Understanding Acceptability of Government Provided Neonatal Vaccination in Pakistan

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Islamabad, Pakistan
2018

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Candidate of M. Phil Health Economics at the Pakistan Institute of Development Economics do hereby declare that the thesis: **"Understanding Acceptability of Government Provided Neonatal Vaccination in Pakistan"** Submitted by me in partial fulfillment of M. Phil Degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution.

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Acknowledgement

Special gratitude is offered to continuous guidance and support by researchers at PIDE. I am in debt of Dr. Nasir Iqbal, Dr. Mahmood Khalid , Dr. Fazl-e-Hakeem Khattak, Dr. Tayyab Masud and Dr. Ahsan Satti for teaching me with patience and kindness. I am also thankful to my class-fellows for the benefit I gained from group discussions, presentations and critical reviews during course-work.

This thesis takes defined indicators in cross-section of population at particular time with limited control setting. No causal inferences and generalizations about behavior should be drawn. Also analysis of factors relies on quality and validity of information available to author. Correlations may change at different scale. Purpose of thesis is mainly to highlight the need for considering cross-integration of human ecology when programming.

Abstract

Investing in child health is successful means of developing human capital and bringing intergenerational equity. Considerable sum of money is sourced from national exchequer to provide easy access to vaccines at zero price for all babies in Pakistan. Under-utilization of service causes economic loss. This thesis identifies patterns of vaccine-acceptability in four provinces of Pakistan and socio-economic conditioning of parental behavior, when access is constant. It is mixed method cross-sectional study aimed at providing market intelligence to government to help improve programming yields. Variables were selected and defined from PSLM 2014-15 datasets. Three categories of dependent variable are taken, i.e. households with at least one baby who is fully immunized or never received immunization or dropped-out of schedule. The independent variables of study are: Province, Region, District, Language of parents, Occupation of parents, Perinatal care, Place of delivery, Over- crowded household, Wealth status, Hygiene in home, Satisfaction level with primary health service. Descriptive statistics are provided to explain the analytical sample. Multiple predictors are regressed against categorical responses in conditional logit model. Principal factors are confirmed in multidimensional structure. Vaccine related behaviors of caregivers and modifiers are assessed qualitatively. In KPK, concern for side-effects and perceived risks of vaccination result in parental refusal. The behavior is associated with low prevalence of education in mothers, low utilization frequency of all government services and reluctance to retain vaccination cards. Across districts of Punjab, vaccine refusals are due to lack of convenience in seeking vaccine. The determinants are frequency of Lady Health Worker visits and occupation in farming. Divorced daughters living with parents are more likely to be hesitant. In Sindh, perceived utility in vaccines depend on lack of convictions. Refusal is correlated with home births, male gender of child and unhygienic conditions. In Baluchistan, complacency to traditions forms the basis of vaccine refusal. It is because of strong adherence to religious and tribal norms. The correlates are low wealth status, dependence on farming occupation and poor quality of postnatal care. Acceptability of vaccination is function of multidimensional socio-economic determinants. Entwined social factors cause parents to rationalize decision of refusing vaccines which is not in best interest of children. A vaccine-behavior model is approached inductively using interpretivism. Government programming for immunization can minimize costs by acknowledging behavioral determinants and adopting targeted approaches.

Contents

Chapter- 1

Introduction

1.1 Background

Attack from viruses of Polio, Diphtheria, Whooping Cough, Diarrhea, Influenza, Pertussis, Meningitis, Hepatitis, Tetanus and Tuberculosis is common during first year of life. Around 44% deaths of under five year olds occur in neonatal period (CDC, 2017). Vaccines can provide necessary acquired immunity against deadly infections and ensure survival. Vaccination against these illnesses remains the most cost-effective intervention that averts permanent disability and promote longevity (UNICEF, 2014).Society, at large, agrees that access to vaccines should be right of citizens in Pakistan[1].Therefore, provision of vaccine is funded for all babies from tax pool. Public sponsorship brings equality. Arrangements are made to provide vaccines at door-step of every household free of price. It is important for government to ensure efficiency and success of immunization program. Up-to $44 are saved from curative side of health system, by each $1 spent on prevention and immunization (WB, 2016).Pakistan has committed to achieving greater than 95% immunization coverage by endorsing SDG through a parliamentary resolution in February 2016.

It is necessary that more than 90% population is vaccinated before titer of virus lowers in environment and susceptibility to infection can reduce. The concept is called 'Herd immunity'. But as more and more people are immunized the fear of infection is replaced by fear of side effects from vaccine and people start rejecting immunization or dropping out of program. This diminishes rate of coverage-expansion. Under-utilization of service results in higher costs for government. Additional money in the range of Rs.3-8 Million is spent annually on supplementary immunization campaigns by respective provincial governments and 20% of target population is still missed (five year average by EPI; 2010-2015). The cost of missed children on public exchequer is Rs.15.058 million (NISP, 2016).Overall coverage of neonatal immunization is at 60% average (PSLM, 2014-15).

Government efforts to expand coverage is hampered by low acceptability of vaccines among parents. Varying social determinants are responsible for hesitancy, refusal or adoption of neonatal immunization in different districts of Pakistan. Various cultural sensitivities, traditional health beliefs, socio-cultural norms or conflicting priorities, time restrictions shape health related behavior. The circumstances of households are also underscored by capacity of health-service-system and the manner in which communities organize. The factors affecting health behaviors are always cross-cutting, entwined, dynamic and relational and relative (Hahn & Payne. 1978).

The confidence gap and value placed in vaccines differs according to local drivers (Larson. 2011). A 67 country survey defined association of parental behavior with social conditions. France reported lowest

[1] Constitution of Pakistan: Article 38(a), 38(d) mentions access to healthcare as fundamental right of citizen. Article 25, 26 establishes safeguard of equality and non-discrimination in terms of all fundamental rights. Bill of 18th amendment (2011) deleted concurrent legislative list of 4th schedule and added social sector research, technical capacity, standards, supervision and regulatory authority as federal subjects in legislative list. In 3rd phase, functions of health system are devolved to provinces but federal govt. continues to provide funding for vertical programs including immunization to avoid short-falls and streamline efforts with international partners.

confidence in vaccine safety. Bangladesh, Ecuador and Iran ranked highest on qualitative scale of vaccine confidence developed by World Health Organization. Azerbaijan, Russia and Italy reported lower agreements about importance of vaccine compared to North America. Factors of refusal have no consistent global pattern and depend on regional socio-economic correlates. Religion, for example, is crucial in sub-populations of Asian origin but is less crucial in mediating decisions of Anglo-Saxons. (Larson & Jones. 2016). Vaccination status if regressed on local socio-economic parameters provides stochastic evidence of those social determinants that are inducing refusal or acceptance. Dissecting constrains of uptake can emerge differential segments. Groups that reject vaccine or lie on spectrum of hesitancy share commonalities resultant of social institutions.

Any academic studies by community health practitioners thus far are either location or hospital specific. Only few Knowledge, Attitude, Practice studies explore vaccine acceptability in context of Pakistan. Reason being the prohibitive amount of resources required to carry out surveys in dense populations. International donor agencies only sponsor studies concerned with control of antigens that are getting exported out of Pakistani territories e.g. Polio; of which Pakistan, Afghanistan and Nigeria are last remaining reservoirs. Cross-sectional surveys are mostly used to indicate performance of the immunization program but they are limited in application and do not explain attributes of vaccine related behavior across parental agency. Service-utilization is modified in its construct by culture, educational levels, past experiences, motivations and economic satisfaction (Rehman, *et al.*2013). Immunization campaign data (EPI, 2016) show missed children in every round. Parents hide their children away from vaccinators. To a provider this leaves two options. Increase perceived comparative value of vaccines or reduce availability of alternate means. These options require an understanding into derivation of utility from vaccines and functional dynamics of relationship that exist between provider and user.

This thesis is designed as cross-sectional, retrospective. Perspective is governmental, societal or that of a public health manager. This thesis is about observing conditions of consumer choice. Who accepts vaccine and why. It maps different socioeconomic factors responsible for acceptability of vaccines inevery province. The premise is: dynamics of relationship parents share with providers and regulators, affect health and productivity of next generation. This answers if formal education of mothers in Pakistan make them literate on health issues? If there is discrimination with female child in preventive health and survival measures? If rural mothers find greater utility than urban mothers in government funded service? If ensuring access to care is successful instrument in itself for promoting welfare? Are parents informed decision makers regarding child health?

1.3 Objectives

This thesis explores circumstances of parental choice. Their behavior of acceptance, hesitance or refusal towards neonatal vaccine, when vaccine is free and available, is related to socioeconomic situation.

i. To analyze relationship of household circumstances on immunization status of babies in different regions of Pakistan when households vaccines are accessible.
ii. To identify those socioeconomic factors which condition particular vaccine related behavior of parent (or primary caregiver) when vaccines are accessible.

We identify patterns of vaccine acceptability across Pakistan. We identify socioeconomic conditions of acceptability and establish how factors of parental behavior are linked with socioeconomic circumstances Hypothesis is that coverage of neonatal immunization service depends on socioeconomic variables of households. Attempt is made to find out (a) How is change in socio-economic status associated with changes in immunization status? (b) What is dispersion of socioeconomic variables in immunized and non-immunized population? Vaccine-acceptability is tested empirically using PSLM 2014-15 data. Policy recommendation will be given for measurement and improvement of vaccination coverage.

1.4 Significance of study

Thesis explores those conditions under which preferences regarding neonatal health change. This information is helpful in designing for coverage expansion so that economic losses can be reduced from immunization program. Pakistan spends Rs37.6 million from exchequer for targeting 3.4 million children (EPI 2015-2020). Money has to be spent on advertising campaigns and administrative efforts to prevent parents from hiding their babies when vaccinators arrive at doorstep to offer free vaccine. This unnecessarily raises system costs and supplementary costs.

A public funded vaccination service adds quality-adjusted-life-years and raises level of human capital by cost-effective means. So there is investment motive for governments. Poor levels of child health is linked with poverty as well as low levels of empowerment, opportunity, security, capability and opportunity (WB, 2016). Also, vaccine preventable infections can have devastating impact on families. Infliction of morbid disease in childhood can cause prolong hospitalizations, life-long disability or death. In addition to financial burden there is also suffering for the household in societal terms when a child is debilitated by illness. Government of Pakistan is committed to eliminating disparities in immunization service and maintaining standards in accordance with WHO [2] declaration of 2011-2020 as a 'Decade of Vaccine'. The explicit mission to achieve full coverage. Greater acceptability can raise efficacy and impact of service-delivery.

This thesis analyses conditioning of user behavior and process by which a parent determines value of vaccinating baby. Parental preference is placed in contextual factors and socio-economic situation of households across Pakistan. Operational definitions are provided in Annexure-1.The evidence of vaccine-hesitancy existing as an issue in Pakistan is oft reported by field workers and campaigners. This thesis does not divulge in surveys or costs. I use data sets available from PBS[3]. I limit our scope to measuring association between distribution of non-users and their socio-economic conditions. Understanding acceptability will provide means to retain higher value in vaccination program. This thesis is about determinants of vaccine hesitancy and it can better inform delivery strategy, cost-appropriation, efficacy in impact and methods of community involvement. It can provide metrics for evaluating health promotion campaigns. As a result, opportunistic micro-planning for high risk and under-performing rural districts can be done. It can aid social marketing strategy in health sector by exploring dynamics of public trust and relational integrity in field of social health.

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[2] Global Vaccine Action Plan (GVAP) and Decade of Vaccine Collaboration was endorsed by the 194 Member States of the World Health Assembly in May 2012. ISBN 978 92 4 150498 0.

[3] Pakistan Bureau of Statistics

Chapter- 2

Neonatal Vaccination in Pakistan

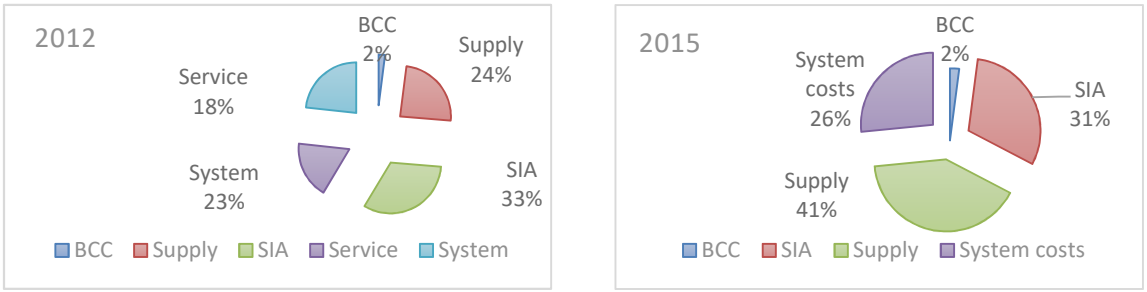
Government undertaking of immunization program in Pakistan includes eleven antigens of deadly infection, eight of which are administered in first 14 weeks of life. Program of immunization in Pakistan includes multivalent vaccines in its expanded schedule because combination vaccines lower the dosage quantity and number of administrations required for complete protection (EPI, 2015). Schedule of vaccines is provided in Annexure-1. Vaccination service explicitly aims to ''strengthen routine immunization coverage by supply/demand-generation reform and achieve full immunization status; equally for 95% of children of appropriate age; disaggregated by gender, income, provincial district and interrupt transmission of polio'' (*EPI mission statement*)

Vaccination service is operated by government agency and funded from indirect taxes. Percapita cost of immunization program in 2014 was $2.64 and $2.74 in 2016. Cost on federal budget for running hepatitis, malaria and tuberculosis control programs is estimated at Rs26.8 Billion annually. Government expenditure on health is 0.9% of GDP in 2015 (WB, 2016). Overall immunization coverage of country stands at 53.8 percent (PDHS, 2012-13). 0.12% of GDP is required to achieve herd- immunity threshold (MoH, 2003). Routine immunization is 2% of total health expenditure. Total cost of national immunization in 2012 was $238.7 Million, a third of which was spent on supplementary activity (Federal EPI-cell 2001-15 *comprehensive Multi-Year Plan*). It was $2.62 Billion in 2015. The cost of 2015-20 plan is Rs.37,645.682 million and it benefits 3,377,510 people (EPI-PC1, 2015).Table 3.1 provides breakdown of cost for maintaining the aims of vaccination program. In 2012, 32% of total cost was due to supplementary immunization activities and 23% was shared health system cost. In 2015, 24% of total cost was due to supplementary immunization activities and 14% was shared health system cost. The difference can be attributed to behavior change communication strategies. Vaccinators were trained in interpersonal communication and program managers worked on community coalitions. Special efforts were undertaken to build knowledge base by educating local youth at union-council level.

Table 3.1: Costing profile of EPI program

Program Component	**2012**	**2014-18**
Supply of vaccine	$ 4,179,030	$ 378,723,741
Cold chain and logistics	$ 5,16,685	$ 1,124,125,441
Surveillance & Information System	$ 2,231,469	$ 28,352,726
Program Management	$ 55,917,287	$ 67,379,934
Service Delivery	$ 516, 685	$ 378,723,741
Behavior Change Communication	$ 42,873,835	$ 20,010,090

Figure 3: Share of components in EPI program



Source: EPI- PC-1(2015)

Table 3.2: Province wise cost analysis of immunization program

Province	Metric	Year 2014-15	Year 2015-16	Year 2016-17	Year 2017-18
Punjab	Coverage (%)	63	65	70	75
	Cost (million dollar)	218.4	164.6	168.3	199.5
	Unit cost ($)	71	75	79	84
	ICER	1073	1132	1194	1260
Sindh	Coverage (%)	31	48	54	61
	Cost (million dollar)	32.4	49.6	59.6	70.3
	Unit cost ($)	77	81	85	90
	ICER	1153	1216	1283	1353
KPK	Coverage (%)	55	58	66	69
	Cost (million dollar)	36.6	45.7	47.1	52.3
	Unit cost ($)	82	86	91	96
	ICER	1230	1298	1369	1444
Baluchistan	Coverage (%)	18	20	39	48
	Cost (million dollar)	5.1	6.4	11.2	14.4
	Unit cost ($)	95	100	106	112
	ICER	1427	1505	1588	1675
Percapita GDP[1]		$ 1298	$ 1322	$ 1357	$ 1407

ICER =USD / DALY saved;
Unit cost = USD / Fully Immunized Child (varies by $5.5 annual inflation);
Coverage percentages at annual birth rate of 14360 babies
[1] This is threshold for cost-efficacy. If the ICER is less than per capita GDP, then it is "very cost-effective," and if it exceeds three times per capita GDP, then it is deemed "not economically viable" according to WHO guidelines.

**Source:* World Bank (2016).*Economic Analysis: EPI and NISP*

With support by global partnerships; 2649 fixed health center, 4564 outreach stations, 98 mobile teams and camps, 10,000 vaccinators, 1800 medical officers, 6000 lady health visitors and 100,000 lady health workers are working in nationwide immunization activities but implementation remains poor (Shah, M. *et. al*, 2011 and PILDAT, 2012).Vaccination program saves 17 percent DALY in health system of Pakistan (Masud, 2010). The focus of program remains on: (i) improving supply chain and (ii) reporting mechanisms upward from grass-root populations through administrative command. Table 3.2 provides province-wise cost analysis of vaccination program. At federal level, ministry functions as main channel for donor financing, preventing short-falls in supply, coordinating inter-provincial activities, strengthening capacity, providing technical support, district level bi-annual monitoring operational planning, data recording, reporting, validation and analysis. Immunization campaigns are organized by provinces and costly efforts are made to ensure the distribution network for access and quality of services. Pharmacovigilance is maintained for manufacturing of vaccines on accredited standards. Outbreaks and seasonal variations are surveilled. Reporting mechanism is put in place for timely detection and treatment. Concerns about allergic reactions and sterility from vaccineproves damaging to public confidence. Steering committees on immunization service are headed by Chief Ministers of respective provinces. National Task Force is in place at federal level whose meetings are held periodically under chairmanship of Prime Minister to assess situation and provide stewardship. Parliament of Pakistan endorsed UN- Sustainable Development Goals.

Third goal of SDG is concerning health and well-being. Targets 2 has 1 indicator and target 3 has 2 indicators about vaccine preventable diseases of babies. Target 8 and 9c concerns health system and workers that supply essential health.

2.1 Situational Analysis of immunization coverage

Childhood mortality figures have steadily declined over past 25 years. Pakistan reached infant mortality rate of 52.1/1000births by 2017 (60.67/1000 male; 54.13/1000 female), down from 82.49/1000 births in 2000. MDG-4 required 40.2/1000 births with >90/1000 under 1 year olds fully immunized by 2015.Pakistan still has among the highest rates in world for first-day-deaths at 45.6 per 1000 births (UNICEF, 2016) with 1 in every 22 babies or approximately 0.2 million babies dying in first month of life due to vaccine preventable infections. Global Burden of Disease for Pakistan[4] (Low:39,156/100,000 births ; High:85,229/100,000 births) has linear correlation with immunization coverage ratios in PDHS (2012-13). Neonatal mortality rate in Pakistan is 45.50 per 1000 live births and under five mortality is 78.80/1000 live births (UNICEF, 2016). Total fertility rates of 2.68 children per woman and birth rate of 29.8 per 1000 women (PBS.[5] 2016 est.) means an increasing score of babies require immunization[6] each year.

Significant disparities are also found in immunization status among different regions of Pakistan with Baluchistan consistently performing poorest of all provinces. One-in-five children (12-23 month) do not receive immunizations in urban regions and two-in-three children are missed in rural regions. Nationally, 48 % children are immunized in rural regions compared to 66 % in urban for all antigens and there is 5 percentage point drop in immunization coverage of female child compared to male child between 2011 and 2014 (WB-NISP, 2016). Overall rate of fully immunized children in Pakistan is at 60% average, based on record (PSLM, 2014-15). Most increase in fully immunized children was observed in Punjab at 63%, followed by Khyber-Pakhtunkhwa at 55%, Sindh at 31% and Baluchistan at 18%. Although an average increase of 3 percentage points is seen in records of 2014-15 compared to records of 2010-11; but the rate of rise in slope is between 0.4 and 0.6. In last ten years coverage dropped in Sindh and KPK while it improved in urban areas of Punjab and KPK. Between 1991-to-2013, probability of dropouts show increasing trends all over Pakistan. Ten times more likelihood of dropping out of immunization program (OR 9.673; 95% CI: 4.758-19.664) was observed in Baluchistan compared to Punjab in 2007 (Arooj, *et.al.*, 2013). There are 17 districts where immunization coverage is persistently lower than 50% and five of them are designated high risk areas because of harboring transmission. In urban Sindh and urban Baluchistan 51% and 36% receive vaccine compared to 14 and 12 percent in rural regions.

According to campaign data five percent of target population is missed and around 2% of parents refuse vaccination by own volition (UNICEF. 2008). The figures vary only slightly each year. WHO (2016) reported plateau in dropout rates of DTP3.Coverage of DTP3 is set as indicator of equity by GAVI. The difference in immunization coverage should not be greater than 20 percentage point between lowest and highest wealth quintiles (Hinman & McKinlay, 2015). In Pakistan this gap is 13.5 percentage points.

[4] Global Burden of Disease (1990-2010) published by IHME (institute of Health Metrics and Evaluation, University of Washington, Seattle, USA)

[5] Pakistan Bureau of Statistics. Same figures were used in update of CIA World Factbook; July 9, 2017.

[6] VPD =Vaccine Preventable Diseases, GAVI =Global Vaccine Alliance; NISP =National Immunization Support Plan

Between 1980-to-2003 remarkable decline was steadily observed in annual cases of Polio i.e. (2980 to 87 cases). But every year since last thirteen years new cases surface during peak season (September to November). Pakistan and Afghanistan are only two countries left in the world which have failed to eradicate Poliomyelitis among their natives. The latest case of polio in Pakistan was reported in April 2018 at district of rural Sindh. Compilation of estimates show that Punjab registered 10 total VPD cases in 2006, total 66 cases from FATA in 2013, 65 cases in 2015 and 48 case in KPK[7]. 2-6 cases of neonatal VPD on average were reported every year between 2010 -2015. This occurred despite of two national campaigns annually and efforts to ensure sustained supply of quality vaccine to every immunization center in country. EPI program costs, targets missed and coverage situation is given in Annexure-2.Government places high priority on achieving targets. Coverage somewhat improved in north western regions of country during 2012 – 2014 period. But endemicity of Malaria, Tuberculosis and Influenza in Pakistan is matter of concern for international bodies. Global health discussion forums continue to stress on need for capacity building within health system of Pakistan. They mount pressure on government to upscale efforts. But restricted outreach capacity, improper service structure, lack of private sector involvement and destructive political interference continue to debar immunization program from meeting its priorities (PILDAT, 2012).

2.2 Issues and Challenges

- We see an increase in resistance, as we get to higher coverage levels. Resistance at initiation levels are offset by higher than average propensity. Achievement on immunization targets is stagnate if we compare rate of increase in coverage against costs. This is in line with conditions of any closed micro-economic system. It means allocations toward behavior change communication has to increase and cannot remain constant. Only 2% share of program cost was marked for promotional efforts in 2012 and amount of money was kept same while planning for 2015-20 as well. Lack of communication with parents results in missed children every campaign. Trend of missed children dipped to its lowest in 2011, touching 18% and highest in 2013, reaching 34%. Since 2001 country has wavered around 26% of targeted population missed on average every year. Figures were at 20% in 2015 (EPI, 2016; numbers include children from birth up to 23 months of age).

- Any analysis is only valid as far as information is accurate. There are many discrepancies in data about immunization. Some of these arise due to poor practices around record maintenance. But some discrepancies also arise due to cumbersome measurement paraphernalia, poor framing in questionnaires and low standards of worker training. During surveys, caregivers are asked about state of child's immunization. Answers are based on recall or a card that is filled by vaccinator but kept with parent or at facility. According to study in Sindh, Kappa Coefficients of agreement for accuracy of survey methodology when compared against laboratory evidence is 43% on recall, 10% on card and 12% on facility records. Figures collected in surveys about BCG and Polio are more accurate than DTP or full immunization (PILDAT, 2012).There are marked differences in how different vaccinators communicate during survey, how they comprehend parental responses and how they report it. Often enumerators don't ask to see entries on card which conveys a sense that card is not important. Predictors of card retention in central Karachi were studied by Ali, *et al.* (2014) and patterns of vaccine-uptake were assessed against user data. Authors concluded that parents can base their opinion, regarding vaccines, upon interaction with vaccinator or

[7] Figures are taken from news sources and print media articles

enumerator. Meaning behavior of vaccinator spills over to effect parental attitude towards vaccine. Likelihood rises 40 percentage points if illiterate, rural and poor households are able to trust health worker. Parents retain immunization-cards, report correctly and follow dosage schedule to completion if their experience was positive with the person informing, administering or asking about vaccines. But workers of EPI maintain a negative attitude about their job. Their dissatisfaction with their job modifies the manner in which they behave with parents and downgrades overall implementation of program. EPI workers complain about poor security conditions and state flawed arrangement of incentives as reason for their demotivation (Mangrio, Alam& Sheikh, 2008).

•EPI-Operations Centre in Karachi reported that 16,319 households had refused all vaccine during 2015. The center identified Sohrab Goth, Gadap, Saddar Town and Kemari as main districts where parental rejection was faced by vaccinators. There are deducible similarities in demography and social circumstances of these areas. A Karachi resident can easily identify these similarities based on empirical observation but no assessments are so-far commissioned by authorities to firmly establish determinants of parental refusal in different regions of city. Subsequent mop-up campaigns at considerable financial-costs are approved every year in all provinces and money is also approved from federal budget for supplementary immunization activities. Repeated campaigns cause dereliction of workers from responsibilities and irritate parents who then go on to hide their children or turn away vaccinators(Iqbal, 2015).

- Safety of health workers depends on how strongly vaccination is refused by community. After 2012-Abottabad operation several groups in KPK retaliated by killing 60 vaccinators. It instilled terror not only in health workers but also among parents who became frightened of any association with vaccine usage, vaccine advocacy or vaccination worker. That year number of polio cases shot-up 96% compared to previous year. This had long term implications for the province. In 2015, hundreds of parents denied to utilize free government provided service in provincial capital alone. Police was used by civil administration to arrest 450 parents for refusing vaccination (Iqbal, 2015). This only made the situation worse. Bent of policy makers towards hard but blind enforcement is counter-productive to objectives of the program.

Chapter -3

Conceptual Framework

In order to frame vaccine acceptability in Pakistan, it is important to understand role of the two agents ; i.e. government and parent.

State Guardianship: Government procures vaccine, installs cold chain for supply, builds technical capacity by training, hiring and organizing health professionals (Ordinance 1980[8]). Mandated agencies provide access to vaccine and educate people about immunizations Policy formulation is centralized to drive equitable distribution of vaccines. Multiyear plan of action are processed to support finances and mitigate potential risks to continuation of program. Routine immunization is bolstered with periodic campaigns for subgroups of population to enhance coverage. Horizontal immunization program is administered through sub-provincial agencies to make sure children receive vaccination. Government also strives to spread literacy about vaccination (Governance Framework, Constitution of Pakistan[9]). Government designed economic structure of vaccination program around supply-induction and cost-minimization. Vaccine is regarded as essential, non-excludable good but expendable with no close substitutes. Vaccination is financed through pooling of tax-payer money (National EPI policy & Strategy Guidelines, 2005). Health spending is seen as a tool for wealth distribution and providing welfare. Government procures from exchequer and ensures delivery system for all children throughout Pakistan.

Government as an agent: Government assumes role of provider as well as agent (Constitution of Pakistan Act, 2010). Even if parents reject vaccine, government has to maintain immunization program because medical professionals agree babies require vaccines and survival is constitutional right of new born child. There is competition between government and parents to decide welfare of child. 'Need' of vaccine is determined on behalf of babies based on biomedical and epidemiological research (Khattak, 1996). 'Need' is a concept where a human or organizational agency fixes quantity that users demand. 'Need' without demand is disparity and demand without access is deprivation. Demand is the quantity of vaccine accepted by user. 'Need' may or may not follow demand. Government set 'need' at full schedule of dosage administered to 95% babies. These levels are required for herd-immunity (Kim, Johnstone & Loeb, 2011).

Justification for government role: The rationale for dual role of government is that immunizations are essential for everyone but not everyone is able to pay. Inequalities are never completely abolishable in market based society but people are relieved of free market purchase-on-price mechanism when it comes to vaccination. There are ethical concerns over profiteering from child-survival medicine if it is left to private producers and distributors. Also, without government the market may not form entirely or it may have limited inclusion, thus, creating wealth-based gaps in access (McArthy, 2016). Prevention of disease translates to reduced loss of wage-work, increased labour productivity and sustained progress through intergenerational equity. Government finances essential vaccines from tax funds so as to hedge against costs of chronic treatments which are always higher in any healthcare system. Public health programming is supply centric. Inputs are pooled for vaccine supplies as well as logistics, surveillance of infectious disease transmission, data reporting and recording systems. Costs from vaccine, supply chains and service

[8] Functions of National Institute of Health under Cabinet Division, Government of Pakistan

[9] Functions of Ministry of National Health Service, Regulation & Coordination, Government of Pakistan

delivery are 16 times less than the net benefits from illness averted. Increased rates of immunization can save $6.2 Billion in remedial treatments, $145 Billion in productivity losses in 10 years (Ozawa & Stack. 2016).

Parental Agency: Skeptics maintain that state in its role as a provider can only suspend doctrine of informed consent under bonafied emergency posing immediate threat to life of citizens. Vaccine, however, remains a preventive medical intervention (Ward, *et al.,* 2017). Parents, as designate guardians of children, are primary agents who can refuse vaccine if they perceive benefit from immunization lower than risk of vaccine side-effects. The inducement should come from supply side and way to achieve that is flooding the market (McGinnis, *et al.,* 2002). Argument on other side is that health related decisions should be made by community sponsored trained professionals who possess technical information about vaccines. It is argued that parents should not be left to claim decisions on immunization because the costs of vaccine and threat of infection spread is shared by community. Parents cannot comprehensively evaluate if benefits gained are higher compared to costs incurred (Ward, *et al.,* 2017).

Implications from parental agency: Healthcare chooser is inherently irrational. Hesitancy in presence of expensive immunization program causes macro-economic losses (WB, 2016). Parental agency executes direct economic action without adequate information. Parents have power to limit quantities of consumption. It is a value-trap because decision space is skewed by parental agency. Refusals devalue vaccination service. But government has to keep-up supply. So less immunized means more vaccine required (Navaratne & Masud, 2012). Brunt of devaluation shifts to financial pool from tax-net. It is debatable whether vaccinating own child should be mandatory under law because it is child's right or should it remain an option accorded to parents. Parental agency can be contrary to welfare especially in poorer households but in real world, can a parent be actually made to relinquish consent over his child's survival? That is asking for a lot of trust on health establishment (Milstein, *et al.,* 2005).

Demand side dynamics of vaccination: Vaccine price is not affected by demand side forces in Pakistan. Demand of vaccine should increase with rise in fertility rate and frequency of new births every year. But actual acceptance centers on motivations around health, illness, birth, death and healing; in-turn influenced by tradition and/or religion. From user perspective, adopting health product is high involvement but often irrational consumption decision (Smith, *et al.,* 2011). Utility is influenced by post-utilization evaluation, risk aversion and testimonials. It is not directed by willingness-to-pay, valid comparison of alternatives, analysis of benefits over costs and elaborate search for credulous information. Grade of vaccine utility is evaluated based on circumstance of choice. 'Vaccine-utility' is described as perceptional evaluation or subjective quantity of satisfaction. Parents are agents and hesitancy is captured in convictions, convenience, complacency and confidence of agent (Glanz, Rimer 2008). An ever increasing cohort of parents still prefer herbal remedies, homeopathy and spiritual healers despite of mounting scientific evidence against their low efficacy value[10]. An economic situation where agents (parents) are impediment to distribution of merit good (vaccine) is un-natural. It is possible to view this behavior in relation to conditions of poverty. Poor households have lower access to information and other faculties that enable choices. In Pakistan average

[10] National Health Service Trust of United Kingdom decided to end flow of public funds into homeopathy or herbal medicine in 2008 and stopped prescription practices from that discipline in public sector hospitals in 2017. http://www.bbc.com/news/uk-40683915

per capita income is less than Rs.2,680 per month (2016). 29.5% of population or 6.8-7.4 million households persist below minimum welfare measure of 2,350 calories/day according to cost of basic needs method (2013-14). Proportion of employed population below $1.90 purchasing power parity is 8.6%. Per capita health spending in Pakistan is $38 (WHO, 2015) and life expectancy at birth is 64.6 (2013)[11]. Collinearity of deprivations in health and standard of living indicators put Multi-Dimensional Poverty Index value[12] of country at 0.264. Out of every 1000 live born, 66 die in first year of life. The way households make their choices for consumption and conservation of resources can ensue or break vicious cycles of entwined generational poverty in multiple interdependent dimensions. Early childhood development is strong projector for productive employable labour. Poor groups are more likely to make health choices that are contrary to their economic interests (Yuqing, 2012). Interventions of neonatal survival and protection are means of generating equal opportunity to lead useful life. Vaccine acceptability depends on socio-economic drivers that contextualize decisions. Cluster of vaccine refusers is often neglected in programming because problem is difficult to address. Its various determinants in heterogeneous groups require a capacity to ensue complex communication and monitoring strategies within community setting.

Acceptability of vaccine: Health authorities are not always successful in communicating an unambiguous message to parents about vaccines, their safety and the fact that adverse reactions are rare. (McKee & Bohannon, 2016). Behaviors are absolute in themselves. But the degree of their variance in population changes and the outcome can be negative or positive. Socioeconomic circumstances condition behavioral responses. In other words, unique behaviors can be assessed in terms of their socioeconomic determinants. The trend of association between socioeconomic variables and health related behavior may follow increasing rate or decreasing rate. No standardized maxima can be ascertained and behavioral factors can be measured through its relational properties. One implication is that power of efficacy in government programming depends upon societal acceptance of the program. The vertical inequities of distribution becomes directly related to utility perception in public (Ozawa & Stack, 2016).

Valuation by parents: Parental refusal of vaccine is cost for government. Demand generation efforts reduce net cost of vaccination program. Vaccine has no competing alternative. But parents do make decisions by prioritizing their competing needs. Determinants of parental preferences form the basis of value in immunization program. Consumption preferences impute value into any product or service. If parents are refusing zero price product, product value is negative (Larson, 2011). Thrust of government policy is only on reinforcing supply side to achieve coverage targets and make program effective. Underlying assumption is that immunization shall be readily adopted when issues of access and quality are settled. Hence, great efforts have gone into logistics. But bringing price down to zero at user-end does not automatically translate to ready acceptance of product and success of service. Underutilization of vaccination service adds dead-weight on sponsors (tax-payer) and active seekers of immunization program. State authority cannot reach its implements without modelling parental preference. Apart from circumstance of product availability, ability to pay and geographical accessibility, there are other elements which bring value to service (McArthy, 2016)). These are understanding of cultural sensitivities, content

[11] SAARC group on Statistics (SAARCSTAT) Retrieved from http://saarcstat.org/db/statistics/

[12] Share of multi-dimensionally poor population is 49.4%, additional 11% are vulnerable. When headcount is adjusted by intensity of deprivation which is 53.4% on average, the MPI value is 0.264

used for health literacy, appeal of communications strategy and trust in providers. Contextual influences that promote behavior of hesitancy arise from living environment, religious roots, regional diversity and strength of social institutions, economic as well as political factors. Several elements model individual decisions; vis-à-vis education, health promotional messaging for modifying behaviors, past experiences of friends and members of immediate community, subjective norms in families and households, historic context, religious and moral convictions, perception of susceptibility. All these influencers of hesitancy interact within ecosystem of public health policy.

Socioeconomic dimensions of acceptability: Scaling confidence-gap requires an understanding into factors of acceptability. Noni, *et al.* (2014) framed behavioral factors according to socioeconomic dimensions. Hesitance, refusal or acceptance of neonatal vaccine is due to circumstances of parents. Decision to accept vaccine is often reactionary or based on varying health related beliefs of parents. Caregivers make subjective evaluation of gains and losses by vaccine administration. Understanding socioeconomic drivers of vaccine acceptance can help government in resolving service-delivery issues.

Table 3.1: Socioeconomic dimensions of vaccine acceptability

Dimensions	**Variables**
Dimension 1: Culture	• Province, District, language
Dimension 2: Empowerment	• Mother's age and relationship status • Education of mother
Dimension 3: Community networks	• Occupation of father and mother
Dimension 4: Associate behavior	• Use of Family planning methods, primary healthcare facilities
Dimension 5: Poverty	• Household : Region of domicile, Over crowded, wealth, hygiene
Dimension 6: Utility of healthcare	• Satisfaction level with primary health service • Perinatal care, place of delivery
Dimension 7: Access by state	• Type of health service accessed for all health issues, Frequency of visits, Time, distance and transport cost of access to immunization center

Lack of confidence over vaccination negatively affects the efforts to curtail spread of contagious neonatal infections. Higher impact is achieved by understanding why people subscribe to a program, manner in which people find utility of service and who are the refusers. Inequalities that exist in utilization of immunization service are because each vaccine depends on economic conditions, epidemiologic factors and social circumstance around households.

Chapter -4

Literature Review

4.0 Introduction

It is important to understand the socioeconomic situation of parents in-order to place their preferences in appropriate context. Government cannot reach desired immunization targets without enhancing acceptability among parents. The topic of vaccine-hesitance is not new but it received broad attention after Wakefield (2007, *retracted 2008*) controversial work which associated MMR[13] vaccine with increased incidence of Autism. This started debate on safety of vaccines. Parents started fearing all types of vaccine. Questions were raised in media about legitimacy of vaccination as a public health intervention; whether tax-payer should sponsor it or should vaccination be privatized. Larson (2011) wrote landmark paper about vaccine-confidence gaps in developing countries. She discovered that shifting realities of parents affect their decision making process and low acceptancy of neonatal vaccine among parents account for 20% loss in coverage. In 2014, SAGE -WHO[14] convened on a standard definition. Hesitancy was described as a spectrum of behavior with refusal as an extreme. SAGE has since proposed explanatory correlates of parental behavior towards vaccination as well as its expression, impact, concentration patterns. Later, Noni, *et al.* (2015) delineated parameters for measuring vaccine acceptance. Using meta-analysis of studies between 2007 and 2012, authors later formulated a matrix of determinants in context-specific settings.

4.1 Determinants of vaccine acceptability

Existing literature was reviewed to understand acceptability of government provided neonatal vaccination. Criteria for selection of literature and systematic review is in Annexure-3. Following are few of the notable studies:

World Health Organization surveyed 301078 families in low coverage districts all over Pakistan. In 2014 report was published on situation of vaccination in Pakistan. The report recognized low acceptance as a problem. High grades of rejection were especially noted in areas of Quetta block and south-western Khyber-Pakhtunkhwa. Around the time of WHO survey these were areas of deteriorated law and order. Subpar security scenario in that particular time-frame can diminish access to vaccines, therefore explain low uptake. But parents were still refusing vaccine as of 2016 when peace had been restored. Low uptake was justification provided by provincial health department in 2016 when allocations were requested from development budget for immunization activities in hard-to-reach areas. The resources to enhance access were made available and vaccine was provided to public at door-step. The overall uptake in KPK (except north-eastern districts) and Baluchistan did not improve (UNICEF, 2016). These parts are comparatively under-developed from rest of the country. When I looked at education levels in these areas, I found them below national average[15]. Health-promotion-messaging was not component of programming for vaccination service in these areas. So refusal by parents, can be attributed to poor parental knowledge about vaccines. Lower levels of education and higher number of children were concluded as strong predictors of

[13] Mumps, Measles, Rubella

[14] Strategic Advisory Group of Experts at World Health Organization, Geneva

[15] Alif Ailaan and SDPI. (2016) Pakistan District Education Rankings. Islamabad:.vi-109 pp. ISBN 978-969-7624-01-0

hesitancy by Owais, *et al* (2011). Specially, maternal knowledge of vaccines can impact rates of neonatal immunization. Asif, *et al*. (2012) also maintains there is inverse relationship between maternal education and non-immunization. The dropout percentage increases as level of mother's education decrease. This was especially true of practices in KPK compared to Punjab. Between two provinces, authors calculated a three point gap in concentration of refusers. KPK faces higher burden of refusing parents who lack confidence in government provided immunization service. But the problem is hardly specific to western provinces of Pakistan. Nisar, *et al.* (2010) assessed knowledge, attitude and practices of mothers regarding immunization of their one year old children at Mawatch Goth, Kemari Town, Karachi. Authors observed that completely illiterate women knew the names of diseases in EPI schedule. But the ratio of missed to complete immunization was 8:1. This shows that health promotion messages percolated to low income shanty towns on the peripheries of urban centers. Education levels are lower in shanty towns but the content was simple enough to be understood by mothers who have had no formal education. But it did not resonate enough with them and failed to convince them. They are not accepting vaccines for their babies. It is even more difficult to convince parents who accept some vaccines but refuse others. These are misinformed caregivers with set minds on dangerous understanding of facts. These parents are not necessarily educated but they have access to free media. At least a third of the women in study dropped out of vaccination schedule because of interference from their work related duties. Some complained dosage schedule was too complicated for them to follow. Others thought children should not be vaccinated during flu and wished trained health professionals were readily available to answer their questions. Systematic review by Zohra, et al. (2015) showed mothers education, hospital birth of child, urban residence of parents and convenient contact with trained health worker as predictors of child successfully reaching age of 5 years. Mothers' confidence is rooted in adequate knowledge about intervention being offered. When Usman, *et al.* (2009) explored impact of center-based maternal health education strategies to reduce dropouts in urban Pakistan, he found that trained birth attendants, post-natal care and place of child delivery are significant determinants of maternal convictions about immunization.

Another pivotol factor is convenience. Omer, *et al*. (2016) state that inconvenience can cause parents to place low utility on immunization service. Determinants of convenience include family situation other than limitations of time, distance and money. This becomes principal reason during door-to-door campaigns. Divorced or widowed mothers have low social standing and decision power in household, making it inexpedient for them to have their children immunized. Similarly employed mothers despite of being literate on health issues find time-off from work to be a constraint in taking their children to health -facility for immunization. According to Arooj S., *et al.* (2013) households headed by female are less likely to remain unvaccinated during immunization campaigns. Older or male children compete for attention of parents, this puts younger or female off-springs at disadvantage. Authors used mixed methods and self-reporting by subjects on stylized questionnaire which was specifically developed to assess knowledge and attitude of caregivers in household. She reported a reduction in coverage of Oral Polio Vaccine due to wealth status, employment and empowerment of mother. I infer that education of primary caregiver is significant regressor of child immunization status. Lack of education, strong adherence to traditions and higher number of children born per mother were characteristic features of parents who refused vaccine in these studies. Another feature was large household sizes. I regard them as factors that structured parental convictions. Joint family traditions can help survive poverty. But the demographics are entwined with illiteracy, orthodocity and rigidness.

Omer, *et al.* (2013) used self-reporting on designed questionnaires in study about convictions of parents. 82% reported adverse reaction to vaccine of someone in family as a reason to not have their next of kin vaccinated. In this study, 75% of cases refusing vaccine were illiterate and below poverty line. Close-knit nuclear families held on to traditional health beliefs more strongly and rejected professional advice. These families require greatest attention of efforts because equity comes from reaching out to families that are in need of essential health services the most. No effort was made to bootstrap sample to make it representative. Asif, *et al*. (2012) asked about perceptions from parents that were not participating in supplementary immunization activities. Cross-tabulation was done for ratios. Results showed that higher birth order, maternal education, early age of conception and home delivery was significantly correlated to low immunization. The parents of middle income group had lower number of total children and more gap between successive births due to positive attitude towards family planning. This was the same group which was most likely to have fully immunized babies. Parents in this group overwhelmingly chose to give birth in hospital and receive antenatal care.

A qualitative cross-sectional study was done by Smith, *et al*. (2011) on random sample from equal number of urban and rural households within similar distance to vaccination centre in Pakistan. Authors observed that babies of working class families had better knowledge about how vaccines worked and why they are necessary compared to parents in agriculture related occupation. The contact of parents with circles outside of immidiate family and had network connections other than tribal affilliations influenced their decisions about children. Parents tend to follow the practices of friends, family and coworkers whom they trust. Experiences from squatter settlements in cluster randomized double-blind trial were assessed in study by Shams (2015) who investigated the role of household asset in explaining the immunization behavior in rural Punjab. Concentration index is used as a relative measure to argue that immunization coverage was declining in households within lowest wealth quintiles. An attempt on ranking was not made which could have elaborated the disparity profile on defined basis. Effectivity of mass immunization campaigns requires quality controls for safe practices and in maintenance of vaccine cold chain. When differentials in immunization uptake were studied by Amin, *et al*. (2014) in children upto 5 years of age, evidence was found that low adherence to immunization schedule can be traced to wealth status of the parents. Logistic regression was applied in the study and it used PDHS data. The results showed strong association of child immunization with distance from urban centre, household socio-demographic characteristics and wealth status of parent. The results of chi square test were large. ‘Global Health Observatory Data Repository’ holds information on assessment of final dose of vaccine against DTP3 coverage among 1 year olds between years 2005-2014 in Pakistan. Their data is sourced from Pakistan Demographic Health Surveys (PDHS) and Multi-Indicator Cluster Survey (MICS) that were carried out at least two times during 10 year period. The median difference between wealthiest (Q5) and poorest (Q1) quintiles was 13.5% which is an increase of 10% in 8 year period. Programmatic issues were suggested as reasons for increasing disparity. Lower income, rural residents were less likely to receive neonatal immunization by 13.5%. No significant disparities were found about immunization of male child and female child in Pakistan. Socio-economic determinants of low immunization coverage in South-Asia were explored. Their results show that households with monthly income greater than $50 (Rs.3000) in Pakistan were 80% more likely to accept and complete immunization schedule. Omer, *et al.* (2013) in their experimental cohort study analyzed knowledge, attitude and practices regarding immunization among users of health facility in Multan. They

concluded that child survival is a low priority in populations that lived on daily wages and sustained on low income even if transport or access is not burdensome.

Siddiqui, *et al*. (2017) conducted a cross-sectional survey in low income urban slum dwellers of Karachi for examining how domicile of parents affects the choices they make. Stylized questionnaires were used as instrument of measurement. Representative sample of 283 women was selected. 53% had never heard of tetanus, why is it dangerous or if there is a prevention avialable. So they were naturally apprehensive of vaccine offered. Approximately 8% refused vaccination owing to reasons such as fear of harm to baby and faith in diety to provide protection from disease making them believe they were invulnerable. Atleast 1 person questioned the biosafety of compound saying 'she did not trust a product if it is manufactured in Pakistan'. Onus rests with healthcare workers to appropriately communicate benefits against possible but improbable side-effects of vaccines. Concerns about safety of vaccines and disinformation about them creates hesitancy among first-time parents. When Hussain, *et al*.(2010) studied determinants of DTP3 completion among cohorts he found that children who received their first dose at rural immunization centers were least likely to complete immunization. Children raised in poverty are most vulnerable to disability because of non-immunization. Pashtun families residing in Punjab or Sindh also projected immunization behavior of their place of origin. Hesitation among parents delays immunization of babies. The recommended schedule is not followed. Usman, *et al.* (2010) assessed the DTP3 coverage and drop-out ratios in rural immunization centers of Pakistan. This study was conducted in six EPI centers involving catchment areas at periphery of Karachi, Sindh. Diverse demographics reside in the drainage population of these centers. Selection was based on volume of return visits. Access to facility was a mediator to full immunization in this study. The cohort study used randomized control trial method and found significant correlation between immunization card design, its retention by parents and drop-out ratios.

The environment of a person, including family, community, culture and habitat, grooms preferences. Complacency to community beliefs is another strong barrier to completing immunization schedule. Stories about vaccine adverse effects reaffirm their convictions in traditional remedies. Bugvi, *et al.* (2014) states that closed communities, large joint families and older in age mothers are especially reluctant to message from health workers. They rather practice the directions of religious preacher or village elder. Household wealth and standard of living differential within the sample came out as insignificant predictor. Instead attitudes about vaccination depended on quality of information reaching famiies and trust-building measures. Thus, caregiver's knowledge and information relating to childhood immunizations is major contributor to alter perception around immunization. Community involvement creates a complacency that influences behaviors even in mobile populations of the region. Community based interventions for improving perinatal and neonatal health outcomes were appraised by Bhutta, *et al.* (2005). Political and religious affiliation influence opinions. Social figures need to dispel misconceptions. Poor parental knowledge about child health specifically and preventive health measures in general leads to suffrage of children. Under coverage is in part due to poor geographical access to health services, lack of technical skill of health staff, lack of resources/logistics, misconceptions in population, fear of side effects, conflicting priorities, socio-cultural norms, missed opportunities and unreliable services. Omer, *et al*. (2016) maintain that limited demand and low utility placed by communities around routine immunization service is a big hurdle. Coverage volumes will remain sluggish without adequate behavior change communication. Lack of scientific enquiry on user-acceptancy burdens responsive strategies. Multi-level, multi-pronged programmatic intervention needs reflective empirics about cross-section of population.

Owais, *et al*. (2011) used multivariable Poisson regression model for estimation on indicators of maternal perception and derived utility. The instrument of experiment was health promotion message based on curriculum of lady health workers. Domains included variables about economic state of community, understanding of social contract with state and perception about vaccination service. These variable incidentally co-occur with poverty, joint-family and rural dwelling. Vaccination probabilities improved if mothers were married into literate families. Although, the study took a randomized controlled sample in low income communities of Karachi and no generalizability tests were done. Despite of limitations, larger qualitative inference can be drawn on subjective behavior of mothers because of cultural commonality in parenting practices all over Pakistan.

Khowaja, *et al.* (2012) conducted observational study about self-reported perceptions of parents non-participating in supplementary immunization activities. The power of study is limited to 90 clusters from 19 towns and 178 communities divided into 90 clusters of 250 households each. Sampling is random and mixed methods approach is applied for analysis. The clusters represent socio-demographic breadth of EPI urban-coverage in low to middle income class. 51% households deliberately refused vaccination. When categorized along ethnic lines, 90 % of the refusing Pashtun families residing in Karachi metropolis gave reasons pertaining to their fast held belief that vaccines adversely affect reproductive physiology of male child. These households also rejected family planning. Some Baloch families believed vaccines are forbidden in Islam (*Haram*). 4% of educated middle-class mothers in cantonment of Punjab believed that vaccines are useless and "do not work". In most cases the testimonials of refusers were rooted in hearsay.Royal Society of Public Health, England and Medical Research Council, Pakistan jointly-funded study to analyze temporal inequalities in immunization. Study concluded that coverage decreased in years immediately preceding 2011. Sharp declines were reported especially in Southern Khyber-Pakhtunkhwa, FATA tribal belt and western Baluchistan. There were also 22 cases of Type-2 circulating vaccine derived poliovirus (cVDPV2) in 2014. The study was based on semi-structured interviews.

The stance of social leaders against vaccination is major barrier. Ullah, Deen & Hussain (2016) in his study about genesis of polio vaccine hindrance in Pakistani society state that religious leaders have strong role in shaping attitudes. Among ratiocinations of vaccine refusals, *fatwas* by religious scholars who hold significant sway in their locales is substantial. In Wazirstan, Killa Abdullah and Jaffarabad religious leaders went so far as to ban immunization as a heretic practice and publically flogged parents who disobeyed -- However, government responded swiftly to reports of vaccine refusals through implementation of National Emergency Action Plan. The rate of decline in coverage between 2006 -2011 was reversed by 2014. Coverage volumes will remain sluggish without adequate behavior change communication. Lack of scientific enquiry on user-acceptancy burdens responsive strategies. Multi-level, multi-pronged programmatic intervention needs reflective empirics about cross-section of population. Usman, *et al.* (2010) found that the negative perceptions about quality of vaccines and negative propaganda of clerics to instill fears are chief reasons of hesitancy in peripheral Punjab; a province with most concentration of children and consistently higher coverage ratio compared to other provinces. Poor householdsperceive lowutility gain in vaccine. Behavior modification of parents in poorer regions require participation of civil activists and community leaders. The objectives cannot be achieved solely through government sponsorship. Design of health promotion messaging should be simple and relatable to poor mothers for them to accept immunization. Health workers should be trained about how to manage parents that are unsure about immunization.

Study by Usman, *et al.* (2009) used randomized controlled trials in 56 centers in Sindh. They state that some parents are not against vaccines per se but they reject to compulsory government funded program of vaccinations. Body language of public sector health worker can also put parents at alarm. The manner and protocol of needle use or recording of information was elaborated in-depth by him. The study was limited in its scope. But the results found strong relationship of immunization percentage with design of immunization cards and training of female health workers at basic units. Authors are of the view that design of vaccination card is a strong instrument of education and compliance with immunization schedule. Hasnain, *et al*. (2007) attributes causes of low vaccination coverage in pregnant women in Lahore district of Punjab to the way health workers interact with user and build rapport is important in how confidant people feel about vaccine administration. Health workers need to receive training in cultural sensitivity and communication techniques. Trust deficit was found as major cause of reduced vaccine- acceptability (US-Deliver Project: *Status of women and children*, 2014). Design of instruments that are used for registering behavior change communication and recording vaccination status is important in building motivations. If the instructions are hard to follow or parlance of vaccinator is intimidating then parents distant themselves from the program. Losing one household to poor action of service delivery staff or paraphernalia ripple through whole community which go onto become hesitant towards vaccines.

Summary: Review of literature establishes social circumstances of parents as determinant of parental behavior towards government provided neonatal vaccination service. Articles from Pakistan employ methodology of direct interviews and self-reported questionnaires. Samples are mostly limited to small area in one city or drainage of one health facility. The conclusions of such studies can describe behavior dominant in specific area. Generalized conclusions cannot be drawn about culture of vaccine usage. The inequalities in health status of children across Pakistan is another subject that is not adequately explored in local publications. Studies seldom take demographic cohorts at sub-provincial level and analyses are not parametric. No generalizability test, sensitivity test and value comparison methods are included. Cross-sectional studies are used to argue performance of vertical health programs.

4.3 Theoretical Foundation

This thesis builds on theoretical foundation of existing behavior models. Noni, *et al.* (2015) examined scope and determinants of vaccine acceptance. Between total refusal and wholehearted acceptance is a behavioral continuum of vaccine hesitancy. Table 4.1 details various social elements that alter or enforce vaccine related behavior of parents. According to Noni, *et al.* (2015) these elements can be grouped as interpersonal influences on behavior, contextual influences and behavior modification due to design of country's health system.

Table 4.1: Elements that influence health related behavior

A-Contextual Influences	
-Communication and media -Leaders -Health program managers -Political lobbies (pro- / anti- vaccine) -Historical	-Religion/ culture/ gender -Economic of communities -Economics of Pharmaceutical -Geographic barriers
B- Interpersonal influences	
-Community or past experience of members of household with disease, pain, disability. -Beliefs and attitudes about health and prevention	-Knowledge / awareness -Trust on providers -Risk/ benefit (heuristic / perceived) -Social norm (perceived / enforced)
C- System specific Issues	
-Risk/ Benefit (epidemiological / scientific evidence) -Intro of new vaccine, new formulation, new schedule recommendation -Mode of administration -Design of programs	-Strength of recommendation/ knowledge base / attitude or healthcare professionals -Mode of delivery (routine / campaign) -Reliability of source of vaccine -Reliability of vaccine supply chain, availability of facility and equipment -Schedule of program / costs of delivery and programming

Source: Noni, *et al.* (2015)

SAGE and Noni (2014) recommends quantifiable measures that can be attributed to each of three groups. Contextual influence can be measured on the basis of variables: Urban/rural residence, Household size, Maternal empowerment, Maternal age, Maternal gravidity, Birth order, Birth intervals.

Interpersonal influence can be measured on the basis of variables: Maternal education, Retention of EPI card, Family planning attitudes, Place of occupation, Place of residence.

System specific issues can be measured on the basis of variables: Satisfaction with health staff, Access to health facility, Postnatal care and delivery in clinic, Home visit of health worker, Knowledge of immunization.

Noni E. MacDonald's work is a reframing of Anderson Healthcare Utilization Model for vaccine related behavior. Babitsch, Gohl and Langarke (2012) also used the same model to find what causes parents to value vaccines differently. Summary description of other models that were reviewed for this thesis is in Annexure-3. Glanz, Rimer, Viswanath (2008) proposed a model where four types of behavior explain vaccine acceptability. The model was called 4C-model, i.e. Conviction, Complacency, Convenience and Confidence. Table 4.2 details the socio-economic indicators for each behavior. Complacency is defined as behavior of individual such that it is consistent with larger group. Convenience is reflected in minimized time and streamlined effort. Convictions are rooted in traditions. Confidence requires clear knowledge.

Table: 4.2: Socioeconomic indicators of vaccine related behavior

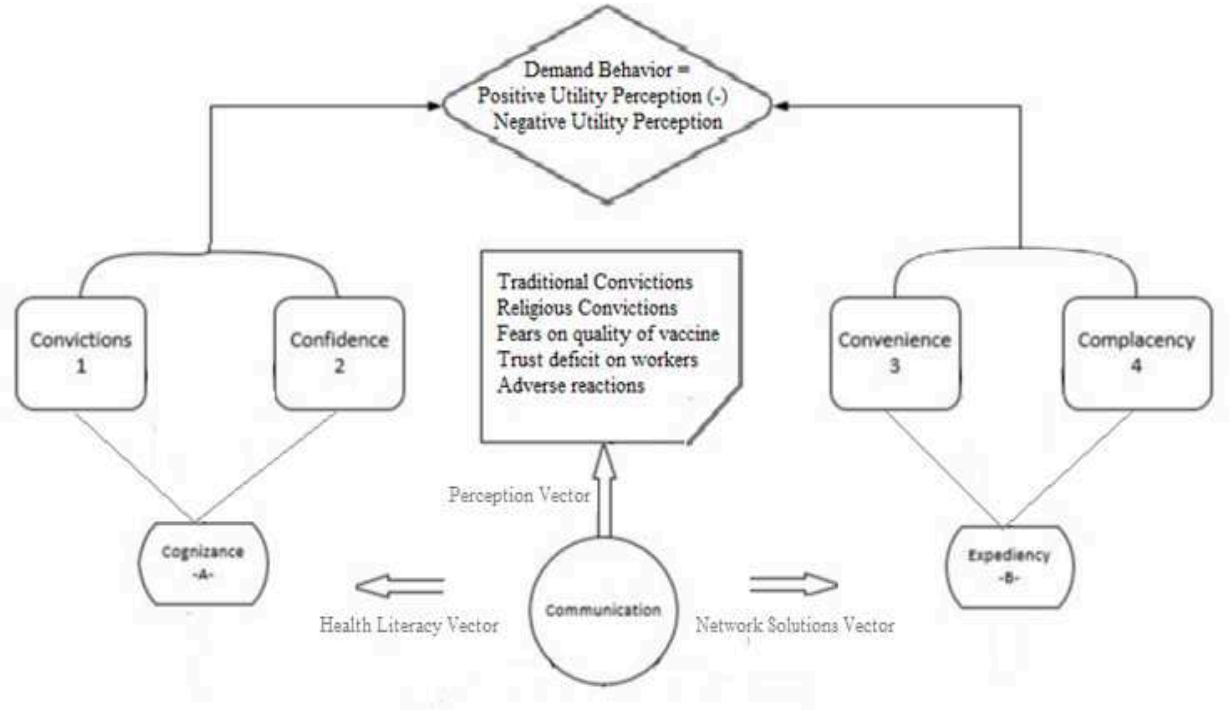
Behavior Dimensions	Socio-economic indicators
Low barrier of traditional **convictions**	Higher age of mom at first conception, Parental literacy, Proper birth interval, Hospital delivery of child instead of home in presence of trained assistance, Adequate reproductive care, Male child, Mothers believing and practicing family planning measures, Mothers' belief on necessity of vaccines and susceptibility to VPD, Elderly are in-charge of household decisions.
Higher degree of **confidence** in vaccines	Maternal care during pregnancy and post-natal period, education about vaccines, cooperative behavior and trained health staff / vaccinators that build rapport and trust with mothers, Birth Interval of 2 years or more, Lack of mothers' fear of side effect or harm from vaccines

Complacency to community influences	Not a strong preference of mothers for female health staff availability of which is harder, No up-to-date immunization card record with responsibility, Urban/ Rural location, Employment in professional or academic occupation are less complacent than wage labour or livestock, previous experience with VPD in community or close social circle, lack of maternal decision prowess in household
Convenience	Mothers' gravidity less than 4, Home visit of vaccinators or LHW, Parents bearing indirect cost to go to vaccination center, Mothers as primary bread earners, higher birth order and competition from siblings, Mothers that are not primary bread earners, not a divorced/ widowed status, Household conditions

Source: Galnz, et al. (2008)

In Figure-4 below, I integrated above models to develop an understanding of acceptability of neonatal vaccination among parents in Pakistan. This figure helps view of vaccine-behavior from government perspective and it is useful for purpose of programming. Confidence and conviction is categorized under 'cognizance'. Convenience and complacency is categorized under 'expediency'. Cognizance is reflected in socioeconomic variables of confidence and conviction (Table 4.2). Expediency is conditioned by socio-economic variables of convenience and complacency (Table 4.2). Both cognizance and expediency is influenced by elements in Table 4.1. These influences can be linked to 'cognizance' and 'expediency' on the basis of their measurable socioeconomic attributes.

Figure 4: Understanding acceptability of neonatal vaccination from government perspective



Source: Author's Own

Strategies by government for behavioral change communication act through two vectors. One is ‘network solutions vector’ which impacts ‘expediency’ behavior using community influences as a tool. Other is ‘health literacy vector’ which impacts ‘cognizance’ vector using interpersonal influences as a tool. Both vectors exist in a balance and can be measured from socio-economic variables. The product of these two vectors is outcome in form of ‘perception vector’. Positive perception increases demand of vaccine among parents.

4.2 Conclusion

We know that service utilization, beside availability and affordability, is one of the metrics of evaluating health programs. But my review of literature tells that different parents value vaccines differently based on their own unique circumstances. In this thesis I ask: what type of population groups are hesitant to avail zero price immunization and why? I expand social indicators to include birth interval, place of delivery, post-natal care and maternal empowerment as regressors. I also study if being born male or female in one of the Pakistani provinces has any advantage over other in terms of survival and disease protection. In independent variables I included formal education up to secondary level to see its relation with awareness about immunizations. I also consider household situation regarding hygiene, sanitation and clean drinking water as infections are spread through orofecal route. I add nature of occupation to see if that explains behavior about essential child-care intervention. Because occupation links a person to social networks and influence compliance with family beliefs. This thesis attempts to establish correlation of various social, behavioral, economics and demographic factors with choice of immunization. Various factors that influence immunization in community, family, parents and household shall be examined. The determinants are analyzed across urban and rural districts of four provinces.

Chapter -5

Data and Methodology

5.1 Survey

Data on social and economic indicators is used from PSLM 2014-15, to support theoretical construct with empirical evidence. Bureau of statistics states the explicit purpose of survey as estimated of representative population that can aid assessments on SDG. 5428 blocks comprising 81992 households were fixed. From Baluchistan, 2 districts were dropped. From Sindh 7 PSU and 108 SSU; from KPK 13 PSU and 208 SSU; from Baluchistan 82 PSU and 1300 SSU were dropped due to non-contact or refusal. Below are the total primary and secondary sampling units covered during the survey.

Table 5.1: Sample- PSLM 2014-15

Province	Sample Blocks (PSU)			Sample Households (SSU)			Districts
	Urban	Rural	Total	Urban	Rural	Total	
Punjab	594	1860	2454	2298	23546	30649	36
Sindh	375	901	1276	3360	13505	19417	28
KPK	104	764	868	972	13781	16489	25
Baluchistan	110	572	682	1248	11437	14049	28
Overall	1183	4097	5280	7775	62269	80604	91

**Source:* Pakistan Bureau of Statistics

Variable for purpose of our particular analysis are developed from PSLM questionnaire. Annexure-4 details PSLM sampling. The retrospect year of 2015-16 is chosen for stochastic evaluation in this thesis. The unit of observation is household with babies under four month of age that were delivered alive and healthy in year 2015-16 to women of reproductive age. Immunization is collected from 'record' as well as 'recall' measures in survey. But we chose the figures from 'record' measure. Data follows normal continuous distribution. Annexure 4 shows district-wise distribution of immunized and non-immunized household from secondary sampling units of PSLM 2014-15.

Table 5.2: Overview of Data- PSLM 2014-15

Variable Y	KPK		Punjab		Sindh		Baluchistan	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Full Immunized	2022 (14.7%)	324 (33.4%)	9868 (41.9%)	1119 (48.7%)	790 (5.9%)	545 (16.2%)	670 (6.0%)	209 (16.7%)
Non-immunized	3899 (28.3%)	126 (12.9%)	2436 (10.3%)	540 (23.4%)	4799 (35.5%)	508 (15.2%)	5316 (46.4%)	363 (29.1%)
Partial immunized	7860 (57.0%)	522 (53.7%)	11242 (47.8%)	643 (27.9%)	7916 (58.6%)	2307 (68.6%)	5451 (47.6%)	676 (54.2%)

**Source:* Pakistan Bureau of Statistics

5.2 Methodological Framework

Framework is based upon method for measuring vaccine confidence gap by Larson (2011). According to this methodology, availability of vaccine is controlled and acceptance of immunization (Y) is reflected as a function of socio-economic variables (X) of household. This framework assumes demand quantity of vaccine as equivalent to acceptance of immunization service in population ('n') of households. Larson (2011) kept confounding effects from 'access' constant by limiting selection of households.

Steps underneath are followed in this study:

1- *Selection of sample:* A qualifying criteria is set for collecting data on independent variables. "Access to vaccine" is defined and controlled at stage of sample selection.

2- *Defining variables:* Data for study is drawn from PSLM 2014-15 and disaggregated district-wise. Figures of immunization are based on 'record' measure of collection. To deal with missing values we impute means.

3- *Describing sample data:* Descriptive statistics are provided for the sample that is selected for analysis.

4- *Multivariate Analysis:* For a deterministic estimation, we perform multivariate regression. Econometric model is constructed for association of independent variables (socio-economic factors) with categorical response (immunization status). Measure of association is tested for significance. Coefficients of determination are calculated across provinces and results are interpreted.

Factors of acceptability are qualitatively assessed qualitatively by inductive reasoning and positivism. Groups emerge in provincial population on the basis of particular behaviors.

Selection of sample

Criteria for selection of households is mentioned below. Access is defined and controlled:-

a. Household should have at least one baby 14 weeks or under, present at the time of enumeration. Family is taken by measuring mothers of babies. So two women married to single man will be two families.
b. Biological parent or one persistent guardian/ caretaker to child is identified as such. Child may not be adopted or under foster care. In case there is no direct guardianship, head of household is taken as primary caregiver and labelled as parent. In case grandparent is only living guardian and direct caregiver to babies, he/she is taken as parent. Only one primary caregiver is taken for analysis.
c. Household should be situated in area with approximately 500 families-per-km^2 density. So that access remains constant in model.
d. A parent visiting facility, may choose government, private or other. But not because there is no government health facility. A public funded primary health unit / vaccination center should be present within approximately 5 km radius of domicile. It should take less than Rs.200 for round trip to facility (direct+ indirect) and under 60 minutes by wheeled transport (motorized/ non-motorized)
e. Household should covered during campaigns or home-visit drives. House has received Lady Health Worker visit at least once in past 6 month. This ensures access is fairly uniform across the area under study.
f. It is assumed that all primary health units provide vaccination service of same quality. All Lady Health Workers, campaign vaccinators, facility based post-natal caregivers are equally trained and if they provide education about schedule and importance of immunizations, that education is standardized throughout country.

g. Areas should be observed as epidemiological reservoirs anytime in past 10 years and there should be recorded incidence of disease in area due to either of these antigens: DPT, Hib, Hepatitis B, Polio, Tuberculosis.

Defining Variables

Following are dependent variable. Two households cannot be in same response category simultaneously.

Table 5.3: Response Variable (Y)

Variable	Response categories	Label
Immunization Status (Y)	1= Households with baby that have never received any immunization.	Non-immunized (Refuser)
	2 = Households with fully immunized babies (OPV_3 , DPT_3 , Hib 3)	Full-Immunized (Acceptor)
	3 = Households with baby that started schedule of immunization but drop out. (Delayed or incomplete at 14 weeks)	Drop-out (Hesitant)

A fully immunized child will have all eleven of the following dosages administered. Non-immunized will have none administered and drop-outs will any three [16] administered.

Response variable is explained by following observed independent variables. Variability of X and Y is on basis of select districts in four provinces in one year (2015-16). The list of districts and development of variables is provided in Annexure-4.

Table 5.4: Socioeconomic variables (X)

Groups	Continuous Variables
Age of mothers in complete years within reproductive bracket (15-49y) {matage}	-1- Mothers between 15/25y -2- Mothers between 26/35y -3- Mothers between 36/49y
Mothers in household according to relationships {_mat}	-1- daughter +mainprovider +divorced -2- spouse +mainprovider +currentlymarried -3- head +mainprovider +widow -4- daughterlaw +member +widow
Education of either parent {edm}	-1- Lower than secondary level education -2- Higher than secondary (currently or previously) -3- No formal education/ informal education
Reason for no education of caretaker {rsn_mated}	-1- Mothers whom were not allowed by parents -2- Mothers whom education deemed useless -3- Mothers who have to work -4- Mothers who are handicapped
Mother's access to health consultation? {hcons}	-1- Mothers accessing facility -2- Mothers accessing Hakeem /Homeopath -3- Mothers accessing LHW

[16] Three of the total dosages mean that babies are either immunized against some antigens but not all eight. Or babies are partially immunized but not completely against an antigen.

Mother's utility from past access of healthcare? {util}	-1- Satisfied Mothers -2- Mothers to whom staff was not available -3- Mothers who complained staff was untrained -4- Mothers who complained staff not cooperative -5- Mothers who complained long waiting period -6- Mothers experiencing unsuccessful treatment
Parent's frequency of access to government healthcare {usebhu}	-1- Parent(s) who visited facility last four month -2- Parent(s) who were visited by LHW visited four past month -3- Parent(s) availed no healthcare since four month
Gravidity of mother in last five years (number of times mother remained pregnant past 20 weeks gestation)	Continuous number between 1 and 4
Parents by employment {emp_w}	-1- Parent(s) who are employer -2- Parent(s) who are paid employee -3- Parent(s) who are unpaid family worker -4- Parent(s) who are cultivator/cropper -5- Parents(s) who earn from live stock
Parents by last month earning {emp_i}	-1- Parent(s) who earn minimum wage -2- Parent(s) who earn upto Rs50k -3- Parent(s) who earn Rs51k to Rs100k -4- Parent(s) who earn greater than Rs100k
Over-crowding in households? ** {oc}	Number of households with more than 7 members living in 2 or less rooms.
Variables	**Categories**
Province	-1- Kp -2- Pb -3- Sd -4- Bl
Region	-1- Rural -2- Urban
Gender of baby {childgender}	-1- Male -2- Female
Parental according to profession {emp_w}	1- Labour -2- Agriculture -3- Professional -4- Business
Visit to nearest primary health unit? {vis}	-1- Never -2- Occasionally -3- Always
Use of family planning facility {fp}	-1- Never -2- Occasionally -3- Always
Vaccine administration {vac}	-1- Separate vaccine -2- Joint/combination vaccine

Number of total children born to same mother? {sibling}	-1- Less than 4 -2- Higher than 4
Language of household {language}	-1- Punjabi -2- Balochi -3- Sindhi -4- Pashto -5- Saraiki -6- Hindko -7- Balti -8- Kashmiri -9- Urdu
Household conditions * {Hcond}	-1- Hygienic -2- Unhygienic
Mother retained vaccination card? {cd}	-0- No -1- Yes [Binary Indicator]
Did mother receive postnatal care? {pnc}	-0- No -1- Yes [Binary Indicator]
Has mother given birth to child during last 3 years? {gap}	-0- No -1- Yes [Binary Indicator]
Place where child was born {birth}	1- Home -2- Facility
Was she given tetanus toxoid injections during pregnancy? {tt}	-0- No -1- Yes(epi) [Binary Indicator]

{…} Value labels

Dummy variable is coded as '0'. Means were imputed for missing values.

**Hygienic/Unhygienic*: pipe/ pump as source of drinking water and flush/ sewerage/ pit as toilet in PSLM 2014-15 is taken as hygienic. All other combination of drinking water and toilet are taken as unhygienic.

***Over-crowded household:* Average national household size is 7 members and 2 person per room (PSLM 2014-15).

Describing sample data

In Punjab, 25741 households were selected, 16865 households in Sindh, 14753 in KPK and 12685 in Baluchistan. All households had babies requiring vaccination and equal access to vaccines. On average 54% households in KPK were fully immunized, 64% in Punjab, 31 % in Sindh, 18% in Baluchistan. Table 5.5 shows percentage of fully immunized households. Out of 38092 households, 34622 were never immunized and 3469 had dropped-out after starting program. 96% of drop-outs or 3355 had not completed schedule of any antigen, whereas 114 households had immunized against selected antigens but not all eight. Observation interval in Sindh and KPK is similar and it is lowest in Baluchistan. Punjabis accepting vaccines at higher percentage for proportionate sample size. Deviation of Punjab is smaller from the mean. Spread of Sindh is greater than KPK. Deviations for Sindh are nearly equal to KPK but distribution of Sindh is skewed to right.

Table 5.5: Percentage of fully immunized

	KPK	Punjab	Sindh	Baluchistan
Min	12.37 %	6.20 %	0.84 %	2.62 %
Q1	22.20 %	67.55 %	7.64 %	10.52 %
Median	47.85 %	76.48 %	24.32 %	15.04 %
Q3	68.14 %	80.72 %	49.16 %	19.06 %
Max	81.30 %	87.39 %	79.26 %	27.97 %
Mean	0.54	0.64	0.31	0.18
Freq.	6697	18199	5135	1808
Range	68.921	81.199	78.415	25.353
S.D	24.399	17.808	23.830	6.614

**Author's Calculation*

Table 5.6 shows the distribution of fully immunized households in drawn sample. Out of 91 districts, only 4 districts have above 70% of households accepting vaccines and all are in Punjab. Half the districts in KPK have higher than 50% acceptors. Only 7 districts in Punjab and Sindh have 50-69% fully immunized households.42.8% of fully immunized households are located across 50 districts in country and 31.1% are located across 15 districts. Mean acceptance in Baluchistan is lower than 20% but if sample of Baluchistan is doubled in size, the acceptance would still be under 30%.

Table 5.6: Fully immunized districts

Percentage of fully immunized	**Number of districts**	**Cum %**
Below 20	22	20.5
20-49	50	42.8
50-69	15	31.1
Above 70	4	5.7
Total	91	100

**Authors calculation*

Comparison among provinces for non-immunized and dropped-out households is presented in Figure-5A. The numbers on circumference are district codes. Names of these districts are mentioned in Annexure-4. Chart is at logarithmic transformation to value of 10. Distribution is on scale of 10%, 20%, 40% and 80% households with access to vaccines. Chart presents standardized amount of rejecters.

KPK				
District		% accept	%reject	likelihood dropout
1)	chitral	15	85	0.56
2)	upper dir	33	67	0.85
3)	lower dir	1	99	0.92
4)	swat	8	92	0.94
5)	shangla	1	99	0.92
6)	buner	1	99	0.96
7)	malakand	1	99	0.97
8)	kohistan	4	96	5.67
9)	mansehra	49	51	0.30
10)	batagram	44	56	0.34
11)	abbottaba	70	30	0.42
12)	haripur	81	19	0.78
13)	tor ghar	54	46	0.13
14)	mardan	56	44	0.37
15)	swabi	47	53	0.64
16)	charsadda	65	35	0.26
17)	peshawar	58	42	0.26
18)	nowshera	79	21	0.52
19)	kohat	56	44	0.24
20)	hangu	2	98	0.95
21)	karak	31	69	0.95
22)	bannu	16	84	0.92
23)	lakki mar	49	51	0.59
24)	d. i. khan	62	38	0.21
25)	tank	53	47	0.34

Punjab				
District		% accept	%reject	likelihood dropout
1)	Attock	62	38	0.17
2)	rawalpindi	57	43	0.18
3)	jhelum	36	26	0.54
4)	chakwal	41	59	0.73
5)	sargodha	66	34	0.29
6)	bhakkar	75	25	0.16
7)	khushab	70	30	0.23
8)	mianwali	62	38	0.32
9)	faisalaba	76	24	0.17
10)	chiniot	63	37	0.32
11)	jhang	22	78	0.79
12)	t.t. sing	56	44	0.56
13)	gujranwal	44	44	0.56
14)	hafizabad	73	27	0.21
15)	gujrat	35	65	0.14
16)	mandi bah	61	39	0.18
17)	sialkot	52	48	0.47
18)	narowal	60	40	0.41
19)	lahore	61	39	0.19
20)	kasur	42	58	0.74
21)	sheikhupu	77	23	0.10
22)	nankana s	8	92	0.71
23)	okara	49	51	0.68
24)	sahiwal	59	41	0.38
25)	pakpattan	53	47	0.44
26)	vehari	42	58	0.65
27)	multan	2	98	0.65
28)	lodhran	63	37	0.21
29)	khanewal	34	66	0.13
30)	d. g. kha	76	24	0.08
31)	rajanpur	46	54	0.44
32)	layyah	47	53	0.71
33)	muzaffarg	74	26	0.16
34)	bahawalpu	65	35	0.26
35)	bahawalna	70	30	0.24
36)	rahim yar	36	64	0.28

Table 5.7 : District codes and percentage of sample households accepting or rejecting neonatal vaccine

Table 5.7: District codes and percentage of sample households accepting or rejecting neonatal vaccine

Sindh				
District		% accept	%reject	likelihood dropout
1)	Jacobabad	97	3	0.75
2)	kashmore	92	8	0.50
3)	shikarpur	96	4	0.14
4)	larkana	96	4	0.04
5)	shahdadko	63	37	0.06
6)	sukkur	94	6	0.03
7)	ghotki	73	27	0.07
8)	khairpur	29	71	0.04
9)	naushahro	33	67	0.06
10)	shaheed b	54	46	0.02
11)	dadu	45	55	0.16
12)	jamshoro	21	79	0.31
13)	hyderabad	89	11	0.35
14)	tando all	35	65	0.05
15)	tando moh	20	80	0.13
16)	matiari	14	86	0.49
17)	badin	58	42	0.43
18)	thatta	12	88	0.74
19)	sujawal	37	63	0.73
20)	sanghar	6	94	0.54
21)	mirpur kh	20	80	0.16
22)	umer kot	39	61	0.35
23)	tharparka	86	55	0.70
24)	351	4	96	0.21
25)	352	22	78	0.17
26)	353	43	57	0.54
27)	354	55	45	0.78
28)	355	6	94	0.56

Baluchistan				
District		% accept	%reject	likelihood dropout
1)	Quetta	2	98	0.49
2)	pishin	45	55	0.27
3)	killa abd	43	57	0.80
4)	chagai	15	85	0.11
5)	nushki	28	72	0.36
6)	loralai	43	57	0.25
7)	barkhan	13	87	0.25
8)	musakhel	11	89	0.47
9)	killa sai	67	33	0.63
10)	zhob	43	57	0.16
11)	sheerani	37	63	0.16
12)	sibbi	46	54	0.42
13)	harnai	6	94	0.30
14)	ziarat	73	27	0.50
15)	kohlu	54	46	0.98
16)	dera bugt	39	61	0.41
17)	bolan/ ka	72	28	0.64
18)	jaffaraba	20	80	0.56
19)	nasirabad	25	75	0.57
20)	jhal mags	17	83	0.78
21)	kalat	39	61	0.46
22)	362	30	70	0.72
23)	379	43	57	0.56
24)	211	27	73	0.35
25)	235	42	58	0.47
26)	396	82	18	0.48
27)	160	61	39	0.45
28)	239	53	47	0.56

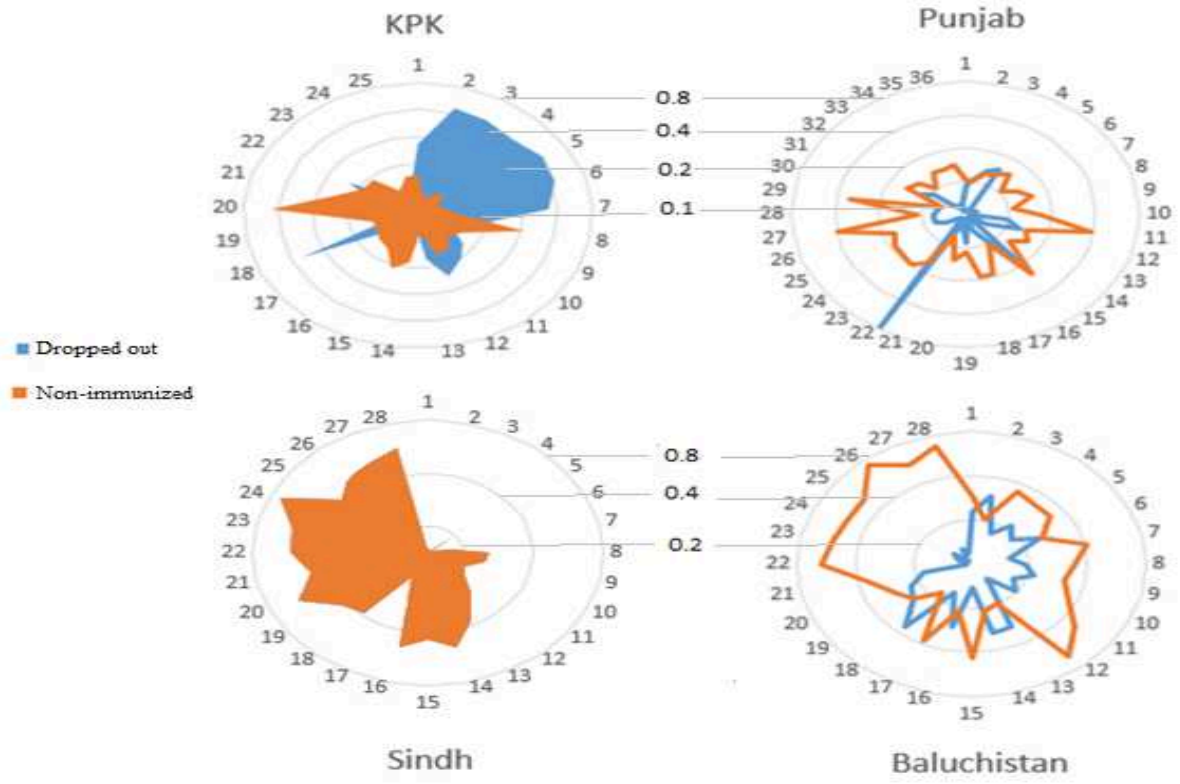


Figure 5A: Provincial comparison of dropped-out and non-immunized households

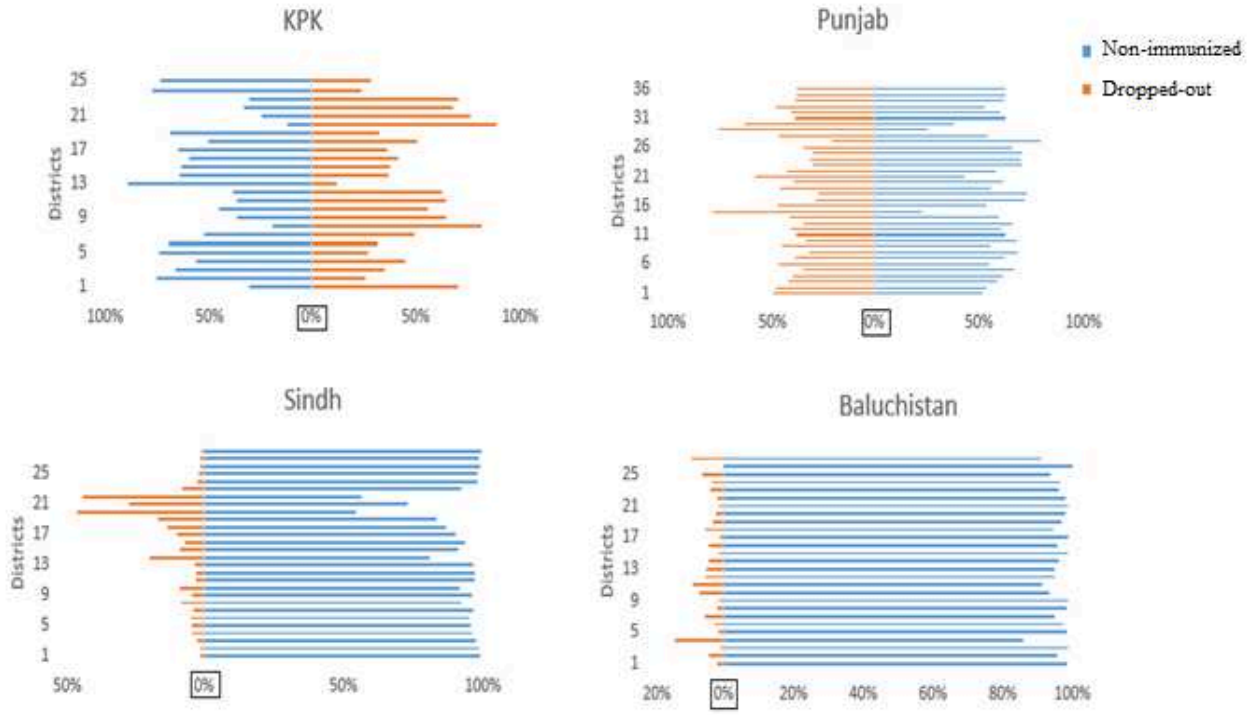


Figure 5B: Likelihood of vaccine refusal across provinces

Figure-5B presents likelihood of vaccine rejection across provinces. District codes are on vertical axis and odds are on horizontal axis. This helps us see that similar sized districts have different likelihood of occurrence for vaccine refusers. Which means it is important to know the socioeconomic correlates of immunization status. This information is useful for government programs. They can assess how outcome is different when vaccine is supplied to same mass of people in different areas. Relative district sizes are provided in Annexure-4. If 12% of eligible people are dropping-out and 20% are refusing then acceptance will be only 68%. Because 100 percent rejection is full acceptance. In Sindh, dropouts in KPK are higher than other provinces. It is more pronounced in 7 districts out of 25. In Punjab dropouts are less than refusals except for one district where they are higher. The dropout peaks are asymmetrical to refusals. It shows that in Punjab, as intervention to promote immunization is effectively reducing refusals; the inability to follow schedule to completion is rising as secondary problem. Program strategy should attend simultaneously to both. In Sindh, the dropouts are minor to refusals in same districts. Almost half the sample size in Sindh districts are refusing neonatal vaccines. The refusal rate is higher than 40%, with odds of refusal in 5 districts being considerably higher. Names of districts are in Annexure-4.In Baluchistan, the dropouts and refusals are synchronous. In two districts the dropouts are slightly higher than refusal. On average dropouts are below 20% of sample size and refusals are above 50%. In Baluchistan, however, odds are higher than 80% for all districts.

I conclude that split social determinants alter the way public health programs are absorbed. Determinants of health are relational and dynamic.

Multivariate Analysis

Multivariate regression method is used. Regressing $f(y|\ x)$ on chosen X_i show if there is a statistically significant difference on Y due to changes in X. Our hypothesis is that average occurrence of socio-economic indicators (X_i), in our frame of population ('n'), is linear as to tendency of response variable (Y). Response variable is categorical in nature. There is no order in the occurrence of response. Regression predicts response by projecting features in lower dimensional space. Constant term is manually set at zero so system is homogenous. The coefficient of regression gives us the degree of difference in Y due to X and its slope measures steepness of curve. We identify X in data and set qualifiers for each variable. X are coded. The trend of data-points tracks and compares households that refuse or accept vaccine. Predictors are linearly independent. Variance of error is constant across values of X and uncorrelated. Different combinations of X_i represent different socio-economic standards of living. We assume there is no error within independent variables. We run models together to reduce standard error. Control arm is made on the basis of constant access.

Treatment Arm: Sequence for treatment arm is given as under:

$(pY_1) / (pY_2 + pY_3)$; $(pY_2) / (pY_1 + pY_3)$; $(pY_3) / (pY_1 + pY_2)$

⇨ $(pY_1) + (pY_2) + (pY_3) = 1$

If pY1 > pY2 and pY2 > pY3 then response is Y1.

Assumption: It is assumed that $y|\ x$ corresponds to fixed X_i in the random sample. Variance $s^2_{X|Y}$ is equal for all X_i and $\mu_{Y|X}$ is constant for any fixed X. Reference is Y_0. There shall be 2(3-1) /2 models.

Model_1:

(i) $\log (pY_1/ pY_3) = \hat{Y}_1 = \alpha + \Sigma(\beta X)_i + \varepsilon\ ; (\mu_\varepsilon = 0)$

(ii) $pY_1/ pY_3 = \exp (\alpha + \Sigma(\beta X)_i)$ or $pY_1 = pY_3 * \exp (\alpha + \Sigma(\beta X)_i)_A$

Model_2:

(iii) $\log (pY_2/ pY_3) = \hat{Y}_2 = \alpha + \Sigma(\beta X)_i$

(iv) $pY_2/ pY_3 = \exp (\alpha + \Sigma(\beta X)_i)$ or $pY2 = pY_3 * \exp (\alpha + \Sigma(\beta X)_i)_B$

⇨ $pY_3 * \exp(\alpha + \Sigma(\beta X)_i)_A) + pY_3 * \exp(\alpha + \Sigma(\beta X)_i)_B) + pY_3 = 1$ ….. (a)

$\mathbf{pY_3} = 1 / \{1 + \exp (\alpha + \Sigma(\beta X)_i)_A + \exp (\alpha + \Sigma(\beta X)_i)_B \}$ …. (1)

As,

$pY_1 = pY_3 * \exp (\alpha + \Sigma(\beta X)_i)_A$ & $pY_2 = pY_3 * \exp (\alpha + \Sigma(\beta X)_i)_B$ ..... (b)

Hence,

$\mathbf{pY_1} = \{\exp(\alpha + \Sigma(\beta X)_i)_A\} / \{1 + \exp(\alpha + \Sigma(\beta X)_i)_A + \exp(\alpha + \Sigma(\beta X)_i)_B \}$ …. (2)

$\mathbf{pY_2} = \{\exp (\alpha + \Sigma(\beta X)_i)_B\} / \{1 + \exp (\alpha + \Sigma(\beta X)_i)_A + \exp (\alpha + \Sigma(\beta X)_i)_B \}$ … (3)

Model 1 explains full immunization and Model 2 explains incomplete immunization. The simultaneous equation for multi-logistic regression analysis is given below:

(I)… $Y_{(1,0)} = \ln \frac{P(Y_1)}{P(Y_0)} = \alpha + \sum_{i=1}^{j} \beta_i (X_i)_j$; where, j is categories of i number of indicators X

(II)… We know that the slope of regression equation as: $\hat{\beta} = \text{cov}(Y_k, X_i)\ .\ \frac{SD\ (Y_k)}{SD\ (X_i)}$

(III)… For odds ratio of Y_1 over Y_2 is $\exp(\beta X_i) / 1 + \exp(\beta X_i)$

Diagnostics:

I used m-1 in the model and excluded dummy which were used for reference.

Separate regressions were run using one of the X as response and rest of the variables as regressors. Tolerance was computed using formula $1-R^2$. Variance inflation factor was set at 1/tolerance. Terms with high interaction (VIF greater than 10) were dropped.

Correlation coefficient can range from -1 to +1, but we want to include X variables, correlation among which is close to zero.

$p<0.05$, $p<0.01$ and $p<0.1$ are used for testing significance. Variables that are insignificant are excluded.

In my estimation: pseudo R-sq = 0.318 ; prob > 0.696 ; LR= 43.29 ; log likelihood = -322.49

Chapter -6

Results and Analysis

Variables that were dropped are: family planning adoption, over-crowding in household, competing needs of siblings, language spoken at home as an indicator of culture and origin, parity of mother in last five years. Coefficient of regression for significant variables are presented in tables below. They are analyzed for full immunization (y_full), non-immunization (y_no), drop-out and odds of non-immunization ($e^{\beta\hat{}}$) in each province. Confidence intervals are reported in brackets. Association of variables with immunization status are also analyzed between provinces.

Table 6.1: Association of neonatal immunization with region of domicile

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
region	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.1**	**p<0.05**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.01**	
urban	91.22 (70.8-97.2)	23.97 (19.8-28.0)	12.81 (05.7-29.9)	ref	93.2 (80.5-96.9)	4.58 (2.7-6.3)	18.12 (15.2-22.9)	ref	48.09 (28.8-81.0)	22.65 (18.6-46.6)	14.19 (10.1-18.1)	ref	9.13 (8.86-9.46)	13.15 (06.8-29.2)	5.18 (4.5-8.1)	ref
rural	38.85 (13.9-43.7)	5.08 (4.2-7.4)	18.29 (09.1-32.7)	0.82	66.2 (51.2-75.2)	8.07 (3.9-19.5)	29.36 (23.0-35.6)	0.93	15.73 (12.7-43.5)	33.74 (22.9-64.5)	5.97 (2.5-9.3)	0.75	7.99 (3.2-9.6)	12.17 (08.4-16.4)	28.38 (20.7-38.2)	1.11

Source: Author's calculation

Permanent domicile has greatest deterministic power among all independent variables. Table 6.1 shows that the correlation of urban dwelling with full immunization is higher in Punjab than other provinces. Dropout rates are higher for rural areas compared to urban areas except Sindh. It makes less difference to live in rural Sindh than urban Sindh to achieve full immunization. Babies in rural Baluchistan suffer highest odds to full immunization. Coefficient for dropouts in rural KPK are higher than non-immunization. Vaccine rejection is greater in rural KPK compared to rural Sindh.

Table 6.2: Association of neonatal immunization with neonatal gender

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
childgender	**p<0.1**	**p<0.01**	**p<0.01**		**p<0.1**	**p<0.1**	**p<0.05**		**p<0.1**	**p<0.1**	**p<0.1**		**p<0.1**	**p<0.1**	**p<0.1**	
male	41.4 (25.0-67.0)	27.45 (23.1-31.7)	45.32 (35.5-45.1)	0.59	23.9 (11.1-66.9)	6.6 (4.6-8.6)	22.69 (17.4-27.8)	0.51	18.1 (05.9-48.3)	8.4 (6.3-9.7)	16.3 (13.9-22.7)	0.52	41.4 (28.3-55.7)	8.6 (5.4-9.7)	35.8 (24.7-58.2)	0.59
female	41.8 (38.8-49.0)	28.01 (26..5-32.1)	45.87 (37.6-83.2)	ref	23.1 (8.7-32.6)	6.1 (4.6-9.6)	21.8 (20.3-43.3)	ref	16.6 (03.8-49.4)	7.9 (5.2-9.4)	15.8 (8.9-17.3)	ref	14.4 (4.5-37.8).	17.9 (4.2-12.5)	37.2 (12.8-58.2)	ref

Source: Author's calculation

Table 6.2 shows that in Baluchistan the coefficients of rejection for female babies are slightly higher than male. But it cannot be regarded as widespread discrimination as the same is not true everywhere. Large gaps are not found between immunization of female child and male child (OR is approx.50%) across other provinces. This dispels the notion that male health receive priority by parents due to their earning potential. This shows changing social culture of Pakistan. Health of female child is given similar importance because education and employment opportunities are equally available. Different coefficients of provinces can be attributed to amount of data and male-female birth ratios.

Table 6.3 shows that correlation of younger than 25 years with full immunization is greater than correlation of less than 25 year olds or higher than 35 year olds. Older than 35 years have lower correlation with full immunization than other groups in all provinces. Maternal age is weaker determinant of immunization status in Baluchistan compared to other provinces.

Table 6.3: Association of neonatal immunization with maternal age

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
matage	**p<0.05**	**p<0.1**	**p<0.01**		**p<0.01**	**p<0.05**	**p<0.01**		**p<0.1**	**p<0.1**	**p<0.01**		**p<0.01**	**p<0.05**	**p<0.05**	
15-25	26.45 (16.4-32.4)	28.7 (26.0-33.4)	42.05 (41.8-49.8)	1.08	24.45 (11.9-36.9)	25.35 (15.8-32.2)	40.57 (16.3-54.7)	0.91	16.1 (9.0-24.2)	26.5 (15.5-38.5)	57.46 (21.6-71.2)	0.87	15.31 (10.4-25.4)	5.08 (3.7-7.9)	19.29 (15.7-29.3)	1.19
26-35	53.28 (47.9-55.1)	29.7 (19.3-38.5)	20.29 (12.4-34.0)	1.28	41.62 (38.7-54.5)	18.94 (10.5-29.3)	23.19 (18.6-27.6)	1.03	34.5 (22.3-46.7)	8.3 (6.6-10.0)	17.08 (14.1-21.5)	1.04	18.45 (2.4-26.6)	7.19 (4.5-19.5)	7.39 (2.2-17.5)	1.24
36-49	19.69 (15.6-20.5)	36.4 (35.4-43.2)	29.83 (9.2-38.6)	ref	36.08 (15.2-52.2)	7.62 (5.2-9.7)	48.53 (18.7-50.3)	ref	28.6 (15.1-30.7)	5.8 (4.9-9.3)	42.59 (13.4-66.8)	ref	8.89 (3.6-15.4)	4.47 (2.4-11.6)	11.35 (10.2-20.8)	ref

Source: Author's calculation

The association is strongest in Punjab of all provinces. The highest association with dropouts is in Sindh, among age group of 15-49 year olds. In KPK, non-immunization has higher association than full immunization in group of under 25 year olds. Also in Punjab, non-immunization is more strongly associated with higher than 25 years age compared to full-immunization. But in other provinces where full immunization is more strongly related with maternal age than non-immunization.

Table 6.4: Association of neonatal immunization with household relationships of mother

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
house_mat	**p<0.01**	**p<0.1**	**p<0.05**		**p<0.1**	**p<0.01**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.1**	**p<0.05**	**p<0.1**	
daughter+divorced	39.39 (36.3-42.3)	35.8 (33.1-38.9)	48.57 (14.0-63.0)	1.26	61.8 (59.3-83.6)	10.42 (6.6-30.2)	18.75 (15.2-22.2)	1.36	21.87 (9.4-64.2)	10.62 (8.7-12.5)	15.6 (12.2-19.0)	0.87	79.6 (72.4-86.4)	12.63 (9.2-15.7)	16.7 (13.4-19.4)	1.34
spouse+mainprovider	16.22 (56.3-70.1)	36.1 (6.7-15.9)	11.39 (5.2-27.2)	ref	18.1 (82.3-87.9)	24.59 (2.8-6.2)	8.39 (22.3-34.3)	ref	35.98 (16.6-59.4)	28.97 (13.6-46.2)	20.3 (11.1-44.5)	ref	22.9 (12.4-48.3)	32.57 (13.9-67.8)	19.7 (8.6-27.8)	ref
head + widow	77.68 (46.8-67.5)	9.6 (7.8-11.4)	52.63 (29.3-79.5)	1.47	55.1 (18.4-64.3)	8.32 (7.1-9.6)	38.47 (22.7-77.5)	1.33	72.86 (49.2-95.7)	6.29 (4.1-21.9)	83.1 (46.9-92.7)	1.18	42.8 (8.3-75.7)	8.79 (5.4-9.7)	15.7 (14.7-18.2)	1.16
daughterinlaw +widow	56.94 (41.8-68.4)	8.6 (5.3-9.7)	41.09 (25.5-85.7)	1.37	18.4 (12.4-41.5)	6.58 (4.8-8.2)	25.31 (20.2-68.7)	1.00	59.23 (22.1-88.3)	5.38 (4.8-6.1)	38.6 (17.4-61.6)	1.12	7.9 (4.4-19.6)	5.35 (4.3-6.4)	28.3 (16.8-43.6)	0.74

Source: Author's calculation

Table 6.4 shows relationship of neonatal immunization with four maternal groups: widowed daughter-in-law, widowed head of household, spouse as main-provider of household, divorced daughter. Widows who are head of household are associated with full immunization of babies to lesser degree in Baluchistan & KPK than Sindh & Punjab. In Sindh, this group has weaker association with non-immunization and stronger association with full immunization compared to other provinces. This group has strongest association with full immunization out of other groups, in three provinces except Baluchistan. Widows living with in-laws have stronger association with non-immunization in Punjab compared to other provinces. In this group, the stronger association with full immunization is found in Sindh. The association of this group with dropouts is strongest in Punjab compared to other provinces. In Baluchistan, full immunization is more strongly associated with divorced daughters than other groups. The association of this group with neonatal immunization in Baluchistan, is also stronger than other provinces. This group is more strongly associated with dropouts in Punjab. This group show lower association with dropout in Sindh than other provinces. The association of this group with non-immunization is nearly similar in KPK and Sindh. Among spouses who are main-provider, the association with non-immunization is greater than full immunization as well as dropouts in Punjab, KPK and Baluchistan. The association of this group is weaker

than other groups in Punjab. In KPK, however, full immunization is strongly associated with daughters living with parents.

Table 6.5: Association of neonatal immunization with condition of hygiene

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
hcond	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.05**	
unhygenic	35.82 (11.9-79.7)	19.37 (3.4-43.2)	86.73 (57.5-102.9)	ref	18.72 (75.2-82.2)	5.93 (3.8-8.2)	29.7 (3.9-42.9)	ref	19.63 (7.2-42.0)	40.46 (8.6-62.2)	39.57 (14.8-63.2)	ref	14.86 (1.4-45.6)	9.48 (7.4-11.6)	33.08 (10.4-56.6)	ref
hygenic	64.39 (38.8-89.8)	29.72 (24.6-34.8)	49.91 (16.2-78.6)	1.14	81.45 (77.8-85.0)	14.57 (2.8-36.2)	24.5 (18.7-30.3)	1.43	87.92 (85.1-90.7)	17.13 (4.9-59.3)	12.93 (8.7-17.1)	1.42	66.53 (38.4-84.7)	9.63 (5.7-13.6)	28.14 (5.2-41.4)	1.45

Source: Author's calculation

Table 6.5 shows that hygenic house conditions shows greater measure of association with full-immunization compared to unhygenic conditions. Unhygenic conditions are stronger determinants of non-immunization in Punjab than KPK or Baluchistan. Coefficient for drop outs is higher in Sindh than other provinces.

Table 6.6: Association of neonatal immunization with vaccination card retention by parent

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
cd	**p<0.05**	**p<0.01**	**p<0.01**		**p<0.05**	**p<0.05**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.01**	
yes	15.91 (5.1-26.7)	1.28 (8.6-47.8)	5.79 (0.86-5.8)	ref	78.83 (72.9-84.7)	2.89 (0.7-10.2)	18.93 (12.0-25.8)	ref	33.72 (9.6-77.4)	3.69 (0.1-5.0)	4.89 (1.0-8.6)	ref	16.24 (5.9-79.1)	5.89 (1.5-7.2)	6.47 (5.2-7.4)	ref
no	39.62 (4.9-52.5)	30.27 (28.6-32.8)	55.04 (26.1-68.1)	1.31	15.12 (5.4-24.8)	18.76 (4.6-32.8)	13.35 (9.3-14.6)	0.66	40.69 (15.7-85.5)	24.35 (8.9-57.7)	53.61 (22.7-93.4)	1.06	15.63 (2.84-32.6)	10.47 (3.9-17.2)	25.04 (12.9-51.6)	1.01

Source: Author's calculation

Table 6.6 shows that in Sindh, card retention explains full immunization to a greater degree than KPK or Baluchistan. Practice of retaining vaccination card is associated with lower dropouts. Card retention is strong measure of determining non-immunization in Punjab as well.

Table 6.7: Association of neonatal immunization with parental education

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
edm	**p<0.1**	**p<0.1**	**p<0.01**		**p<0.1**	**p<0.01**	**p<0.01**		**p<0.01**	**p<0.05**	**p<0.1**		**p<0.05**	**p<0.01**	**p<0.1**	
secondary or lower	48.8 (39.0-58.6)	17.2 (8.3-25.1)	59.82 (45.6-66.4)	1.18	19.5 (5.5-53.5)	8.62 (0.5-19.7)	49.57 (18.1-70.9)	0.87	39.75 (1.6-82.8)	8.45 (3.4-15.6)	50.9 (13.5-70.5)	1.36	9.51 (2.8-45.7)	9.48 (3.4-16.6)	18.2 (3.5-22.5)	1.09
higher than secondary	69.4 (58.9-75.5)	3.9 (1.0-4.3)	14.09 (1.8-29.5)	1.27	42.6 (35.4-55.8)	4.89 (2.7-5.1)	5.63 (0.8-10.4)	1.04	54.9 (48.2-61.6)	2.37 (2.1-5.4)	48.4 (15.4-72.3)	1.46	11.62 (5.6-24.8)	3.15 (0.5-6.9)	5.7 (1.2-20.8)	1.12
no formal education	24.3 (18.8-31.8)	37.1 (26.2-45.0)	69.53 (55.2-73.1)	ref	34.9 (12..6-76.8)	18.52 (5.2-25.7)	13.62 (9.8-58.4)	ref	12.17 (2.8-44.4)	21.96 (18.5-32.3)	34.8 (18.6-76.6)	ref	6.56 (3.4-14.7)	15.36 (3.2-35.6)	28.2 (15.7-32.5)	ref

Source: Author's calculation

Table 6.7 shows that direct caregivers who are educated above secondary levels are more likely to accept full immunization in all provinces. Those with no formal education have weaker association with full immunization in all provinces. In Baluchistan, education is less associated with immunization status compared to other provinces. Highest association is seen in Punjab. In Sindh, association of dropouts is higher among educated caregivers compared to other provinces. Dropouts are higher than expected in Punjab for caregivers with some level of formal education. In KPK association of full immunization among those with no formal education, is higher than other provinces.

Table 6.8: Association of neonatal immunization with type of schooling of parent

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
inst	**p<0.01**	**p<0.1**	**p<0.05**		**p<0.1**	**p<0.05**	**p<0.01**		**p<0.01**	**p<0.01**	**p<0.01**		**p<0.01**	**p<0.1**	**p<0.01**	
gov	36.19 (13.5-64.9)	15.7 (3.7-26.1)	37.81 (15.3-55.7)	ref	28.6 (80.2-85.2)	12.64 (6.6-10.4)	16.35 (13.6-20.6)	ref	42.77 (19.8-84.4)	19.36 (10.8-31.4)	26.52 (4.8-59.8)	ref	28.73 (19.8-54.4)	39.8 (27.8-51.4)	18.59 (4.8-41.8)	ref
prv	64.16 (30.5-88.6)	7.2 (2.6-19.8)	25.63 (8.2-35.4)	1.14	54.6 (22.2-104.7)	6.74 (2.5-9.5)	7.15 (2.4-28.7)	1.17	76.85 (52.4-98.5)	28.72 (15.2-32.7)	44.67 (28.9-55.9)	1.14	68.27 (54.6-83.6)	26.9 (5.3-38.1)	35.27 (13.8-54.6)	1.23
rlg	22.79 (15.9-66.8)	35.3 (20.4-48.6)	45.62 (38.2-69.2)	0.89	16.2 (7.8-28.2)	24.72 (14.9-39.5)	28.47 (21.2-50.2)	0.87	55.18 (47.7-61.5)	13.68 (8.5-29.3)	37.42 (18.6-46.6)	1.06	13.71 (9.4-24.7)	42.5 (32.8-58.9)	19.32 (10.8-22.4)	0.83

Source: Author's calculation

Table 6.8 shows that receiving education from private institute is associated with full immunization more strongly than government education in all provinces. Coefficient for dropouts is higher in Baluchistan among privately educated compared to other provinces. The sample size for Baluchistan is smaller than other provinces, therefore, results are not absolute reflection of local drivers but a relative measure. Education from religious institutes is more strongly associated with full immunization than government institute in Sindh. Dropouts are more strongly associated with religious institute education than government or private in KPK and Punjab. Coefficient of dropout is higher for government institute than private in Punjab. Smallest coefficient for non-immunization is in KPK for private education.

Table 6.9: Association of neonatal immunization with health worker preferred by parent

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
hcons	**p<0.1**	**p<0.01**	**p<0.1**		**p<0.1**	**p<0.01**	**p<0.05**		**p<0.1**	**p<0.1**	**p<0.05**		**p<0.1**	**p<0.01**	**p<0.1**	
facility	54.2 (30.0-79.2)	6.36 (2.8-17.8)	40.4 (22.1-68.7)	ref	57.6 (38.4-77.0)	17.15 (4.8-29.4)	31.67 (12.4-41.6)	ref	43.8 (19.2-75.6)	15.3 (5.3-39.7)	28.39 (13.8-42.8)	ref	29.2 (10.2-45.6)	18.15 (4.2-37.4)	28.4 (15.8-45.8)	ref
Hakeem/Homeo	18.1 (13.8-42.0)	35.48 (30.2-40.4)	45.6 (35.8-60.6)	0.77	12.3 (8.6-34.4)	36.49 (24.4-48.6)	75.35 (54.4-93.4)	0.69	6.3 (1.9-12.8)	25.7 (13.5-47.7)	68.57 (45.6-90.7)	0.62	7.6 (2.5-16.5)	18.43 (3.2-35.4)	67.3 (44.7-82.4)	0.71
LHW	66.7 (56.3-70.1)	1.49 (6.7-15.9)	35.2 (25.2-53.2)	1.05	53.5 (22.3-67.9)	5.26 (2.8-11.2)	22.67 (16.4-51.2)	0.98	48.9 (15.3-69.3)	4.1 (0.7-9.8)	13.26 (1.3-29.2)	1.02	82.7 (65.4-105.6)	2.91 (0.4-9.6)	15.1 (5.4-36.6)	1.27

Source: Author's calculation

Type of health worker consulted by family is significantly correlated to their behavior towards immunization. Table 6.9 shows that families who frequent any health facility (government or private) for treatments have lower association with non-immunization in all provinces. Consulting 'hakeem' has lower association with full immunization in all provinces but it is especially weak in Sindh. LHW visits has stronger association with full immunization in Baluchistan compared to other health workers. The weakest association with non-immunization among provinces is of facility in Punjab.

Table 6.10: Association of neonatal immunization with frequency of healthcare utilization

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)	y_full	y_no	Dropout	$e^{\beta\hat{}}$ (Rej)
usebh	**p<0.1**	**p<0.01**	**p<0.1**		**p<0.1**	**p<0.1**	**p<0.05**		**p<0.1**	**p<0.1**	**p<0.1**		**p<0.1**	**p<0.1**	**p<0.1**	
facility use past four month	28.5 (24.5-32.5)	26.09 (11.6-35.4)	86.3 (80.7-91.9)	1.11	10.2 (7.9-12.5)	7.5 (5.6-8.4)	80.79 (78.1-83.3)	1.34	69.5 (56.6-83.7)	7.6 (6.3-9.2)	17.5 (9.62-30.4)	1.13	55.6 (36.8-71.4)	7.5 (5.4-9.2)	23.5 (19.5-27.4)	1.25
LHW visit past four month	41.2 (34.7-47.7)	16.83 (10.4-23.2)	67.6 (56.7-78.5)	1.21	4.1 (1.8-6.4)	5.1 (3.7-9.8)	87.06 (83.7-90.3)	1.08	85.8 (71.2-91.3)	6.8 (2.4-8.6)	21.3 (14.6-37.2)	1.18	68.4 (54.2-73.9)	6.1 (5.2-7.4)	26.5 (19.6-33.6)	1.31
no healthcare availed past four month	18.6 (9.7-22.3)	47.67 (33.4-59.0)	71.5 (64.9-78.1)	ref	2.8 (1.3-6.5)	8.6 (4.3-7.4)	89.81 (87.7-91.9)	ref	41.4 (26.7-55.4)	8.1 (6.4-8.1)	19.7 (12.4-26.8)	ref	22.3 (15.3-32.4)	8.3 (6.4-9.5)	30.4 (22.6-37.4)	ref

Source: Author's calculation

Table 6.10 shows that the association of dropping out from immunization schedule is lower with visits of Lady Health Worker compared to facility visit in all provinces. Non-immunization is more strongly associated with no healthcare availed in all provinces. Full immunization is more strongly associated with LHW visit compared to facility use in all provinces except KPK. Frequency of healthcare utilization has smaller measure of association with immunization status in KPK than other provinces.

Table 6.11: Association of neonatal immunization with training and cooperation of health worker

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
util	**p<0.1**	**p<0.01**	**p<0.01**		**p<0.1**	**p<0.1**	**p<0.01**		**p<0.1**	**p<0.1**	**p<0.01**		**p<0.01**	**p<0.1**	**p<0.01**	
staff untrained	28.4 (18.8-49.8)	12.63 (14.6-54.8)	45.16 (31.2-78.6)	ref	42.6 (22.8-55.0)	45.8 (35.8-51.2)	71.91 (58.7-88.3)	ref	31.7 (20.1-57.7)	58.4 (44.9-69.3)	79.86 (58.7-97.1)	ref	38.72 (28.4-64.7)	47.2 (25.7-53.6)	67.4 (55.2-81.4)	ref
staff non-coperative	15.8 (3.9-33.7)	15.92 (9.8-38.0)	37.93 (16.7-59.9)	0.86	30.6 (10.5-56.9)	25.2 (12.7-36.3)	44.33 (23.0-65.6)	0.92	29.1 (16.8-41.0)	36.4 (24.2-47.4)	86.87 (60.1-99.1)	0.98	17.48 (5.6-28.6)	32.4 (24.5-58.1)	79.52 (65.2-82.9)	0.82

Source: Author's calculation

Table 6.11 shows that association of training and cooperation is weaker in Punjab than other provinces. The association with full immunization after dealing with non-cooperative workers are higher in KPK compared to other provinces. The drop outs are associated strongly with untrained staff in KPK. In Sindh, association of non-immunization with untrained, non-cooperative health worker is higher than other provinces.

Table 6.12: Association of neonatal immunization with mode of vaccine administration

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
vac	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.05**	
sepvac	35.87 (31.9-39.7)	39.37 (35.4-43.2)	56.72 (70.5-82.9)	ref	28.71 (10.2-42.2)	11.76 (8.3-23.7)	78.4 (53.9-92.9)	ref	49.65 (27.2-62.0)	19.48 (9.6-28.2)	69.57 (54.8-83.2)	ref	11.42 (5.7-28.6)	9.67 (4.1-17.6)	23.84 (10.4-46.8)	ref
jointvac	44.32 (31.8-59.8)	29.75 (14.6-33.8)	29.92 (11.2-58.6)	3.88	81.44 (77.8-95.0)	6.83 (4.5-19.1)	24.5 (18.7-39.3)	4.44	77.98 (65.1-98.2)	10.15 (4.9-21.3)	12.92 (8.7-37.1)	1.10	16.56 (8.4-34.7)	8.35 (5.7-18.6)	8.49 (5.2-17.4)	1.10

Source: Author's calculation

Table 6.12 shows that association of full immunization is stronger with joint or combination vaccine compared to separate vaccine in all provinces. The difference of coefficients is more pronounced in Sindh. Lowest association of immunization status with mode of vaccine administration is found in Baluchistan. The strength of correlation for dropouts is higher with separate type of vaccine in all provinces. Joint type of vaccine has strongest association with full immunization in KPK compared to other provinces. Non-immunization has strongest association with separate vaccine in Punjab compared to other provinces.

Table 6.13: Association of neonatal immunization with tetanus toxoid injection

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
tt	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.05**	
yes	20.6 (5.1-26.7)	38.5 (28.6-57.8)	11.58 (8.6-22.8)	ref	76.27 (72.9-84.7)	9.62 (8.7-10.2)	15.8 (12.0-25.8)	ref	95.31 (90.6-97.4)	4.19 (3.1-5.0)	6.24 (1.0-8.6)	ref	79.27 (75.9-95.1)	6.35 (3.5-7.2)	5.71 (5.2-7.4)	ref
no	50.5 (49.5-60.5)	14.2 (6.7-25.7)	88.92 (79.4-92.6)	1.25	87.96 (86.0-91.4)	3.74 (1.7-4.7)	25.7 (17.4-29.6)	1.03	86.97 (85.1-91.1)	7.58 (3.6-8.0)	24.63 (15.6-26.6)	0.98	62.61 (58.1-76.1)	55.93 (33.8-79.0)	22.77 (18.6-24.6)	0.95

Source: Author's calculation

Table 6.13 shows that measure of correlation of tetanus toxoid administration, in pregnant mothers with full immunization of babies, is highest in Sindh and lowest in Punjab. Non- immunization is associated

with non-administration of tetanus toxoid to mothers more strongly in Baluchistan than other provinces. Neonatal drop-outs are most associated with maternal tetanus toxoid in Punjab compared to other provinces

Table 6.14: Association of neonatal immunization with place of birth

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
birth	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.05**	
hosp	85.91 (83.2-87.4)	5.24 (4.9-6.5)	14.38 (9.1-39.5)	ref	78.72 (75.2-82.2)	79.65 (71.8-88.4)	18.4 (13.9-22.9)	ref	64.92 (43.5-76.2)	3.71 (0.6-10.2)	19.53 (14.8-23.2)	ref	20.41 (5.4-35.6)	8.62 (3.4-15.3)	6.38 (5.2-8.4)	ref
home	37.42 (17.5-52.3)	29.78 (24.6-34.8)	48.63 (37.4-59.3)	0.83	51.47 (37.8-85.0)	6.84 (4.5-9.1)	88.4 (78.6-96.4)	0.91	71.97 (55.1-90.7)	47.19 (34.9-69.3)	86.95 (75.8-97.2)	1.03	16.57 (8.4-24.7)	59.65 (35.7-73.6)	78.43 (55.2-91.4)	0.98

Source: Author's calculation

Table 6.14 shows that non-immunization is strongly associated with choice of mothers to deliver baby at home in all provinces except KPK. Measure of association of full-immunization is smaller for hospital births in Sindh compared to other provinces. The coefficients of drop-outs for hospital births are smallest in Punjab.

Table 6.15: Association of neonatal immunization with postnatal care of mother

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
pnc	**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.1**		**p<0.01**	**p<0.01**	**p<0.05**		**p<0.01**	**p<0.01**	**p<0.05**	
no	38.21 (35.1-41.3)	39.51 (36.4-42.6)	76.73 (71.7-81.7)	ref	70.79 (48.2-89.4)	19.15 (8.1-30.4)	18.3 (16.8-23.8)	ref	21.96 (9.0-44.8)	9.44 (7.2-11.6)	26.35 (13.3-29.3)	ref	19.82 (6.7-27.9)	6.76 (4.7-8.6)	51.49 (35.1-67.5)	ref
yes	88.24 (51.2-95.2)	11.18 (6.6-15.6)	39.96 (20.0-79.8)	1.20	79.91 (67.3-82.5)	9.13 (7.3-10.9)	8.6 (6.4-11.2)	1.02	87.86 (85.3-90.3)	6.47 (4.5-8.3)	16.35 (13.4-26.8)	1.39	51.39 (38.6-85.4)	5.54 (3.8-7.2)	12.64 (8.3-16.9)	1.26

Source: Author's calculation

Table 6.15 shows that association of mothers who received post-natal care is stronger with full immunization in all provinces. The dropouts are also associated more strongly with lack of postnatal care in all provinces.

Table 6.16: Association of neonatal immunization with occupation of parent

	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
emp_w	**p>0.1**	**p<0.01**	**p>0.1**		**p>0.1**	**p>0.1**	**p<0.05**		**p<0.1**	**p>0.1**	**p<0.1**		**p<0.1**	**p>0.1**	**p<0.1**	
agri	42.7 (22.8-63.9)	57.35 (32.8-71.8)	30.4 (12.1-58.7)	0.95	39.7 (20.4-57.0)	17.2 (3.4-24.7)	27.43 (12.4-41.6)	0.87	33.1 (21.2-58.6)	7.5 (5.3-9.7)	6.8 (3.8-15.8)	0.90	12.2 (4.2-17.6)	6.5 (2.1-15.4)	20.8 (15.8-31.8)	1.59
wrkr	53.8 (34.6-79.2)	17.48 (5.2-21.4)	55.1 (38.8-70.6)	ref	72.3 (58.8-94.8)	19.7 (8.4-21.6)	52.39 (34.4-73.4)	ref	48.3 (25.1-65.8)	21.5 (13.5-35.7)	26.5 (8.6-32.7)	ref	2.6 (0.5-7.5)	3.8 (1.3-9.4)	16.3 (4.7-21.4)	ref
bsns	70.6 (49.7-96.4)	15.47 (1.2-24.4)	67.3 (40.2-80.5)	1.06	60.3 (48.8-84.8)	16.4 (4.8-38.3)	15.79 (4.1-23.4)	0.96	78.3 (65.1-95.8)	12.5 (3.5-27.7)	16.5 (15.6-20.7)	1.11	26.2 (18.5-46.5)	5.8 (0.7-8.4)	19.9 (7.3-23.7)	1.96

Source: Author's calculation

Occupation provides link to particular network. Social circle effects attitude of people. Table 6.16 shows that in Punjab, agricultural occupation is associated with non-immunization more strongly compared to other professions or self-employment. In Sindh, worker group is associated with non-immunization more strongly than agriculture or business fields of employment. Employment in agriculture is associated with dropouts more strongly compared to other occupations in Baluchistan. In KPK, association of full immunization is stronger with professional employment than business occupation and occupation in agriculture has weaker association than business. Agriculturists in Punjab have higher association with drop-outs than other provinces. In Sindh, business occupation has stronger correlation with full

immunization and drop-outs are more associated with workers. In Baluchistan, employees are less associated with full-immunization compared to businessmen and agriculturists.

Table 6.17: Association of neonatal immunization with income of household

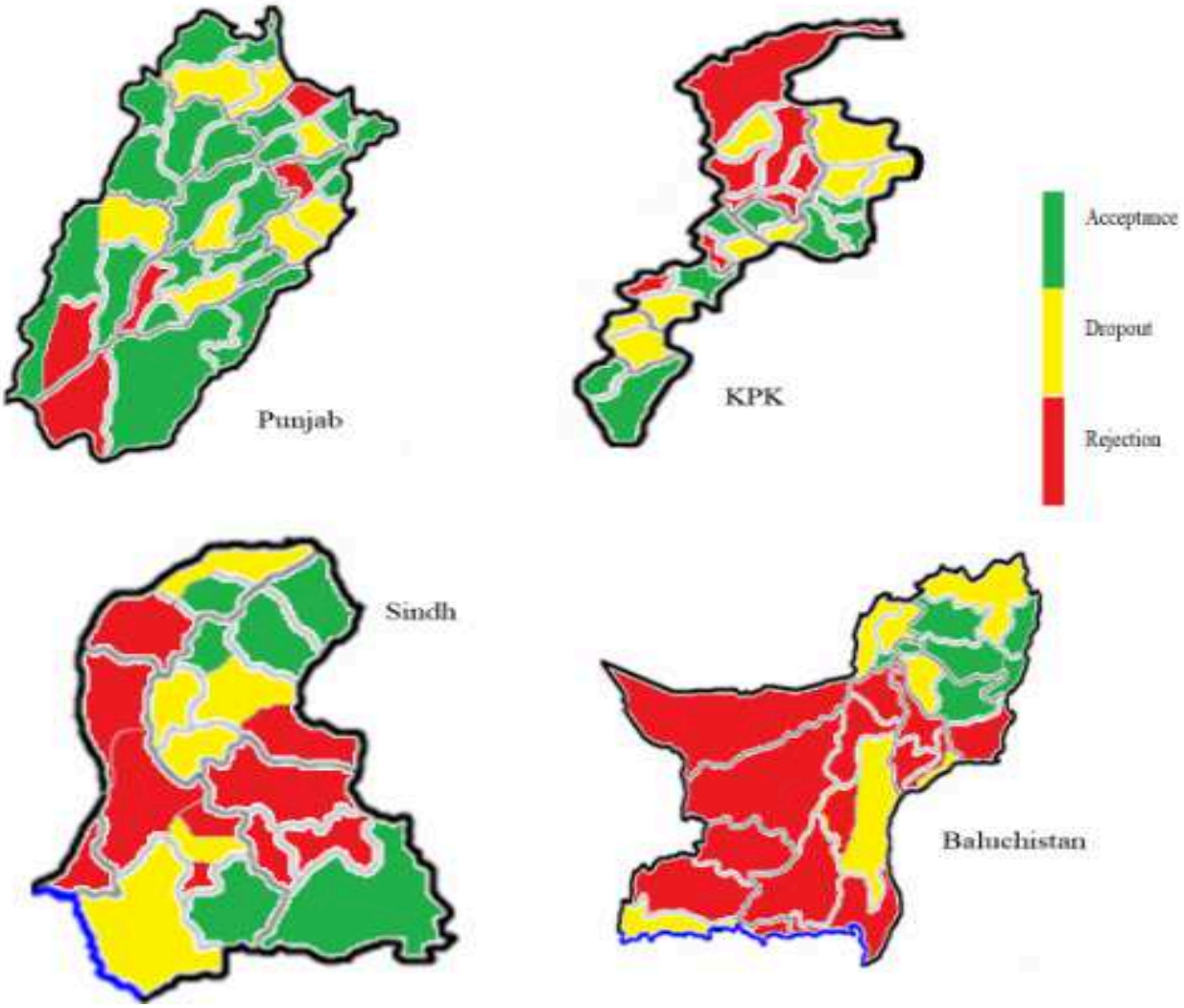
	PUNJAB				KPK				SINDH				BALUCHISTAN			
group/variable	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)	y_full	y_no	Dropout	$e^{\hat{\beta}}$ (Rej)
emp_i	**p>0.1**	**p<0.01**	**p>0.1**		**p>0.1**	**p>0.1**	**p<0.05**		**p<0.1**	**p>0.1**	**p<0.1**		**p<0.1**	**p>0.1**	**p<0.1**	
upto10k	50.3 (39.6-62.4)	11.83 (9.2-13.2)	83.4 (80.7-91.5)	1.04	70.9 (50.4-87.0)	76.9 (58.6-94.7)	19.05 (12.4-21.6)	0.95	63.4 (49.2-75.6)	27.8 (15.3-39.7)	6.7 (4.4-8.6)	0.95	29.4 (15.8-44.7)	26.5 (4.2-27.4)	16.8 (5.8-25.8)	0.88
10k-50k	38.2 (32.0-42.0)	35.48 (30.2-40.4)	65.1 (60.8-70.6)	0.98	82.3 (68.8-94.8)	39.4 (27.3-41.5)	3.08 (2.9-5.7)	0.97	68.3 (45.1-85.8)	6.7 (4.4-8.6)	16.5 (15.6-20.7)	0.96	42.6 (28.5-66.5)	14.8 (3.2-27.4)	11.3 (1.7-21.4)	0.96
50k-100k	42.3 (39.5-45.1)	40.97 (36.4-42.6)	77.8 (71.7-81.7)	ref	93.7 (75.2-96.4)	9.8 (8.1-10.4)	17.31 (16.8-23.8)	ref	80.7 (79.0-84.8)	18.6 (7.2-32.6)	15.9 (13.3-19.3)	ref	51.7 (21.7-67.9)	5.8 (4.7-8.6)	2.7 (0.1-7.5)	ref

Source: Author's calculation

Traditions and compliance to societal pressures are different in households of different wealth and income. Table 6.17 shows that in Punjab the coefficient for full-immunization is smaller in income class of Rs.10k to Rs.50k but it is greater among parents with income between Rs.50k-100k. In KPK, higher incomes are stronger determinant for full immunization. In Sindh, non-immunization is strongly correlated with household income under Rs.10k. In Baluchistan, the association with full immunization is weaker in class of parents whose monthly income is lower than Rs.50k.

Conclusion:

Different variables have association with vaccine acceptance in different provinces. In Punjab, receiving post-natal care, hospital birth instead of home, higher education levels and urban residence is stronger determinant of full immunization. The determinants of vaccine refusal are frequency of Lady Health Worker visits and occupation in farming. Divorced daughters living with parents are more likely to be hesitant. In KPK, urban dwelling, retention of vaccination card, higher household income are stronger determinants of full immunization. Rejection is associated with lower levels of education in mothers, low utilization frequency of all government services and reluctance to retain vaccination cards. In Sindh, factors of vaccine acceptability are private education, higher incomes, business occupation, joint vaccines and being head of household. Vaccine refusal is correlated with home births, male gender of child and unhygienic conditions. In Baluchistan, hygenic household conditions, tetanus toxoid vaccination to pregnant mothers, LHW visits to home, mothers living with own parents instead of in-laws are stronger determinants of neonatal immunization. The correlates of refusal are low wealth status, dependence on farming occupation and poor quality of postnatal care.



Punjab

Districts with higher relative rejections
RahimyarKhan, Rajanpur, Nankana Sahib, Gujrat Muzaffargarh

Districts with higher relative dropouts.
Layyah, Vihari, TobatekSingh, Kasur, Okara, Chakwal, Jhelum

KPK

Districts with higher relative rejections in province
Lower-Dir, Swat, Shangla, Buner, Malakand, Hangu

Districts with higher relative dropouts in province
Upper-Dir, Swabi, LakkiMarwat, Bannu, Karak, Swabi

Sindh

Districts with higher relative acceptance in province
Karachi, Badin, Sukkur, Shikarpur

Districts with higher relative dropouts in province
Thatta, Hyderabad, Nawabshah, Larkana

Baluchistan

Districts with higher relative acceptance
Kohlu, Killa-Saifulla, Ziarat, Quetta, Musakhail

Districts with higher relative dropouts
Khuzdar, Jaffarabad, Gawadar, Pishin, Killa-Abdullah, Sibi, Harnai, Zhob, Sherani

Figure 6: Districts according to likelihood of vaccine related behavior

Chapter - 7

Discussion

Vaccination is means to produce health. Accessibility of vaccination is entwined with acceptability of vaccination. Utility of neonatal vaccination is determined by parents as well as government. This double agency system is by design. In districts where 80% parents are rejecting immunization, it clearly means parents don't want their tax money spent on vaccine. But government cannot halt vaccination service in these districts. Parental agency can, theoretically, lower the value of vaccine but government cannot allow that. Government has to buy more vaccine to lower susceptibility and spend extra on efforts to generate acceptance. Additional cost of low demand puts additional burden on people who pay taxes and immunize their babies because communities cannot reach herd-immunity. On the other hand, high acceptability by greater cross-section of parents can prevent costs of treating ailments from health system and increase human capital. So, value in vaccination service is composed of (a) distribution function of government (b) utility function of parents (Yuqing, 2012). Government has motive to include in programming the concern for parental acceptability together with processes for availability and affordability. Acceptability of parents is probability for government to achieve full impact of vaccination service.

Acceptability is dynamic, relational and subjective. Some health responses are reactive. Others maybe adaptive. Behaviors are also integrative rather than selective (Sallis, *et al.,* 2015). Fathers may be more accepting of vaccination out of concerns for larger community when they are told that their anti-vaccine stance is causing titers of infection to remain high and vectors to remain active. Which in turn are causing community to remain susceptible to disease and infirmity. However, mothers respond strongly to fear of injury to their baby. In households where mothers have more decision power, they are more receptive to health promotion messages. They accept immunization even if that means going against will of family patriarchs or social leaders. On the other hand, mothers' fear of side effect or belief that vaccine is unnecessary shows connection with vaccine refusal much more strongly than father. Fathers are more likely to perceive threat of falling ill from vaccine-preventable-disease as not real or imminent. Thus, refraining from getting babies vaccinated. Parental opinions are seldom rational; rather they are shaped out of orthodocity, fear of unknown, preservation of own authority or influenced by celebrated personalities. Behavior of one household also radiates to associated social networks or distant family in varying grades. Parental education, dwelling and convenient contact with trained health worker are strong predictors of child being successfully immunized and reaching 5 years of age. (Zohra, *et al*., 2015). When parent finds utility of accepting vaccine greater than the utility of refusing it or the costs of refusal are prohibitive to him, then the acceptability rises.

Acceptance of immunization is higher in urban areas and among parents with formal education. They are able to place greater value to neonatal vaccines. But rural households may accept vaccine simply because they respect doctors. The balance of trust with health managers and workers is stronger modifier of behavior in rural communities. Attitude of health-service worker that is insensitive to cultural sensibilities can prompt vaccine refusal (Haines, *et al.* 2007). Urban mothers are likely to not follow traditional health beliefs with blind conviction and they actively seek benefits of preventive interventions for baby (Fosu, 1994). Demand for immunization is high in urban regions but babies still dropout. This can be attributed to reduced expediency because of poor time management and inconvenience of parents (Shaikh & Hatcher, 2004).

Higher birth order of babies also improve the odds of receiving immunization. Chances of missing immunization and dropping out without completion are lower in older sibling. This maybe because parents are inexperienced when children are born earlier in marriage and therefore they are more anxious and concerned. Child may be 'precious- birth'. This term can mean male born, only child or born late into marriage depending on region (Gavrielov-Yusim, *et al.,* 2012). There also remains greater acceptance of vaccination in households that have witnessed the consequences of vaccine-preventable-disease. When parents see occurrence of infirmity in children due vaccine refusal by other parents in community, parents become more likely to accept vaccination (Schwartz, *et al.,* 2011). In districts of Baluchistan, large families create constraints regardless of urban dwelling or rural. Even when parents are aware of importance of immunization, mothers having more than five children accept immunization less readily than mothers in smaller families. Competing needs of older children changes parental priorities for younger ones. More the number of children born to one couple, greater is the competition for time and cost resources. When there is increased pressure on parents to meet needs of all children, vaccination of babies gets neglected (Gavrielov-Yusim, *et al.,* 2012). Similarly in households of urban Punjab, when there are distractions coming from life or career, parents tend to miss dates and dropout. This is especially true for households and families where both parents are employed. These parents fail to follow complete schedule. This group of households benefit least from campaigns. Only higher quality system utilities can raise coverage among this group.

Education of parent is important factor in shaping vaccine related behavior. Educated mothers are in contact with larger circle of people. Traditional beliefs are not concentrated and there is exposure and greater understanding of scientific information about neonatal health. Educated caregivers are less likely to comply with orthodocity of community elders or rigidity of in-laws (Peltola, 1997). In urban cities there is higher acceptance even among uneducated parents. It shows success of promotion messaging (Usman, *et al.,* 2009). However, vaccine refusal is high in Baluchistan for parents with formal education as well. It may be a reflection of deteriorating quality of educational institutes, absence of public health knowledge in curriculum or preference to tradition over schooling in that province compared to rest of the country. Religious schooling in particular can entrench negative perception about vaccines (Larson, 2011).

Certain parental occupations are more strongly associated with full immunization of child. For example parents associated with farming and agriculture refuse vaccine to greater extent than business professionals. In situation where both parents are retaining wage-occupation makes it difficult for them to take time off from work. It is inconvenient for them to visit health facility routinely. The chance of full immunization are also higher if parents are in labour work or minimum wage occupations. Parental occupation acts as channel to connect with societal networks. And attitudes align with networks parents choose to associate with. Similarly, acceptance of joint vaccines is greater. This maybe because mode of administration requires less visits and is more convenient.

Age of mother plays a role too. Either she is younger than 25 or older. Higher than 25 is more strongly associated with immunization. This can be attributed to greater experience of parents, more network connections and higher confidence of mothers (Bugvi, *et al.,* 2014). But very old age increases complacency and fixates behavior. Older woman may have less number of children and more formal education. But her formal education was inconsequential to her health seeking behavior. Dominant influence was of environment she was married into. Then there are mothers who are deeply concerned for health of their children but are unaware about how to care for their baby. They rely on mothers-in-law for time tested implements of child rearing. These mothers are rural residents living within nuclear family

systems. They are house-wives which is non-wage occupation. Their interactions are limited to closely knit network of relatives or tribe. The structure is often patriarchal with concentrated power held by elders. Mothers are not free to take decisions regarding their children which are heir-apparent of family assets (Omer, *et al.,* 2013). Religious convictions of life and death, negative messaging by family elders play regulating role. For this group there should be constant communication for health promotion. Social institutions and family connections paternalise choice architecture of parent. When intense campaign is not followed up by promotional actions due to resource constraints behavioral change is incomplete. User may fail to comprehend the schedule of administration or gain clarity on benefits of immunization (Glanz, Rimer, Viswanath, 2008). Close-knit nuclear families hold on to traditional health beliefs more strongly and reject professional advice. Divorced mothers living with parents find social pressures less hindering than widows living with in-laws or rural spouses with low empowerment. Mothers living with own parents find it convenient to take babies for vaccine or allowing vaccinator at door. Widows living with in-laws are complacent to regional influences. Widows who are head of household are less likely to fully immunize babies under their care. Reasons can be fear of side-effects and low female empowerment (Arooj, *et al.,* 2013*)*. Spouses who are main-providers show higher association with accepting neonatal immunization. These families require greatest attention of efforts. Mothers' confidence is rooted in adequate knowledge about intervention being offered. Health workers should be trained about how to manage parents that are unsure about immunization.

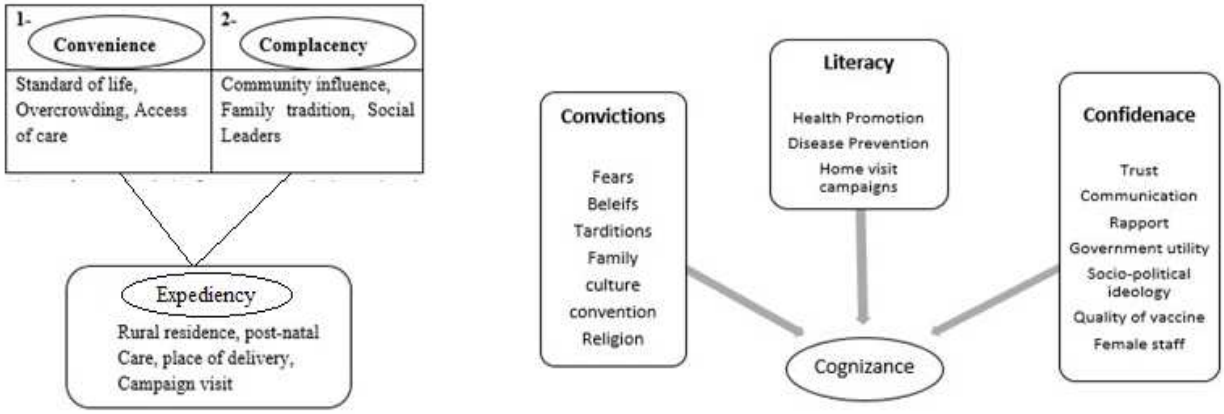
Health workers educate parents about necessity of vaccines and alleviate possible fears. Substituting the number and frequency of attendance to 'hakeem' by increase contact with qualified health professionals can raise acceptability. Usually those preferring hakeem/herbal/ homeopathic treatments hold pacifist attitude towards health and death (Usman, *et al.,* 2009). Low acceptability in Baluchistan or rural Sindh compared to other parts of country can be attributed to issues of health-worker capacity and education

Biological mothers, when in role of caregivers, are more akin to needs of child compared to situation where child care is responsibility of male or distant relative. Parents who are less busy in careers and have greater time and attention reserved for children of their own behave pro-actively towards immunization. Mothers presently not-pregnant with another child, are more likely to have higher decision power in households which lets them cater to needs of child. Mothers delivering in hospitals receive immunization advice from doctors as part of their post-natal care. This is offset by parental literacy and satisfactory rapport with health worker. With higher number of births and shorter inter-birth intervals; the measure of partial immunization rises. Where a parent is educated, mother had two year interval between births, mother received post-natal care, household was visited by vaccinators; the most impactful cause of vaccine acceptability was their convictions and literacy about health issues. In this group, benefits of vaccine are known. They refuse due to conflict with belief system. Domicile, occupation, company of peers and connections with extended family, all of these factors influence acceptability. The parenting style and methods of childcare are result of prevalent attitudes in contact circles. Compliance to community norms and traditional beliefs is low in households of urban Punjab and urban Sindh. A persistent communication effort and role of societal leaders is most important to change behaviors for this group.

Where mothers delivered at hospital facility under professionally qualified and received postnatal care. The hesitance to vaccination, when reported, was result of their fears. In this group, there is delayed immunizations and dropouts to greater extent instead of total refusal. The barriers to acceptance are rooted in disinformation. Sometimes mothers believe that it is harmful to introduce foreign substance in body of

children while they are being breast-fed. These mothers are sensitive to way health workers communicate who often compete against negative messaging of religious leaders. Faith leaders and traditionalists often provide an uphill battle to campaigns for raising immunization coverage through their negative propaganda (Siddiqui, *et al.,* 2017). They spread suspicions against vaccine is most evident in pockets where there is deep conformity to faith and tradition. A health-belief model in Pakistan must accord demographic and anthropological dimensions. Traditional health beliefs, aversion to *'English- Medicine'* in favor of herbals are a hurdle. The opinions are swayed by trustworthy health professionals. If communicated effectively and convinced of the benefits of immunization against severity of illness, these mothers are likely to be mindful of dosage schedule of vaccination without too much concern of transport or other indirect health costs. Health workers have to be tactful in their communication approaches. Speaking in local language and being mindful of culture are matters of importance. Interventions are rejected if worker fails to gain trust. Periodicity of campaign also affects coverage, as follow-up is needed to bolster participation and motivation in community. Figure 7.1 presents socioeconomic indicators of parental behaviors

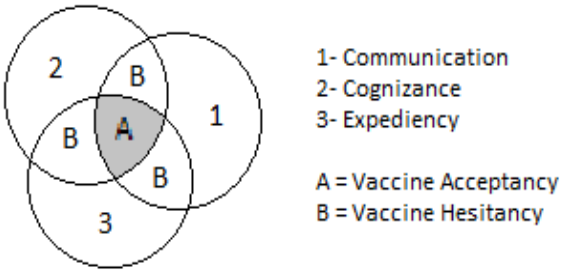
Figure 7.1: Behavioral Factors and socioeconomic indicators



Acceptability is representation of conditioning by social environment. Acceptance of public health intervention is directly associated with individual's perceived severity of illness, perceived benefit of vaccine and perceived barriers to expedience (Baranowski, Perry & Parcel, 2002). Gradations of hesitancy are not disparately arranged in severity. Greater hesitancy culminates into rejection and its gradual decrease ends in acceptance. Table 7.2 shows the spectrum of acceptability. When parent refuses vaccine deeming immunization unnecessary while having full information or show hesitancy when female health staff is not available, it reflects 'convictions' which is emotional choice. When parent fears child will get sick as a result of immunization, it reflects disinformation and lack of confidence on safety of vaccines. The choice rooted in "confidence' is rational. Confidence in vaccines leads to compliance with recommended regimen for full prevention. Availability of staff near residence or long waiting period is issue of access. But when parent do not immunize babies because health worker not visited home, it reflects preference for 'convenience' and choice is heuristic. Hesitancy because of not knowing about immunization or favoring family traditions or using herbal medicines is 'complacency' (Baranowski, Perry & Parcel, 2002). Hence, we can divide parental agency according to vaccine related behaviors and acknowledge socio-economic determinants of vaccine acceptability in provinces. Government can attempt to change behaviors through communication strategies that are tailored according to circumstances of parents.

Table 7.2: Spectrum of Acceptability

Rejection	Hesitancy	Refusal	Acceptance
Completely rejects vaccines and prevention value of them Convinced of harms to children that comes from vaccines. Actively advocates against vaccine usage.	Retains concerns about dosage schedule or capacity of health workers Misgiving about certain vaccines not all.	Delayed, incomplete vaccination	Conviction in benefits of immunization. Follows administration schedule of immunization program for all vaccines. Receptive to health communication and participates in community to promote vaccination.



The union of communication, cognizance and expediency (grey area in Venn-diagram) is the behavioral area that prevents or promotes action of parents about vaccine. These are elements of hesitancy (Which forms outer circle). Absence of all three leads to refusal of immunization.

Acceptance	H e s i t a n c y		**0**	H e s i t a n c y		Acceptance
	+2	+1		-1	-2	
	Convenience of time, place, person	Parent is informed of preventive interventions	Rejection	Fear of side effects , traditional convictions alleviated	Questions on efficacy and susceptibility answered.	

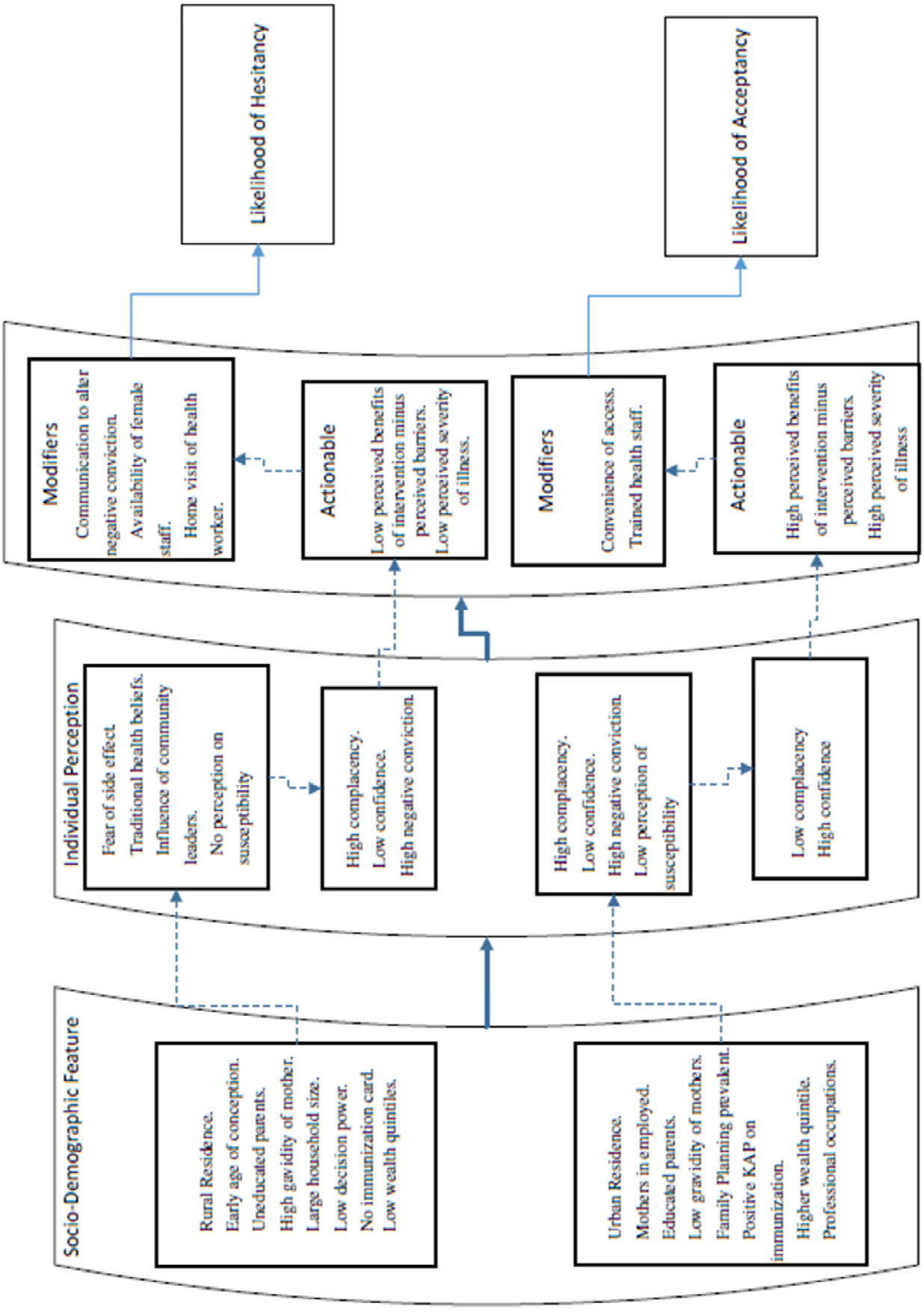
Source: Author's Own

The protections and threat of vaccine preventable diseases are appraised by systematic play of vaccine related behavior. Perception of what constitutes as healthy varies among parents. This variation occurs in terms of culture, empowerment, community networks and poverty. The reluctance of parents to allow their children be vaccinated may assume varying forms and intensities. The non-uptake of misinformed is not the same as apprehensions of ill-informed. Where former will modify behavior upon receiving correct information from reliable source, the latter will need rapport building with health worker. Parental education and community influences modify these behavior. Vaccine hesitancy is different behavior from refusal. Parents might not think childhood disease is common in their family. They may not heed to the warnings. Parents may favor alternative medicine in place of vaccine. Where some parents may fear side-effects of vaccines others may question its efficacy but still desire the inherent protection it offers. A distinct lack of trust is found among parents over safety of vaccines and motivations of health workers. There is disconnect between provider's perspective and user experience. Metrics of value and quality are not same between the two. When user income effect is taken out of equation, ability-to-pay is rendered null. Consumption in lower wealth quintiles of population should steadily expand whereas consumption in upper wealth quintiles should remain inelastic. But we are not seeing that. The behavior is linked with

social situation of household. Poor households often adopt risk prone health behaviors and negative perceptions are (Smith, *et al*. 2011). Some parents are cognizant of value in immunization. But they fail to recognize the susceptibility of their children. Care of children is shared by fathers or other family members. Sometimes care of child assumes secondary priority due to pressing economic issues or unstable marriage situation of parents. Sometimes mothers feel embarrassed to take children to health facility because they feel either partner will not be supportive or question will be asked about their ability to provide care and nutrition to child. Negative experience of user in their contact with health worker or concerns over quality may cause hesitance. Figure 7.3 presents health behavior model using socio-economic factors.

When communication strategies are employed; behavior modification of all groups don't continually increase in sophistication. Habit formation suspends rational reasoning and precautionary actions. Motivations, Ability, Role in community, and Stress on emotions (MARS) framework proposed by UNICEF can improve acceptability of EPI program in Pakistan. Vaccine refusing households are present all over the country; from rural or northwestern mountainous localities to urban metropolis like Karachi. Programming by government in absence of qualitative assessment of grass root situation is bound to fall short. The consumerist orientation to neonatal vaccination is key to achieving coverage targets. Stronger vaccine logistics and effective supply management has diminishing efficacy in health-value chain which plateaus after certain concentration levels are achieved. The long-term cost impact makes it imperative to address vaccine hesitancy. Socioeconomic conditions of households influence behavior patterns. The precedence relationships in economic satisfaction and poverty alleviation are also evident in vaccine behavior. Comprehensively designed programs should draw from common behavioral factors to transform patterns in health choices.

Figure 7.3: Modified vaccine behavior model



Chapter -8

Conclusion

Household socioeconomic conditions shape acceptability of neonatal vaccination by parents. Social factors can cause parents to rationalize choices that are not in best interest of children. Understanding determinants of vaccine acceptance can improve immunization in Pakistan. Poor households are more likely to reject vaccination which generates additional economic burden for country.

Limitations of study

Inconsistencies in survey micro datasets were noted which constrain sensitivity. Limitations arise due to secondary sourced panel data.

1. Estimation of sample for its maximum likelihood in population was done by PBS. We do not test robustness of results for our study on same population. No analysis for sensitivity and cross-applicability were employed. No attempt is made to test consistency and validity of model in different social settings.
2. Small area variations within urban/rural regions are unaccounted. We find the parameters of urban/rural demarcation to be unparticular and inconsistent across population.
3. Selection criteria is pre-determined. Calculations assume a world of random mixing. Coverage numbers are a reliable albeit non-perfect measure of herd immunity in the population.
4. Qualitative measures of health delivery service situation in area of residence may not be constant.
5. Arrangements in absence of primary care taker of children impacts child-survival strategies but adoption or foster children are not recorded in datasets we are using.
6. Observable attributes that are present in households with drop-outs or partially immunized status is not available in data.
7. Questionnaire based study is required to establish true association of behavioral dimensions and their socioeconomic indicators. Information on characteristics of mothers/parents that influence vaccine acceptancy isn't directly surveyed. Community influences on perception and utility is not directly measured.
8. Migrant, vagabond, transgender, street children are not recorded in dataset we are using.
9. Multi-collinearity is prevented by wrangling data. In real world survey based study it is counter-intuitive that social determinants are not correlated. E.g. low literacy of widowed mother living with parents at age of 25. Multiple two-way causal loops can occur among X variables.

Recommendations

1- Efficacy of EPI can be mapped in each district based on propensity of population to have their children vaccinated.

2- Real-time data collection and visualization instruments can be strengthened.

3- Collective will should be generated through behavior change communication strategies for enhancing community participation

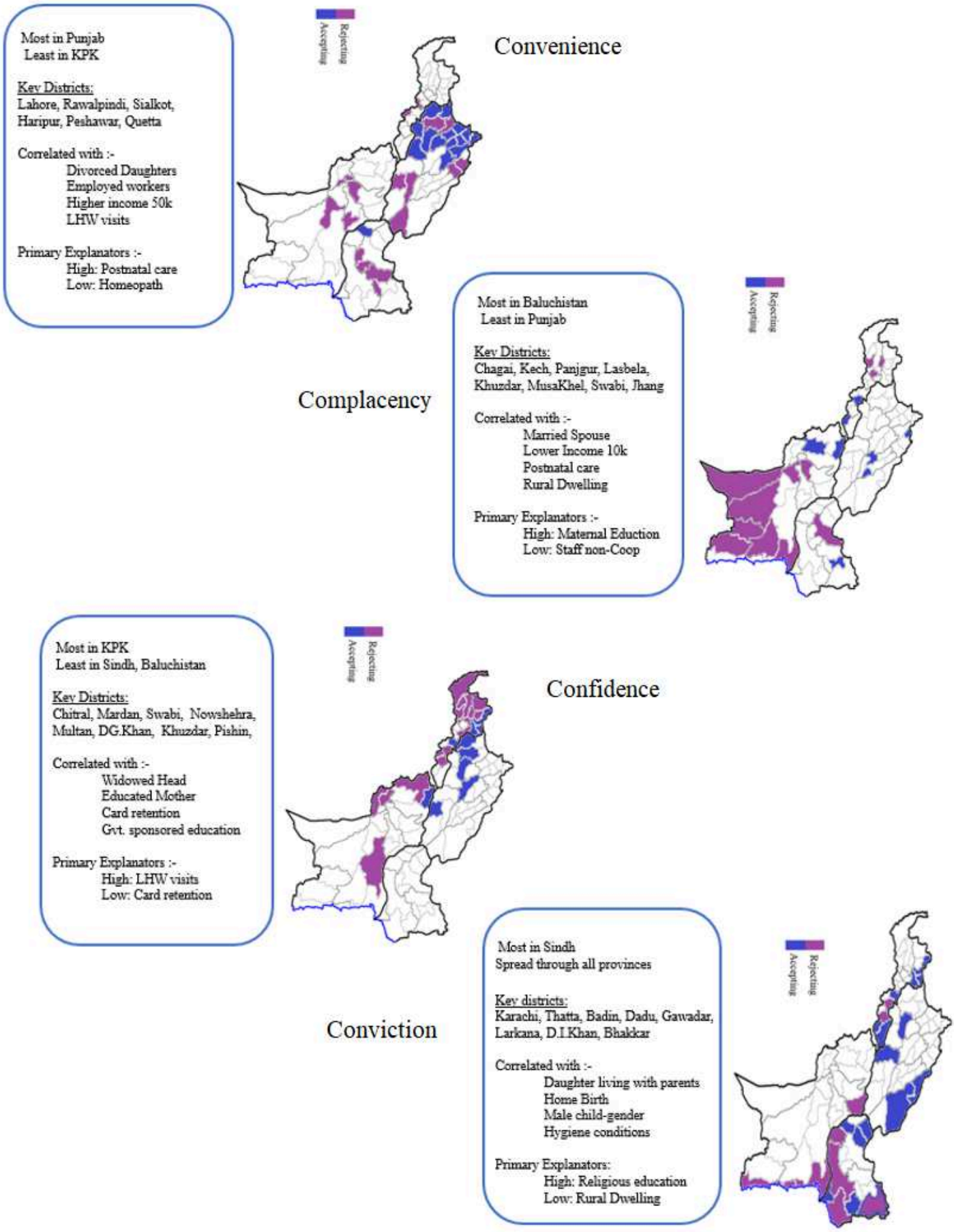


Figure 8: Dimensions of Vaccine related behavior and their distribution across Pakistan

Future prospects

Coverage dips can be attributed to vertical inequities, negative perception and gaps in total-quality-management. Following prospects can considered.

1- Instead of vaccination card, redeemable computerized cards maybe issued to parents upon birth registration. Card works as a voucher, instrument of recording vaccine administration and vital statistics. Card can hold credit points every time immunization is missed. It can also be used to manage convenience of parents, supporting their access and .Loss aversion is powerful motivator. Parents are more likely to accept vaccine if they know they have already paid for it (indirectly in taxes) and will lose money if they hide children from vaccinator at the door. Parents subscribe to program and complete 2 year schedule in progressive steps. Accumulating credit points at each dosage. It gives them sense of involvement with child care and provides structure to their efforts. In this way, even if parents don't like outside interference with matters of their child, they feel it is them who are pursuing immunization for tangible gains. Completing the program may be rewarded; for example, with a small blanket for child. Money for such initiative can be pooled from community because susceptibility to infection increases, in area and contacts, when individuals do not vaccinate.

2- 'Vaccine rejection' should be included as one of the metric while determining wastage ratio in programming. Greater research is needed in framing and deploying behavior change communication strategies for various groups. Measuring acceptability of essential health product, utility at consumer level and impact on health poverty requires evidence based synthesis. Government can induce private sector to invest more in social-marketing and social entrepreneurship. Gwatkin, Bhuiya, & Victora (2004) describe approaches that have worked in small scale to remove gaps in essential immunization such as identifying demographics of privations and using social- marketing strategies. A stochastic statistical model is desirable together with ex-post evaluation of health promotion campaigns for cost-benefit analysis. Knowledge of how clusters emerge based on socio-graphic and behavioral causality is important. Opportunistic and sensitive micro-planning for high risk migrant groups and under-performing rural districts is needed.

3- Curriculum of General science taught in elementary and secondary schools should include a chapter on public health with basic information about vaccines. This will drive home the fact that vaccines are safe and effective. This will also help eliminate misconceptions or fears due to disinformation. Religious scholars should also be brought on board to support vaccination campaigns. A simple picture of religious leader promoting immunization in *madrassah* will resonate to distant tribal corners where simple minded villagers believe vaccines are either un-Islamic or causes infertility.

4- Disincentives to vaccination due to economic conditions of parents are eliminated to a substantial degree by zero price availability of vaccines. But the coverage targets set by government to achieve herd immunity cannot withstand in absence of adequate confidence building measures. Several factors like low education levels and economic mobility hamper capacitance of parents for information and decision-making. This contributes to extent of confidence gap in vaccination.

5- Low vaccine uptake are continuously reported in feedback reviews. Experimental study can be designed to test population data on time series. Such study can explore elasticity of behavioral factors with coverage. This will provide a way to measure parental agency in value exchange between government and children. Collinearity among factors can be simulated for causal inference. Identifying demographic information on privation can help opportunistic micro-planning for high risk groups and solve in-equity issue.

6- Utility concentration of various groups can be scored and indexed for vertical health programs. This can provide evaluation of promotion strategies and programming element on demand based metrics. Managers will have means to calibrate financial flow according to service take-up. We should make agent based model for value paradigm about health interventions and also decision algorithms that track high probabilities of desired outcome.

7- Exchange instrument can be developed to change social determinants of acceptability into dollar metric. Research can investigate methods to add parental behavior in unit cost of vaccination.

Better service delivery mechanisms, improved managerial and technical capacities for effective and sustained response, augmented knowledge and practices toward vaccine preventable diseases and good health-governance functions are instrumental. Object-oriented strategies are required for coverage expansion of immunization program. Disability free children are able to uplift population groups out of poverty and create sustainability.

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Annexure- 1

Operational Definitions

Full versus Complete immunization

Full immunization is when all recommended dosages of particular vaccine are received at appropriate age schedule conferring full immunity from specific disease. Never immunized is term for state when no dosage of particular vaccine is administered ever. Completely immunized refers to status of child when all vaccines in EPI program are administered. Partial immunized is term for state when some vaccine is administered but not all. Full immunization is taken as either DTP3 or OPV3 (if pentavalent was substituted) received under 1 year of age.

Acquired Immunity

Acquired immunity is of two types: active and passive. These are further divisible into natural and artificial. Active-natural immunity comes from contact of host with pathogen. Active-artificial immunity is result of vaccine. Passive-natural immunity is due to antibodies passing from mother to child. Passive-artificial can be injected through serum of gamma-globulin.

Behavior vs attitude

Behavior is when an attitude is sustained for longer than five years of person's life. Attitude is based on preferences and perceptions of utility.

Neonate, Infant and Child

Neonate is a baby of 0 – 28 days. Infant is under 1 year of age. Child is between 12-23 months of age. Toddler is under 5 year of age. In this thesis vaccine-dosages that are completed during 0-14 week are supposed as 'neonatal'

Need vs Demand

Need is determined by government health manager on advise of health professional based on collection of evidence as a matter of policy. Demand is user related. It is subjective and equals to quantity sought.

Herd Immunity

Protection against acquiring an infection that individuals gain despite of non-inoculation of vaccine; but due to non-contagion environment that exists because rest of the people in community or close proximity have full passive immunization state. Threshold coverage is antigen specific. It is 80pc in case of polio eradication. 95pc in case of influenza control.

Health-Poor

It is a state of high risk to disease and disability because of differential immunization coverage. Health-poor individuals are unable to achieve highest attainable levels of health despite the fact that government provided equal investment in their region as other areas where coverage of immunization is proportionally higher.

Hesitancy vs Refusal

Hesitancy refers to lack of motivation and passive reluctance to adopt new thing. Refusal is conscious and active resistance to a product based on a self-constructed reasoning.

Missed vs Discontinued

Missed is group referring to children who were never covered in immunization program. Discontinued is a group referring to children that dropped out of schedule with only partial immunization.

Agent or Actor

Parents or caregiver or direct guardian is the agent whose acceptance, hesitancy, refusal modulates usage of vaccine on demand-side

User vs Provider

Neonates to whom immunization is administered and who are end beneficiaries are users. Public sector health departments, district administrators, health managers and health workers including doctors, nurses and vaccinators are providers of healthcare.

Value and Price

Price is a money metric of value exchange whereas costs can be incurred either direct, indirect, societal or time based. A priori perspective is required for cost measurements. Value in our thesis positive decision based on perceived utility.

Uptake

It is a term used when spread of vaccination from provider perspective is discussed. Parents may take up vaccine for their child while feeling hesitant towards benefits due to complacency. They may also miss vaccination round while believing in them because of inconvenience of time or place.

Household vs Family

A family is constituted by one mother and one father and children they gave birth. For purpose of our study we are excluding adopted or foster children. Single couple of up to 7 children are considered. Household includes descendants up to three degree of separation living together under one roof or eating from one kitchen. The limits include child, parents and grandparents.

Caregiver

Doctor, LHW is a caregiver too. But the term in this thesis refers to caregiver of neonate in family. In most cases biological mother is referred to as primary caregiver. Where data was missing father or head of household is taken

Table 1A: EPI schedule

Administration	Vaccine	Disease
At birth	BCG + OPV0 + HBV	Oral Poliomyelitis Vaccine (OPV), anti-Tuberculosis
6-weeks	Pentavalent1 + PCV10-1 + OPV1 + Rota1	Diphtheria, Pertussis, Tetanus (DPT), Meningitis (F Hepatitis-B(HapB), Haemophilus Influenza- B (HiB), Poliomyellitus (OPV), Diorrheal diseases
10 weeks	Pentavalent2 + PCV10-2 + OPV2 + Rota2	-do -
14 weeks	Pentavalent2 + PCV10-3 + OPV 3 + IPV	-do -
9 months	Measles 1	Measles
15 months	Measles 2	Measles
Woman of child bearing age	Tetanus Toxoid (5 doses)	Anti- Tetanus
0 – 59 months	OPV supplementary doses	Booster
6 months – 10 years	Measles supplementary doses	Booster
4 – 23 months	IPV supplementary doses	Booster

Source: Provincial Health Department (Notification 2-246; KPK 18th Jan 2018)

*Vaccine for Mumps, Measles and Rubella disease (MMR) is administered at 01 month and 09 month of age. Considerations are underway to modify EPI schedule to include vaccine against Rotavirus that controls etiology of diarrheal diseases.

**EPI schedule includes eleven antigens of 'Vaccine Preventable Diseases' (VPD). For purpose of this study population of neonates under 1 year of age are selected only. Hence, patterns and hindrances in coverage of MMR vaccine shall not be discussed. This paper shall elaborate on eight antigens within EPI program that are given to neonates from birth to 14 weeks..

*** Measles vaccine first dose is administered at 9 months from birth and final dose at 23 months. Four other vaccines included in EPI schedule are recommended in second year.

Annexure 2

Table 2B: Comparison of EPI Targets 2012 vs 2015

#	Targets
A	Improve socioeconomic equity difference between the lowest and highest wealth quintiles
B	Improve geographical equity percentage of districts that have at or above 80% coverage
C	Decrease drop-out rate percentage point difference
D	Increase demand percentage of children whose mothers intend to vaccinate their children
E	Increasing proportion of completely immunized children

TARGET	Year (2012) Levels				Proposed levels for 2015				Annual Assessment 2016				Target Missed			
	Pb	Sd	Kp	Bl	Pb	Sd	Kp	Bl	Pb	Sd	Kp	Bl	Pb	Sd	Kp	Bl
A	-	33 %	43%	-	-	15%	15%	-	-	30%	40%	-	-	15%	25%	-
B	-	29%	53%	-	61%	75%	90%	60%	35%	65%	75%	-	-	10%	37%	15%
C	11%	30%	10%	11%	<10%	08%	07%	<10%	11%	25%	10%	11%	100%	17%	100%	100%
D	2%	26%	-	-	<2%	-	35%	50%	2%	45%	63%	-	100%	-	28%	
E	66%	-	-	16%	77%	80%	80%	65%	70%	-	-	16%	7%			100%

*Source: GoP; EPI- PC-1/ Annual Monitoring Report EPI Cell; *Pb= Punjab, Sd= Sindh, Kp= Khyber-Pakhtunkhwa, Bal= Baluchistan*

*** No data for blank cells*

Annexure- 3 Criteria for literature review

We review literature in area of social health and behavioral economics. We nominate subareas of actors and social correlates. We also find literature that can aid us in better defining the topic of vaccine hesitancy, elaborate purposeful methodology for evaluation and explain causal factors in latent human behavior resultant of demographic conditioning. Our source of peer-reviewed publications was web-based open-access repositories which we navigated using engines of internet search. Articles from both international and national journals were consulted based on set inclusion criteria. Documents from governmental department, EPI operational cells and international development partners were also reviewed. Extracted pool of articles is categorized in systematic order by year of publication, specificity with Pakistan and supra-specialization of area. We chose eight subjects on which literature was reviewed. They define vaccine refusal, circumstantial effects, demographics, caregiver conditions, equity situation and state of community influence, societal system, bias due to instrumentation and methodology of research. Preference of selection was given to studies by Pakistani researchers about Pakistan. No grey literature was included. Peer reviewed articles were included if they met above criteria.

- Our inclusion criteria was as follows:

a- Literature was considered if reading of the abstract revealed relevance to country context of Pakistan or its population behaviors. In this regard cohort studies, situation analysis, campaign reports, facility assessments, departmental white paper and independent studies of national non-governmental agencies was included. Preference was placed in favor of Pakistani authors writing specifically about Pakistan.

b- Literature was included if relevancy was found in providing clearer definition and explanation of our topic. In this regard landmark papers, studies by research groups of international universities and evaluation of UN agencies was included.

c- Literature was included if it was about behavior around neonatal immunization and eight antigens of neonatal vaccine.

d- Literature was searched in directory of open access journals, google-scholar and digital library of university by entering key-words: vaccination hesitancy, vaccine-refusal, health behaviors, confidence gap and immunization programming.

- Exclusion criteria was as follows:

a- Only English language literature was included.

b- Only literature post year 2000 was included except if it helped define premise of our topic or was seminal research.

Author & Title	Year	Study & Data Type	Methods	Findings

Social Factors				
Bhutta et al. Community-based interventions for improving parinatal and neonatal health outcomes in developing countries: a review of the evidence.	2005	Qualitative evidence from programs in developing countries	Systematic review	Misconceptions, fear of side effects, conflicting priorities, cultural norms
Usman et al. Determinants of DTP3 completion in rural centres in Pakistan	2009	Facility based data for cohort study	Item response	Nature of contact with health worker in particular setting shapes perception towards vaccination
Nisar et al. KAP of mothers regarding immunization of one year old children	2010	Observational study at select locations	Descriptive Statistics	Health literacy has tendency to percolate into areas and influence different groups. Framing of message is important.
Usman et al. Improve childhood immunization adherence: redesigned card and maternal education	2010	Retrospective Experimental study	Centre based evidence synthesis using descriptive statistics	Redesigning vaccination cards and interaction of parents with health worker
Owais et al. Does improving maternal knowledge of vaccines impact immunization rates?	2011	Community based experimental design in Karachi	Randomized control trial	Educational interventions separately designed according to demographic conditions of people improve immunization attitudes.
Arooj S et al. Socio-economic factors effecting vaccination in Pakistan	2013	PDHS	Mixed methods	Wealth status and nucleus of family or community organization has greatest effects on immunization behavior
Omer et al.	2013	Location	Likelihood	Adverse reaction to vaccine of one

Vaccine refusal and disease eradication		specific experimental cohort study	ratios	can instill fear and reluctance in entire community.
Bugvi et al Factors associated with non-utilization of immunization in Pakistan	2014	PDHS	Binary Logit	Parental occupation and living arrangements are strong predictors of incomplete -immunization.
Ullah, Deen, Hussain Genesis of polio vaccination hinderance syndrome in Pakistan society	2016	Structured interviews and case reports in low coverage areas	Evidence synthesis through qualitative methods	Religious leaders have greatest impact in shaping opinions and perceptions in Pakistan
Economic Factors				
Stack et al. Estimated economic benefits during 'Decade of Vaccine' including treatment savings and labour productivity	2011	Review	Return on investment method	Increased rates of immunization can save 6.2$B in remedial treatments, 145$B in productivity losses in 10 years.
Amin et al. Mothers related differentials in childhood immunization uptake in Pakistan.	2014	Cross-sectional	Logistic regression	Low adherence to schedule and high drop-out ratios in households ranking lower in wealth
Shams. Status of immunization coverage and maternal child healthcare in Punjab, Pakistan	2015	Cluster experiment	Randomized double-blind trial	Concentration of fully immunized children declines in squatter settlements and households in lower wealth quintiles
Ozawa and Stack Return on investment from childhood immunization	2016	Low and middle income countries 201120	Cost efficacy comparison	Derivative costs from vaccine product, supply chains and service delivery are 16 times lower the net benefits from illness averted.

Siddiqui et al. Intention to accept pertussis vaccine among pregnant women	2017	City wide facility based cross-sectional survey in Karachi	Representative sampling and descriptive statistics	Question of safety and fear of side effects are result of misinformation. They alter immunization behavior across the variables of education, wealth, employment and household.
Demographic Factors				
Hasnain et al. Causes of low vaccination coverage in pregnant women	2007	City wide facility based survey in Lahore	Scaled Questionnaire	Equipment, cleanliness and training of health workers is also important in addition to convenience of access in shaping health related behavior.
Hussain et al. Determinants of DTP3 completion in children who received DTP1 at rural center	2010	Cohort study for 6 months	Randomized control trial. Multivariable log-binomial regression	Children receiving immunization in poor rural areas are more likely to dropout.
Smith et al. Parental delay or refusal of vaccine doses, childhood vaccination coverage at 24 months of age and health belief model.	2011	Case reports from representative focus groups	Qualitative cross-sectional study	State of mother's empowerment and dynamics in family unit alter the behavior towards state services in healthcare.
Asif et al. Parental perceptions surrounding polio and self-reported nonparticipation in polio supplementary immunization activities	2012	Cross-sectional survey in city Karachi	Thematic analysis of qualitative data and bivariate analysis of quantitative variables	Participatory community interventions are most useful in modulating immunization behavior. Distinct patterns are observed along ethnic lines.
Ali et al Predictors of vaccination card retention in children 12-59 mo	2014	Analytical cross-sectional study of specific location	Response on standardized questionnaire	Communication measures and information management can pull complacent groups to improved immunization status.

Zohra et al Interventions to improve neonatal health and later survival.	2015	Cochrane Review	AMSTAR and GRADE criteria	Early immunization is among essential interventions for child survival. Confidence of people in services at point of care is component of social contract.
Omer et al. Routine immunization services in Pakistan: seeing beyond the numbers	2016	Program Assessment	Evaluation Technique	Mothers are primary caregivers and their empowerment and marital relationship is important predictor of attitude towards vaccinators.
Intermediaries				
Save the children; Ending newborn deaths	2012	Population Survey	Report	Conditions surrounding immunization program in Pakistan.
SAGE- WHO	2014	Survey of families in representative sample	Report	High vaccine refusal was problem in areas of Baluchistan and KPK that rank lowest in vaccination coverage
UNICEF; State of the world's children	2014	Observational study	Report	Prevalence of morbidity and mortality in neonates and infants
Global Health Observatory	2015	PDHS and MICS	Report	Lower income rural residents are 13.5% less likely to be fully immunized in Pakistan
EPI federal monitoring cell		Enumerator observation and SIA accounts	Report	Latest case of Polio in Sindh in March 2018. Ethnic Pashtun are most likely to hide children and turn away vaccinators
Definition				
Hiedi Larson	2011	Systematic Review	Descriptive	"Measuring and addressing vaccine confidence gaps"
Noni MacDonald	2014	Systematic Review	Descriptive	"Definition, scope and determinants of vaccine hesitancy"

**Author's own*

Health utilization behavior models

McGinnis, *et al.* (2002) took position that environmental exposures and social determinants are main reasons for utilization. Economic circumstance prevalent in households are responsible for 55% of gap

from desirable standards of health. Rest can be attributed to shortfalls in access, quality of care and genetic predispositions to disease.

Jacobson, *et al.* (2007) presented a health belief model that sorted domains of vaccine behavior according to : (A) Demographic situation (B) Economic status (C) Access to healthcare (D) Immunization choice (E) Behavioral Factors. Households sustaining on daily wages are often not satisfied with government services and they harbor suspicions. Concurrence of social determinants of deprivations predispose preferences which lead to adverse health outcomes.

Keane, *et al.* (2005) categorized parental behavior into believer, cautious, relaxed and unconvinced. Household economic status are correlated to immunization status even if there are no direct incurred costs on parents. A means-end framework is better equipped for value determination in health services.

Gust *et al.* (2008) divided users into those who involve themselves in advocacy and activism, those who take interest in health issues and like to be aware of public health initiatives, those who are worried about their family and seek information that concerns them to make rational decisions, those who are anxious about side effects of pharmacologic medicines and that extends in a way to vaccines, lastly there are those who denounce vaccination and its programmatic delivery completely.

Nichter (1995) states that parental doubts about vaccines result in starting but not completing schedule of immunizations and dropping out or delaying immunizations. But he warned that gaps in health literacy cannot be classifeid same as hesitancy. Not knowing about government's immunization program is not the same as not knowing about vaccines. Disinformation leads to hesitancy. Social norms, religion, culture, socio-economic, geographic barriers, historical influences, public health lobbies and policies are component attitudes of refusers. Formally educated does not automatically imply awareness about vaccines and their usefulness. Variations in vaccination status such as delay, hesitance are observed.

Health behavior model by Janz, Champion and Stretcher (2002) present the confirmatory bias and compliance to social norms at the root of health decisions. It defines health-seeking as conditioned utility by social forces. The model provides useful model for evaluating health behaviors.

Annexure- 4

Table 4A: Coding of districts

KPK Punjab Sindh Baluchistan

District	Count	District	Count	District	Count	District	Count
1) chitral	303	1) Attock	553	1) Jacobabad	891	1) Quetta	390

2) upper dir	761	2) rawalpindi	509	2) kashmore	704	2) pishin	431
3) lower dir	600	3) jhelum	401	3) shikarpur	812	3) killa abd	564
4) swat	512	4) chakwal	419	4) larkana	638	4) chagai	409
5) shangla	720	5) sargodha	786	5) shahdadko	935	5) nushki	325
6) buner	865	6) bhakkar	994	6) sukkur	646	6) loralai	299
7) malakand	482	7) khushab	854	7) ghotki	851	7) barkhan	715
8) kohistan	855	8) mianwali	744	8) khairpur	874	8) musakhel	330
9) mansehra	418	9) faisalaba	992	9) naushahro	517	9) killa sai	381
10) batagram	949	10) chiniot	628	10) shaheed b	730	10) zhob	638
11) abbottaba	371	11) jhang	633	11) dadu	487	11) sheerani	244
12) haripur	500	12) t.t. sing	934	12) jamshoro	604	12) sibbi	333
13) tor ghar	700	13) gujranwal	694	13) hyderabad	418	13) harnai	552
14) mardan	588	14) hafizabad	834	14) tando all	770	14) ziarat	516
15) swabi	315	15) gujrat	452	15) tando moh	865	15) kohlu	482
16) charsadda	604	16) mandi bah	558	16) matiari	614	16) dera bugt	667
17) peshawar	517	17) sialkot	676	17) badin	535	17) bolan/ ka	429
18) nowshera	392	18) narowal	741	18) thatta	488	18) jaffaraba	701
19) kohat	479	19) lahore	547	19) sujawal	463	19) nasirabad	662
20) hangu	421	20) kasur	619	20) sanghar	594	20) jhal mags	605
21) karak	596	21) sheikhupu	920	21) mirpur kh	755	21) kalat	330
22) bannu	609	22) nankana s	533	22) umer kot	915	22) 362	462
23) lakki mar	553	23) okara	570	23) tharparka	945	23) 379	479
24) d. i. khan	972	24) sahiwal	565	24) 351	159	24) 211	311
25) tank	671	25) pakpattan	657	25) 352	193	25) 235	335
		26) vehari	593	26) 353 149		26) 396	496
Total	14753	27) multan	970	27) 354	149	27) 160	260
		28) lodhran	956	28) 355 164		28) 239	339
		29) khanewal	948				
		30) d. g. kha	927	**Total** 16865		**Total**	12685
		31) rajanpur	773				
		32) layyah	664				
		33) muzaffarg	914				

34) bahawalpu	765
35) bahawalna	735
36) rahim yar	683
Total	25741

'Count' refers to number of households in districts with access to vaccines. In ideal world figures in 'count' should also present number of fully immunized. Table 4B shows distribution of districts according to 'size' or number of households. The district codes are same as table above

Table 4B: Relative district sizes

Size	Punjab	KPK	Sindh	Baluchistan
Under 100	-	-	-	-
Under 200	-	-	24, 25, 26, 27, 28	-
Under 300	-	-	-	6, 11, 27
Under 400	-	1, 11, 15, 18,	-	1, 5, 8, 9, 12, 21, 24, 25, 28
Under 500	3, 4, 15	7, 9, 19, 20	11, 13, 18, 19	2, 4, 15, 17, 22, 23, 26
Under 600	1, 2, 16, 19, 22, 23, 24, 26	4, 12, 14, 17, 21, 23	9, 17, 20	3, 13, 14
Under 700	10, 11, 13, 17, 20, 25, 32, 36	3, 16, 22, 25	4, 6, 12, 16	10, 19, 20
Under 800	5, 8, 18, 31, 34, 35	2, 5, 13	2, 10, 14, 21	7, 18
Under 900	7, 14	10, 24	7, 8	-
< 1000	6, 9, 12, 21, 27, 28, 29, 30, 33	6, 8	5, 23	-

Sampling –PSLM 2014-15 :

The respondent in PSLM is head of household. According to PBS, the universe of survey is all urban and rural regions of four provinces. We excluded federal capital and military restricted areas. PBS has developed its own sampling frame, stratification plan, selection-criteria for units and reliability measures[17] based on population census of 1998. Each town is divided into enumeration blocks of 200-250 households. Number of blocks in Punjab is 14549, Sindh is 9025, KPK is 1913 and Baluchistan is 613. Districts in provinces constitute strata. In Urban domain, large sized cities constitute separate stratum. Population in defunct administrative divisions is grouped into separate stratum. Sample size is fixed at approximately 17600 households comprising 1252 blocks for reliability of results. District samples are fixed at approximately 79600 households comprising 5563 blocks. Two stage sampling design is adopted. Blocks in urban and rural regions are taken as primary units. Sampling units are selected from sub-strata with probability-proportional-to-size technique. Primary sampling units at provincial level is 596 for urban and 656 for rural. Data quality is controlled through built system of supervision at each stage of collection, recording and analysis. A supervisor, 2 male and 2 female enumerators collected data from the field. Monitoring-teams counter check the data for reliability. Field offices carried out preliminary editing and data-entry program has built-in consistency checks. Coefficients of variation and confidence limit of indicators is tested for reliability of estimates. Maximum Likelihood estimation methods were used for coverage.

[17] HIES Report and HIES Manual (Annual). *Pakistan Bureau of Statistics, Islamabad, Pakistan.* www.pbs.org.pk

Table 4B : Indicator Development

	PSLM Variables	Categories	Indicator
Sbq02	Relationship with head of household.	1- Head -2- Spouse -3- Son/Daughter -4- Son/daughter in law	□ Head+ female+ economic provider/family elder+ widowed/divorced
Sbq03	Reason for considering him as head of household.	1- Main economic provider -2 Family elder	□ Member+ Spouse+ female+ currently married
Sbq11	Member of Household	1- Yes -2- No	□ Member + son/daughter law+ Female+ married/widowed
Sbq04	Gender of person.	1- Male -2 Female	
Sbq07	Marital status of Household	1- Currently married -2-Widowed -3- Divorced	
age	Age of mother in complete years		

	PSLM Variables	Indicator
Scq03	Has ever attended institution of formal education?	Attended+ lower than secondary
Scq04	What was highest level of education received?	Attended+ Higher than secondary
Scq05	Is person currently studying in any educational institute	Currently attending+ lower than secondary
Scq07	Where is person currently studying?	Not attended+ not currently attending+ reason
Scq9	Reason for not studying	

	PSLM Variables	Indicator
Shq09	Whom consult for health issu	□□Type of health facility+ satisfaction level
Sdq07	Any LHW visited in past month?	□ Preference for facility or home visit
Sdq08	Any member of household visited health facility in past month?	
Sdq5	Faced any difficulty in consultation?	
Sjq01b	Reason not to consult health center (BHU)? [control] How far is it to reach nearest healt facility?	
Sgq10_7		

	PSLM Variables	Categories	Indicator
Mon	month of birth [control]		□ Partial or delayed immunization at 14 weeks. □ Accepts some not all vaccines
Int_mon	month of enumeration		
Shq03	Has child ever been immunized?		
Shq04	Do you retain up-to-date immunization card?		
Shq05	Which pattern of immunizatic was followed?		

	PSLM Variables	Categories	Indicator
	Province	1- Kp -2- Pb -3- Sd -4- Bl	□ Two or less rooms is crowding (Average member of family is 7) □ Hygenic are Drinking water from pipe or pump and toilet from flush to sewerage or pit
	Region	1- Rural -2- Urban	
	Language spoken	(regional languages)	
Sgq02	Number of rooms in dwelling?	1- one room -2- two rooms -3- three or more	
Sgq05	What is the main source of drinking water?	1-piped -2- open well -3- river/lake/stream -4- pump	
Sgq06	What kind of toilet facility your household use?	1- no toilet -2- flush to Septic-Tank/sewerage -3- pit latrine -4- flush to open drains	

	PSLM Variables	Categories
Shq6b	Has child receive dpt/ combo/ penta1?	1- Yes -2- No
Shq6c	Has child receive dpt/ combo/ penta2?	1- Yes -2- No
Shq6d	Has child receive dpt/ combo/ penta3?	1- Yes -2- No
Shq6e	Has child receive polio1?	1- Yes -2- No
Shq6f	Has child receive polio2?	1- Yes -2- No
Shq6g	Has child receive polio3?	1- Yes -2- No
Shq6h	Has child receive hb1?	1- Yes -2- No
Shq6i	Has child receive hb2?	1- Yes -2- No
Shq6j	Has child receive hb3?	1- Yes -2- No
Shq6a	Has child received bcg?	1- Yes -2- No

	PSLM Variables	Categories
Sjq01a	How often you use nearest primary health unit?	1- Never -2- Occasionally -3- Always
Sjq02a	Do you use family planning facility?	1- Never -2- Occasionally -3- Always

	PSLM Variables	Categories
Siq01	Has mother given birth to child during last 3 years?	1- Yes -2- No
Siq08	Where was the child born?	1- Home -2- govt. -3- pvt.
Siq10	Did mother receive postnatal care?	1- Yes -2- No
Siq04	Was she given tetanus toxoid injections during pregnancy?	1- Yes(epi) -2- No

	PSLM Variables	Categories
Seq06	What was employment of mother?	Employer -2- paid employee -3- unpaid family worker -4- cultivator/cropper -5- live stock
Seq08	How much money did earn last month?	-1-Minimum wage -2-upto Rs50k -3- Rs51k to Rs100k -4- greater than Rs100k

Annexure 5

Table 5: Dosages

Antigen	Dose	Indicators
BCG	BCG-1 : At birth	Y_{BCG}^{0}
DPT Hap-B Hib	Penta-1 : 6 weeks Penta-2 : 10 weeks Penta-3 : 14 weeks	Y_{PENTA}^{1} Y_{PENTA}^{2} $Y_{PENTA.}^{3}$
OPV	OPV-0 : At birth OPV-1 : 6 weeks OPV-2 : 10 weeks OPV-3 : 14 weeks	$Y_{OPV.}^{0}$ $Y_{OPV.}^{1}$ $Y_{OPV.}^{2}$ $Y_{OPV.}^{3}$
PCV	Pneumo-1 : 6 weeks Pneumo-2 : 10 weeks Pneumo-3: 14 weeks	$Y_{PCV.}^{1}$ $Y_{PCV.}^{2}$ $Y_{PCV.}^{3}$

Factorial analysis

We employ Macdonald's criteria for identifying theoretical behavior in projected factors. If more than 3 vectors from pattern matrix load at value greater than 0.05 then factor is nominated according to determinants matrix (MacDonald. 2011; *Table 2.2*). For ease of interpretation values lower than S.D =0.3 are not retained in pattern matrix of vectors.

Punjab

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	17.996	16.706	0.7752	0.7752
Factor 2	1.2907	0.1159	0.0755	0.8507
Factor 3	1.1748	0.1509	0.0506	0.9013
Factor 4	1.0239	.	0.0987	1

AIC = 171.1

Baluchistan

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	7.4757	1.7495	0.4358	0.4358
Factor 2	5.7262	3.136	0.151	0.5868
Factor 3	2.5902	1.0606	0.3338	0.9206
Factor 4	1.5296	.	0.0794	1

AIC =858.24

KPK

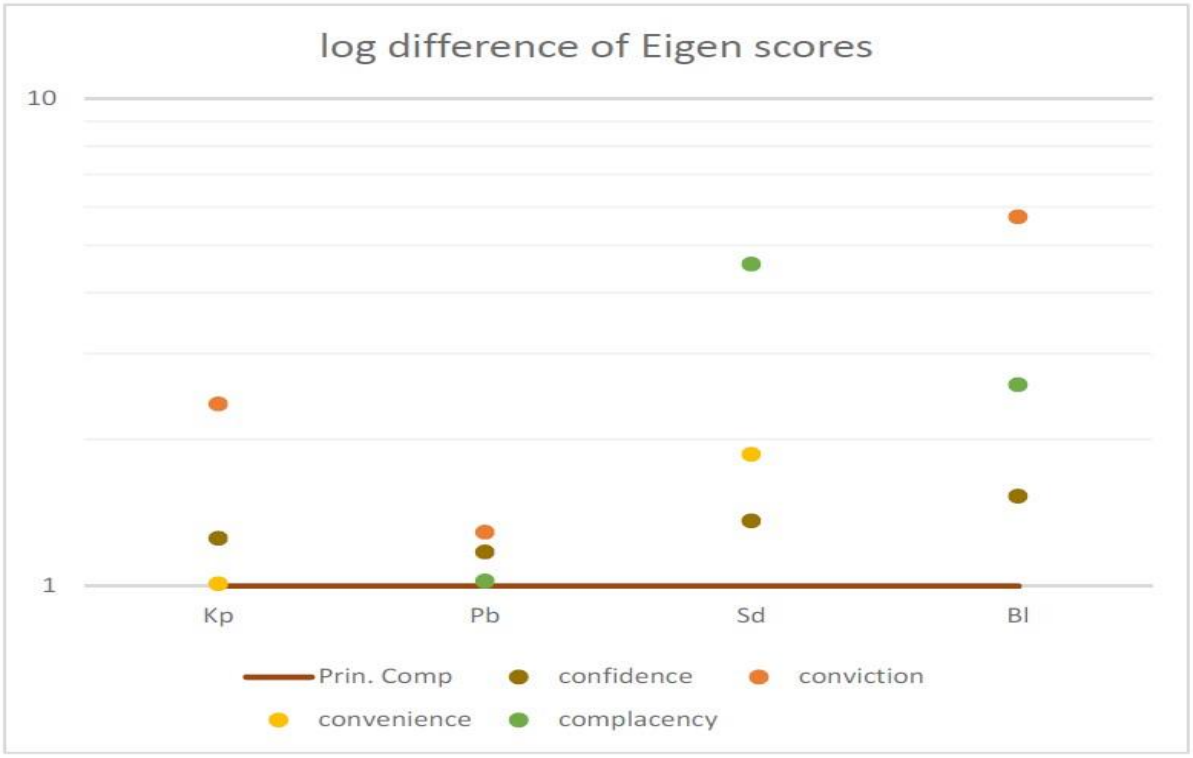
Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	10.883	8.5162	0.6809	0.6809
Factor 2	2.3668	1.1134	0.0784	0.7593
Factor 3	1.2534	0.2427	0.0632	0.8225
Factor 4	1.0106	.	0.1775	1

AIC = 735.738

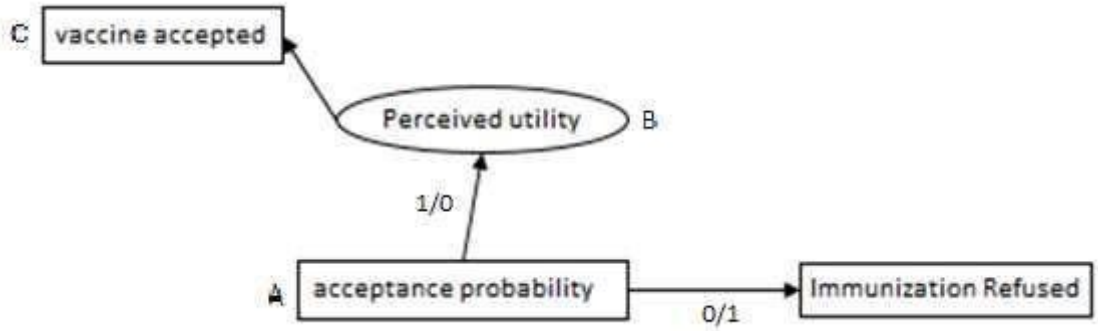
Sindh

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	11.577	6.9935	0.5921	0.5921
Factor 2	4.5832	2.7193	0.2344	0.8264
Factor 3	1.8639	0.5022	0.0953	0.9218
Factor 4	1.3617	.	0.0782	1

AIC=102.4



Pathway Analysis



Probabilistic Schema

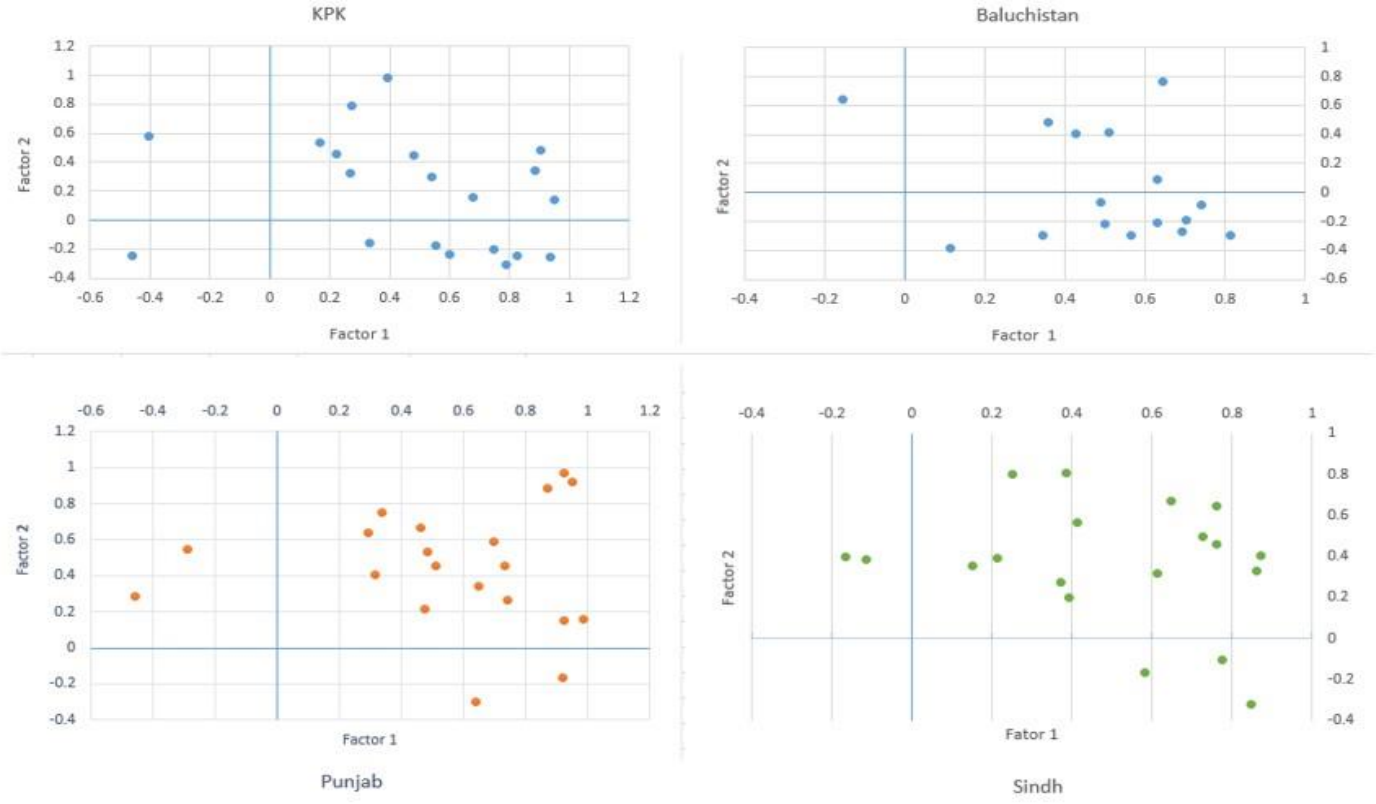
Identification of factors

Following combination of variables matched from MacDonald matrix and we labelled factors accordingly.

Complacency	Conviction	Confidence	Convenience
Married spouse Lower income 10k Postnatal care Rural dwelling	Daughter parents Home birth Male childgender Hygenic conditions	Widowed head Educated mother Card retention Gvt. sponsd eductn	Daughter divorced Employed worker Higher income 50k LHW visits

Eigen score

Proportion of data explained by Principal Component is 77% in Punjab, 68% in KPK, 59% in Sindh and 43% in Baluchistan. The uniqueness values for all eigen vectors are under 0.01.



Ranking of factors on Eigen score is tabulated below:

	Punjab	KPK	Sindh	Baluchistan
Factor 1	Convenience	Confidence	Conviction	Complacency
Factor 2	Conviction	Conviction	Complacency	Conviction
Factor 3	Confidence	Complacency	Convenience	Convenience
Factor 4	Complacency	convenience	confidence	confidence

Principal Components

The variables at extremes have the greatest deterministic value. Variables with highest and lowest Eigen scores in principal dimension are presented below:

Province	Punjab		KPK		Sindh		Baluchistan	
Principal Factor	Convenience		Complacency		Conviction		Convenience	
Loading (x)	Highest (0.98)	Lowest (0.35)	Highest (0.94)	Lowest (0.41)	Highest (0.87)	Lowest (0.26)	Highest (0.81)	Lowest (0.15)
Explanators	Postnatcare	Hakeem/homeo	Educat mother	Staff noncoop	Rural dwelling	Relig s eductn	Daughter divorced	Sep vac

Diagnostics: For factorial analysis we want no perfect multicollinearity and no heteroskedacity in variables. We used m-1 in the model and excluded dummys used for reference to remove perfect multicollinearity. In collinearity diagnostics the condition index of less than 30 will show no multicollinearity. 'n' here is household population with YJ . The closer the tolerance is to 1, greater is the linearity. Correlation can range from -1 to +1. We diagnose collinearity using correlation coefficient: $r = (n(\Sigma xy) - (\Sigma x)(\Sigma y)) / \sqrt{([n(\Sigma x^2) - (\Sigma x)^2][N(\Sigma y^2) - (\Sigma y)^2])}$

Ultra-Haywood case: Communality is squared correlation and lies between 0 and 1. When there are too many common factors factor estimation results exceed 1. To prevent that missing values were dropped

Good fit: The goodness of fit is measured by taking square of the difference between observed Y and expected Yˆand dividing it by the expected Yˆ(chi-square). Akaike Information criteria (AIC) is used on set of iterations to select model of relatively higher quality based on amount of information lost in log likelihood estimation.

Significance value: Alpha is at $p<0.05$, $p<0.01$ and $p<0.1$ are used for testing significance. Variables not significant are excluded from factorial analysis

KPK

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
Rural	0.9494				0.001082
male	0.5393		0.3419	0.6488	0.000448
matage_2635	0.3911	0.9844			0.00016
util4			0.8531		0.000388
house_mat2		0.4586	0.4746		0.000251
housemat_3	0.3319				0.000476
hcond_unhyg	0.5525			0.5673	0.000357
cd_yes	0.8254		-0.357		0.00197
edm1	0.9024	0.4842			0.00274
fated1	0.8869			0.4237	0.00484
fated3		0.3261	0.3533		0.00158
inst_gov	0.9372		0.657		0.00107
inst_rlg	0.6008				0.00332
hcons1		0.5327			0.00219
hcons2			0.5627		0.00009
usebh1	0.4816	0.4441		0.4814	0.00371
usebh2	0.7886	0.3071			0.00436
tt_no	0.7453	0.2042			0.03602
Birth_home	-0.4045	0.5481		0.431	0.03168
pnc_no	-0.4589		-0.3764		0.01984
emp_agri	0.6781				0.04727
emp_worker		0.7925	0.4699		0.02385

Punjab

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
rural	0.9856		0.9529		0.00235
male	0.8693	0.8851			0.00227
matage_2635	0.7415		0.9243		0.0019
house_mat1		0.5489			0.00571
house_mat2	0.648				0.00372
house_mat4				0.7376	0.00196
hcond_hyg		0.536	0.7982		0.002642
cd_yes			0.8636	0.4274	0.003724
edm2	0.4638	0.6686			0.0031
edm3	0.7347	0.4538	0.6895		0.0164
fated2	0.6989	0.5867			0.00129
inst_gov	0.952	0.9223			0.00665
inst_rlg		0.6391	-0.5803		0.00235
inst_prv			0.3077		0.00135
hcons1			0.604		0.00209
hcons2		0.7487			0.00157
util3	-0.4567		0.5489	0.3105	0.00608
usebhu1		0.4075	0.5209	-0.3346	0.00395
usebhu3			-0.4843		0.00134
tt_yes	0.5095	0.4521			0.00485
birthhosp	0.924	0.9711			0.00319
pnc_yes	0.9174				0.00532
emp_agri	0.6404	0.3003		-0.3686	0.00362
emp10k	0.9217		0.9409		0.00138
jointvac	0.476		0.542		0.00662

Sindh

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
rural	0.8708	0.4067			0.00413
male		0.3842	0.8657		0.00363
matage_1525	0.8609	0.3275			0.00433
house_mat1	0.3932			-0.6299	0.007984
house_mat2		0.3995		-0.3239	0.007421
house_mat4		0.3896	0.3678		0.006393
hygenic	0.4149	0.5627		0.447	0.002832
cd_yes	0.5805			0.3006	0.005558
edm1	0.7766		0.4267		0.00098
fated3	0.6114		0.5556		0.00275
inst_gov	0.7612	0.6485			0.00368
inst_rlg		0.7992			0.00186
usebh2	0.3844	0.8064	0.357		0.001034
usebh3	0.3724		0.4988		0.05279
tt_no	0.6488	0.6685			0.01236
birth_hosp	0.7601	0.4579			0.00119
pnc_no	0.8466	0.32			0.00238
emp_agri			0.5082		0.00498
emp_worker	0.7284	0.4945		0.4113	0.00545
emp_10k			0.7027		0.00135
sepvac		0.3569			0.07397

Baluchistan

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
rural		0.6439	0.643		0.00448
male	0.4998		0.7003	-0.4636	0.00405
matage_2635	0.6317		0.5394	-0.3498	0.00144
housemat_3			0.3235	-0.3982	0.00561
house_mat4	0.8141		0.305		0.001637
hcond_unhyg	0.5087	0.4164	0.57		0.002312
cd_not	0.7011		0.5529		0.001963
edm1	0.6924				0.001576
edm2	0.631			0.5395	0.004516
inst_gov	0.4889		0.6959		0.00128
inst_prv	0.5648				0.00461
hcons1			0.7051		0.0036
usebh1		-0.3833	0.8109		0.0015
usebh2	0.6448	0.7643			0.002
tt_no	0.7418		0.4633		0.002152
birthhome	0.4272	0.4032	0.6454		0.00238
pnc_no	0.3564	0.4823	0.7151		0.001006
emp_agri	0.3457		0.4296		0.005703
sepvac				0.4593	0.004805

Annexure 6


Results - Baluchistan
Districts with higher relative acceptance
Kohlu, Killa-Saifulla, Ziarat, Quetta, Musakhail
Districts with higher relative dropouts
Khuzdar, Jaffarabad, Gawadar, Pishin, Killa-Abdullah, Sibi, Harnai, Zhob, Sherani
Correlation
Acceptance
LHW visits
Professional employee
Refusal
Rural Dwelling
Female Child
Dropout
Privately educated parents
Results - Sindh
Districts with higher relative acceptance in province
Karachi, Badin, Sukkur, Shikarpur
Districts with higher relative dropouts in province
Thatta, Hyderabad, Nawabshah, Larkana
Correlation
Acceptance
Younger than 25 y.o mothers
Widows
Card retention
Tetanus toxoid to pregnant
Refusal
Untrained non-coop health worker
Lower income
Dropout
Consulting "hakeem"
Labour work
Results - KPK
Districts with higher relative rejections in province
Lower-Dir, Swat, Shangla, Buner, Malakand, Hangu
Districts with higher relative dropouts in province
Upper-Dir, Swabi, LakkiMarwat, Bannu, Karak, Swabi
Correlation
Acceptance
Daughters living with parents
Govt. institute educated parents
Card retention
Refusal
Under 25 y.o mothers
Spouses main providers
Religious institute
Lower incomes
Drop-out
Rural dwelling
Agriculture occupation
Results - Punjab
Districts with higher relative rejections
RahimyarKhan, Rajanpur, Nankana Sahib, Gujrat Muzaffargarh
Districts with higher relative dropouts.
Layyah, Vihari, TobatekSingh, Kasur, Okara, Chakwal, Jhelum
Correlation
Acceptance
Hospital Births
Urban dwelling
Facility visits
Refusal
Un-hygenic conditions
No formal education
Widows living in-laws
Older than 35 y.o mothers
Dropouts
Divorced daughters
Parents educated govt. institute
Income between Rs.50k-100k.

Review Reports

Thesis Title: **Understanding acceptability of government provided neonatal vaccination**

Student: Khalid Abbas

Supervisor: Dr. Nasir Iqbal
Reviewers: Dr. Fazli Hakeem, Dr. Mahmood Khalid

Defense of proposal was held on 16th of April 2018. Comments were provided upon review of thesis proposal. Following changes are incorporated into the proposal.

	Comments	Response
1	Title may add Pakistan	Complied with the comment. New title is: " Understanding acceptability of government provided neonatal immunization in Pakistan"
2	Rearrange and revise format of paper.	Complied with comment. Paper is arranged in accordance with approved university guidelines. Literature Review is presented in separate paragraphs with headings.
3	In introduction, add economic consequence figures of non-immunization from some report	Complied with the comment. A paragraph is added with citation in section 1.0: Background. Chapter 2 also provides said information. Please review and guide. Unfortunately no survey reports about actual loss of value on currency metric is available for Pakistan particularly.
4	Also talk about parental rights in medical decision making.	Paragraph was added under section 1.1: "Acceptability of immunization in Pakistan".
5	In part 1.2, goals are broader &objectives are baseline for empirical query.	Complied with the comment. Section 1.2 now provides defined baseline for empirical query.
6	In part 3.3, first write broader contribution, then go to specific variables	Complied with the comment. Section 3.3 is now altered in accordance with the reviewers' comment.
7	In part 4.1, provide reference of assumptions	The assumptions are now linked with references in preceding text. They are reduced and rearranged. They give specificity to our analysis.
8	Use continuous variable for age.	Categories are replaced with continuous variable of standard reproductive age 15-49y. Right hand side of model now include mixed variable types.

9	Define variable of overcrowded household	Definition is added under table and variable type is made continuous. Furthermore operational definitions are included in Annexure 1. Explanation of all developed variables is now included in Annexure 5.
10	Include explanatory role of father	Two additional variables are added on father's education and occupation.
11	What about variables external to household?	Clarity over externalities and proxy for community-based factors is now in Chapter 4. Explanatory variables about community are not directly available in PSLM datasets
12	Equations have to be numbered as a rule	Numbering is now done of equations in the paper.
13	How would you differentiate between PCA versus conditional logistic regression? Why use both	Detail explanation is added in Methodology chapter. In logit regression the coefficient of X is same for all responses of dependent Y variable and values of X changes. But when we compare model for its component it explains greatest difference of variation within Y-responses. We want to know dimension that is most associated with accepting full immunization. And from results of factorial analysis we will have correlation. We can argue choices based on expected utility. We can also reduce amount of data as variables will combine within factors. We can score factors and identify principal factor.
14	Is immunization free of cost? Use zero price where no charge to parent is meant	The phrase "free cost" is now revised. By word "price", charge of currency is meant. Childhood immunization in Pakistan is funded from public exchequer. No payment is sought from parents at doorstep which is point of delivery. In case parent visits health facility for immunization, That cost is included as one of quantitative variable. But indirect costs incur on households because of taxation.
15	**In Abstract**: Explain phrase: " economic structure that … "	Conventional structure is profit maximization and cost minimization. But in context of immunization there is no motive for either on supply or demand side. The structure becomes pooling and equitable distribution. The sentence implies to this. Further detail is in Chapter 4
16	**In Abstract:** Replace word 'vaccine' with 'vaccination'	The fragment reads: "It is a political decision that vaccine is right of citizen.. ". The meaning we are trying to convey is essential good and not the service. Hence the use of word 'Vaccine' which is plural in sense without use of 's'.

17	**In Chapter 1:** Phrase "At, birth innate immunological systems are... " Are immunological systems genetic or congenital?	Neither. Word 'Genetic' implies chromosomal product in embryonic development. Word 'Congenital' implies maternal effects or birth process. Word 'innate' is used here to indicate evolution of human physiology.
18	**In Chapter 1:** Phrase "Attack from …. during first year of life" Is it for first year only or go beyond to full 05 years.	Types of immunity are active, passive, acquired and natural. Antibodies develop as result of vaccine or infection. For said agents in endemic region the time scale is first year of life and either way only two are outcomes: permanent immunity against disease, permanent disability as result of disease.
19	Explain objective (i) Objective (i) reads: To theorize behavioral factors on which immunization take-up depends.	The behavior of population depends of socio-cognitive elements. These make theoretical construct of study and adequate basis is provided in literature review. We establish that socio-economic variables condition the immunization behavior and perceived utility of parents.
20	Objective (ii) is not mentioned in introduction. Objective (ii) reads: To measure maximum likelihood of immunization from socio-economic determinants.	The Y of our model is immunization status. X of our model is dimensions of acceptability. Chapter of introduction provides implications of vaccination, situation in Pakistan and government programming, economic consequences of immunization, role of agent/provider.
21	**In Chapter 1:** "Up to 44$ …. Treatments" Provide reference.	Reference of CDC is now added. No cost impact is available for Pakistan in particular. Statement provides generic figure of global average from international agency.
22	**In Chapter 1:** " Equal access … citizen" Provide reference to constitutional article.	Reference is now added in footnote. Article 38(a), 38(d) mentions access to healthcare as fundamental right of citizen. Article 25, 26 establishes safeguard of equality and non-discrimination in terms of all fundamental rights. Bill of 18th amendment (2011) delete concurrent legislative list of 4th schedule and add social sector research, technical capacity, standards, supervision and regulatory authority as federal subjects in legislative list. In 3rd phase, functions of health system are devolved to provinces and federal continues to provide funding for vertical programs including immunization to avoid short-falls and streamline efforts with international partners.
23	Explain "benefits over cost?"	Refers to cognitive decision science by which every refusal is effort to avert risk of loss.
24	Explain "credulous information"	Refers to issues of parents in believing information conveyed by

		health workers
25	Provide reference to phrase "country fails on immunization goals"	Reference is now added from MDG report 2015 for Pakistan
26	Problem statement is not mentioned in the proposal. Establish direct link with introduction and objectives	Complied with the comment. Problem statement is added in Chapter1. The phrasing is improved to relate with introduction and objectives.
27	Conceptual framework is congested and require revision.	Complied with the comment. The chapter is revised according to suggestion of reviewers.
28	Vaccine is inelastic good, need explanation	Price of vaccine is not pulled by demand side forces in Pakistan. It is essential good procured and provided to all children by government.

Response to comments of internal review

Thesis: Understanding Acceptability of government provided neonatal vaccination in Pakistan (revised)

The revisions recommended by reviewer (Dr. Saima Bashir) have been incorporated. Following alterations were made in revised version of thesis;

a. In chapter 'Introduction', citations were corrected. Paragraphs were rearranged for consistency.
b. Chapter 'Literature review' was made concise by removing redundant information.
c. In chapter "Neonatal Immunization" adjustments were made to sequence of paragraphs to bring ease of reading.
d. In chapter 'Data and Methodology' presentation of content is improved. Procedure is detailed in start for easy identification of statistical technique. Description of sample is put in chapter "Data & Methodology". 'Conceptual Framework' is put in separate chapter. Explanation of methodology is simplified and improved.
e. Menopause was used as upper limit of maternal age (52 y.o). It is replaced with reproductive age (15-49 y.o) as advised.
f. 'Analysis' and 'Results' is made one chapter so reader may easily find estimations.
g. Titles are added to tables in thesis which lacked them.
h. Editing mistakes are corrected. Notations and numerical are changed to standard.
i. Reported figures are rechecked.

Following answers are provided to questions raised by internal reviewer;

a. Sample is drawn from PSLM dataset 2014-15 and 'access' variables are controlled. Those households are not included that did not visit health facility and are not visited by health worker at home. The interpretation is not generalized.

b. 97% household in Pakistan are not immunized. The syntax is improved to remove confusion.
c. Education from one of either parents is used in analysis. Or Head of household if data is missing
d. Out of 11 possible combinations for 'var_mat' only 4 are used. Missing values are dropped.
e. Unit of study is 'household'. Response variable is categorical.
f. Explanation of terms were added in footnotes where needed.

Rest of the suggestions are politely refused after consultations with supervisor. Thesis is subsequently accepted and approved.

Report after comments of external examiner

Following is corrected.

1- Age bracket written for neonate is corrected according to Dorland's Dictionary. Name is removed where it was wrongly used.
2- References are added to Chapter "Discussion".
3- Limitations of study are placed earlier.

Following is explained.

1- Thesis addresses complete vaccination in first year against 8 antigens in EPI schedule (BCG,OPV,PCV,DPT,HiB,HapB)
2- Thesis design is cross-sectional retrospective.
3- Result of private schooling in Baluchistan is relative to other provinces. And sample size for Baluchistan is smaller. I have added to inference that within Baluchistan private schooling is more associated with completing immunization but compared to other provinces this association is weaker in Baluchistan due to endogenous forces.

Submit please.

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