. Unfortunately, Sindh has experienced a steadiness in rape cases, but the urban slum area is still a high-risk area. Data analysis for this study will follow a mixed-methods approach to garner the multifaceted intersection of healthcare workforce distribution on the efforts for polio eradication. Quantitative data will be statistically analyzed using descriptive statistics, regression analysis, suitable statistical tests, and spatial mapping to discern trends in workforce density and its correlation with the rates of immunization. To determine the mismatch measurement, KPK, Punjab and Sindh will be compared to show dissimilarity among the regions and in efficiency of workforce distribution. Such a happening in the context of the effect of misinformation happened in Peshawar, KPK, in April 2019. False rumors spread through WhatsApp videos and social media posts led to refusal to take polio vaccine across the country. Thousands of parents refused to vaccinate their children after one video went viral falsely claiming that polio drops made kids sick. The resultant panic caused enormous escalation of hospital occupancy, attacks on vaccination teams, and an upsurge in polio cases. By the end of 2019, 91 polio cases were newly reported in Pakistan, the majority of these from KPK. Unlike KPK, the rural religious misinformation in Sindh has hindered polio eradication efforts. Some religious leaders or elders did not allow vaccination because they quite believed that there was an agenda behind health initiatives funded from Western resources. Most of the religious scholars and clerics are positively inclined toward polio eradication but most do not trust government programs. Vaccination refusals are still very high in Karachis Orangi Town and Baldia Town, despite awareness drives and government incentives. Punjab, unlike KPK and Sindh, won the battles against vaccine hesitancy with early constructive media campaigns, community engagement, and the adoption of digital technology. A real-time tracking system of vaccination was enforced by the government, thus ensuring transparency and alleviating fears attached to the public regarding safe vaccination. These strategies contributed to Punjab being declared polio-free in 2017. Also, periodic joint ventures with religious scholars on community influencers helped demolish myths surrounding immunization against polio. Good governance and very strong policy implementation have been a key determinant for polio eradication across the provinces of the country.

**Factors Healthcare workers Polio Eradication**

The major factor behind healthcare workers the success of Punjab polio eradication was indeed a very strict enforcement of policies along with modern monitoring systems as well as measures for government accountability. The Punjab Information Technology Board (PITB) made a digital tracking system to report real-time collections of immunization coverage. It provided health workers with smartphones and GIS-based tracking apps to ensure that every household was met. The latter also introduced legal penalties against parents who refused to vaccinate their children, which further boosted compliance. KPK and Sindh had to grapple with the problem of weak and inconsistent vaccination campaigns with regard to policy implementation. One of the prominent problems in KPK has been lack of security associated with vaccination teams, resulting in disruption of vaccination drives due to cases of violence. Attacks on polio workers have caused repeated delays in upcoming campaigns, which in turn have resulted in a decreased coverage for immunization. The same was also the case for Sindh, where bad governance has affected the polio vaccine mostly in informal settlements in Karachi. Frequent administrative delays with the lack of coordination between local and federal health

departments impeded vaccination. Ineffective health infrastructure further complicated the situation. Sindh reported several sporadic cases of polio despite government incentives such as cash for immunization. International health organizations such as WHO, UNICEF, and the Bill & Melinda Gates Foundation have played very vital roles in shaping a polio eradication strategy within Pakistan. The (GPEI) has provided financial and technical assistance, including support for mass immunization campaigns and disease surveillance programs. Much remains to be done, however, in ensuring that these policies reflect an appropriate implementation at the provincial level, especially in high-risk areas. Continuing to be a major challenge to polio eradication in KPK and Sindh is the threat to security directed against vaccination teams. Health workers and security personnel accompanying vaccination teams have been the victims of many violent assaults in KPK. Over 100 polio workers and security officers lost their lives in militant-targeted attacks while opposing vaccination from 2013 to 2023. Fear of violence routes many health workers to refuse to work in high-risk districts for a mere assignment, further diminishing outreach for the cause. By nature, many parts in KPK, including tribal districts and far-flung mountain villages, are inaccessible, thus are creating a problem for the vaccination team in reaching the children. Similarly, the dynamic populations and urban slums in Sindh hamper low immunization. Many migrant families, especially those from Afghanistan, lack complete documents to be given access to vaccines for their children.

**Discussion**

There are significant implications of this research for Heathercare workers polio eradication in Pakistan, keeping in mind the disparities emerging from variations in the distributions of healthcare workforce across Khyber Pakhtunkhwa (KPK), Punjab, and Sindh where the implications of this study for the successful eradication of polio in Pakistan are substantial. Punjab is the most healthcare worker-dense province in the country and also has relatively better immunization coverage, implying that successful vaccination campaigns go hand in hand with well-distributed workforce density. On the contrary, KPK presents the two most important low healthcare worker densities and security-related challenges to polio vaccination that lead to lower coverage rates. Overall, Sindh presents a mixed pattern; urban centres have relatively better accessibility; however, workforce shortages in certain rural and flood-affected pockets deny reach for vaccinating [11]. The security risk for health-care workers remains among the most serious risks in polio eradication efforts in KPK. As the violence directed at polio teams has progressed, the amount of polio eradication from these communities has stagnated because the vaccination campaigns are met with resistance so strong that it hampers the mobilization of immunization personnel. These risks need more attention to security, community action plans, and policies directed towards protecting the health workers and enabling the continuity of immunization activities. On the other hand, Punjab has a much more favorable socio-political environment so that there can be a more systematic and continuous vaccination campaign [12]. Vaccination outcomes are also largely influenced by the participation of female health workers. In the KPK and portions of Sind Sindh culture prohibits the mobility of male vaccinators so there is no way that households can be vaccinated unless there are women on the vaccinating team. On the other hand, there is have not been enough trained women to go to these out-lying areas so that has greatly restricted the scope of immunization campaigns. This issue might be solved through the targeted recruitment and training of female health workers who will go out in the community for vaccine promotion and build confidence on the vaccine in the community [13]. Thus, Punjab may be proclaimed a good-example role model in adequate workforce distribution while issues witnessed in KPK and Sindh reflect that there is a need for improvement. It recommends investing more in the number of trained health care workers, especially female vaccinators, improving security for polio teams, and investing in digital health solutions for immunization campaign improvement. Pakistan needs an all-inclusive approach by government

agencies in association with NGOs and local leaders to eradicate polio satisfactorily while minimizing the workforce inequality [14].

**Conclusion**

This is just one of many ways in which the distribution of the healthcare workforce can shape polio eradication efforts in Pakistan. Comparatively, KPK, Punjab and Sindh have shown that Punjab being the most densely populated province with healthcare workers has better immunization coverage. In contrast, despite various efforts, the KPK still struggles with low vaccination rates owing to workforce shortages, security threats, socio-cultural resistance, etc. Sindh shows differences between urban and rural areas in terms of equal resource availability, with remote areas facing severe workforce deficiencies. The results indicate that correcting healthcare worker disparities is critical for the successful eradication of polio. Policy interventions should emphasize the need for more trained vaccinators, especially female health workers, to improve the accessibility of the vaccine for conservative populations. Improved security arrangements and community mobilization efforts are key to safeguarding health staff and reinforcing public confidence in immunization initiatives. Additionally, investment in digital health technologies, GIS-based mapping, and mobile vaccination units can optimize workforce deployment and expand immunizations to hard-to-reach populations. To sum up, on one hand, some regions have achieved better vaccination rates, while others still have a long way to go. As such, a multi-pronged strategy involving government entities, health NGOs, and community leaders is needed to address workforce inequities while augmenting polio eradication efforts. "Equitable access to healthcare and optimizing the distribution of vaccines, particularly in low-income households, will be crucial to driving down polio in Pakistan and ensuring the Global Immunization Target is met."

**Limitations of the study**

The present study has been conducted through a qualitative research methodological approach only, which makes its scope and findings inherently limited in the context of reliability and credibility. In qualitative research, scholars usually use judgments and personal experiences in the interpretation and collection of information because the data collected under such methodology is mostly descriptive or theoretical in nature, which necessitates the active involvement of the researchers in the process of data collection and its subsequent analysis. This in turn increases the chances of personal bias and exercise of the researcher’s personal prejudice in processing and analyzing the collected information, which could bring biased or impaired findings. Furthermore, the present study has conducted a comparative analysis on the KPK region of the country alone, which limits its scope in terms of generalization of these findings on the other regions that have been consistently reporting active cases of the polio virus in the country Karachi and some areas of Balochistan Province. Similarly, the findings of the present study cannot be effectively replicated in the context of other countries.

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