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# Remittances and Vaccine Hesitancy in the Punjab Province of Pakistan

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## Abstract

Pakistan is one of only three countries that have failed to stop the transmission of poliovirus and experienced a surge of polio paralysis in 2019. Meanwhile, misconceptions persist about the safety and efficacy of vaccines in Pakistan and elsewhere. Our study investigates the effect of remittances on the likelihood a household vaccinate its children against polio and measles/mumps/rubella (MMR). Based on data from a Multiple Indicators Cluster Survey conducted in Punjab in 2014, we isolate the effect of receiving remittances using distance and exact matching. We find that access to remittances increases the likelihood of vaccinating male children against polio by about 11 percentage points and against MMR by about 12.5 percentage points. Unfortunately, remittances do not significantly improve vaccinations of girls. The results imply that vaccination campaigns – including campaigns to vaccinate against SARS-CoV-2 – should focus on communities without migration experience and vaccinating girls.

**Keywords:** Remittances, Vaccines, Polio, Gender, Pakistan

**JEL Codes:** F24, O15, I15.

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## 1. Introduction

Pakistan is the only country apart from Afghanistan and Nigeria that has failed to stop the endemic transmission of Poliomyelitis, and in 2015 the World Health Organization (WHO) identified Pakistan as the only country which was a global exporter of the disease.<sup>1</sup> As such, considerable scholarly interest has been devoted to exploring reasons behind the persistence of Polio in Pakistan, emphasizing the role of factors such as political instability (Garon and Orenstein, 2015; Verma et al., 2018), low socio-economic status of women (Arooj, et al., 2013; Imran et al., 2019; Khan, et al., 2017), misperceptions about the efficacy or side-effects (Obregon et al., 2009), and the failure of government health agencies to effectively engage with the population (Aylward and Tangermann, 2011), to name a few.

This study explores the extent to which access to remittances increases the likelihood that a household will provide its children with necessary vaccination against polio and measles, mumps, and rubella (MMR). Using data from a Multiple Indicators Cluster Survey (MICS) conducted in the Punjab province of Pakistan in 2014, we isolate the causal effect of remittances using a combination of distance and exact matching to compare remittance-receiving households to nearly identical households that did not receive remittances. We find that the access to remittance income increases the likelihood of children under five receiving necessary vaccination by about 11 percentage points for polio and 12.5 percentage points for MMR. The effects persist when we differentiate between households that received remittances from within Pakistan and those that received them from abroad, the latter having slightly higher effects on both types of immunization.

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<sup>1</sup> See <https://www.who.int/mediacentre/news/statements/2015/polio-27-february-2015/en/> and Ahmad, et al. (2015)

However, we see a far less optimistic picture once we differentiate between the immunization impact of remittances on male and female children: while remittances increase the immunization likelihood of boys by an economically and statistically significant amount; remittances have a smaller and statistically insignificant effect on immunization for girls. As such, access to remittances is not enough to overcome the stark gender differentials in child immunization that have been documented across the developing world, including South Asia.<sup>2</sup>

Our study contributes to three distinct areas of research: First, it is part of the rich literature that explores the impacts of remittance income on various household outcomes in Pakistan, such as consumption (Javed, Awan, and Waqas, 2017); labor supply (Mughal and Makhoulf, 2013); and domestic violence (Mitra et al., 2021). Second, it contributes to the literature on the health impact of remittance income (Ponce et al., 2011; Yabiku et al., 2012; Chezum et al., 2018). Finally, it adds to research that explores gender differentials in household utilization of remittances (McKenzie and Rapoport, 2010; Antman, 2012; Vogel and Kurinek, 2012).

## **2. Polio in Pakistan**

Immunization saves millions of lives across globe and is regarded as the most cost-effective health intervention worldwide (WHO, 2018). Ozawa et.al. (2016), estimate that for Lower- and Middle-Income Countries (LMICs) for the decade 2011-2020 every US dollar spent on childhood vaccinations returns US\$44 when we consider the full range of economic benefits, and in the aggregate vaccines prevent 4-5 million deaths annually (WHO, 2019). In 2012, WHO set the goal of its member states achieving 90 percent immunization by 2020 as part of its Global Vaccine Action Plan (GVAP). By 2018, 86 percent had received three doses of the diphtheria, pertussis, and tetanus (DPT3) vaccine and 85 percent received three doses of the

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<sup>2</sup> See Merten et al. (2010) for a description of the survey.

polio vaccine. Global coverage of these vaccines has increased by only 1% since 2010 (WHO 2018). Due to this slow progress in vaccination coverage, the GVAP targets remain off-track (WHO 2018). As a result, in 2018, 19.4 million children worldwide remained unable to receive routine vaccinations (UNICEF/WHO, 2019). Almost half of these unvaccinated children live in 16 countries, including Pakistan (Hussain, et al., 2016; WHO, 2018).<sup>3</sup> Pakistan remains one of only three countries (along with Afghanistan and Nigeria) where Wild Polio Virus 1 (WPV1) is still prevalent (WHO, 2018; PPEP, 2019).

The World Health Organization (WHO) initiated the Expanded Program on Immunization (EPI) in 1974 to save children from life threatening, disabling childhood illnesses (WHO, 2018; Sheikh et al., 2013). EPI aimed to immunize children against six vaccine-preventable diseases (VPDs) including: tuberculosis; measles; poliomyelitis; and diphtheria, pertussis and tetanus (DPT). In Pakistan, EPI launched in 1978 with the objectives of eradicating polio by 2012; eliminating measles and neonatal tetanus by 2015; and minimizing the incidence of other VPDs (Devasenapathy, et.al, 2016). Later, EPI added vaccines against hepatitis B (2002), hemophilic influenza B (2008) with support from the government and development partners (Sheikh et.al., 2013). EPI in Pakistan considers a child is fully immunized if he/she has received the following: one dose of the bacille Calmette-Guerin (BCG) vaccine against tuberculosis; one dose of MMR; three doses of DPT; and at least three doses of the polio vaccine. After the 18<sup>th</sup> Constitutional Amendment in 2010, the health department dissolved control to provincial health departments and EPI is being managed with the coordination of the Ministry of Inter-Provincial Coordination. Over 37 million children under 5 are targeted by about 250,000 vaccinators during national immunization days (NIDs) with the support of 2,000 social

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<sup>3</sup> The full list includes: Afghanistan, Central African Republic, Chad, Democratic Republic of Congo, Ethiopia, Haiti, Iraq, Mali, Niger, Nigeria, Pakistan, Somalia, South Sudan, Sudan, Syria, and Yemen. [https://www.who.int/immunization/global\\_vaccine\\_action\\_plan/GVAP\\_national\\_immunization\\_coverage\\_score\\_cards\\_estimates\\_2018.pdf?ua=1](https://www.who.int/immunization/global_vaccine_action_plan/GVAP_national_immunization_coverage_score_cards_estimates_2018.pdf?ua=1)

mobilizers and nearly 400 transit points (Relief Web 2017; Shah, M. et. al, 2011; Molodecky et.al, 2017 and PILDAT, 2012).

The Polio Eradication Initiative launched in Pakistan in 1994, and reduced the number of cases of polio from 1,155 cases in 1997 to 28 in 2005 (Nishtar 2010). In 1991, nearly 35 percent of Pakistani children 12-23 months old were fully immunized against VPDs, increasing to 47 percent in 2006-07, 54 percent in 2012-13, and 66 percent in 2018, (NIPS 2019). In 2018, the vaccination coverage for Punjab remained 76.5 percent (MICS Punjab 2018).<sup>4</sup> Among Pakistan's provinces, Baluchistan achieved the lowest rates of vaccinations with 29 percent in 2018, followed by Sindh with 49 percent (Imran, Abbas, Javed, 2018; NIPS, 2019). Consequently, since 2009, there has been a marked resurgence of polio. As we report in Figure 1, Pakistan reported 144 polio cases in 2019 of which 10 occurred in Punjab, 30 in Sindh, 92 in Khyber Pakhtunkhwa, and 12 in Baluchistan (PPEP, 2019). Prior to this, Punjab had reported no polio cases in 2016 or 2018. Pakistan poses a major hurdle towards achieving global polio eradication due to unvaccinated pockets and dropouts.

### **3. Data and Methods**

#### **3.1. MICS 2014**

MICS Punjab 2014 consists of households in the nine administrative divisions and 36 districts of Punjab. A two-stage stratified cluster sampling approach was used for the selection of the sample. The primary sampling unit (PSU) was the enumeration block in urban areas and the village in rural areas. The PSUs were stratified on the basis of living standards and housing quality. The survey first selected PSUs with probability proportional to size, then sampled twenty households (secondary selection units, SSUs) with equal probability from each PSU.

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<sup>4</sup> Basic vaccination coverage for both Punjab and Pakistan for children 12-23 months old and this includes one dose of BCG, three doses of DPT three doses of polio and one dose of measles.

The SSUs were drawn using systematic sampling with a random start from 774 urban and 1,276 rural PSUs for a total 2,050 clusters with 20 households in each, yielding 41,000 households. The response rate was almost 98 percent, making the sample representative of the province as a whole. We refer the reader to the Punjab Bureau of Statistics Planning & Development for further information on the methodology.

### **3.2. Outcome Variables**

We test whether access to remittance income increases a household's propensity to immunize a child against polio. We obtain the immunization data from the *Questionnaire for Children under Five* administered by MICS Punjab 2014. The questionnaire surveys one child from each household that reports at least one child under five. If a household reports more than one child under five, the survey randomly selects one of the children.

Our primary outcome variable is an indicator equal to one if the sampled child is current with a given immunization and zero otherwise. Of the 10,273 households reporting a child under five, 4,921 (47.9 percent) reported that the sampled child was current with their polio vaccinations, and 5,217 (50.8 percent) reported that the sampled child was current for MMR vaccinations.

### **3.3. Variable of Interest**

The primary variable of interest is an indicator variable equal to one if the household received remittances and zero if it did not (or if the respondent did not know). Hence, what we are essentially modeling is the marginal impact of receiving any remittance income whatsoever rather than the effect of receiving an additional rupee of remittances. Of the 10,273 households reporting at least one child under five 1,268 (12.3 percent) reported receiving remittances.

Note that this is consistent with current practice (Adams and Cuecuecha, 2010; 2013; Bang, Mitra, and Wunnava, 2016; Mitra, Bang, and Abbas, 2021). The measurement of household

income in a developing country like Pakistan is subject to considerable error, not the least because of the distrust of the state that prevails among low-income households. Compounding the problem, some households, especially the poor, receive much of their remittances in the form of durable goods brought back by return migrants, which would not show up were we to consider the monetary value of remittances.

Given the concern that child health, especially immunization outcomes, are highly sensitive to gender, we subsequently explore immunization impact of remittances separately on female and male children. In this case, we interact whether a household received remittances with the child's gender to test the gender differentials. We have also explored whether the probability of vaccinating a child responds differently to domestic and international remittances. Since the two types of remittances are neither mutually exclusive nor nested, we could not account for them in a single model and had to estimate two separate models, comparing households receiving domestic remittances to those that do not and households receiving international remittances to those without such access, respectively.

### **3.4. Matching Method and Variables**

To identify a causal effect of remittances, we would like to compare the likelihood of vaccinating children in households with access to remittance income to that in households similar to the former in every respect except the access to remittances. The methodological challenge in this context is that access to migration and hence, remittances, is not randomly distributed. Rather, migration is a household decision undertaken to overcome constraints imposed by a lack of liquidity and imperfect credit or insurance markets, which also exacerbate the impact of unanticipated household income shocks (Taylor and Wyatt, 1996; Amuedo-Dorantes and Pozo, 2006). As such, any attempt to identify a causal effect of remittances requires addressing the bias in treatment assignment inherent to migration.



Our response to this problem is to match treated, remittance-receiving households with highly similar control households that did not receive any remittances. This yields causal estimates of the treatment effect under the conditional independence assumption that all variables which influence the decision to migrate and hence, selection into the ‘treated group’ of households receiving remittances, are observed.<sup>5</sup> As a first step to the empirical analysis, we focus on the subsample of households who report having a child less than five years old currently residing with them. We then match each of the households in our sample that received remittances (1,268 households) with demographically-similar households which did not receive remittance income (9,005 households).

At a minimum, matching seeks to balance the characteristics of the treated and control groups on the average, as would be the case if we could randomly assign access to remittances between identical pairs of households. In other words, matching allows a pairwise comparison of closely-comparable households differing only with respect to the receipt of remittance income.

Two approaches to balancing or creating comparable treatment and control groups dominate the literature, namely, Propensity Score Matching (PSM) and Mahalanobis Distance Matching (MDM), with a third alternative Coarsened Exact Matching (CEM) emerging more recently.<sup>6</sup> While PSM is the most well-known method, it suffers from several deficiencies. In particular, reducing the covariates for the treatment variable to a unidimensional score ignores a lot of potential variation in the characteristics we would like to match on. Doing so can

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<sup>5</sup> This is not a tenuous assumption given the richness of the data.

<sup>6</sup> PSM calculates the estimated probability of receiving the treatment and matches each treated observation to the untreated observation with the nearest propensity. By contrast, MDM and CEM match observations directly on the observed determinants of the treatment variable: MDM does so based on the Mahalanobis distance measure,  $D_M(x_1, x_2) = \sqrt{(x_1 - x_2)'S^{-1}(x_1 - x_2)}$  (i.e. the Euclidean distance weighted by the covariance of the variables), whereas coarsened exact matching does so by cutting each of the variables into ranges and then finding matches that fall into the same ranges on all of the variables.

therefore worsen the balance, efficiency, bias, and model dependence of the match (King and Nielsen, 2019). MDM and CEM remedy this problem by matching directly on the characteristics believed to be correlated with treatment. Iacus, King, and Porro (2012) show that both procedures usually result in better matches than PSM, though the relative desirability of MDM and CEM depends on the context. In practice, research often uses a combination of MDM and CEM and we follow this approach as well.

We match remittance receiving households on both household characteristics (size, region, and mobile telephone ownership) and characteristics of the household head (gender, age, education, and source of income). Of these variables, we match *exactly* on region, mobile phone ownership, and gender; we *coarsely* exact match on head's age (in 10-year increments), education (preschool, primary, middle, matriculation, or higher), and source of income (employed, self-employed, or not employed/student); and we *distance* match on household size (number of persons residing in the household who eat together). We further restrict our matching to only consider matches that contain full observations of the variables in our subsequent regression model. This yields a matched sample of 615 treated remittance-receiving households and 535 unique controls (which we matched to the treated households *with replacement*).

### **3.5. Main Specification and Variables.**

Once we have matched households receiving remittances with demographically-similar households without access to such transfers, we are in a position to estimate the treatment effect of remittances on the likelihood of a child under five being fully immunized for polio or MMR. The simplest option is to conduct a difference in proportions test of immunized children in the matched treatment and control samples. However, while the estimates so obtained might be free of bias in the assignment of remittances, they are likely to be subject to omitted variable

bias since we would not have controlled for household characteristics which influence the likelihood of children receiving immunization.

As such, we estimate a logit model on the matched sample, controlling for household and child characteristics that previous studies have documented as influencing the likelihood of children receiving vaccination. These include the total number of children in the household; the birth order of the sampled child among children with the same mother; a set of variables indicating whether the child's age is 12-23 months, 24-35 months, or 36-47 months; and set of variables indicating whether the mother and father of the child are living. Finally, we control for the financial position of the household in the form of an aggregate wealth index score and whether the household has access to some form of social safety net. This last takes the form of two variables indicating whether the household receives government transfers and whether it receives Zakat benefits administered by religious authorities. We report the descriptive statistics for all of the variables in both stages in Table 1.

#### **4. Results**

We present our main results in Table 2. The first two columns pertain to immunization against polio and the last two to immunization against MMR. In each case, we have included results based on the full, unmatched sample of observations that does not account for the bias in household access to remittances and the analogues obtained from the matched sample. Results based on the unmatched and matched samples appear in the odd and even numbered columns respectively, the latter being the results of interest.

Note from column 2 that the impact of remittances on the likelihood of a child being fully immunized against polio exhibits a stark differential based on the sex of the child: while the access to remittances increases the likelihood of fully vaccinating a male child against polio by more than 11 percentage points with a 1% level of significance, the corresponding effect for

female children is just 2.6 percentage points and statistically insignificant. A comparison with column 1 based on the unmatched sample highlights the obfuscating impact of nonrandom assignment on the treatment effect of remittances. Without balancing the sample, it would appear that both the effect of remittances and the gender differential in remittances' impact is much smaller in magnitude. Not only is the positive impact on males smaller at about 7.4 percentage points, but remittances also increase the likelihood of females being current with the polio vaccine by 4.5 percentage points with a two-tailed significance level of 10%.

Columns 3 and 4 reveal similar effects and gender differentials with respect to MMR: while access to remittances improves the likelihood of male children receiving immunization against MMR by 12.5 percentage points, with significance at the 1% level; the impact for girls is just 3 percentage points and statistically insignificant. Note that the size of the gender differential and its consistency across disease types suggests that the pooled average marginal effect of remittances across both genders, while standing at about 7% for Polio and 7.9% for MMR, is somewhat misleading.

Finally, it is natural to ask if the immunization impact of remittances differs depends on whether the remittances originate from within Pakistan or from abroad. Since the two types of remittances are neither mutually exclusive nor nested, we cannot account for them in a single model. As such, we estimate two separate models, comparing children in households receiving domestic remittances to those that do not and children in households receiving international remittances to those without such access, respectively. We report these exercises in Table 3. We have omitted the unmatched sample results from this table in order to economize on space, but will make them available to interested readers on request.

We again observe a stark gender differential in the immunization impact of remittances regardless of where they originate. Neither domestic nor international remittances have a

statistically significant impact on immunization of female children against either polio or MMR, while both sources of remittances increase vaccinations of boys. Interestingly, access to international remittances have a consistently greater impact than the access to remittances sent from within Pakistan. While the latter increases the immunization probability of boys by comparable magnitudes of about 9.5% and 9.8% for Polio and MMR respectively, the corresponding impacts are 13.5% and 17.1% for international remittances.

## **5. Conclusion**

In summation, we find a strong positive impact of remittance income on the likelihood of a household providing a boy child under five with needed immunization against Polio and MMR. While the impacts persist even when we disaggregate remittances according to whether they are sent from within the country or abroad, the latter has a consistently greater impact. Unfortunately, however, neither domestic nor international remittances have a statistically significant impact on the likelihood of girl children being fully immunized against either Polio or MMR. As such, while the access to remittances may help to improve child immunization outcomes at the aggregate level, there is no reason to expect that it will necessarily mitigate the stark gender differentials in child immunization outcomes observed all over the developing world.

More explicitly, recall that gender differentials in child health outcomes arise from the interplay of binding household information and resource constraints with patriarchal gender norms that prioritize the boy child in the resource allocation problem of the household. Placed in this context, our results suggest that while remittances to the Punjab may have helped to alleviate the information and resource constraints that affect the immunization decision of households, they have not been able to transform gender norms prevailing in Punjabi society sufficiently to improve immunization outcomes for girl children. This, in turn suggests that

policy initiatives focusing on improving the access to vaccines and enhancing popular awareness regarding their necessity may not be enough to eradicate polio in Pakistan. The issue of gender has to be addressed head on.

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## Tables and Figures

**Table 1 – Descriptive Statistics**

| VARIABLES                          | Full Sample        | Remittance-<br>Receiving<br>Households | Non-Receiving<br>Households | Matched<br>Remittance<br>Households | Matched Non-<br>Remittance<br>Households |
|------------------------------------|--------------------|--|-----------------------------|-------------------------------------|--|
| Polio Vaccination                  | 4,921<br>(47.90)   | 711<br>(56.07)                         | 4,210<br>(46.75)            | 615<br>(56.27)                      | 535<br>(48.95)                           |
| MMR Vaccination                    | 5,217<br>(50.78)   | 739<br>(58.28)                         | 4,478<br>(49.73)            | 639<br>(58.46)                      | 546<br>(49.95)                           |
| Received Remittances               | 1,268<br>(12.34)   | 1,268<br>(100)                         |                             | 1,093<br>(100)                      |  |
| <i>Quantitative Variables</i>      |                    |  |                             |                                     |  |
| Children under 5                   | 2.106<br>(1.106)   | 2.352<br>(1.332)                       | 2.072<br>(1.066)            | 2.438<br>(1.377)                    | 2.060<br>(1.008)                         |
| Total Children                     | 3.761<br>(2.314)   | 4.040<br>(2.594)                       | 3.721<br>(2.269)            | 4.166<br>(2.707)                    | 3.745<br>(2.047)                         |
| Household Size                     | 8.128<br>(4.136)   | 9.108<br>(4.644)                       | 7.990<br>(4.040)            | 9.633<br>(4.687)                    | 9.050<br>(3.780)                         |
| Child Rank                         | 2.341<br>(1.522)   | 2.470<br>(1.635)                       | 2.323<br>(1.504)            | 2.524<br>(1.682)                    | 2.425<br>(1.647)                         |
| Household Head Age                 | 45.28<br>(14.91)   | 51.17<br>(16.09)                       | 44.45<br>(14.54)            | 53.61<br>(15.39)                    | 53.23<br>(14.85)                         |
| Wealth Score                       | -0.0284<br>(0.978) | 0.461<br>(0.916)                       | -0.0973<br>(0.967)          | 0.487<br>(0.918)                    | 0.435<br>(0.894)                         |
| Household Head Wealth              | 2.927<br>(1.386)   | 3.588<br>(1.278)                       | 2.834<br>(1.375)            | 3.623<br>(1.276)                    | 3.623<br>(1.276)                         |
| <i>Qualitative Characteristics</i> |                    |  |                             |                                     |  |
| Child Female                       | 4,991<br>(48.58)   | 597<br>(47.08)                         | 4,394<br>(48.80)            | 511<br>(46.75)                      | 535<br>(48.95)                           |
| Child Age 12-23 Mo.                | 5,151<br>(50.14)   | 649<br>(51.18)                         | 4,502<br>(49.99)            | 564<br>(51.60)                      | 480<br>(43.92)                           |
| Child Age 24-35 Mo.                | 5,064<br>(49.29)   | 608<br>(47.95)                         | 4,456<br>(49.48)            | 529<br>(48.40)                      | 613<br>(56.08)                           |
| Child Age 36-47 Mo.                | 58<br>(0.565)      | 11<br>(0.868)                          | 47<br>(0.522)               |                                     |  |
| Mother Alive                       | 10,232<br>(99.60)  | 1,260<br>(99.37)                       | 8,972<br>(99.63)            | 1,085<br>(99.27)                    | 1,093<br>(100)                           |
| Mother Deceased/Unknown            | 41<br>(0.4)        | 8<br>(0.63)                            | 33<br>(0.37)                | 8<br>(0.73)                         |  |
| Father Alive                       | 10,216<br>(99.45)  | 1,258<br>(99.21)                       | 8,958<br>(99.48)            | 1,086<br>(99.36)                    | 1,064<br>(97.35)                         |
| Father Deceased/Unknown            | 57<br>(0.55)       | 10<br>(0.79)                           | 47<br>(0.52)                | 7<br>(0.64)                         | 29<br>(2.653)                            |
| Government Benefits                | 710<br>(6.911)     | 58<br>(4.574)                          | 652<br>(7.240)              | 45<br>(4.117)                       | 49<br>(4.483)                            |
| Zakat Benefits                     | 80<br>(0.779)      | 11<br>(0.868)                          | 69<br>(0.766)               | 7<br>(0.640)                        | 10<br>(0.915)                            |

|                        |                  |                  |                  |                  |                  |
|------------------------|------------------|------------------|------------------|------------------|------------------|
| Unknown Zakat          | 704<br>(6.853)   | 57<br>(4.495)    | 647<br>(7.185)   | 44<br>(4.026)    | 48<br>(4.392)    |
| Head Female            | 603<br>(5.870)   | 362<br>(28.55)   | 241<br>(2.676)   | 207<br>(18.94)   | 207<br>(18.94)   |
| Mobile Phone           | 9,638<br>(93.82) | 1,238<br>(97.63) | 8,400<br>(93.28) | 1,083<br>(99.09) | 1,083<br>(99.09) |
| Head Employed          | 4,330<br>(42.15) | 265<br>(20.90)   | 4,065<br>(45.14) | 249<br>(22.78)   | 249<br>(22.78)   |
| Head Self-Employed     | 4,002<br>(38.96) | 400<br>(31.55)   | 3,602<br>(40)    | 374<br>(34.22)   | 374<br>(34.22)   |
| Head Not Employed      | 1,941<br>(18.89) | 603<br>(47.56)   | 1,338<br>(14.86) | 470<br>(43.00)   | 470<br>(43.00)   |
| Head Preschool         | 3,951<br>(38.46) | 515<br>(40.62)   | 3,436<br>(38.16) | 452<br>(41.35)   | 452<br>(41.35)   |
| Head Primary School    | 1,905<br>(18.54) | 234<br>(18.45)   | 1,671<br>(18.56) | 178<br>(16.29)   | 178<br>(16.29)   |
| Head Middle School     | 1,452<br>(14.13) | 183<br>(14.43)   | 1,269<br>(14.09) | 157<br>(14.36)   | 157<br>(14.36)   |
| Head Secondary Diploma | 1,883<br>(18.33) | 244<br>(19.24)   | 1,639<br>(18.20) | 229<br>(20.95)   | 229<br>(20.95)   |
| Head Higher Educated   | 1,076<br>(10.47) | 92<br>(7.256)    | 984<br>(10.93)   | 77<br>(7.045)    | 77<br>(7.045)    |
| Head Education Unknown | 6<br>(0.06)      |                  | 6<br>(0.07)      |                  |                  |
| Head Age Under 25      | 241<br>(2.346)   | 28<br>(2.208)    | 213<br>(2.365)   | 17<br>(1.555)    | 17<br>(1.555)    |
| Head Age 25-34         | 2,777<br>(27.03) | 231<br>(18.22)   | 2,546<br>(28.27) | 143<br>(13.08)   | 143<br>(13.08)   |
| Head Age 35-44         | 2,727<br>(26.55) | 208<br>(16.40)   | 2,519<br>(27.97) | 158<br>(14.46)   | 158<br>(14.46)   |
| Head Age 45-54         | 1,505<br>(14.65) | 204<br>(16.09)   | 1,301<br>(14.45) | 195<br>(17.84)   | 195<br>(17.84)   |
| Head Age 55-64         | 1,571<br>(15.29) | 295<br>(23.26)   | 1,276<br>(14.17) | 285<br>(26.08)   | 285<br>(26.08)   |
| Head Age 65+           | 1,452<br>(14.13) | 302<br>(23.82)   | 1,150<br>(12.77) | 295<br>(26.99)   | 295<br>(26.99)   |
| Observations           | 10,273           | 1,268            | 9,005            | 1,093            | 1,093            |

**Table 2 – Main Results**

| VARIABLES                              | Polio                   |                        | Measles, Mumps, Rubella |                       |
|--|-------------------------|------------------------|-------------------------|-----------------------|
|  | Unbalanced              | Balanced               | Unbalanced              | Balanced              |
| <i>Effect of Remittances by Gender</i> |                         |                        |                         |                       |
| Male Children                          | 0.0744***<br>(0.0232)   | 0.112***<br>(0.0334)   | 0.0830***<br>(0.0232)   | 0.125***<br>(0.0334)  |
| Female Children                        | 0.0449*<br>(0.0238)     | 0.0264<br>(0.0341)     | 0.0301<br>(0.0238)      | 0.0296<br>(0.0339)    |
| <i>Average Marginal Effects</i>        |                         |                        |                         |                       |
| Remittances                            | 0.0602***<br>(0.0168)   | 0.0703***<br>(0.0241)  | 0.0575***<br>(0.0168)   | 0.0787***<br>(0.0241) |
| Female                                 | -0.00571<br>(0.0108)    | -0.000934<br>(0.0237)  | -0.00524<br>(0.0108)    | -0.0146<br>(0.0236)   |
| 36-47 Months Age                       | -0.194***<br>(0.0108)   | -0.149***<br>(0.0238)  | -0.217***<br>(0.0108)   | -0.176***<br>(0.0237) |
| Total Children Ages 1-4                | 0.00307<br>(0.00622)    | 0.0163<br>(0.0126)     | 0.00351<br>(0.00622)    | 0.0183<br>(0.0126)    |
| Total Children Ages 1-17               | -0.0319***<br>(0.00439) | -0.0345***<br>(0.0101) | -0.0339***<br>(0.00441) | -0.0348***<br>(0.01)  |
| Household Size                         | 0.0107***<br>(0.00242)  | 0.00449<br>(0.0055)    | 0.0120***<br>(0.00243)  | 0.0044<br>(0.0055)    |
| Birth Rank of Selected Child           | -0.00442<br>(0.00457)   | 0.00563<br>(0.00945)   | -0.00288<br>(0.00451)   | 0.00612<br>(0.00941)  |
| Mother Deceased                        | -0.145*<br>(0.0808)     |                        | -0.130*<br>(0.0782)     |                       |
| Mother Living D/K                      | 0.532***<br>(0.00542)   |                        | 0.505***<br>(0.00542)   |                       |
| Father Deceased                        | -0.0793<br>(0.0736)     |                        | -0.0697<br>(0.0842)     |                       |
| Father Living D/K                      | -0.468***<br>(0.00542)  |                        | -0.495***<br>(0.00542)  |                       |
| Wealth Index Score                     | 0.0509***<br>(0.00599)  | 0.0562***<br>(0.0135)  | 0.0425***<br>(0.00605)  | 0.0417***<br>(0.0135) |
| Received Government Benefits           | 0.0648<br>(0.117)       | 0.171<br>(0.194)       | 0.0432<br>(0.12)        | 0.176<br>(0.19)       |
| Received Zakat Benefits                | -0.0793<br>(0.0598)     | -0.101<br>(0.117)      | -0.0959<br>(0.0598)     | -0.0957<br>(0.118)    |
| Received Zakat D/K                     | -0.0693<br>(0.123)      | 0.016<br>(0.216)       | -0.103<br>(0.122)       | 0.0282<br>(0.208)     |
| Observations                           | 10,215                  | 2,186                  | 10,215                  | 2,186                 |

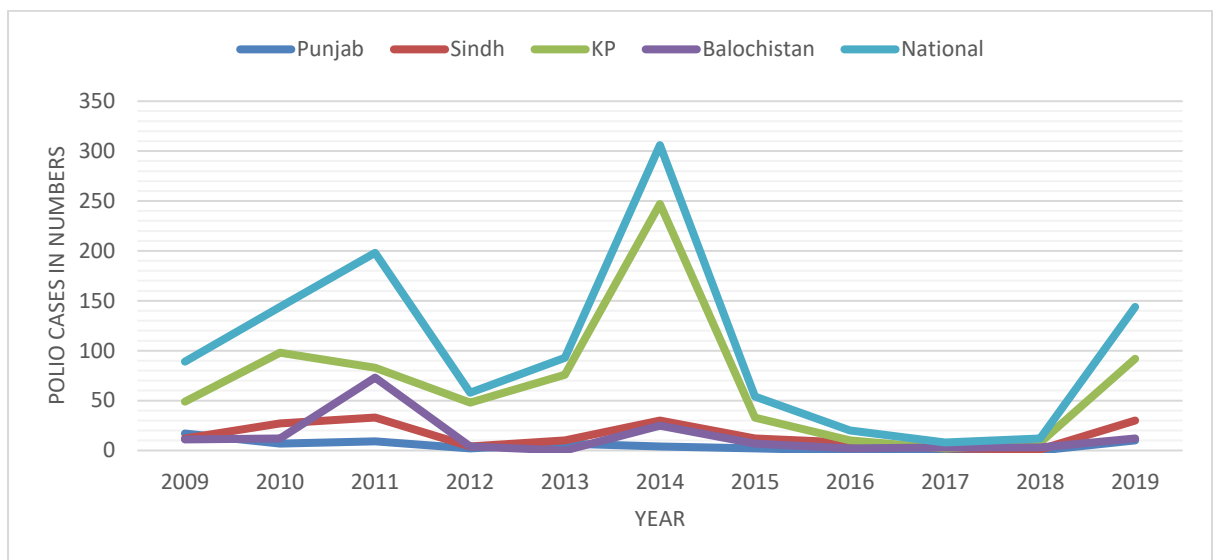
Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 3 – Domestic and International Remittances**

| VARIABLES                              | Polio                  |                        | Measles, Mumps, Rubella |                        |
|--|------------------------|------------------------|-------------------------|------------------------|
|  | Domestic               | Abroad                 | Domestic                | Abroad                 |
| <i>Effect of Remittances by Gender</i> |                        |                        |                         |                        |
| Male Children                          | 0.0948**<br>(0.0395)   | 0.135**<br>(0.0548)    | 0.0976**<br>(0.0395)    | 0.171***<br>(0.0547)   |
| Female Children                        | 0.0569<br>(0.0398)     | 0.0102<br>(0.0581)     | 0.0575<br>(0.0396)      | 0.0106<br>(0.0586)     |
| <i>Average Marginal Effects</i>        |                        |                        |                         |                        |
| Remittances                            | 0.0766***<br>(0.0284)  | 0.0778*<br>(0.0402)    | 0.0784***<br>(0.0283)   | 0.0978**<br>(0.0403)   |
| Female                                 | -0.00201<br>(0.0278)   | -0.0175<br>(0.0409)    | -0.0120<br>(0.0277)     | -0.0412<br>(0.0408)    |
| 36-47 Months Age                       | -0.167***<br>(0.0280)  | -0.0743*<br>(0.0398)   | -0.178***<br>(0.0279)   | -0.149***<br>(0.0397)  |
| Children under 5                       | 0.0210<br>(0.0147)     | 0.000317<br>(0.0213)   | 0.0165<br>(0.0147)      | 0.0232<br>(0.0210)     |
| Total Children                         | -0.0306***<br>(0.0112) | -0.0537***<br>(0.0192) | -0.0297***<br>(0.0112)  | -0.0558***<br>(0.0191) |
| Household Size                         | 0.00281<br>(0.00637)   | 0.0148<br>(0.00904)    | 0.00401<br>(0.00633)    | 0.00881<br>(0.00895)   |
| Rank of Child                          | -0.00435<br>(0.0105)   | 0.0198<br>(0.0181)     | -0.00547<br>(0.0105)    | 0.0302*<br>(0.0180)    |
| Mother Deceased                        |                        | -0.163<br>(0.207)      |                         | -0.178<br>(0.197)      |
| Father Deceased                        |                        | -0.116<br>(0.136)      |                         | -0.136<br>(0.133)      |
| Wealth Index Score                     | 0.0465***<br>(0.0172)  | 0.0332<br>(0.0240)     | 0.0354**<br>(0.0173)    | 0.0235<br>(0.0243)     |
| Received Government Benefits           | 0.189<br>(0.197)       | 0.468***<br>(0.0314)   | 0.195<br>(0.198)        | 0.488***<br>(0.0221)   |
| Received Zakat Benefits                | -0.0890<br>(0.144)     | -0.0671<br>(0.194)     | -0.0865<br>(0.145)      | -0.0695<br>(0.188)     |
| Received Zakat D/K                     | -0.0324<br>(0.238)     | 0.465**<br>(0.195)     | -0.0418<br>(0.239)      | 0.442**<br>(0.187)     |
| Observations                           | 10,215                 | 1,576                  | 10,215                  | 740                    |

Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Figure 1: Number of Polio cases in various regions (Provinces) of Pakistan (2009-2019)**



Source: PPEP, 2019.