Coverage and predictors of COVID-19 vaccination in rural districts of Pakistan

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Abstract

Background: One of the keys to preventing a re-emergence of the COVID-19 pandemic is the attainment and maintenance of high vaccination coverage in urban and rural areas.

Aims: To estimate the coverage of COVID-19 vaccination in a rural population and identify the determinants of vaccination.

Methodology: A cross-sectional survey was conducted in April 2023 in 5 rural districts of Sindh Province, Pakistan. From each district, 30 clusters (villages) were randomly selected, and 7 households were randomly sampled from each cluster using the 30/7 technique. Household members above 12 years of age were included. Vaccination status was categorized as non-vaccinated, partially vaccinated (either with 1 dose or without booster) and completely vaccinated (2 doses with 1 booster). Adjusted odds ratios with 95% confidence intervals using multinomial logistic regression were computed to determine the factors associated with partial and complete vaccination. Data was analysed using SPSS version 20.

Results: Among the 3545 individuals surveyed across 1050 households, 25.9% were not vaccinated, 55.0% were partially vaccinated, and 19.1% were fully vaccinated. Younger age, lack of formal education and residing in flood-affected districts were significantly negatively associated with being vaccinated, while living at <5 km from a vaccination facility was significantly positively associated with partial and complete vaccination. Residents of Dadu (OR=0.03, 95% CI=0.01–0.04), Jamshoro (OR=0.05, 95% CI=0.03–0.08), Hyderabad (OR=0.03, 95% CI=0.02–0.05), and Tando Allahyar (OR=0.09, 95% CI=0.05–0.15) districts were significantly less likely to be completely vaccinated than those in Tharparkar. The most common reasons for not being vaccinated were, the perception that COVID-19 is mild (34.5%), fear of side-effects (22.7%), unavailability of the vaccine (19.8%), and fear of acquiring COVID-19 infection through the vaccine (15.8%).

Conclusion: Vaccination coverage was low in some of the districts, particularly the flood-affected districts, mainly due to certain myths. There is a need for community outreaches to debunk myths about COVID-19 vaccination among these rural populations.

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Background

Because of the mass vaccinations, transmission of COVID-19 pandemic has slowed down globally and it is no longer considered a public health emergency of international concern *(1)*. While re-infection with newer strains is a concern in some countries, the vaccines remain effective against all new strains *(2)*. The need for boosters and constant surveillance will continue, as immunity against infection and vaccination wane in a few months *(3)*. Ineffective surveillance and non-availability of vaccines may provoke a re-emergence of infection to epidemic levels *(4)*.

Rural populations are highly vulnerable to adverse effects of any epidemic due to limited resources and preparedness *(5)*. Awareness and prevention among rural populations have been found to be below desired levels *(6)*. The key to preventing the re-emergence of the pandemic is to maintain high vaccination coverage and reduce urban–rural disparities. The urban–rural disparity in vaccination coverage of COVID-19 is wide, even in developed countries like the United Kingdom and United States *(7,8)*. Vaccine hesitancy is also high in rural areas when compared to urban areas *(9)*.

Pakistan has seen a steady decline in COVID-19 cases and deaths since the commencement of its vaccination campaign. By July 2022, two-thirds of the eligible population in the country was vaccinated for COVID-19 *(10)*. However, urban–rural disparities in vaccine coverage are not known.

Study objective

Underserved communities without formal work or requirement to travel may not consider the COVID-19 vaccine a high priority as they struggle day-to-day with poverty, hunger and ill-health. This study aimed to estimate the coverage of COVID-19 vaccine in the underserved communities of 5 rural districts of Sindh and identify determinants of vaccination in these communities.

Methodology

This cross-sectional survey assessed the vaccination coverage in 5 rural districts of Sindh Province in Pakistan. It was carried out on 1–30 April 2023 and analysis and write-up was completed in July 2023. The 5 districts included were Dadu, Jamshoro, Hyderabad (flood-affected area), Tharparkar (desert area) and Tando Allahyar. The project was carried out in collaboration with the non-government organization (NGO) Thardeep Rural Development Program (TRDP), which is working to alleviate poverty in 5 districts of Sindh. The population in the 5 districts varies from 0.5 to 1.5 million.

WHO's 30/7 technique was used for sampling in each district. This technique is used by the Expanded Programmes on Immunization to assess vaccination coverage and is considered a satisfactory method *(11)*. According to the technique, a geographical area is identified and a population of interest defined, then 30 sites, termed clusters, are randomly selected in each geographical area and at least 7 units are chosen from which information is gathered on each cluster *(12)*.

In this study, from each district (geographical area) 210 households (units) were selected. Then 30 clusters (villages) were randomly selected from a list of 2336 villages in Tharparkar, 1592 in Tando Allahyar, 2506 in Jamshoro, 2516 in Dadu and 850 in Hyderabad. From each village, 7 households were randomly sampled. Overall, 1050 households in 5 districts were surveyed. All eligible members of the household above 12 years of age were asked about their COVID-19 vaccine status and their vaccine cards checked to verify.

Training took place in centrally located Hyderabad District; the data collectors, hired through collaboration with TRDP, had previous experience in conducting field surveys. Data collectors comprising 5 males and 5 females (2 for each district) were trained first through an orientation on the questionnaire and then by piloting the tool on a subset of the population.

The survey teams were monitored and they shared their data with the project office in Karachi every week. Each questionnaire was checked for completeness and accuracy, and the data were entered and analysed using SPSS version 20.

Data was gathered on socio-demographic variables (age, gender, education, monthly income and distance from vaccination facility) and COVID-19 vaccination status. Vaccination status was categorized as non-vaccinated, partially vaccinated (1 dose or without booster) and completely vaccinated (2 doses with 1 booster). For those who were not vaccinated or partially vaccinated, their reasons for not getting vaccinated were also requested.

Community leaders within the survey areas were approached and permission to collect data was sought. Seven households were randomly selected from the household lists of the selected villages. The head of household was approached for data collection. Since the project was implemented in collaboration with a rural NGO that has good presence and acceptance in these communities, there were no refusals.

Informed consent from participating adult members of each household was obtained, while assent was sought from those aged 12–17 years. The consent form and questionnaires were translated into the local language (Sindhi).

Statistical analysis

Socio-demographic characteristics were summarized as percentages for qualitative variables and means and standard deviations for quantitative variables. Frequencies and percentages of vaccination coverage were computed according to each district and *Tehsil* (sub-district).

Frequencies and percentages of reasons for non-vaccination or partial vaccination were also computed. The predictors of partial and complete vaccination including age, gender, socioeconomic index, distance from vaccination facility and district were estimated by calculating adjusted odds ratios with 95% confidence intervals using multinomial logistic regression.

The socioeconomic index was generated using principal component analysis. Six items (house type, home ownership, water source, sanitation type, household monthly income and possession of household items) were reduced to a composite indicator and categorized as low, moderate or high. The constructed composite indicator explained 67.2% of cumulative variance.

Ethical approval

This study was approved by Institutional Review Board of Jinnah Sindh Medical University (IRB No. JSMU/IRB/2022/1627).

Results

Data were collected from 3545 individuals from 1050 households in the 5 districts (210 from each district). Table 1 shows the descriptive characteristics of the participants. The sample included individuals of all age groups with the age group of 18–32 constituting the highest proportion (31.0%) and the age group of 61 and above comprising the lowest (6.7%). Almost two-thirds (61.2%) had no formal education.

Overall, 25.9% were not vaccinated and 55% were partially vaccinated (Figure 1). Among the reasons for non-vaccination (Figure 2) were the perception of COVID-19 as mild (34.5%), fear of side effects (22.7%), unavailability of vaccine (19.8%) and fear of acquiring COVID-19 infection from the vaccine (15.8%).

Less common reasons included the perception that children under 18 were not eligible (2.3%), refusal due to acute or chronic sickness (2.1%), fear of injection (1.2%), avoided due to pregnancy (1%) and belief that COVID-19 does not exist (0.4%).

Reasons for partial vaccination (Figure 3) included the perception that COVID-19 has ended (30.2%), field teams

Table 1 Sociodemographic characteristics of participants (*n* = 3545)

	% (n)
Age in years	
12–17	21.3 (755)
18–32	31.0(1098)
33–46	25.8 (914)
47–60	15.3 (542)
61 and above	6.7 (236)
Gender	
Male	52.2 (1850)
Female	47.8 (1695)
Education	
No formal education	61.2 (2168)
1–8 years	22.7 (806)
9–12 years	7.6 (270)
University graduate or equivalent and above	8.5 (301)
Family structure	
Nuclear	80.5 (2853)
Extended	19.5 (692)
Occupation of household head	
Labourer	66.3 (2351)
Farmer	18.3 (648)
Formal employment	9.0 (319)
Businessperson	2.9 (103)
Landlord (real estate)	2.7 (97)
Housewife	0.4 (14)
Unemployed	0.4 (13)
District	
Dadu	20.3 (720)
Jamshoro	21.5 (761)
Tando Allahyar	21.3 (755)
Hyderabad	16.2 (574)
Tharparkar	20.7 (735)

not conducting home-based vaccination (26%), unaware about boosters (24.1%) and experience of side effects after being vaccinated (14.1%).

Table 2 shows the unadjusted and adjusted relationships of socio-demographic factors with the likelihood of being partially and completely vaccinated. Younger age groups of 12–17 (OR=0.17, 95% CI=0.10–0.30) and 18–32 (OR=0.50, 95% CI=0.30–0.84) years were significantly less likely to have received complete vaccination than the older age group of 61 and above.

Both groups were also significantly less likely to be partially vaccinated. Those who had no formal education (OR=0.17, 95% CI=0.11–0.28) or education from 1–8 years (OR=0.31, 95% CI=0.19–0.52) were significantly less likely to have been completely vaccinated than graduates and above. There was a significant negative association of having no formal education with being partially vaccinated.

Gender and socioeconomic status had no significant relationship with being partially or completely vaccinated. Compared to Tharparkar, residents of Dadu (OR=0.03, 95% CI=0.01–0.04), Jamshoro (OR=0.05, 95% CI=0.03–0.08), Tando Allahyar (OR=0.09, 95% CI=0.05–0.15) and Hyderabad (OR=0.03, 95% CI=0.02–0.05) were significantly less likely to have received complete vaccination.

Residents of Dadu, Jamshoro and Hyderabad districts were less likely to be partially vaccinated. Those who lived <5 km from a vaccination facility were significantly more likely to be completely vaccinated (OR=2.63, 95% CI=2.06–3.36) or partially vaccinated (OR=2.03, 95% CI=1.67–2.47).

Discussion

This is the first study that reports coverage and predictors of COVID-19 vaccination in the rural areas of Pakistan. More than one-fourth of the participants were not vaccinated and the reasons for non-vaccination were mostly based on misconceptions.

Among the vaccinated, the proportion of those who had received the booster dose was low. Younger age group and lack of formal education were significantly negatively associated and a distance of <5 km from a vaccination facility was significantly positively associated with partial and complete vaccination. Vaccination coverage varied by district, and flood-affected districts had lower coverage.

The study shows that around three-quarters of participants in rural areas had been vaccinated against COVID-19 at least once. This confirms the report that more than two-thirds of the population had received the

Figure 1 COVID-19 vaccine coverage in 5 rural districts of Pakistan (*n* = 3545)

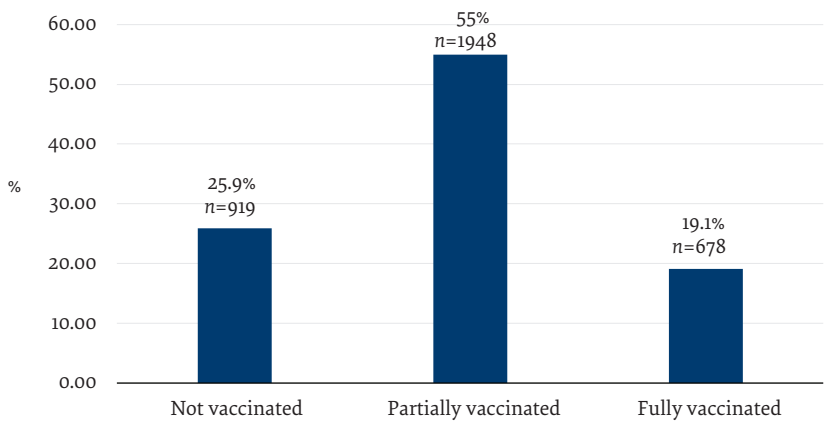
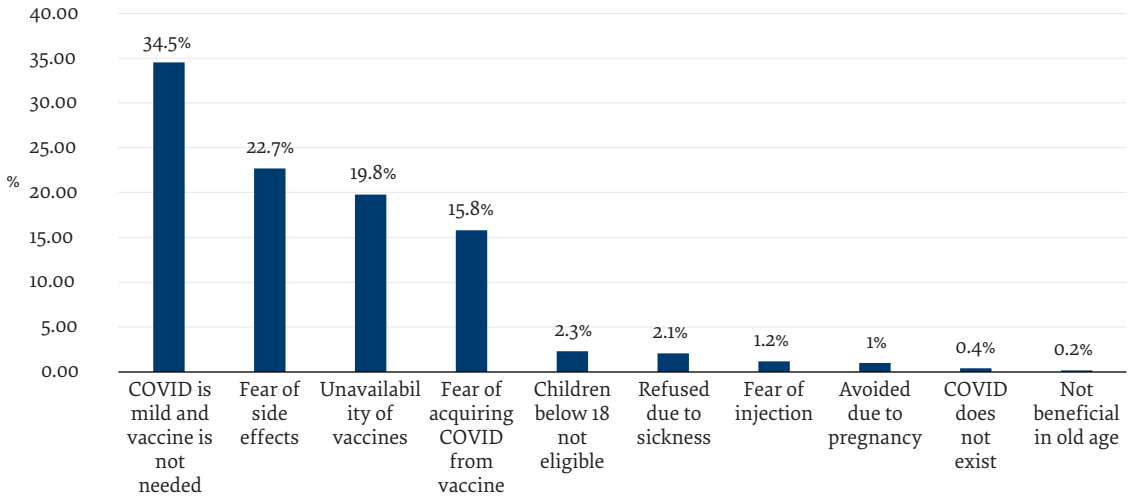


Figure 2 Reasons for non-vaccination (*n* = 919)



vaccine *(10)*. Globally, vaccine acceptance rates vary from as low as 46.1% in the Middle East to as high as 85% in South America *(13)*.

Although overall coverage was high, only one-fifth of participants had received a booster dose after completing two doses of vaccine. This trend is consistent with previous studies from Norway and Peru which found intake of booster dose to be much lower *(14,15)*.

Possible reasons for partial vaccination include the perception that the COVID-19 pandemic had ended, absence of home-based vaccination by field teams, lack of awareness about boosters, and experience of side effects after getting vaccinated. It is likely that as the severity of the pandemic reduced during the latter half of 2022, getting a booster dose became a low priority for the population and health providers.

Coverage was variable across districts, possibly due to the 2022 floods, which affected the districts near the Indus River belt *(16)*. The percentage of non-vaccinated people ranged from 33.2% to 45.3% in flood-affected districts (Dadu, Jamshoro and Hyderabad) compared to 5–9.1% in other districts (Tharparkar and Tando Allahyar).

Alongside the perception that COVID-19 was mild, fear of side effects and of acquiring COVID-19 infection from the vaccine have been reported in other studies *(17–21)*; unavailability of vaccine was also cited as one of the major reasons for non-vaccination, possibly in flood-affected areas.

Figure 3 Reasons for partial vaccination (*n* = 1948)

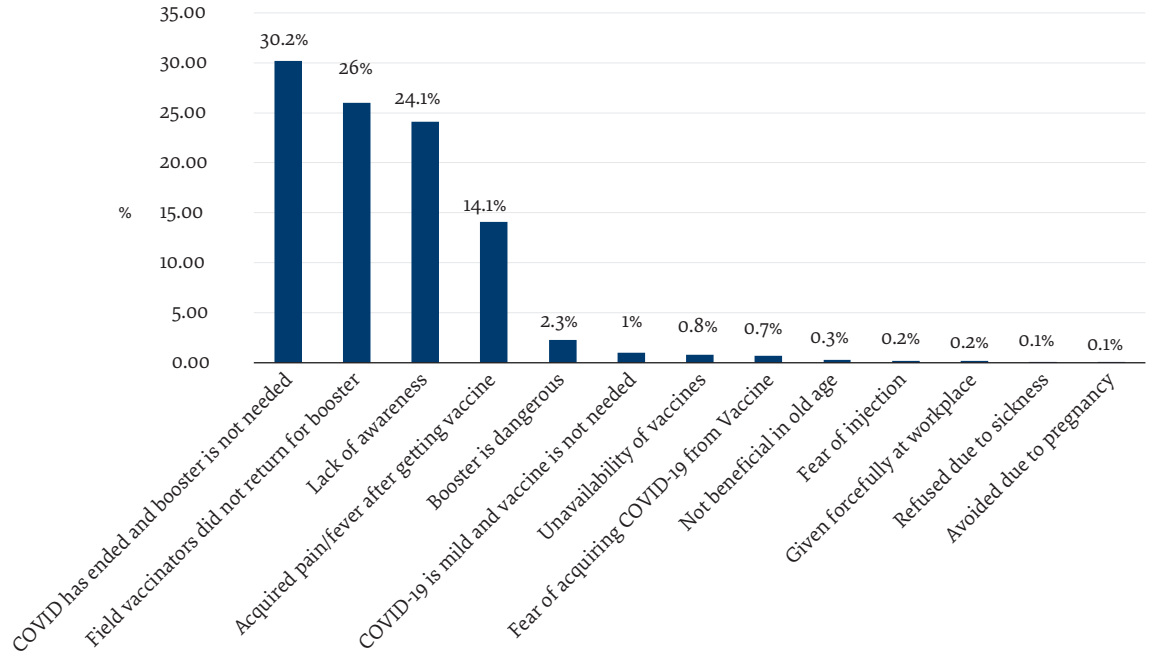


Table 2 Socio-demographic predictors of partial and complete vaccination (*n* = 3545)

	Partial vaccination		Complete vaccination	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age in years				
12–17 (*n* = 755)	0.27 (0.19–0.39)***	0.14 (0.09–0.22)***	0.38 (0.23–0.61)***	0.17 (0.10–0.30)***
18–32 (*n* = 1098)	0.63 (0.44–0.91)*	0.47 (0.31–0.70)***	0.76 (0.47–1.21)	0.50 (0.30–0.84)**
33–46 (*n* = 914)	1.04 (0.71–1.53)	0.93 (0.62–1.41)	1.40 (0.87–2.26)	1.22 (0.73–2.05)
47–60 (*n* = 542)	0.81 (0.54–1.21)	0.78 (0.51–1.21)	1.32 (0.80–2.18)	1.19 (0.69–2.04)
61 and above (*n* = 236)	Reference	Reference	Reference	Reference
Gender				
Male (*n* = 1850)	1.33 (1.14–1.56)***	1.20 (1.00–1.44)	1.29 (1.05–1.57)*	1.01 (0.80–1.28)
Female (*n* = 1695)	Reference	Reference	Reference	Reference
Education				
No formal education (*n* = 2168)	0.42 (0.29–0.61)***	0.41 (0.27–0.63)***	0.22 (0.15–0.33)***	0.17 (0.11–0.28)***
1–8 years (*n* = 806)	0.46 (0.31–0.68)***	0.67 (0.43–1.05)	0.26 (0.16–0.40)***	0.31 (0.19–0.52)***
9–12 years (*n* = 270)	0.84 (0.51–1.36)	1.15 (0.67–1.97)	0.46 (0.27–0.80)**	0.62 (0.34–1.13)
Graduation and above (*n* = 301)	Reference	Reference	Reference	Reference
Socioeconomic status				
Low	1.57 (1.30–1.91)***	0.89 (0.70–1.14)	2.50 (1.94–3.22)***	1.30 (0.95–1.78)
Medium	1.35 (1.12–1.63)**	0.97 (0.78–1.22)	1.35 (1.56–2.57)***	1.15 (0.86–1.55)
High	Reference	Reference	Reference	Reference
District				
Dadu (*n* = 720)	0.07 (0.05–0.11)***	0.04 (0.03–0.06)***	0.04 (0.03–0.07)***	0.03 (0.01–0.04)***
Jamshoro (*n* = 761)	0.14 (0.10–0.21)***	0.12 (0.08–0.18)***	0.05 (0.03–0.08)***	0.05 (0.03–0.08)***
Tando Allahyar (*n* = 755)	0.84 (0.55–1.28)	0.69 (0.44–1.07)	0.11 (0.07–0.18)***	0.09 (0.05–0.15)***
Hyderabad (*n* = 574)	0.11 (0.07–0.16)***	0.09 (0.06–0.14)***	0.03 (0.02–0.04)***	0.03 (0.02–0.05)***
Tharparkar (*n* = 735)	Reference	Reference	Reference	Reference
Distance from vaccination facility				
<5 km	1.66 (1.41–1.94)***	2.03 (1.67–2.47)***	1.84 (1.51–2.26)***	2.63 (2.06–3.36)***
>5 km	Reference	Reference	Reference	Reference

Younger people were significantly less likely to be vaccinated. A previous study in urban areas of Pakistan reported higher willingness for vaccination among older adults *(17)*. Similarly, studies in Brazil and Guatemala reported a positive association of older age groups with vaccination *(22,23)*. It is understandable that the initial focus of vaccination campaigns was the older population, and demand was higher due to significantly higher chances of severe disease and mortality among older adults.

Education and proximity to a vaccination facility were positively associated with vaccination status. Other studies have reported positive effects of education *(24,25)*. Socioeconomic status had no significant relationship with partial or full vaccination in this study. This is inconsistent with previous studies which reported that higher income was associated positively with vaccination *(22,23,25)*. Reasons for this could be lack of significant variation in income quintiles in this study as the populations were rural. Moreover, since the vaccines were provided free, the ability to pay probably did not matter. Gender did not show any significant relationship with vaccination, a finding consistent with most studies.

Study limitations

Limitations of this study include a lack of urban data to compare with rural areas. The study was planned for rural areas as it was assumed that coverage would be low. An educational campaign was planned for low-coverage areas and to study their effect. However, since COVID-19 was no longer considered a public health emergency, vaccination against the virus was no longer of concern to the population; therefore, the campaign was not implemented.

This study recommends mass vaccination campaigns in low-coverage areas, particularly the flood-affected districts. Previous mass vaccination campaigns in other settings have resulted in a remarkable increase in vaccination rates *(26,27)*. Health systems must be ready in future to address inequities in distribution of vaccines in case of another pandemic. Strategic planning must be undertaken to ensure that vaccines reach those remote geographical areas.

Finally, the myths surrounding vaccines must be debunked by community health workers, community leaders and teachers in primary health care programmes to address hesitancy, particularly among the unvaccinated populations, who are still at risk of severe disease.

Conclusion

Vaccination coverage was low in some of the 5 rural districts, particularly the flood-affected districts. There is a need to debunk the myths about vaccines and vaccination and carry out mass vaccination among these and similar populations.

Acknowledgement

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Competing interests: None declared.

Couverture de la vaccination contre la COVID-19 et facteurs prédictifs associés dans les districts ruraux du Pakistan

Résumé

Contexte : Un des éléments clés pour prévenir la réémergence de la pandémie de COVID-19 est d'atteindre et de maintenir un taux de couverture vaccinale élevé dans les zones urbaines et rurales.

Objectifs : Estimer la couverture de la vaccination contre la COVID-19 dans une population rurale et identifier les déterminants associés.

Méthodologie : Une enquête transversale a été menée en avril 2023 dans cinq districts ruraux de la province du Sindh (Pakistan). Dans chaque district, 30 groupes de cas (villages) ont été sélectionnées aléatoirement, et sept ménages ont fait l'objet d'un échantillonnage aléatoire à partir de chaque groupe à l'aide de la méthode des 30/7. Les membres du ménage âgés de plus de 12 ans ont été inclus. Le statut vaccinal a été classé en trois catégories : non vacciné, partiellement vacciné (soit avec une dose, soit sans rappel) et complètement vacciné (deux doses avec un rappel). Des odds ratio ajustés avec des intervalles de confiance à 95 % ont été calculés à l'aide d'une régression logistique multinomiale afin de déterminer les facteurs associés à la vaccination partielle et complète. Les données ont été analysées au moyen du logiciel SPSS version 20.

Résultats : Parmi les 3545 personnes interrogées dans 1050 ménages, 25,9 % n'étaient pas vaccinées, 55,0 % étaient partiellement vaccinées et 19,1 % étaient complètement vaccinées. Il y avait une association négative significative entre le jeune âge, l'absence d'éducation formelle, le fait de résider dans des districts touchés par les inondations et la vaccination, tandis que le lien entre le fait de vivre à moins de cinq kilomètres d'un centre de vaccination et la vaccination partielle et complète était significativement positif. Les résidents des districts de Dadu (OR = 0,03, IC à 95 % = 0,01-0,04), Jamshoro (OR = 0,05, IC à 95 % = 0,03-0,08), Hyderabad (OR = 0,03, IC à 95 % = 0,02-0,05) et Tando Allahyar (OR = 0,09, IC à 95 % = 0,05-0,15) étaient significativement moins susceptibles d'être complètement vaccinés que ceux de Tharparkar. Les raisons les plus fréquentes expliquant l'absence de vaccination sont les suivantes : perception selon laquelle la COVID-19 est une maladie bénigne (34,5 %) ; crainte des effets secondaires (22,7 %) ; indisponibilité du vaccin (19,8 %) ; et peur de contracter la COVID-19 en se faisant vacciner (15,8 %).

Conclusion : La couverture vaccinale était faible dans certains districts, en particulier dans les districts touchés par les inondations, principalement à cause de certaines idées reçues. Il est nécessaire de sensibiliser les communautés afin de démystifier la vaccination contre la COVID-19 au sein de ces populations rurales.

التغطية بالتطعيم ضد كوفيد-19 وعوامل التنبؤ بها في خمس مناطق ريفية في باكستان

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الخلاصة

الخلفية: إن تحقيق تغطية عالية بالتطعيم والإبقاء على هذه التغطية في المناطق الحضرية والريفية أحد مفاتيح الوقاية من عودة ظهور جائحة كوفيد-19.

الأهداف: هدفت هذه الدراسة الى تقدير التغطية بالتطعيم ضد كوفيد-19 بين سكان مناطق ريفية، والوقوف على مُحدِّدات التطعيم.

طرق البحث: أُجريت دراسة مقطعية في نيسان/ أبريل 2023 في 5 مناطق ريفية في إقليم السِّنْد، في باكستان. ومن كل منطقة، اختيرت 30 مجموعة (قرى) اختيارًا عشوائيًّا، وأُخذت عينات عشوائية من 7 أسر من كل مجموعة باستخدام أسلوب 7/ 30. وأُدرج أفراد الأسرة الذين تزيد أعمارهم على 12 عامًا. وقد صُنِّفت حالة التغطية التطعيم على أنها حالة غير مطعَّمة، ومطعَّمة جزئيًّا (في حالة التطعيم بجرعة واحدة، أو عدم الحصول على جرعة مُعَزِّزة)، وصُنِّفت على أنها مطعَّمة بالكامل (في حالة الحصول على جرعتين وجرعة مُعَزِّزة واحدة). واحتُسبت نسب الأرجحية المُصحَّحة بفترات ثقة تبلغ 95٪ باستخدام الانحدار اللوجستي المتعدد الأطراف، لتحديد العوامل المرتبطة بالتطعيم الجزئي والكامل. وحُللت البيانات باستخدام الإصدار 20 من برنامج SPSS.

النتائج: من بين الأفراد الذين شملهم المسحُ، والبالغ عددهم 3545 فردًا من 1050 أسرة، فإن 25.9٪ منهم لم يحصلوا على التطعيم، و55.0٪ منهم حصلوا على التطعيم الجزئي، و19.1٪ على التطعيم الكامل. وتبيَّن وجود ارتباط سلبي كبير بين تلقِّي التطعيم وعوامل صغر السن، والافتقار

إلى التعليم الرسمي، والإقامة في مقاطعات متضررة من الفيضانات، في حين تبيَّن وجود ارتباط إيجابي كبير بين التلقي الجزئي أو الكلي للتطعيم، والإقامة على بُعد أقل من 5 كيلومترات من مرفق التطعيم. وكان احتمال التطعيم الكامل لسكان مقاطعات دادو (نسبة الأرجحية=95،0.03٪ فاصل الثقة=0.01–0.04)، وجامشيرو (نسبة الأرجحية=0.05، 95٪ فاصل الثقة=0.03–0.08)، وحيدر أباد (نسبة الأرجحية=95،0.03٪ فاصل الثقة=0.02–0.05)، وتاندو ألهيار (نسبة الأرجحية=0.09، 95٪ فاصل الثقة=0.05–0.15) أقل كثيرًا من تلك الموجودة في ثاربركار. وأكثر الأسباب شيوعًا لعدم التطعيم كانت الشعورَ بأن كوفيد-19 مسألة بسيطة (34.5٪)، والخوفَ من الآثار الجانبية (22.7٪)، وعدمَ توفُّر اللقاح (19.8٪)، والخوفَ من الإصابة بعدوى كوفيد-19 من خلال اللقاح (15.8٪).

الاستنتاجات: كانت التغطية بالتطعيم منخفضة في بعض المقاطعات، ولا سيما المقاطعات المتضررة من الفيضانات، الأمر الذي يُعزى بالدرجة الأولى إلى خرافات بعينها. ولذا، فإن ثمة حاجة إلى توعية مجتمعية لدحض الخرافات بشأن التطعيم ضد كوفيد-19 بين سكان الريف.

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