Effects of extra immunization efforts on routine immunization at district level in Pakistan

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تأثيرات جهود التمنيع الإضافية على التمنيع الروتيني على مستوى المناطق الصحية في باكستان

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الخلاصة: أُجريت دراسة عن تأثير أنشطة التمنيع الإضافية على التغطية بالتمنيع الروتيني على مستوى المناطق الصحية في باكستان، في إطار تحليل ثانوي للمعطيات المستمدة من منظمة الأمم المتحدة للطفولة (يونيسف) والتعداد الوطني في باكستان. وتم إجراء تحليل التحوُّف الخطي للمعطيات المستقاة من 107 مناطق، بُغْيَةَ تقدير تأثير جهود التمنيع الإضافية، التي بذلت في إطار البرنامج الوطني لتمنيع الولدان ضد الكزاز (التتانوس)، على معدل التغطية بالجرعة الثالثة من اللقاح الثلاثي (ضد الخناق والكزاز والشاهوق) بعد أن تؤخذ في الحسبان سائر العوامل المربكة المحتملة بشكل مستقل. وتبيَّن أن المناطق الصحية التي نفّذت الحملات الوطنية الإضافية لتمنيع الوِلْدان ضد الكزاز معرَّضة لاحتمال انخفاض معدل التغطية الروتينية باللقاح الثلاثي، بالمقارنة مع المناطق التي لم تنفذ هذه الحملات، مما يدل على أن جهود التمنيع الإضافية غير المعزّزة بموارد إضافية، يمكن أن تؤدّي إلى تقليص أثر البرنامج الروتيني الموسَّع للتمنيع.

ABSTRACT A study was made of the effects of extra immunization activities on routine immunization coverage at district level in Pakistan in a secondary analysis of data from UNICEF and the Pakistan national census. Linear regression analysis was made on data from 107 districts to estimate the effects of extra immunization efforts in the national neonatal tetanus programme on the coverage rate of the third dose of diphtheria–pertussis–tetanus (DPT3) after controlling for other potential confounding factors. The districts that implemented extra national neonatal tetanus immunization were at risk of having lower routine DPT3 coverage than those that did not. Additional immunization efforts, without additional resources, may reduce the effect of the routine Expanded Programme on Immunization.

Incidence des efforts de vaccination supplémentaire sur la vaccination systématique au niveau du district au Pakistan

RÉSUMÉ Une étude a été réalisée sur l'incidence des activités de vaccination supplémentaire sur la couverture vaccinale systématique au niveau du district au Pakistan dans une analyse secondaire des données provenant de l'UNICEF et du recensement national au Pakistan. Une analyse de régression linéaire a été effectuée sur des données provenant de 107 districts pour estimer l'incidence des efforts de vaccination supplémentaire déployés dans le cadre du programme national de lutte contre le tétanos néonatal sur le taux de couverture par la troisième dose du vaccin antidiphtérique-antitétanique-anticoquelucheux (DTC3) après élimination d'autres facteurs de confusion potentiels. Les districts ayant mis en œuvre la vaccination supplémentaire contre le tétanos néonatal au niveau national risquaient d'avoir une plus faible couverture vaccinale systématique par le DTC3 que ceux qui ne l'avaient pas mis en oeuvre. Les efforts de vaccination supplémentaire, sans ressources additionnelles, peuvent réduire l'effet du Programme élargi de vaccination systématique.

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Introduction

Immunization programmes are among the most cost-effective ways to reduce childhood morbidity and mortality [*1,2*]. In Pakistan, the Expanded Programme on Immunization (EPI) was started in 1978 with support from the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) to provide immunization to all children aged less than 5 years against tuberculosis, diphtheria, whooping cough, tetanus, polio and measles [*3*]. EPI services cover the following vaccines and schedule as recommended by WHO [*4*]: Bacillus Calmette-Guérin (BCG), given at birth; diptheria, pertussis, tetanus (DPT3), given in 3 doses at 6, 10 and 14 weeks; oral polio vaccine (OPV), given in 3 doses at 6, 10 and 14 weeks; and measles vaccine, given at 9 months.

Fully vaccinated children are potentially prevented from morbidity and mortality associated with those diseases and high immunization coverage in the population is necessary to reduce transmission and prevent disease outbreaks. However, Pakistan has not been able to provide optimum immunization coverage. Pakistan has received considerable financial support from the Global Alliance for Vaccines and Immunization and has committed itself to substantially increase immunization coverage. Unfortunately, as in many other low-income countries, progress on immunization coverage in Pakistan has been modest over the last decade. Data from UNICEF and WHO indicate that from 1990 to at least 2001, immunization coverage rates have been essentially stagnant in low-income countries (data not shown), and there is a pressing need to identify specific actions that can be taken by governments and EPI managers to change the current trend. Since 1999–2000, the EPI cell of the Pakistan National Institute of Health has reported a significant decline in immunization based on aggregated data at the provincial level. Household surveys by UNICEF in 2001–2, found very large variations of immunization coverage rates between districts. For example, the average DPT3 coverage of 58% represents a very large variation between districts, ranging from 6.0% to 92.5% [*5*]. This variation is important because it provides an opportunity to identify the factors that are associated with coverage and because it highlights districts that need extra help so that inequalities in immunization coverage can be corrected.

In Pakistan, the EPI programme is managed and implemented at the district level. Events that add extra burden on the programme can compromise its performance and the coverage at district level (M. Saeed, unpublished report for the World Bank, 2003). This study aimed to examine the effects of extra immunization activities of the national neonatal tetanus programme on routine immunization coverage at district level.

Methods

This study was based on the secondary analysis of data from UNICEF and Pakistan Census Bureau published reports with all identifying information about individual districts removed.

Information was used from 107 districts included in the UNICEF "third party evaluation" household surveys [*6,7*]. The survey used quantitative methods and was designed according to the WHO standard for EPI evaluations, i.e. 30-cluster sampling technique [*4*]. The sample of districts was from the total 119 districts in 4 major provinces of Pakistan. For security reasons, Azad Kashmir region (region is equiv-

alent to province) with 7 districts and Northern Areas region with 5 areas (area is equivalent to district) were not included in the original surveys. Islamabad Capital Territory was also not included.

The sample included all 34 districts of Punjab, 31 of 38 districts and agencies (agency is also equivalent to district) of North Western Frontier province and Federal Administered Tribal Areas, l8 of the 21 districts of Sindh and 24 of the 26 districts of Baluchistan (Table 1). Thirty clusters were randomly selected in each district with probability proportional to the size of the village population, except for urban districts such as Lahore and Karachi, where 60 clusters were selected for each district: 30 clusters for urban, and 30 clusters for rural. In each cluster, 7 households that had at least 1 child aged 12–23 months were randomly selected to interview for EPI coverage; and 7 households that had at least 1 child aged 0–11 months were randomly selected to interview the mother for her tetanus toxoid status. The most current district immunization coverage data were from 2001–2 third party evaluation household surveys.

From early 2001 to 2002, Pakistan launched the national neonatal tetanus (NNT) programme to accelerate neonatal tetanus elimination by conducting a series of tetanus toxoid campaigns in 57 districts (out of 119) for all women of childbearing age. These included 15 districts in Punjab province, 18 districts of the province of Sindh, 7 districts from Baluchistan province and 17 districts in North Western Frontier province and Federal Administered Tribal Areas (Table 1). The participating districts were provided some financial input to cover the cost of extra activities. However, they were not allowed to hire additional staff and asked to use current EPI staff to run the programme [*8*].

Because information on full immunization coverage in children aged 12–23 months is not available, information on the third dose of DPT3 is used as a proxy indicator for full immunization coverage. A

Table 1 **Sample of districts in the UNICEF's third party evaluation for the Expanded Programme of Immunization between 2001–2 and districts participating in national neonatal tetanus (NNT)**

Province[a]	Total districts	Total of districts sampled		NNT programme districts	
	No.	No.	%	No.	%
Punjab	34	34	100	15	44
Sindh	21	18	86	18	100
Baluchistan	26	24	92	7	29
North Western Frontier province and Federal Administered Tribal Areas	38	31	82	17	55
Total	119	107	90	57	53

[a] ***Azad Kashmir, Northern Areas and Islamabad Capital Territory are not included.***

child who has received DPT3 is very likely to have received at least 3 doses of DPT and OPV, and most likely BCG and measles vaccine also [*9*].

Characteristics of the districts that were potential factors associated with immunization rate were recorded: population density, adjusting for population growth rate of 2002 (< 100, 100–200, > 200 per square kilometre); percentage of households with galvanized roof material such as concrete, brick or tin (0–20%, > 20%); percentage of households with electricity (< 50%, 50–75%, > 75%); percentage of households with television (0–20%, 21–50%, > 50%), percentage of school-age children enrolled in primary education (0–30%, > 30%); district literacy rate (< 20%, 20–40%, > 40%); and district female literacy rate (< 10%, 10–20%, > 20%). Population density was controlled for because of its association with immunization coverage [*10*]. The analysis also controlled for economic status (represented by 3 household asset variables: roofing, electricity, and television); and education attainment. Previous studies show that economic status and education attainment are positively associated with immunization coverage [*11*].

Linear regression was used to analyse the association between the rate of DPT3 coverage and the NNT coverage and other district characteristics using *STATA*, version 8.1. Regression coefficients and 95% confidence intervals were used to assess the significance level of the association.

Results

The distribution of the sample districts by province was similar to the national distribution (Table 1). It included all districts from Punjab, 86% from Sindh, 92% from Baluchistan and 82% from North Western Frontier province and Federal Administered Tribal Areas. Among those districts, 53% overall participated in the extra-immunization NNT programme.

Table 2 compares the household and literacy characteristics of the whole sample of districts and the DPT3 coverage of the sample districts and the districts participating in the NNT programme. The characteristics of NNT districts were significantly different from the whole sample of districts ($P < 0.05$) in terms of percentage of households with electricity, percentage of households owning a television set and adult literacy rate.

The DPT3 coverage among districts included in the NNT programme was 53.8%, compared with 62.1% among those without the NNT programme (Table 2). Table 2 shows the effects of variables controlled in the univariate analysis. The DPT3 coverage was higher in districts with a higher population density, higher proportion of households with quality roofing, higher proportion of households with electricity, and higher proportion of households with a television set. The coverage was also higher in districts with a higher school enrolment rate, higher adult literacy rate or higher female literacy rate. These effects did not hold in multivariate analysis, except for owning a television.

The DPT3 immunization coverage in districts that implemented NNT immunization was about 8% lower than those that did not (unadjusted regression coefficient = –8.30) ($P < 0.1$) (Table 3, model 1). Adjusting for population density and household durable assets such as galvanized roofing, electricity and television, sharpened the effect and the regression coefficient remained significantly large (–11.79) ($P < 0.01$) (Table 3, model 2). In the full model (model 3), when the analysis was also adjusted for district educational characteristics such as school enrolment rate, litera-

Table 2 **Distribution of district level diptheria-pertussis-tetanus (DPT3) coverage and the national neonatal tetanus (NNT) programme coverage between 2001–2 by selected characteristics**

District characteristics	Total of districts sampled (*n* = 107)	DPT3 coverage Overall (*n* = 107)	NNT programme districts (*n* = 57)
NNT programme district			
No	46.7	62.1	–
Yes	53.3	53.8	–
Population density (per km²)		***P*** = 0.036	***P*** = 0.055
< 100	31.8	42.7	21.4
100–200	21.5	56.4	25.0
> 200	46.7	68.1	53.6
Galvanized roof (% of households)		***P*** = 0.001	***P*** = 0.970
0–20	56.2	49.1	56.4
> 20	43.8	67.3	43.6
Electricity (% of households)		***P*** = 0.002	***P*** = 0.049
< 50	35.2	46.8	25.0
50–75	34.3	58.9	42.9
> 75	30.6	68.7	32.1
Television (% of households)		***P*** = 0.001	***P*** = 0.013
< 20	38.7	41.2	27.3
20–50	27.4	58.2	38.2
> 50	34.0	74.5	34.6
School enrolment rate (% of school-age children)		***P*** < 0.0001	***P*** = 0.749
0–30	57.0	46.0	58.5
> 30	43.0	72.6	41.5
Literacy rate (% of adults)		***P*** < 0.0001	***P*** = 0.016
0–20	23.2	37.3	14.3
21–40	48.2	54.8	60.7
> 40	28.7	78.2	25.0
Female literacy rate (% of women)		***P*** < 0.0001	***P*** = 0.091
0–10	28.7	38.2	21.4
11–20	27.8	51.9	35.7
> 20	43.5	73.8	42.9

n ***= number of districts.***

cy rate and female literacy rate, the effects of the NNT programme on DPT3 coverage remained unchanged (regression coefficient = –11.20, $P < 0.01$). The DPT3 coverage rate in the districts that implemented NNT was about 11% lower than the districts that did not. The NNT programme, population density, household durable as-

Table 3 **Unadjusted and adjusted regression coefficients of the effects of the national neonatal tetanus (NNT) programme on routine diptheria–pertussis–tetanus (DPT3) coverage rate at district level**

Variables	Model 1 (*n* = 107)		Model 2 (*n* = 102)		Model 3 (*n* = 96)	
	r	(95% CI)	*r*	(95% CI)	*r*	(95% CI)
NNT programme district						
No[a]	–		–		–	
Yes	8.30	(–17.37, 0.81)	11.79	(–19.65, –3.92)	11.20	(–18.59, –3.81)
Population density (per km²)						
< 100[a]			–		–	
100–200			5.53	(–5.97, 17.04)	3.86	(–8.14, 15.86)
> 200			5.62	(–6.85, 18.09)	3.70	(–8.32, 15.72)
Galvanized roof (% of households)						
0–20[a]			–		–	
> 20			7.90	(–0.76, 16.57)	2.60	(–6.99, 12.18)
Electricity (% of households)						
< 50[a]			–		–	
50–75			–1.90	(–12.91, 9.11)	–3.94	(–14.68, 6.80)
> 75			0.88	(–11.05, 12.81)	–4.39	(–16.98, 8.20)
Television (% of households)						
< 20[a]			–		–	
20–50			14.21	(1.01, 27.42)	6.57	(–6.84, 19.97)
> 50			28.63	(15.63, 41.63)	15.75	(1.46, 30.03)
School enrolment rate (% of school-age children)						
0–30[a]					–	
> 30					2.01	(–9.69, 13.71)
Literacy rate (% of adults)						
0–20[a]					–	
21–40					11.04	(–6.62, 28.70)
> 40					21.84	(–0.70, 44.39)
Female literacy rate (%)						
0–10[a]						
11–20					7.37	(–8.47, 23.20)
> 20					11.38	(–8.67, 31.43)

r = ***regression coefficient.***
n = ***number of districts.***
CI = confidence interval.

sets and educational characteristics explained about 52% of the variation in DPT3 coverage rates in districts (adjusted R^2 = 0.52).

Discussion

The districts that implemented extra NNT were at-risk of having lower routine DPT3

coverage than those that did not. The findings from this study suggest some action policies are needed for improving the performance of the routine EPI programme. The NNT programme in 57 districts was implemented without mobilization of additional staff and relied exclusively on the existing routine EPI staff in the districts. The NNT programme unavoidably demands more efforts and puts more pressure on the EPI staff who are obliged to share their time and effort to satisfy both activities; this can compromise the routine activity. A previous study in 2 districts of Punjab, one with high and another with low immunization coverage, showed that national immunization days—another special activity similar to NNT but targeting poliomyelitis—could harm routine immunization, as the proportion of routinely immunized children always dropped during national immunization days (M. Saeed, unpublished report for the World Bank, 2003). It indicated that unless the issues of storage of supplies, supervision and manpower were addressed adequately during these additional immunization efforts, which in many cases they were not, the national immunization days compromised the ongoing routine immunization activities. A study in rural India on the impact of national polio immunization campaigns on levels and equity in immunization coverage also found that mass polio immunization campaigns lacked positive effects on coverage of other non-polio EPI vaccinations [*12*].

The effects of controlling for factors that were observed in the univariate analysis did not hold in the multivariate analysis except for the effect of television ownership. The effect of level of television ownership on the DPT3 coverage rate was statistically significant and independent of other variables. This effect may be mediated by televised immunization promotion messages, which are common in Pakistan. The positive effect of immunization promotion on immunization coverage rates through television and radio has been observed in Senegal, Colombia, Brazil, Ecuador and Mexico [*13,14*].

There were a number of limitations to the study. First, it is an observational study and the districts were not randomly assigned to the exposure factor (implementation of NNT). Secondly, there were no survey data before the implementation of the NNT programme; therefore, we cannot compare the coverage between NNT and non-NNT districts before the implementation of NNT. There are reporting data to suggest that prior to implementation of NNT, the DPT3 coverage in NNT districts is higher than that in non-NNT districts (data not shown) and these support the finding in the paper. However, the reporting data were not collected in the same manner as survey data and cannot be used to compare with survey data. Thirdly, there was a potential bias caused by the exclusion of 12 districts (10%) from the sample and we were not able to adjust the population density from the census data, which were collected in 1999. Finally, during the past few years, political instability in the regions around Pakistan may contribute to the variation in immunization coverage at district level due to population displacement. However, we did not have relevant information at the district level related to these factors for our analysis.

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