Global Pediatric Health
Volume 11: 1–8

DOI: 10.1177/2333794X241235746
journals.sagepub.com/home/gph
Sage

Predictors of Uptake of Rotavirus Vaccination Amongst Disadvantaged Communities in Pakistan

Maryam Huda[1], Tazeen Ali, PhD[1], Fauzia Basaria Hasnani, MSc[1], Saleem Sayani, PhD[1], and Shehla Zaidi, PhD[1]

Abstract

Introduction. Pakistan has the highest childhood mortality associated with diarrheal diseases. The objective of this study is to identify underlying factors contributing to lack of knowledge among mothers regarding vaccine's efficacy in the prevention of diarrhea. *Methodology.* Secondary data was analyzed from a cross-sectional household survey in Northern Pakistan of eligible households having under-2-year children. Univariate and multivariate logistic regression analyses were carried out. *Results.* Only 30% of the mothers had knowledge regarding diarrhea prevention by vaccine. The main factors found significantly correlated with this knowledge were mother's education, distance of households from EPI centers, immunization status of children, counseling regarding clean drinking water and hygiene, provision of ORS, and antenatal care services by LHWs. *Conclusion.* Women's literacy, access to care and LHW services are important for improving awareness and acceptance of vaccines for vaccine preventable diseases including diarrhea. Policy makers need to focus on improved monitoring and reprioritization of undermined services by LHWs.

Keywords

diarrhea prevention, vaccine awareness and acceptance, LHW services, mother's knowledge, rotavirus vaccine

Received March 22, 2023. Received revised January 16, 2024. Accepted for publication February 12, 2024.

Introduction

With the largest improvements having occurred in Central and Southern Asian countries after establishment of 2030 Agenda for Sustainable Development, there is still significant need to address the major global disparity in child and maternal health outcomes.[1]

Even though many interventions are being implemented based on SDGs,[2] Pakistan continues to face major barriers in achieving improved child health. The reported Child Mortality Rate (CMR) in Pakistan is 74 per 1000 live births, nearly double the average global CMR.[3,4] The major drivers of CMR in Pakistan are attributed to diarrheal diseases and pneumonia; moreover, Pakistan is among the top 5 countries contributing to the global CMR, highlighting the need for targeted approaches to reduce the national and global burden of CMR through mitigating death by diarrheal diseases and pneumonia.[5,6]

Across low and middle-income countries (L&MIC), diarrheal diseases cause over 500 000 childhood deaths every year.[4] Among these countries, Pakistan is home to the highest rate of childhood mortality associated with diarrheal diseases.[4] Current research demonstrates that there are 2 major factors driving the prevalence of diarrheal diseases among children in Pakistan: lack of proper sanitation and poor access to safe drinking water.[7,8] With approximately 84% to 89% of water sources in Pakistan falling under the quality standards for human consumption, and disproportionately lower access of safe tap water in rural regions of the country, many are vulnerable to contracting water-borne diseases by viruses existing in unsanitary water.[7] Particularly, Rotavirus is a significant cause of severe diarrheal-associated illness in children under the age of 5 in Pakistan.[9]

[1]Aga Khan University, Karachi, Pakistan

Corresponding Author:
Maryam Huda, Department of Community Health Sciences, Aga Khan University, Aga Khan University Hospital, Ibn e Ridwan Building, Stadium Road, Karachi 74800, Pakistan.
Email: Maryam.huda@aku.edu

Despite the significant burden of diarrheal diseases among children under 5 in Pakistan, diarrheal diseases are vaccine-preventable.[10] In 2009, the World Health Organization (WHO) encouraged countries to add rotavirus vaccines in national routine vaccination systems, specifically in countries with a high burden of diarrheal-related mortality among children under five.[9] As of 2018, the rotavirus vaccine has been implemented nationally and across 100 countries globally, substantially reducing the global burden of severe diarrheal diseases.[10] With the support of the government of Pakistan and GAVI, the Vaccine Alliance, the RVA vaccine (Rotarix) has been introduced in Pakistan's Expanded Program on Immunization (EPI) plan across 4 provinces.[9]

However, despite the relatively high vaccine efficacy, there are major socioeconomic and demographic barriers facing RVA vaccine uptake in Pakistan; in particular, the overarching barrier is the lack of awareness and acceptance of the RVA vaccine among mothers and caregivers.[7,11]

While there are many strategies to mitigate the risk of maternal and child mortality, current research suggests access and utilization of Maternal and Child Health (MNCH) services is of utmost importance in reducing the burden of maternal and child mortality, and ultimately integral in progressing toward achieving SDG 3.[4,10,12] The Lady Health Worker (LHW) Program plays a pivotal role in connecting marginalized and rural communities with mainstream, established healthcare systems[13,14,15]

LHWs in Pakistan are females hired from the local community who are assigned to deliver preventative and primary health promotion, providing a set of curative services communities (150-200 households) after about 3 months of pre-service and 1 year of in-service training.[16] More specific to child mortality and diarrheal diseases, LHWs work to provide Oral Rehydration Solution ORS and routine immunization to children, as well as promotion activities such as improving water sanitation, educating mothers and caregivers on vaccine efficacy, and principles of basic hygiene- these responsibilities all mitigate the risk of rotavirus infection and subsequent diarrheal diseases.[15,17,18] The current scope of research in this field is heavily focused on socioeconomic and demographic barriers to increasing rotavirus vaccination coverage in Pakistan and reducing the burden of child mortality.[7,11] While the responsibilities and services of LHWs have increased over the time, there is insufficient data on extent of uptake of these community health services within Pakistan. Moreover, there is a research gap in assessing barriers to community-level uptake of maternal and child health services, thus limiting the perceived impact of LHWs on child health outcomes in Pakistan.

The objective of this study is to identify underlying factors contributing to lack of knowledge regarding vaccine's efficacy in the prevention of diarrheal diseases, among mothers of children under 2 years of age.

Material and Methods

This study is a secondary analysis of a cross-sectional study to find out the strength of association between different contributing factors and knowledge of mothers regarding prevention of diarrhea with vaccine.

Study Setting

A cross-sectional household survey was conducted in the LHW covered areas across 2 regions of Pakistan from March-April 2019. This study was part of a larger, quasi-experimental study which assessed the effect of digitalizing LHWs routine documentation on their performance- findings from the baseline survey are reported in this study. The survey was carried out in 2 districts of Gilgit Baltistan region named Ghizer and Astore, and one district Chitral of Khyber-Pakhtunkhwa (KP) province. Because this was a baseline survey for implementation research for health worker mobile app, these study areas were selected based on feasibility to implement the intervention, after consultations with health departments.[19]

Sampling was done using a 2-staged cluster sampling technique. A cluster was defined as the coverage area of LHW (approximately 1000 people) and considered as the primary sampling unit. A complete list of all LHWs from the study areas was obtained from the respective health departments. In the first stage, 80 clusters were randomly sampled from each list. In the second stage, 15 eligible households were systematically sampled from each cluster, with the first household being randomly selected by the spin of a pen (pen was spun on a flat surface and that house was selected toward which the pen pointed). From the first identified and surveyed household, 15 eligible households were selected using systematic sampling, where every fifth household was checked for eligibility that is, where at least 1 living child of <2 years resides at the time of survey. If the selected household was not eligible, the next-door neighbor was checked for eligibility and the process continued till the required sample size was achieved. The inclusion criteria for the survey included households where at least 1 living child of <2 years resided at the time of survey and who were willing to participate. Similarly, the exclusion criteria were households which did not have children under 2 years of age and were not willing to participate.

Data Collection Tool and Sample Size

Structured questionnaire was used to collect data on maternal and child health, immunization status, and satisfaction about services of LHWs. Questionnaire was adapted from Demographic and Health Survey and similar surveys conducted previously and reviewed by experts in this field of research in the researchers' university. These questionnaires were translated in Pakistan's local language (Urdu) and then translated into English for data analysis, with revisions made if there were any consistencies. The questionnaire was pretested in 5% of the sampled households in the same community and minor language modification was carried out accordingly.

A sample of 1080 eligible households was required to detect a 10% increase in routine vaccine coverage among children <2 years from baseline of 66% coverage in Pakistan with 5% level of significance, 80% power and design effect of 1.5. A total of 1204 eligible households were sampled.

Data Analysis

Data was entered into Statistical Package for Social Sciences (SPSS), (version 25.0) by double entry strategy. Data was analyzed and descriptive and inferential statistics were conducted. The list of factors which could be associated with the knowledge of mothers regarding diarrhea prevention with vaccines were selected based on biological and statistical relevance. These factors were distance of household from EPI center, child's mother's education frequency of LHW visits, immunization Status, antenatal care by LHWs, growth of children under 5, management of minor illnesses, Oral Rehydration Solution for referral to first care facility, LHWs see children under 5, knowledge of diarrhea prevention by vaccine. Logistic regression was applied to measure the association between independent variables and dependent variables. The logistic regression was carried out in 2 steps. In the first step association between each independent variable was examined with the dependent variable and the odds ratios, standard errors and their 95% CI were calculated. Subsequently all those variables which were found significant at the univariate level (P-value $\leq .2$), were considered for multivariable model.

Ethical Approval

Ethics approval was obtained from the Ethical Review committee of the Aga Khan University Hospital (ERC#2018-0375-951) prior to the start of the study. Written Informed consent was taken before each interview, and both the soft and hard data was kept confidential. The anonymity of the participants was maintained.

Table 1. Socio Demographic Characteristics of the Participants (n = 1204).

Variables	Categories	n (%)
Family size (mean)	Males	4.6
	Females	4.5
Mother's education	No schooling	314 (26.1)
	Religious education	79 (6.6)
	Primary	224 (18.6)
	Secondary	266 (22)
	Inter	194 (16.1)
	Graduation and above	127 (10.5)
Source of household earning	Govt job	556 (46.2)
	Private job	174 (14.4)
	Own business	84 (7)
	Laborer	348 (28.9)
	Agriculture	24 (2)

Results

Socio Demographic Characteristics of the Participants

A total of 1204 households were interviewed. On an average, there were 4.6 males and 4.5 females per household. Regarding mother's education level, 26% of the mothers had no schooling and almost 11% had a graduate level degree. The major source of household earnings was government jobs for 46.2%, followed by laborers who were 29% (Table 1).

Out of the total 1204 households, 593 (49.3%) had less than 2 km distance from the EPI center. Moreover, 451 (37.5%) mothers had no schooling/ religious education or incomplete primary education. The LHWs visited 791 (65.7%) of the households at least once a month. Regarding LHW counseling and services; ANC services were provided in 136 (11.3%) of the households, growth monitoring of children under 5 years of age was carried out in 104 (8.6%) of the households, management of minor illnesses including diarrhea was carried out in 474 (39.4%) of the households, ORS for diarrhea was provide in 249 (20.7%) of the households.

Likewise, 695 (57.7%) of children under 5 years of age were seen by LHWs. However, only 25 (2.1%) were referred to first level facility. Furthermore only 365 (30.3%) mothers had the knowledge that diarrhea can be prevented by vaccines (Table 2).

Table 2. Frequencies of Independent & Dependent Variables (n = 1204).

Variables	Categories	Frequency	Percent %
Distance of household from EPI center	<2 Kilometers	593	49.3
	>2 Kilometers	611	50.7
Child's mother's education status	Illiterate	451	37.5
	Literate	753	62.5
Frequency of LHW visits	At least once a month	791	65.7
	Once a week	400	33.2
Immunization Status	Partially immunized.	518	43.6
	Fully immunized	669	56.4
Antenatal care by LHWs	Yes	136	11.3
	No	1051	87.3
Growth monitoring of children under 5	Yes	104	8.6
	No	1084	90
Management of minor illnesses	Yes	474	39.4
	No	716	59.5
Oral Rehydration Solution for diarrhea	Yes	249	20.7
	No	941	78.2
Referral to first care facility	Yes	25	2.1
	No	1152	95.7
LHWs see children under 5	Yes	695	57.7
	No	509	42.3
Knowledge of diarrhea prevention by vaccine	Yes	365	30.3
	No	839	69.7

Logistic Regression

Inferential statistics, that is, logistic regression, was applied to identify the association between Dependent variables and independent variables. The dependent / outcome variable is knowledge regarding prevention of diarrhea by vaccine Logistic regression is the most appropriate method to find the association between a categorical dependent variable and one or more continuous or categorical independent variables. The logistic regression was carried out in 2 steps. In the first step association between each independent variable was examined with the dependent variable and the unadjusted odds ratios and their 95% CI were calculated. Subsequently all those variables which were found significant at the univariate level (P-value $\leq .2$), were considered for multivariable model.

Univariate Analysis

The significance (P-value), unadjusted Odds Ratio (OR), and their 95% confidence intervals are reported in the table for all the 12 variables (Table 3). The variables which were found to be significant were Antenatal care services, Routine Immunization, Management of minor illnesses, ORS for diarrhea, Cleanliness of drinking water and hygiene, Mother's education, Distance from EPI center, Immunization Status. The other variables which were added in logistic regression model at univariate level that is, Growth monitoring, LHW seeing children under 5, Frequency of LHW visits and Referrals to first level facility, did not show significant association.

Antenatal care service provision by LHWs was found to be significantly associated with knowledge of mothers regarding diarrhea prevention by vaccine (OR = 1.958, 95% CI: 1.361-2.817, P-value $< .001$). Those women who were provided ANC services by LHWs had 1.958 times more knowledge regarding diarrhea prevention by vaccine. Moreover, an association between **routine immunization** (RI) by LHWs and knowledge regarding diarrhea prevention by vaccine was found statistically significant (P-value .005). The odds were 1.425 times more as compared to those who did not receive RI services. Similarly, those who received **management of minor illnesses** by LHWs had 1.255 times more knowledge regarding diarrhea prevention by vaccine (P-value .076).

Moreover, **Counseling regarding cleanliness of water and hygiene** by LHWs was significantly associated with knowledge regarding diarrhea prevention by vaccine (OR = 1.503, 95% CI 1.171-1.929, P-value .001). Likewise, **mother's education level** was found significantly associated with knowledge regarding diarrhea prevention by vaccine (P-value $< .001$). OR demonstrated that literate mothers had 1.676 times more knowledge regarding diarrhea prevention by vaccine than the illiterate ones.

Table 3. Univariate Logistic Regression of Contributing Factors Associated with Knowledge Regarding Diarrhea Prevention by Vaccine in North Pakistan (n = 1204).

Independent variables (12)	*B*	SE	Sig. (≤0.2)	Odds ratio	95% CI
Antenatal care services	0.672	0.186	**0.000**	1.958	(1.361-2.817)
Routine Immunization	0.354	0.127	**0.005**	1.425	(1.112-1.827)
Management illnesses of minor	0.227	0.128	**0.076**	1.255	(0.977-1.612)
Growth monitoring	0.254	0.215	0.237	1.290	(0.846-1.967)
LHW see children under 5	−.043	0.127	0.732	0.958	(0.747-1.228)
Referrals to first level facility	0.254	0.422	0.547	1.289	(0.564-2.945)
Oral Rehydration Solution for diarrhea	−.241	0.160	**0.132**	0.786	(0.575-1.075)
Cleanliness of drinking water and hygiene	0.408	0.127	**0.001**	1.503	(1.171-1.929)
Mother's education	0.516	0.135	**0.000**	1.676	(1.287-2.182)
Distance from EPI center	0.656	0.128	**0.000**	1.927	(1.500-2.474)
Frequency of LHW visits	0.416	0.667	0.533	1.515	(0.410-5.601)
Immunization Status	−.616	0.145	**0.000**	0.540	(0.407-0.717)

Table 4. Correlation Among Significant Independent/Predictor Variables.

Independent variables	Distance of HH from EPI Center	Mother' s education	Antenatal care services	Oral rehydration n solution for diarrhea	Immunization status	Cleanliness of drinking water and hygiene
Distance of HH from EPI Center	1.000	−0.086	0.031	0.057	−.028	0.021
Mother's education	−0.086	1.000	−.042	−.050	0.103	−.051
Antenatal care	0.031	−.042	1.000	−.002	0.006	0.114
Oral Rehydration Syrup for diarrhea	0.057	−.050	−.002	1.000	0.007	0.170
Immunization Status	−.028	0.103	0.006	0.007	1.000	−.051
Cleanliness of drinking water and hygiene	0.021	−.051	0.114	0.170	−.051	1.000

Furthermore, **distance of the household from the EPI center** is another factor which showed significant association with the dependent variable (*P*-value < .001). Those mothers who lived less than2 km away from the EPI center had 1.927 times more knowledge than those who lived more than2 kms away.

Lastly, **immunization status** was found significantly associated with knowledge regarding diarrhea prevention by vaccine (*P*-value < .001). Mothers who had partial or no vaccination of their children were 0.540 times less likely to have knowledge regarding diarrhea prevention by vaccine (OR = 0.540, 95% CI 0.407-0.717).

Assumptions of Multivariate Logistic Regression

It is very important to check for collinearity among independent variables, otherwise the regression analysis will become insignificant even if its significant in univariate analysis. Since the data is categorical and the Variance Inflation Factor (VIF) cannot be used, correlation was used.

Spearman's rho Correlation was carried out among all the independent variables. All the values of correlation coefficient were between −2 and + 2 which showed almost no correlation or very weak correlation (very weak ± 0-0.19) (Table 4).

Multivariate Analysis

The multi-variable model includes 6 variables which were found to have significant association at the multivariate level (*P*-value < .05). In the final model, variables like Antenatal care services, ORS for diarrhea, Cleanliness of drinking water and hygiene, Mother's education, Distance from EPI center, and Immunization Status demonstrated significant association with the dependent variable that is, knowledge regarding diarrhea prevention by vaccine. However, 2 variables Routine Immunization (*P*-value = .005) and Management of minor illnesses (*P*-value = .076), which were found to be significant in the univariate analysis turned insignificant in multivariate analysis as *P*-value .134(Routine Immunization) and *P*-value .579 (Management of minor illness) (Table 5).

Distance of households from EPI center was found to be significantly associated (*P*-value .000) with mother's knowledge regarding diarrhea prevention by vaccine. The odds of having knowledge regarding diarrhea prevention

Table 5. Multivariate Logistic Regression for Contributing facTors Associated with Knowledge Regarding Diarrhea Prevention by Vaccine in North Pakistan (n = 1204).

Predictor variables (6)	*B*	SE	*P*-value Sig.	Adjusted odds ratio	95% CI
Distance from EPI center	0.624	0.132	0.000	1.866	(1.441-2.414)
Mother's education	0.463	0.140	0.001	1.589	(1.208-2.090)
Antenatal care services	0.594	0.192	0.002	1.811	(1.243-2.641)
Cleanliness of drinking water and hygiene	0.342	0.135	0.011	1.408	(1.082-1.833)
ORS for diarrhea	−.370	0.169	0.028	0.691	(0.496-0.962)
Immunization Status	−.522	0.150	0.001	0.594	(0.442-0.797)

by vaccine was 1.866 times higher among those who lived less than2 km away from the EPI center than those who lived more than2 kilometers away.

Similarly, **Mother's education level** demonstrated significant association (*P*-value .001) with knowledge regarding diarrhea prevention by vaccine. Literate mothers were 1.589 times more likely to have knowledge regarding diarrhea prevention by vaccine than those who were illiterate.

Likewise, **antenatal services provision** was observed to have significant association (*P*-value .002) with knowledge regarding diarrhea prevention by vaccine. Those women who were provided ANC by LHWs were 1.811 times more likely to have knowledge regarding diarrhea prevention by vaccine than those who were not provided ANC.

Moreover, counseling regarding **cleanliness of drinking water and hygiene** revealed significant association (*P*-value .011) with knowledge regarding diarrhea prevention by vaccine. The odds of having more knowledge regarding diarrhea prevention by vaccine were 1.408 times more for those who were counseled by LHWs for cleanliness of drinking water and hygiene than those who were not.

Furthermore, **provision of ORS for diarrhea** (*P*-value .028) and **Immunization status** (*P*-value .001) were also found significantly associated with knowledge regarding diarrhea prevention by vaccine. The odds of ORS for diarrhea were (0.69-1) 31% less likely to have knowledge regarding diarrhea prevention by vaccine than those who were not provided ORS for diarrhea by LHWs. Similarly, mothers with children who had partial, or no vaccination were (0.59-1) 41% less likely to have knowledge regarding diarrhea prevention by vaccine than those who had fully vaccinated children.

The Standard Error (S.E) of the regression (S), also known as the standard error of the estimate, represents the average distance that the observed values fall from the regression line. The standard error for ANC services is the highest and Distance from EPI service the lowest. All values are more or less the same.

Model Fitness and Significance

The findings of the multivariate analysis found the overall model to be significant as evident by significant *P*-value of less than.001 in Omnibus test of model coefficients. We have sufficient evidence to conclude that Distance from EPI center, Mother's education, Antenatal care services, Cleanliness of drinking water and hygiene, ORS for diarrhea, and Immunization Status are statistically associated with knowledge regarding diarrhea prevention by vaccine in multivariate adjusted model. Finally, the model explained that 8.6% of the variability in knowledge regarding diarrhea prevention by vaccine is explained by all the independent variables present in final model as depicted by Nagelkerke R square value. Goodness for fit test, the Hosmer and Lemeshow test statistics was 7.235 with a non-significant *P*-value of .405 which shows that we fail to reject null hypothesis and conclude that the model was well fit to the data.

Discussion

The study aimed to identify the factors associated with knowledge of mothers regarding diarrhea prevention by vaccine. The current research found significant associations between 6 major contributing factors to RVA vaccine awareness for prevention of diarrhea, among mothers and caregivers in Pakistan: (1) mother's education level, (2) distance of households from EPI centers, (3) immunization status of children under 2 years of age (4) counseling regarding cleanliness of drinking water and hygiene, (5) provision of oral rehydration solution (ORS) for diarrheal diseases, and (6) provision of antenatal care services. These factors impact knowledge of RVA vaccine for prevention of diarrhea among mothers and caregivers, ultimately impeding the prevention of diarrheal diseases by vaccine and subsequent death among children under 5 in Pakistan.

The current scope of literature suggests that lack of awareness and/or acceptance of the RVA vaccine is a major barrier to RVA uptake and coverage across Pakistan[20]

This study found a significant association of mother's educational level with knowledge regarding diarrhea prevention by vaccines. This is in congruence to other studies providing evidence to suggest that maternal occupational, educational, and economic status are key determinants of child mortality.[7] Similarly, a study done in Pakistan in 2017 demonstrated that status of women's education is positively associated with use of public health care services, and furthermore, is closely associated with decreased infant mortality.[11] Similarly, evidence suggests that low health literacy and awareness, supplemented with poor economic conditions among mothers can limit accessibility of health services (eg, Antenatal care) known to mitigate the burden of child mortality.[7] This parallels our results in that education level of parents is positively associated with child health within the household, emphasizing the importance in education and health literacy as it pertains to uptake in health promotion activities[11]

The other important finding was strong association of distance of households from EPI center with knowledge regarding diarrhea prevention by vaccines. Those households which had less than 2 km distance from the EPI centers had mothers with better knowledge regarding diarrhea prevention by vaccines than those who lived more than 2 kilometers away. The study findings are aligned with previous literature which shows that systemic socioeconomic inequalities drive demographic barriers to accessing health services; low socioeconomic status is associated with rural living, where mothers are particularly vulnerable to physical barriers to not only high-quality healthcare services, but also income, nutrition, decent housing, and sanitary water, all of which can impact the prevalence of child mortality.[7]

This is further emphasized in the existing urban-rural differentials as it pertains to child mortality.[7,11] Furthermore, there is evidence to suggest that living in a community with government vaccination facilities within 5 km, with better housing conditions, were positively associated with vaccine uptake; contrastingly, regions of Pakistan with worse roof quality and further distanced from health centers and health services were negatively associated with vaccination uptake.[21]

Similarly, the study also revealed that mothers who were provided with better LHW services regarding antenatal care had better knowledge regarding diarrhea prevention by vaccines. Furthermore, households where LHWs provided counseling regarding water sanitation and hygiene had better overall knowledge regarding diarrhea prevention by vaccination. There is evidence to suggest there is an association between maternal and/or caregiver access and use of antenatal care services, and completion of children's immunization schedules.[22] More specifically, the current scope of research demonstrates that attendance of ANC was significantly associated with the uptake of the rotavirus vaccine; this emphasizes the study findings, demonstrating that ANC is associated improved knowledge, awareness, and uptake of rotavirus vaccines.[22]

One of the pertinent findings was the significant association between immunization status of children under 2 years of age and knowledge regarding diarrhea prevention by vaccines. Mothers of fully immunized children had more knowledge than those who had partial or no vaccination. These findings are consistent with data in literature where better immunization status confers to better knowledge regarding prevention of diseases.[22]

This study demonstrated strong association between households where LHWs provided ORS for diarrhea and knowledge regarding diarrhea prevention by vaccines. With better LHW counseling and services, mothers have more awareness regarding vaccine preventable diseases. The scope of this study is small which could be a limitation to generalize the study findings. Such in-depth analysis could be carried out at a large level with the inclusion of more factors.

Conclusion

The findings of this study have provided evidence that better education level, improved geographic access to EPI centers, and better counseling and service provision by LHWs results in better knowledge of mothers regarding vaccine preventable diseases including pneumonia and diarrhea, which will subsequently result in better awareness and acceptance of vaccines and reduction in child mortality. This calls for measures to be taken to ensure better education for girls, LHW program should focus on provision of routine counseling sessions and robust monitoring mechanisms for monitoring and governance to ensure service provision and establishing EPI centers or availability immunization services within a reach of <2 km.

Author Contributions

MH: contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted manuscript; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring itegrity and accuracy. TA: contributed to conception and design; contributed to analysis; ; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring itegrity and accuracy. FB: contributed to design; contributed to analysis; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring itegrity and accuracy. SS: gave final approval; agrees to be

accountable for all aspects of work ensuring itegrity and accuracy. SZ: critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring itegrity and accuracy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Maryam Huda https://orcid.org/0000-0002-7409-4965

Supplemental Material

Supplemental material for this article is available online.

References

1. United Nations. *Goal 3: Ensure Healthy Lives and Promote Well-Being for All at All Ages*. United Nations; 2022. Accessed December 2021. https://sdgs.un.org/goals/goal3
2. Akseer N, Kamali M, Arifeen SE, et al. Progress in maternal and child health: how has South Asia fared? *BMJ*. Published online April 11, 2017. doi:10.1136/bmj.j1608
3. Takahashi K, Nomura M, Horiuchi S, Miura H. Global policy directions for maternal and child health in the SDG era. *J Natl Inst Public Heal*. 2017;66(4):395-401.
4. Islam M, Usman M, Mahmood A, Abbasi AA, Song OY. Predictive analytics framework for accurate estimation of child mortality rates for Internet of things enabled smart healthcare systems. *Int J Distrib Sens Netw*. 2020;16(5):1550147720928897. doi:10.1177/1550147720928897
5. Brizuela V, Tunçalp Ö. Global initiatives in maternal and newborn health. *Obstet Med*. 2017;10(1):21-25. doi:10.1177/1753495X16684987
6. Qamar FN, Zaman U, Quadri F, et al. Predictors of diarrheal mortality and patterns of caregiver health seeking behavior in in Karachi, Pakistan. *J Glob Health*. 2016;6(2):020406. doi:10.7189/jogh.06.020406
7. Zakaria M, Tariq S, Ul Husnain MI. Socio-economic, macroeconomic, demographic, and environmental variables as determinants of child mortality in South Asia. *Environ Sci Pollut Res*. 2020;27:954-964. doi:10.1007/s11356-019-06988-w
8. Zahid J. Impact of clean drinking water and sanitation on water borne diseases in Pakistan. Published 2018. Accessed December 2021. https://www.jstor.org/stable/pdf/resrep17223.pdf
9. Basharat N, Sadiq A, Dawood M, et al. Rotavirus gastroenteritis in Pakistan, 2018: updated disease burden. *BMC Infect Dis*. 2021;21:426. doi:10.1186/s12879-021-06123-6
10. Burnett E, Parashar U, Tate J. Rotavirus vaccines: effectiveness, safety, and future directions. *Paediatr Drugs*. 2018;20(3):223-233. doi:10.1007/s40272-018-0283-3
11. Patel KK, Rai R, Rai AK. Determinants of infant mortality in Pakistan: evidence from Pakistan Demographic and Health Survey 2017–18. *J Public Heal*. 2021;29:693-701. doi:10.1007/s10389-019-01175-0
12. PDHS 2017-18. Pakistan - demographic and health survey 2017-2018. Accessed December 2021. https://dhsprogram.com/pubs/pdf/FR354/FR354.pdf
13. Najafizada SA, Labonté R, Bourgeault IL. Community health workers of Afghanistan: a qualitative study of a national program. *Confl Health*. 2014;8(1):26. doi:10.1186/1752-1505-8-26
14. Ninazhu EA, Kearns A. *Jacquelyn Caglia, Rifat Atun, Lady Health Workers in Pakistan; Improving Access to Health Care for Rural Women and Families*. Harvard School of Public Health; 2014. Accessed December 2021. https://www.hsph.harvard.edu/wp-content/uploads/sites/2413/2014/09/HSPH-Pakistan5.pdf
15. Wazir MS, Shaikh BT, Ahmed A. National program for family planning and primary health care Pakistan: a SWOT analysis. *Reprod Health*. 2013;10(1):60. doi:10.1186/1742-4755-10-60
16. Ahmed S. Women's Empowerment Through Polio Eradication: Agency and Representation of Lady Health Workers in Pakistan – ProQuest. www.proquest.com. Accessed January 2, 2024. https://www.proquest.com/openview/1aebb42d3a6a1ccc78938b0898cbcef1//1?pq-origsite=gscholar&cbl=18750&diss=y
17. Folz R, Ali M. Task sharing in health workforce: an overview of community health worker programmes in Afghanistan, Egypt and Pakistan. *East Mediterr Health J*. 2018;24(9):940-950.
18. Edward A, Branchini C, Aitken I, et al. Toward universal coverage in Afghanistan: A multi-stakeholder assessment of capacity investments in the community health worker system. *Soc Sci Med*. 2015;145:173-183. doi:10.1016/j.socscimed.2015.06.011
19. Zaidi S, Kazi AM, Riaz A, et al. Operability, usefulness, and task-technology fit of an mhealth app for delivering primary health care services by community health workers in underserved areas of Pakistan and Afghanistan: Qualitative study. *J Med Internet Res*. 2020;22(9):e18414. doi:10.2196/18414
20. Ullah S, Malik FR, Qureshi SH, Ullah A. Awareness and acceptance of Rotavirus vaccine among mothers of neonates attending Kuwait Teaching Hospital, Peshawar-Pakistan. *Khyber Medical University Journal*. 2019;11(3):170-175. doi:https://doi.org/10.35845/kmuj.2019.19326
21. Mitchell S, Andersson N, Ansari NM, et al. Equity and vaccine uptake: a cross-sectional study of measles vaccination in Lasbela District, Pakistan. *BMC Int Health Hum Rights*. 2009;9 Suppl 1:S7. doi:10.1186/1472-698X-9-S1-S7
22. Wondimu A, Cao Q, Wilschut JC, Postma MJ. Factors associated with the uptake of newly introduced childhood vaccinations in Ethiopia: the cases of rotavirus and pneumococcal conjugate vaccines. *BMC Public Health*. 2019;19(1):1656. doi:10.1186/s12889-019-8002-8