The Effect of Literacy Rate and Area Covered by Health Facilities On the Performance of Universal Immunization Program in West Bengal

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Introduction:

"The impact of vaccination on the health of the world's peoples is hard to exaggerate. With the exception of safe water, no other modality has had such a major effect on mortality reduction and population growth"

- Plotkin and Mortimer, 1988

A strong foundation needs a strong base to stand tall, strong and long. Similarly a healthy adulthood can only be built upon a healthy childhood. A healthy adult can work productively, effectively and efficiently in contribution to the development of a nation. So it is a basic duty of a nation to provide child health security.

The child health needs extra attention because infants and children of 12 to 23 months can easily be diagnosed with and can even be died from some common diseases like the Polio, Small pox , Measles, Diphtheria, Pneumococcal diseases, Hepatitis B , Hepatitis A, Tetanus etc because they have a very delicate immunity system. So it is necessary to make their immunity system able to fight these diseases so that child mortality and morbidity can be reduced. This is possible through immunity vaccination in children at very early stage of life.

The relationship between health and the economy is bidirectional, whereby economic growth enables funding in investments that improve health; and a healthy population contributes to and enhances an economy. Vaccination is a cost effective method in compare to other health interventions. A child vaccination program has some minimum direct cost of vaccine purchase, infrastructure to run the program, maintain the cold chain, administrative personnel. Govt. invests in child vaccination with the intension of improving health system. The reduction in child morbidity and mortality through vaccination program, has led to reduce the incidence of diseases, their associated treatments and the cost in health care. This potentially led to economic growth with less money spent on medical tests, treatments, health care and less time off work by patients or parents. The impact of childhood illness falls primarily on adult career. An unhealthy child is unable to attend school, does not have motivation of doing anything in life, so he/she will grow up to a physically and emotionally weak adult; that adult will not be able to work properly , will not have energy to work for long hours and will be unskilled. This will merely affect on a nations

economy in long term because it will decrease the labor supply to a lot of economic sectors, will give a significant push to the expenditure in health sector and will hold back the economic growth.

Child vaccination, not only helps to protect the most vulnerable members of our community: infants and children but also protects the whole society. While a child gets vaccination for a disease, he/she gets protected against the disease and also the vaccination of one child prevents spreading of diseases to many. This is called 'population protection'.

According to United Nations Children's Emergency Fund (UNICEF) child immunization program is one of the biggest health programs in the world. Immunizing children is the main component for a happy and healthy nation; it also lowers the cost in health sector up to an extent. As World Health Organization (WHO) quoted "child vaccination saves five lives in one minute."

WHO's Expanded Immunization Program (EIP) was introduced in India at 1978 which expanded to Universal Immunization Program (UIP) at 1985. Govt. of India aimed to provide vaccination to prevent seven most common diseases: Diphtheria, Polio, Tetanus, Measles, Pertussis (whooping cough), Haemophilus influenza type b (hib). Govt. of India aimed to cover each and every state of India with UIP within 1990-91. At 1947 India has largest number of smallpox affected children, before 1990 India was home to one third of world's unimmunized children. Despite producing large number of vaccines still India has a vast number of unimmunized children and till date there exist child mortality to a large extent. This is because of the tight budgetary policy of government regarding child vaccination process, low rate of literacy – large amount of population being illiterate does not realize the importance of child immunization and are not aware of this program. These setbacks of immunization program draw extra attention of Govt. of India on the Universal Immunization Program; the Govt. is constantly implementing initiatives to make people aware about the immunization program and also trying to facilitate unreached areas of the country with suitable infrastructure for immunity vaccination.

Among 27 states of India Assam and West Bengal are doing fairly better in UIP than lot of other states in India since 1990. All primary health centers, districts and block health officials, major hospitals organize child vaccination sessions on daily basis. The highest immunization coverage reported was 104.73% and 80.13% for BCG in West Bengal and Assam respectively.

West Bengal is a middle-rung performer in health status among all states in India. The state has general non-month-specific vaccination coverage higher than the Indian national average; Infant mortality rate is far lower than the national average. But still West Bengal had 33% child mortality rate reported in 2012 which is higher than many countries of India. Despite of huge vaccination coverage in all over West Bengal, there exist large number children affected by the Polio, Measles, Tetanus, hib. However, the state has one of the highest rural-urban disparities in most of maternal and child healthcare indicators.

Although Govt. of India takes up large amount of initiatives for better immunization coverage but there are certain factors which push the child vaccination rate backward. One of the main barriers is illiteracy, people being illiterate do not even realize the importance of child vaccination, they do not understand the life of their children can be better off with immunity boosters. Also there exist some superstations about vaccination, that vaccination may make their children infertile, may kill their children and much more can happen. Also there exists some anti-vaccination advocates who make illiterate people believe on those untrue assumptions. Another notable barrier is less available health facilities. In many areas of India (mostly rural and semi urban areas), there is no infrastructure of implementing immunization program. So in these areas people cannot be able to vaccinate their child even if they are aware about vaccinating children. Other barriers are lack of awareness of vaccine preventable disease, lack of awareness of vaccination schedule as per their age and much more.

Motivation:

After the implementation of UIP at 1985, the program covered 108 million children and infants in India each year (2014 report) till date. The UIP is one of the biggest health programs in the world. Govt. of India is organizing campaigns on daily basis to spread awareness on immunization of children and infants so that each and every child in this country can be immunized through vaccination. All primary health centers organize vaccination sessions every week on a particular day. The block health centers organize vaccination sessions on two days of a week. All the major hospitals have the vaccination facilities by any day of the year. Different non govt. organizations take initiatives to organize vaccination campaigns in slum areas, rural areas on a regular basis to provide awareness on immunization of children and infants.. Despite of all the labor the main motive of bringing every children and infants under the UIP cannot be achieved. According to

UNICEF, India still has 2.1 million of unimmunized child reported in 2012. Also India has 28.3% child mortality rate (2019) which is significantly higher than many other countries in the world. All the effort of govt. and other organizations on immunizing each and every children of the country is not getting expected success because of some direct and indirect factors.

The factors includes literacy rate: not knowing the importance of vaccinations, believing in superstations and on anti-vaccine advocates, not being aware about vaccine preventable disease, about the schedule of vaccination at per child age; health facilities: many areas of India do not have suitable infrastructure or no infrastructure at all for implimenting UIP so many families cannot be a part of the program. Also there is a huge number of drop outs because of unavailable health facilities and lack of education. There are a lot of other factors as well, those are: tight budgetary policy regarding UIP of Govt.: being a developing country India Govt. cannot invest a lot of money on this program. Lack of health personnel to employ in UIP: India has low number of health employees (doctors, nurses, medical technicians) compared to the population of India. These factors have adverse effects on Govt. initiation regarding UIP and make India one of the biggest home of unimmunized child and a leading country in child mortality.

Against this backdrop it is necessary to study the factors that determine the rate of vaccination in the state of West Bengal. Once we can truly understand the factors that determine the spread and success of vaccination, we certainly promulgate steps and policy actions that will not only strengthen the health of the labor population but will also contribute to economic growth and development.

Literature review:

There exists large number of research studies and articles on child immunity vaccination program. Enormous number of economists and health researchers has shown interest in working on this health movement. Anekwe and Kumar (2012) have explained the importance of child vaccination in strengthening the nutritional status of children and in achieving right weight and height according to their age, especially in developing countries. Valadez and Weld (1992) discovered that mothers' recall can also be used to continue routine immunization in children in the absence of child vaccination card. So that routine vaccination will not be interrupted. Vashistha and Kumar (2013) have found that India is lagging behind its relatively less-developed neighbor countries in

child immunity vaccination coverage. The reasons are huge population, lack of micro planning to reach each and every area of the country, poor health infrastructure and lack of supervision and monitoring of the program and lack of awareness regarding child immunization.Lahariya (2014) stated that the reluctance, opposition and slow acceptance of vaccine have been the main characteristics of India's child immunization program. He added that lessons should be taken by analyzing the history of India's child immunization program to maximize the effectiveness of initiatives of Govt. regarding child vaccination. Vashistha (2012) found that immunization coverage in India has slow progress and even after various initiatives by Govt., immunization coverage in some states in India is still very low. He suggested a revamp to the UIP with introduction of new vaccines, affordable supply of vaccines. Rammohan and Awofeso (2015) have researched upon the socio-economic factors responsible for district level variation of child immunity vaccination in India and came to the conclusion that district's per capita income is a strong predictor of varying immunization coverage among districts also mother's education has a positive effect on immunization. Al-Zahrani (2013) pointed out that parent's knowledge of vaccination has positive effect on immunization coverage. In fact, varying attitude of parents toward vaccination causes variation in immunization coverage in different low and middle income countries. Rainey and Banerjee (2011) have found that despite of increase in routine vaccination coverage in low and middle income countries during past three decades the number of children getting vaccinated is below expected target. They suggested that the situation can be improved by outreach services, vaccine supply and health worker training. Arsenault, Harper and Nandi (2020) have researched on whether the child vaccination has any effect on children's learning achievements. They discovered that fully vaccinated children have a better academic participation and achievements than non-vaccinated children and under-vaccinated children.

Dawn and Basu (2014) have represented the reasons of child's malnutrition in West Bengal even after the implementation of large number of initiatives of Govt. regarding immunizing the children. They pointed poverty, illiteracy, negligence towards family members, lack of awareness, inappropriate feeding habit, unhygienic living condition, discrimination in gender and poor health infrastructure as the key reasons of malnutrition among children in West Bengal.Burman and Dutta (2013) have discovered that in West Bengal month-specific child vaccination coverage in badly 20% but non-month-specific coverage of child vaccination in 75%. Birth place of children, religious status of head of the family, lack of availability of health workers and equipments in sub

health centers are important predictors of month-specific vaccination coverage in West Bengal. Manna, Chaterjee, De, Ghosh (2017) have found that in rural areas of West Bengal the immunity coverage is much lower than the national coverage. They added that in rural areas of West Bengal mother's knowledge regarding immunity vaccination is significantly lower compared to the national results also disease susceptibility in children and child mortality rate is very high in these rural areas. Som, Pal, Chakraborty, Bharati (2010) came upon with the fact that child vaccination rate among vulnerable groups of poor, minorities especially in rural areas is remarkably low in districts of West Bengal. In West Bemgal gender discrimination is mostly absent in vaccination preference of parents while parent's education level plays a vital role in vaccinating their child. Dasgupta, Bhattacharjee, Mukhejee, Dasgupta (2018)have looked into child vaccination habitin slums areas of West Bengal and found that almost all the families have hestation in vaccinating their children. Suspecting it as a serious problem they suggested that uniformity in health routine in slum areas, counseling regarding child vaccination, widespread awareness and increase in mother's knowledge of child health can help the situation.Bhatnagar, Gupta, Kumar, Halder, Sethi, Bhal(2016) examined how UIP is covering remote and inaccessible rural areas,urban slums,migrants and mobile communities. They discovered that vaccination coverage have gradually increased in 2010 compared to 1990. They mentioned that there is lot of scopes and possibilities in improving UIP in India.

In this section, the literature upon the child immunity vaccination is summarized to examine the state and condition of the child vaccination program. It is clear that there are significant numbers of researches on child vaccination present in current time period. The present condition of child vaccination program, effects of the program and factors affecting the vaccination program is discussed in this section. Various conceptual models and approaches help to understand the concept of the child immunization program. The interconnections between the different strands of literatures help us to build an aggregate understanding of the condition of child vaccination program in West Bengal.

Objective:

This study is motivated by the broad objective of examining present condition and performance of UIP in West Bengal. Secondary data for this research is collected from the Statistical Hand Book of West Bengal 2015, the report of District Level Household and Facility Survey of West Bengal

(DLHS-4) 2012-13, the West Bengal Health Portal and the Census of India 2011. The detail objectives of this study are ---

a) Examine the achievement of UIP in the year 2009-10 and 2010-2011 in districts of West Bengal
b) Examine the performance of UIP from 2001 to 2011 in West Bengal
c) Look into the status of child vaccination in West Bengal in 2012-13
d) Evaluate the factors responsible for backdrop in vaccination rate in West Bengal
e) Study the National Immunization Schedule recommended by WHO
f) Regression analysis to find out the effect of literacy rate and availability of health facilities on the rate of child immunity vaccination.

Methodology:

Different authors followed different methods to estimate the performance of UIP in India as well as West Bengal. Anekwe and Kumarestimated UIP's effect across various subpopulations of Indian children by sample survey and regression analysis,Bhatnagar, Gupta, Kumar, Halder, Sethi, Bhal used sample survey to estimate vaccination coverage in India,Lahariya used sample observation to predict the characters of UIP in Indian over the past years, Vashishthaused sample observation to analyze the status of UIP in India. Dawn and Basu used purposive sampling survey to find the reasons of child malnutrition in West Bengal. Som, Pal, Chakraborty, Bharatiused sample survey to examine the variation in child vaccination rate in West Bengal due to different socio-economic factors. Burman and Dutta have usedsmple survey to discover the barriers of UIP in West Bengal.

Here, this study is focused mainly on the affects of two factors – literacy rate and availability of health facilities on UIP. Also our study is particularly focused on the trends and condition of UIP in West Bengal.

Research study on UIP should be done on the basis of primary sample survey. But in current pandemic situation of Covid-19 we have to obey some limitations instructed by our university. Therefore we cannot step out of our house to conduct survey and collect data for our study so we relied on secondary data. Our secondary data is collected from the report of DLHS-4 of West Bengal 2012-13, reports on UIP published in National Health Portal and West Bengal Health portal

from 2009 to 2011, Statistical Hand Book of West Bengal 2015 and articles mentioned in the section " Literature Review " .

After collecting the secondary data, we have formed a descriptive statics to analyze the trends of UIP in West Bengal over the past few years. Pie charts, bar diagram, trend levels and descriptive statistics are used to analyze the program of child vaccination in West Bengal thoroughly. This study aims to focus particularly on the effects of literacy rate and area covered by health facilities with the success rate of UIP in West Bengal. A three variable multiple regression analysis is conducted to scrutinize the correlation among success rate of UIP, literacy rate and availability of health facility. Further t-test is performed to examine the significance of the endogenous variable- the success rate of UIP and also F-test is performed to analyze the overall significance of the our regression model .

Result and Discussion:

Our present study aims to find the status and the trends of UIP in the district of West Bengal particularly. Universal Immunization Program (UIP) is a part of Expanded Immunization Program (EIP) by WHO. EIP is a program which aims to provide vaccination to children of six common diseases which are Diphtheria, Polio, Tetanus, Measles, Pertussis (whooping cough), Hiaemophilus influenza type b (hib), free of cost or with very low payment to the respected authority. UIP is a part of EIP implemented in India at 1985. The vaccines are prescribed and scheduled by the suggestions of health experts. Also we will study about the doses of Vitamin A recommended by WHO and UNICEF and added to UIP in the year of 2006. The Vitamin A doses are funded by central Govt. The child immunity vaccination schedule of UIP is displayed below:

Table-1:

National Immunization Schedule

Vaccine	**When to give**	**Dose**	**Route**	**Site**
FOR INFANTS				

BCG	At birth or as early as possible before 1 year of age	0.1 ml (0.05 ml until one month age	Intra-dermal	Left upper arm
Hepatitis birth dose	At birth or as early as possible within 24 hours	0.5ml	Intra-muscular	Anterolateral side of mid left thigh
OPV birth dose	At birth or as early as possible within 15 days	2 drops	Oral	
OPV 1,2,3	At 6 weeks, 10 weeks and 14 weeks	2drops	Oral	
IPV	At 14 weeks	0.5ml	Intra-muscular	Anterolateral side of mid right thigh
Pentavalant 1,2,3	At 6 weeks, 10 weeks and 14 weeks	0.5ml	Intra-muscular	Anterolateral side of mid left thigh
Rotavirus vaccine	At 6 weeks, 10 weeks and 14 weeks	5 drops	Oral	
Measles 1st dose	9 complete months if not done then before 5 years	0.5 ml	Subcutaneous	Right upper arm
Vit A 1st dose	At 9 months with measles	1ml	Oral	
FOR CHILDREN				
DPT 1st booster	16-24 months	0.5ml	Intra-muscular	Anterolateral side of mid left thigh
OPV booster	16-24 months	2 drops	Oral	

Measles 2nd dose	16-24 months	0.5ml	Subcutaneous	Right Upper Arm
Vit 2nd dose	16 months with DPT/OPV booster then 1 dose every 6 months till 5 years	2ml	Oral	
DPT 2nd booster	5-6 years	0.5ml	Intra-muscular	Left upper arm
TT	10 years and 16 years	0.5ml	Intra-muscular	Upper arm

Source: National Health Mission, India

Here we see that 8 different vaccines for children starting at their very age recommended by WHO are recommended to every children, these vaccines are given free of cost by theGovt in India. Although there exist numbers of non-Govt. organization, privet ownership hospital where any children can get immunity vaccination but here a particular amount of money is charged. A vaccination card is assigned to every children coming to be a part of this vaccination program to make a track of vaccines given to them. Govt. of India as well as private organizations is constantly taking initiatives to spread awareness on the UIP to each and every corner of the country so that no children remain unvaccinated.

As it is mentioned before, this study is particularly focused on the status and condition of UIP in districts of West Bengal; we will now analyze the performance of UIP only on infants(0-9 months) in West Bengal over past few years. Here the performance of five must needed vaccines for infants: Polio, DPT, Measles, TT(PW),BCG is listed.

Table:2

Performance of Universal Immunization Program: West Bengal

Year	**Method**	**Estimated number of infants**	**Achievement (numbers)**	**Percentage achievement (%)**
2006-2007	TT(PW)	1900029	1572581	82.77
	DPT	1735923	1588878	91.53
	POLIO	1735923	1600286	92.19

	BCG	1735923	1859385	107.11
	MEASLES	1735923	1522628	87.71
2007-2008	TT(PW)	1979750	1560803	78.84
	DPT	1799464	1573700	87.45
	POLIO	1799464	1524566	84.72
	BCG	1799464	1804918	100.30
	MEASLES	1799464	1539610	85.56
2008-2009	TT(PW)	1902679	1492925	77.73
	DPT	1737187	1192106	68.62
	POLIO	1737187	1415432	81.48
	BCG	1737187	1698653	97.78
	MEASLES	1737187	1401356	80.67
2009-2010	TT(PW)	1921247	1502713	78.22
	DPT	1739780	1678522	96.48
	POLIO	1739780	1600142	91.97
	BCG	1739780	1719572	98.84
	MEASLES	1739780	1552782	89.25
2010-2011	TT(PW)	1803513	1526529	84.64
	DPT	1704030	1468044	86.15
	POLIO	1704030	1462452	85.82
	BCG	1704030	1654042	97.07
	MEASLES	1704030	1423533	83.54

Source: West Bengal Health Portal (wbsc.gov.in)

Now using descriptive statistics for table-2 we get:

First calculating the Means of achievements ----

For 2006-07 = $\frac{8143758}{5}$ = 1628751.6; For 2007-2008= $\frac{8003597}{5}$ = 1600719.4; For 2008-09= $\frac{5856842}{5}$ = 1171368.4; For 2009-10 = $\frac{8053731}{5}$ = 1610746.2; For 2010-11= $\frac{7534600}{5}$ = 1506920

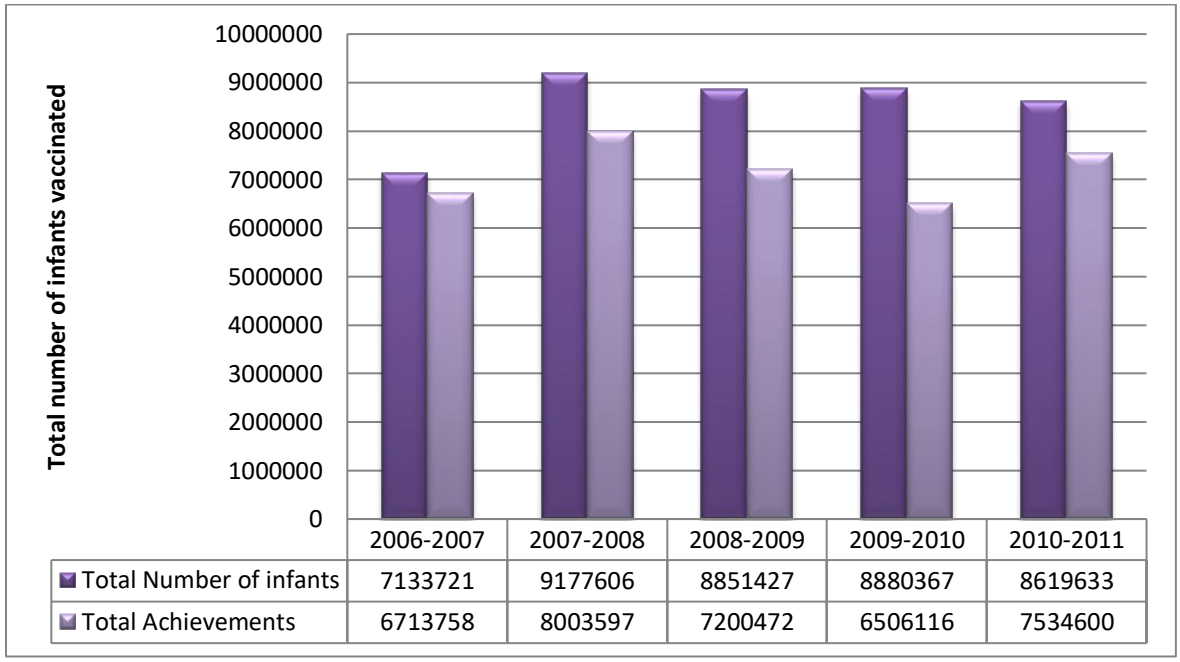
So here it is seen that the average number of infants successfully vaccinated every year from 2006 to 2011. From the results we can say that 2008-09 has the lowest average number of vaccinated infants where 2006-2007 has the highest one.

Next calculating Standard Deviation (S.D.) we get----

For 2006-07 S.D. is = 52918.5; For 2007-08 S.D. = 103493.1; For 2008-09 S.D. is = 51617.7; For 2009-10 S.D. is = 79456.9; For 2010-11 S.D. is = 80587.3

So it can be said that in the year 2008-09 rate of vaccination has minimum variation comparing to other years, in this year listed 5 vaccinations have most consistent achievement. And in the year 2007-08 has the highest variation in vaccination rate , vaccination rate was least consistence in this year.

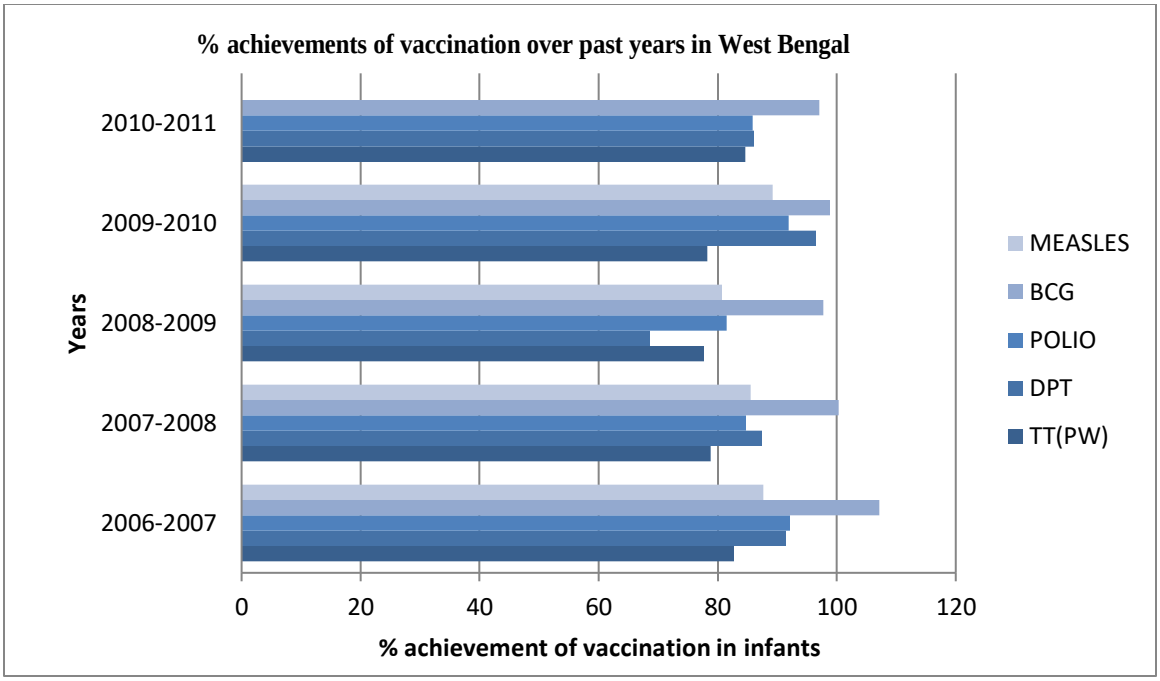
Figure 2-A: Total number of infants getting vaccination in past years in West bengal



	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Total Number of infants	7133721	9177606	8851427	8880367	8619633
Total Achievements	6713758	8003597	7200472	6506116	7534600

In figure 2-A we see that total vaccinated infants in West Bengal is highest in the year of 2006-2007 and then it declines in consecutive 2 years and become lowest in 2009-2010. Again it increases in the year 2010-2011.

Figure 2-B -



In figure 2-B we see that BCG vaccine has the highest average achievement among all five vaccines. Following that Polio vaccine has achieved consistent success over the past years. DPT vaccine has the significant lowest coverage in past years.

As we are focusing on UIP achievements in West Bengal, it is needed to focus on district wise results of UIP on children success. The district wise performance of UIP in West Bengal is put forward in following table -

Table 3 –

District-wise variation in child vaccination rate in West Bengal of the year 2009-10 and 2010-11:

Districts	TT(PW) (numbers of children vaccinated)	DPT (numbers of children vaccinated)	POLIO (numbers of children vaccinated)	BCG (numbers of children vaccinated)	MEASLES (numbers of children vaccinated)

	2009-10	**2010-11**	**2009-10**	**2010-11**	**2009-10**	**2010-11**	**2009-10**	**2010-11**	**2009-10**	**2010-11**
Cooch Bihar	56670	554826	55791	37020	55394	52960	63529	62930	54562	54059
Jalpaiguri	67554	67902	69737	47403	62666	59711	63529	68574	66260	55212
Darjiling	25081	30259	30962	30488	31103	32684	75936	38022	29843	55212
Malda	83627	81551	85708	56839	76703	72467	36465	95109	82843	34231
Uttar Dinajpur	68605	63190	68178	53341	68116	54710	97486	75768	67629	78456
DakshinDinajpur	29257	29496	30125	26300	29989	28161	77331	32428	29443	61840
Murshidabad	147202	145491	143227	102111	140259	121410	33749	159028	141833	28476
Nadia	84571	78301	78188	60662	76395	78333	166969	82442	78241	124477
North 24 Parganas	134511	11811	137914	136932	137964	136831	83820	147948	134511	73238
South 24 Parganas	137328	130942	78188	100876	129145	125715	151663	141440	139786	131173
Kolkata	67831	53025	69511	33967	70579	44388	149151	80304	66178	120792
Howrah	81284	68613	74566	50187	72100	60458	89265	77003	70378	46000
Hooghly	76399	72947	82673	66471	78953	73706	90199	85945	80174	62400
Bardhaman	143723	135382	134591	90597	133670	120286	155612	146092	125096	73100

Birbhum	73462	76625	72120	54882	66379	74265	80342	84430	70934	119741
Bankura	58373	61823	60660	46985	56965	58504	67854	65979	61819	71057
Puruliya	57585	57433	58630	46692	58381	50299	64724	58340	58056	50435
PurbaMedinipur	88754	89057	97515	77056	95637	89610	107356	104726	99076	84381
PaschimMedinipur	78986	77951	85455	73302	84168	80934	95969	91965	86008	78241
West Bengal	1560803	1492925	1573700	1192106	1524566	1415432	1804918	1698653	1539610	1401356

Source: West Bengal Health Portal (wbsc.gov.in)

We will calculate mean and standard deviation to examine average vaccinated number and variation in vaccination rate respectively in context of table 3.

Calculating Mean we get----------

For TT(PW) vaccination in 2009-10 = $\frac{1502713}{19}$ = 79090.16 and in 2010-11 = $\frac{1526529}{19}$ = 80343.63

For DPT vaccination in 2009-10 = $\frac{1678522}{19}$= 88343.26 and in 2010-11 = $\frac{1981044}{19}$ = 104265.05

For Polio vaccination in 2009-10 = $\frac{1600142}{19}$= 84218 and in 2010-11 = $\frac{1462452}{19}$ = 76961.16

For BCG vaccination in 2009-10 = $\frac{1719572}{19}$ = 90503.79 and 2010-11 = $\frac{1654043}{19}$ = 87054.89

For Measles vaccination in 2009-10 = $\frac{1552782}{19}$ =81725.37 and 2010-11 = $\frac{1423533}{19}$ = 74922.79

From above values of mean we can say that TT(PW) vaccination rate has increased from average 79090.16 vaccinations in 2009-10 to average 80343.63 vaccinations in 2010-11. Also DPT vaccination rate has increased from average 88343.26 vaccinations in 2009-10 to average 104265.05 vaccinations in 2010-11. Polio vaccination rate has decreased from average 84218

vaccinations in 2009-10 to average 76961.16 vaccinations in 2010-11, which is not at all appreciable. DPT vaccination rate has increased from average 88343.26 vaccinations in 2009-10 to average 104265.05 vaccinations in 2010-11. Just like Polio vaccination, BCG vaccination and Measles vaccination also have decreased from 90503.79 vaccinations and 81725.37 vaccinations in 2009-10 to 87054.89 vaccinations and 74922.79 vaccinations in 2010-11 respectively. Further we see that in 2009-10 the highest average vaccination was 88343.26 vaccinations for DPT and the lowest average vaccination was 79090.16 vaccinations for the TT(PW). In 2010-11 the DPT vaccination had the highest average of 104265.05 vaccinations and the Measles vaccination had the lowest average of 74922.79.

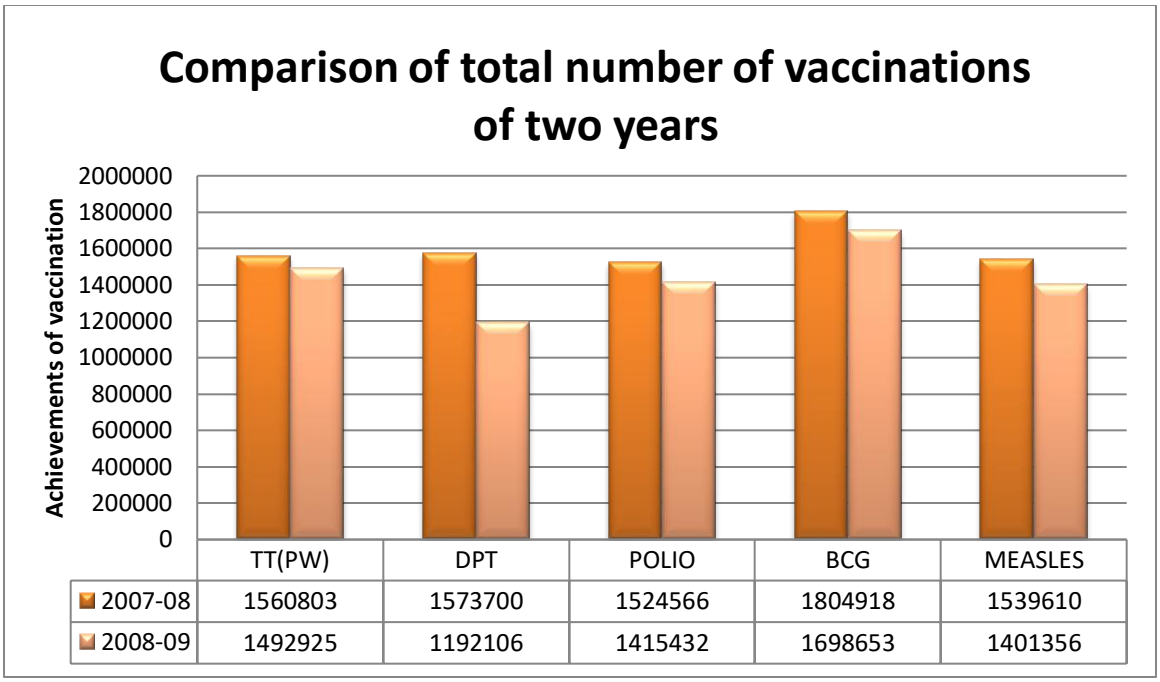
Now calculating S.D. we get ----------

For the year of 2009-10, S.D. of TT(PW) = 35568.3; DPT = 12422.22; Polio = 36406.42; BCG = 35741.39; Measles= 35033.38

For the year of 2010-11, S.D. of TT(PW) = 34337.42; DPT= 43627.59; Polio = 33115.69; BCG = 33912.77; Measles = 32034.21.

So from S.D. of vaccination rate we can conclude that in the year of 2009-10 Polio has the highest variation in its vaccination rate and DPT has the lowest variation in its vaccination rate. Taking individually, the variation in TT(PW) vaccination has decreased in 2010-11 compared to 2009-10. The variation in DPT vaccination has increased in 2010-11 being 43627.59 from 12422.22 in 2009-10, which is not at all a good sign. Variation in the Polio vaccination, he BCG vaccination and the Measles vaccination has a decreasing variation from 2009-10 to 2010-11.

Figure 3:



In Figure 3 we see the variation in total vaccination coverage in districts of West Bengal. The TT(PW) vaccination coverage was 1560803 in 2009-10 and 1492925 in 2010-11 so TT vaccination coverage has declined. We also see a drastic fall in DPT vaccination. It was 1573700 in 2009-10 where it came down to 1192106 in 2010-11. Polio vaccination coverage has fallen down from 1524566 in 2009-10 to 1415432 in 2010-11. BCG and Measles also has a downward trend. BCG had coverage of 180918 in 2009-10 and 1698653 in 2010-11 whereas Measles vaccination had coverage of 1539610 in 2009-10 and 1401356 in 2010-11. Thus we see that all these vaccination has a fall in their total coverage in districts of West Bengal comparing these two years.

The District Level Household Survey 2012-13 (DHLS-4) presented the percentage statistics of child immunity vaccination coverage and also coverage of Vitamin A doses in the districts of West Bengal. The report was under the heading of "Child health immunization" and particularly focused on the vaccination coverage of 2012-13. We will look into the report of DHLS-4 and analyze the results -

Table 4 -

Status of childhood vaccination by districts in 2012-13

Districts	BCG (%)	DPT3 (%)	Polio3 (%)	Measles (%)	Full (%)	None (%)	VIT A dose (%)	Number of children
Darjiling	98.5	92.0	94.9	90.2	86.5	0.0	78.6	72
Jalpaiguri	97.3	96.2	91.1	97.8	81.5	0.0	58.3	77
Cooch Bihar	94.8	92.2	91.7	94.8	86.5	1.1	45.7	73
Uttar Dinajpur	96	87.1	84.7	86.5	76.7	2.5	50.7	115
DakshinDinajpur	98.2	93.1	89.1	94.1	86	.0	71.1	67
Malda	92.5	91.1	85.5	88.2	80.5	1.0	77.3	108
Murshidabad	93.9	79.7	78.9	81.2	67.8	1.0	63.7	111
Birbhum	89.9	87.0	72.4	83.5	67.2	5.9	73.8	96
Bardhaman	91.7	86.1	84.5	78.9	70.8	6.1	43.8	91
Nadia	96.9	98	93.9	96.9	92	1.0	70.1	106
North 24 Parganas	91.4	83.6	70	80.5	56.4	1.9	53.6	57
Hooghli	98	96.1	96.4	88.2	84	0.0	43.1	90
Bankura	100	100	92.5	96.8	89.3	0.0	44.0	89
Puruliya	96.6	95.5	89.8	92.9	83.8	1.5	82.2	122
PaschimMedinipur	97.1	86.5	84.7	88.2	77.4	0.0	63.2	65
Howrah	98.9	94.6	90.3	90.5	81.5	1.1	79.5	73
Kolkata	91.6	85.6	81.3	84.1	73.9	4.6	53.0	42
Souh 24 Parganas	95.6	85.7	83.4	79.2	70.8	1.1	61.7	93
PurbaMedinipur	98.8	95.6	85.1	91.9	79.3	1.2	67.0	80
DHLS-4	95.9	91.5	87	88.7	79.5	1.4	52.8	1627
DHLS-3	96.2	83.5	83.8	82.8	75.7	1.6	82.5	1853

Source: District Level Household Survey 4 (2012-13)

Here Full vaccination refers to the vaccination of BCG, doses of DPT, three doses of Polio (excluding polio 0) and measles. Children getting all these vaccines are termed fully vaccinated children. Also Vitamin A doses are listed here.

Now we will calculate the mean value of vaccination rates of each vaccine separately and also the completed doses of Vitamin A and compare it with each other to see which individual vaccine has a better performance than the others and which does not. Here the year taken is 2012-13.

Calculating Mean values (in percentage) we get----------

For BCG vaccine the mean value is = $\frac{1817.7}{19}$ = 95.67

For 3 injections of DPT vaccine the mean value is = $\frac{1725.7}{19}$ = 90.83

For 3 doses of Polio vaccine the mean value is = $\frac{1640.2}{19}$ = 85.33 (except Polio 0)

For Measles vaccine the mean value is = $\frac{1684.4}{19}$ = 88.65

For full vaccination the mean value is = $\frac{1491.9}{19}$ = 78.9 (including BCG,DPT3, Polio3, Measles)

For Vitamin A doses the mean value is = $\frac{1180.4}{19}$ = 62.12

So from the calculated means values of vaccination rates we see that BCG vaccine has the highest average number of vaccinations. BCG vaccine has average 95.67% vaccines successfully taken. The lowest average vaccination taken is 85.33% which is for 3 doses of Polio (except Polio 0). The DPT vaccine (3 injections) has average of 90.83% vaccines taken and the measles vaccine has average 88.65% vaccines taken. Most noticeable thing is the average number of fully vaccinated children (BCG, 3 injections of DPT, 3 doses of Polio and measles) is 78.9% which is lesser than every other average number of vaccines taken individually. This implies that there exist some dropouts in the vaccination schedule. And the Vitamin A doses has average coverage of 62.12% children which should be increased more.

Now we will calculate the variations in districts regarding vaccinations. For that purpose we will calculate S.D. of each vaccine and compare them with each other.

Calculation S.D. we get ----------

For BCG vaccination the S.D. is = 2.94;

For 3 injections of DPT vaccination the S.D. is = 5.42;

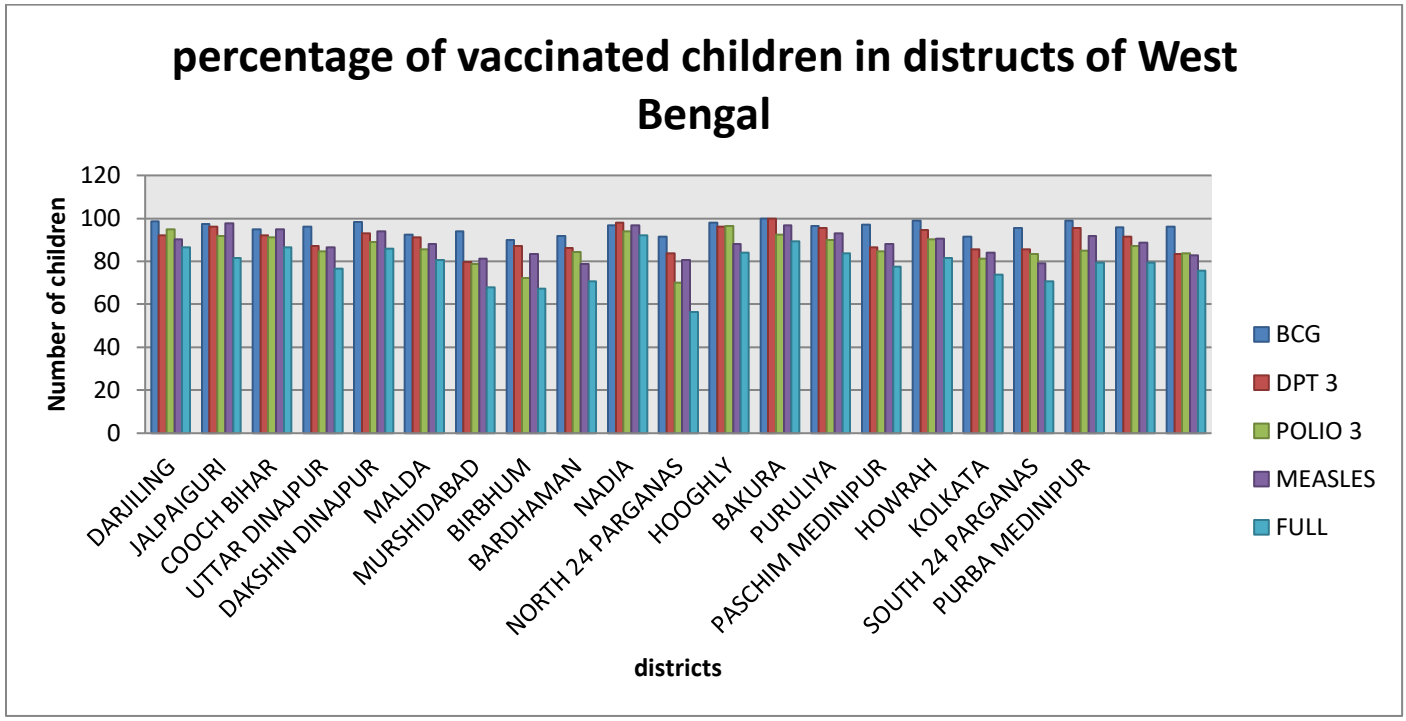
For 3 doses of Polio vaccination the S.D. is = 6.95;

For Measles vaccination the S.D. is = 5.96;

For full vaccination the S.D. is = 8.7;

From the values of the S.D. we can conclude that full vaccination has the highest variation that any other individual vaccines. So number of fully vaccinated children is not at all consistent in different districts of West Bengal. Taking individually, BCG vaccine has minimum variation and Polo (3 doses except Polio 0) has maximum variation in its vaccination rate.

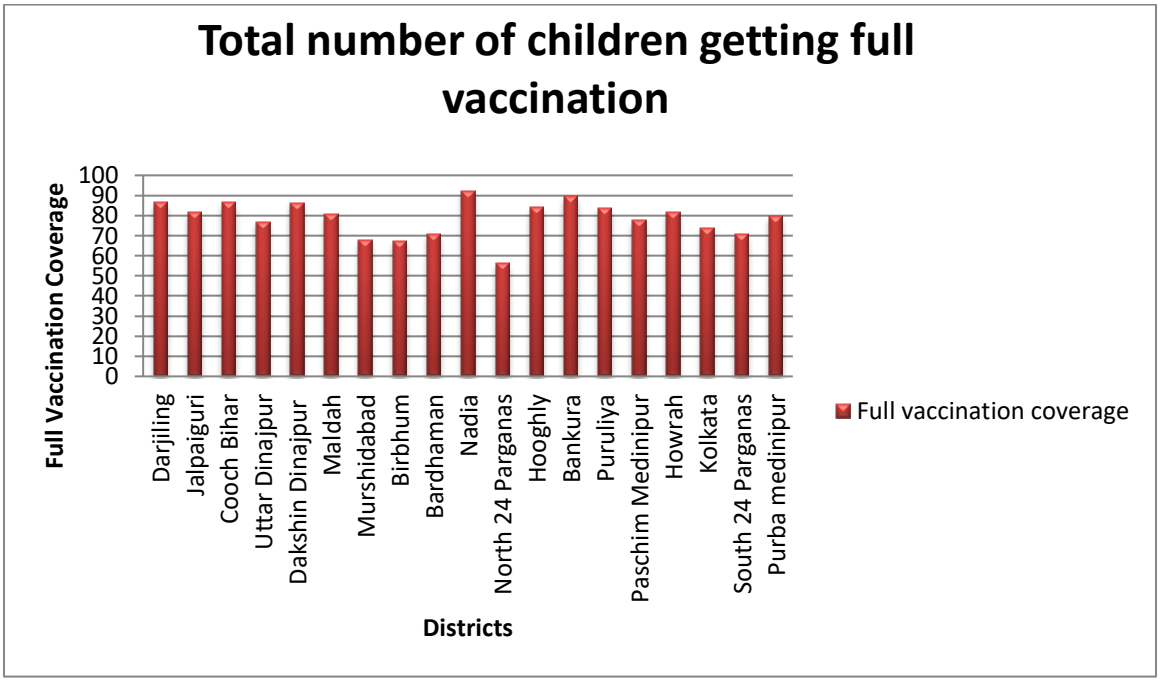
Figure 4-a:



In figure 4-a, , we see that Coverage for BCG, DPT, and Polio (except Polio 0) vaccinations is much higher than the percentage fully vaccinated. BCG vaccination was highest in Bankura being 100% and lowest in Birbhum being 89.9% . Vaccination coverage of 3 injections of DPT is highest, 96.2% in Jalpaiguri and lowest, 83.6% at North 24 Parganas. Coverage of 3

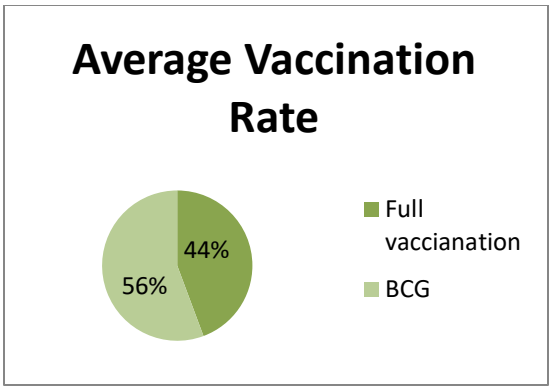
doses of Polio (excluding Polio 0) is highest, 94.9% in Darjiling and lowest, 70% in North 24 Parganas. Lastly Measles has the lowest coverage, 78.9% in Bardhaman and highest, 97.8% in Jalpaiguri. If we compare the vaccination coverage individually with full vaccination coverage then we will see that full vaccination coverage has lower percentage at every case. It indicates that parents are not having track of vaccines given to their children or may be unaware about the necessary vaccination to be given.

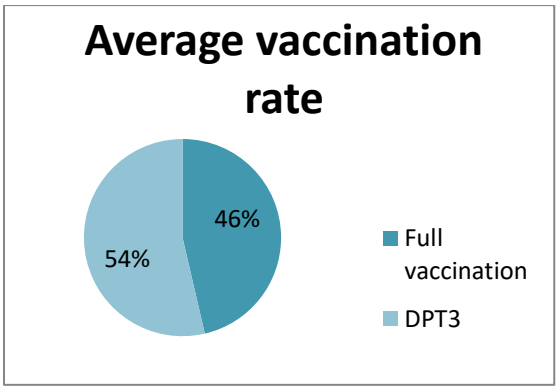
Figure 4-b:

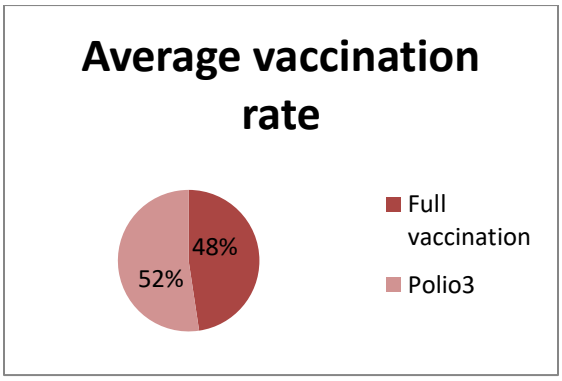


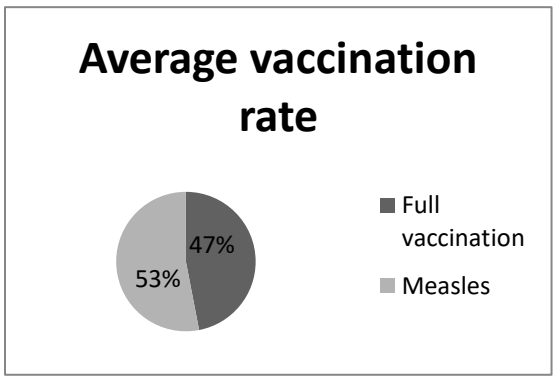
In this figure 4-b we see that percentage of fully vaccinated children (getting vaccination of BCG, 3 injections of DPT, Polio 1,2,3 and measles) is highest in Nadia. It is 92% in Nadia. Full vaccination coverage is lowest 56.4% in North 24 Parganas.

Figure 4-c:



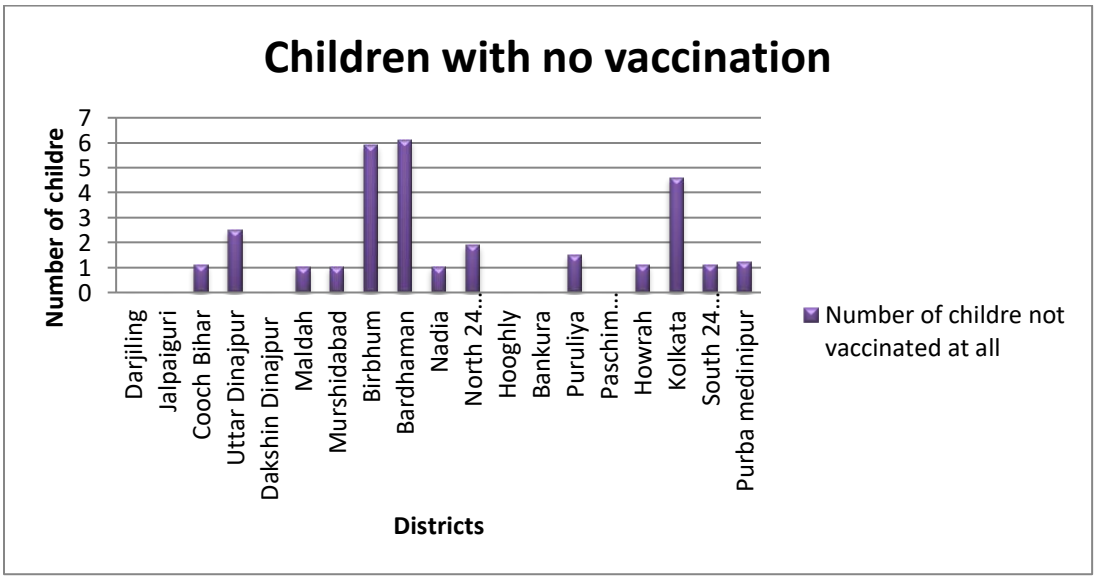






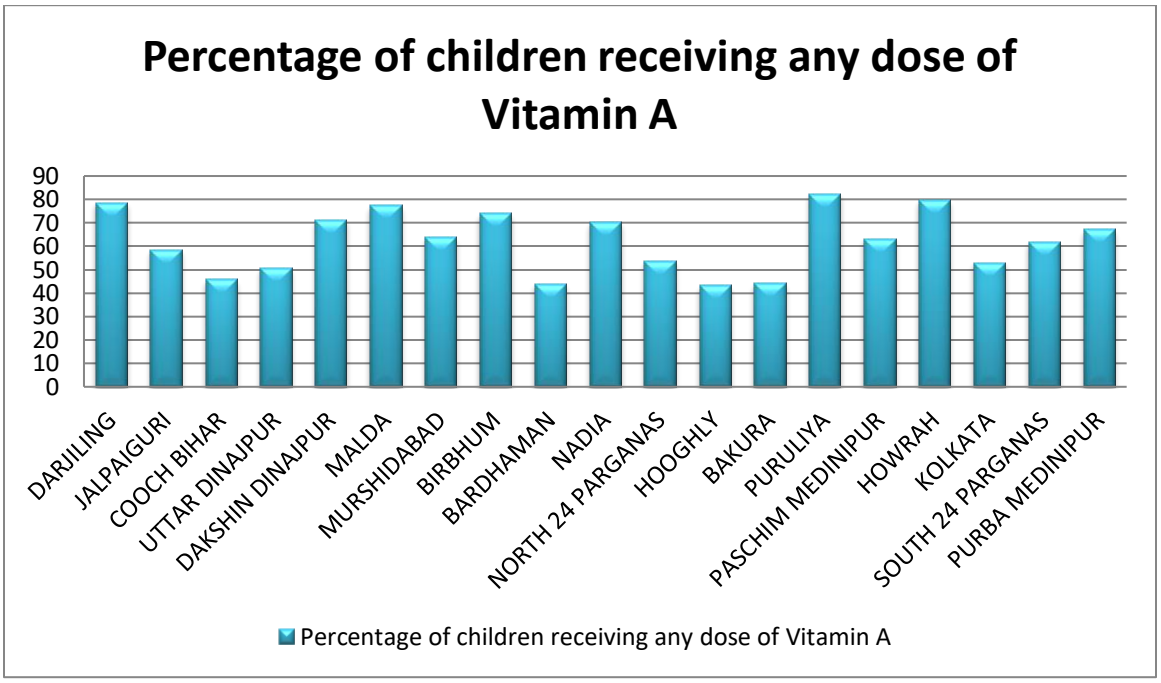
In figure 4-c we illustrated individual comparison of full average vaccination rate with BCG, DPT3, Polio3, Measles by using pie-chart. In every diagram we see that full vaccination has lower average vaccination than any other individual vaccination. This clearly indicates the existence of vaccination dropout.

Figure 4-d:



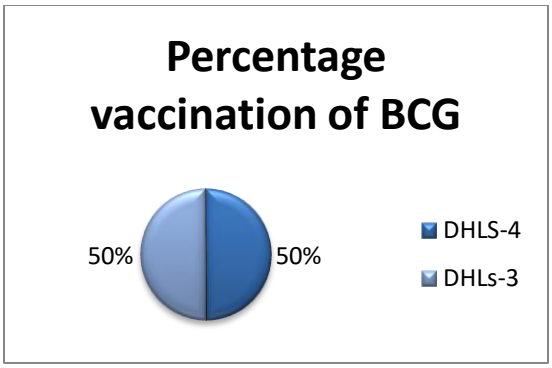
In figure 4-d, percentage of not vaccinated children is presented. Not vaccinated refers to those children who had none of the vaccine among BCG, 3 injections of DPT, 3 doses of Polio and Measles. Fortunately there exist 6 out of 19 districts in West Bengal where no children remains un-vaccinated. Those 6 districts are Darjiling, Jalpaiguri, Dakshin Dinajpur, Hooghly, Paschim Medinipur. Highest number of unvaccinated children resides in Bardhaman. 6.1% of children were unvaccinated in Bardhaman. After Bardhaman , Birbhum had the second highest number of unvaccinated children,5.9%. Malda and Murshidabad had second lowest number of unvaccinated children which is 1%.

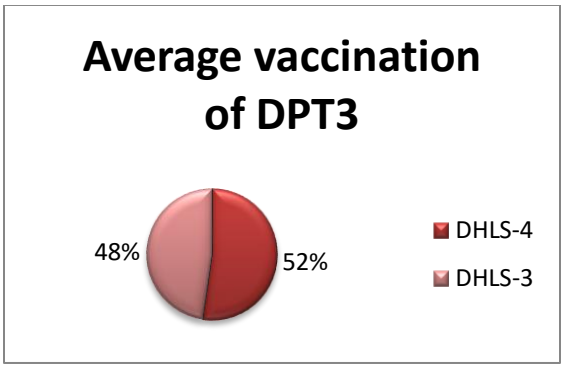
Figure 4-e :

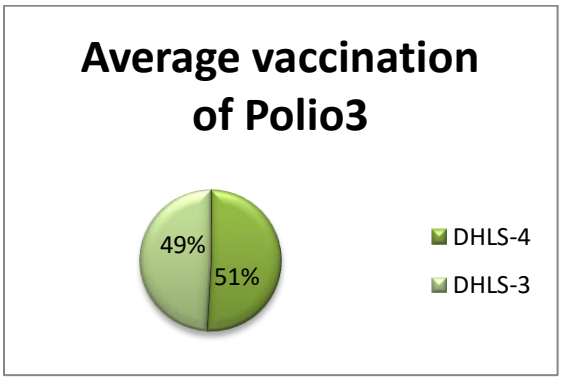


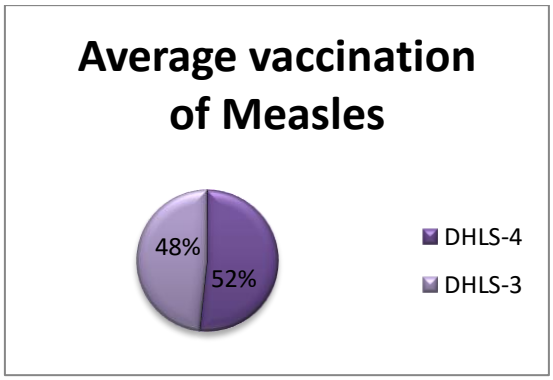
In figure 4-e , percentage of children getting Vitamin A doses is projected. Children of 12 to 35 months getting any Vitamin A dose is listed here. Here we see that Darjiling has the highest children who got Vitamin A doses, the number is 78.6% . The second highest district is Maldah having 77.3% children with vitamin A doses. The lowest percentage of children getting Vitamin A doses is 43.1% Bardhaman and the second lowest percentage is 43.8% in Bardhaman.

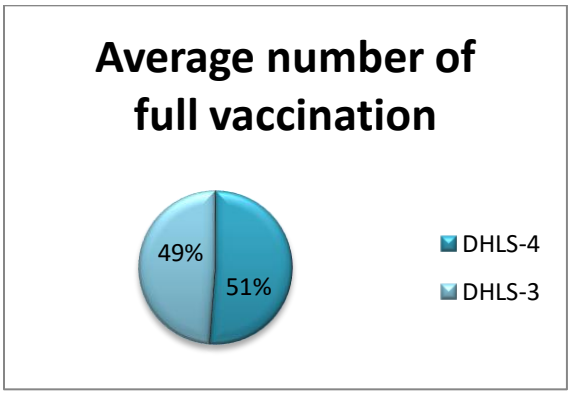
Figure 4-f:

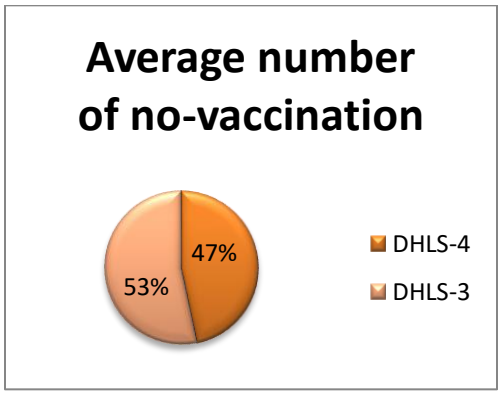

Percentage vaccination of BCG
50%
50%
DHLS-4
DHLs-3

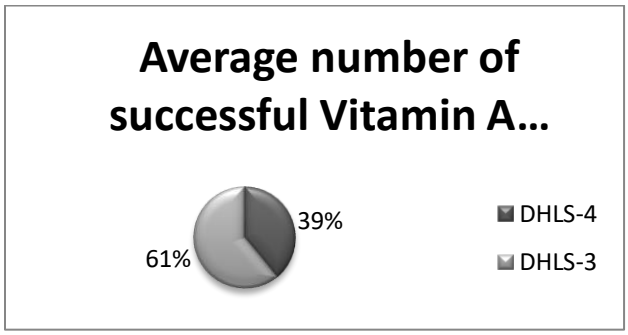

Average vaccination of DPT3
48%
52%
DHLS-4
DHLS-3


Average vaccination of Polio3
49%
51%
DHLS-4
DHLS-3


Average vaccination of Measles
48%
52%
DHLS-4
DHLS-3


Average number of full vaccination
49%
51%
DHLS-4
DHLS-3


Average number of no-vaccination
47%
53%
DHLS-4
DHLS-3


Average number of successful Vitamin A...
39%
61%
DHLS-4
DHLS-3

In this figure 4-f, we have projected the comparison between report of UIP by DHLS-4 (2012-13) and DHLS-3 (2007-08). By comparing these two results we see that BCG vaccination rate is 95.9% in DHLS-4 and 96.2% in DHLS-3. BCG vaccination coverage has fallen. Vaccination coverage of DPT-3 has increased; it was 83.5% in DHLS-4 and 91.5% in DHLS-3. Polio 3 vaccination coverage has also increased. It increased from 83.8% in DHLS-3 to 87% in DHLS-4. Similarly Measles vaccination coverage has an increasing trend; it was 82.8% in DHLS-3 and 88.7% in DHLS-4. The percentage of fully vaccinated children has increased from 75.7%(DHLS-3) to 79.5% (DHLS-4). Fortunately, the number of non vaccinated children has fall by a little amount. It was 1.6% in DHLS-3 and 1.4% in DhLS-4. Percentage of children getting Vitamin A doses has fallen significant amount, it has fallen from 82.5% in DHLS-3 to 52.8% in DHLS-4.

Variations in child immunity vaccination rate in different districts of West Bengal depend on many factors. Factors includes lack of health literacy in parents, lack of health facilities , lack of proper mechanism, tight budgetary policy of Govt. , lack of awareness regarding immunity vaccination, lack of proper monitoring of the program, lack of health workers so on and so forth. But as mentioned in the objective section our aim is to find out the effect of literacy rate and area covered by health facilities on UIP. So in this study our supply side variables are literacy rate and availability of health facilities.

As we only focusing on rate of child vaccination in districts of West Bengal we will look into the literacy rate in different districts of West Bengal. In following table we will project the literacy rate in districts of West Bengal published in 2011 census report.

Table 5- Various dimension of Literacy in West Bengal, 2011

Districts	**Total Literacy rate (%)**	**Rural literacy rate (%)**	**Urban literacy rate (%)**	**Male literacy rate (%)**	**Female literacy rate (%)**	**Rural male literacy rate (%)**	**Urban male literacy rate (%)**	**Rural female literacy rate (%)**	**Urban female literacy rate (%)**
Darjiling	79.92	74.97	87.98	85.94	73.74	82.5	91.23	67.2	83.65
Jalpaiguri	73.79	70.55	82.33	80.61	66.65	78.31	86.69	62.43	77.78
Cooch Bihar	75.49	73.87	89.10	81.52	69.08	80.25	92.41	67.07	85.54

Uttar Dinajpur	60.13	57.15	80.67	66.65	53.15	64.06	84.31	49.77	56.69
Dakshindinajpur	73.86	71.18	89.42	79.63	65.81	77.42	92.61	64.61	86.15
Malda	62.71	60.42	76.82	67.27	57.84	65.37	78.71	55.18	74.71
Murshidabad	67.53	66.27	78.65	71.20	63.88	69.25	77.15	62.84	68.02
Birbhum	40.9	69.25	81.74	77.42	64.07	56.01	86.75	62.18	76.55
Bardhaman	77.15	73.39	82.75	83.44	70.47	80.05	88.43	66.39	76.63
Nadia	75.58	71.5	85.88	79.58	71.35	76.65	89.63	67.08	81.98
North 24 Parganas	84.95	78.11	89.8	88.66	81.05	82.86	92.79	73.08	86.66
Hooghly	82.55	79.22	87.75	87.93	76.95	85.71	91.39	72.5	83.95
Bankura	70.95	69.6	85.23	81	60.44	80.06	90.97	58.66	79.24
Puruliya	65.38	63.57	76.24	78.85	51.29	77.96	84.68	48.93	67.29
Purba Medinipur	87.66	87.47	89.14	93.14	81.81	93.1	93.41	81.45	82.3
Paschim medinipur	79.04	77.92	87.1	86.66	71.11	85.97	91.96	69.45	84.98
Howrah	83.85	80.82	87.14	87.69	79.73	86.06	88.61	75.29	79.09
Kolkata	87.14	0	87.10	89.04	84.98	0	89.08	0	82.25
South 24 Parganas	78.57	76.78	83.62	84.72	70.01	85.59	87.93	69.59	84.52

Source: Census of India, 2011

Given data in table 5 we will first compare the literacy rates i.e. total literacy rate, rural and urban literacy rate, male and female literacy rate, rural male and rural female literacy rate and urban male and urban female literacy rate. We will follow the mean values to compare them.

Calculating Mean values (in percentage) we get ----------

Mean of total literacy rate = $\frac{1437.15}{19}$ = 75.64

Mean of urban literacy rate = $\frac{1602.19}{19}$ = 84.32; Mean of rural literacy rate = $\frac{1302.22}{19}$ = 68.54;

Mean of male literacy rate = $\frac{1550.77}{19}$ = 81.62; Mean of female literacy rate = $\frac{1317.49}{19}$ = 69.34;

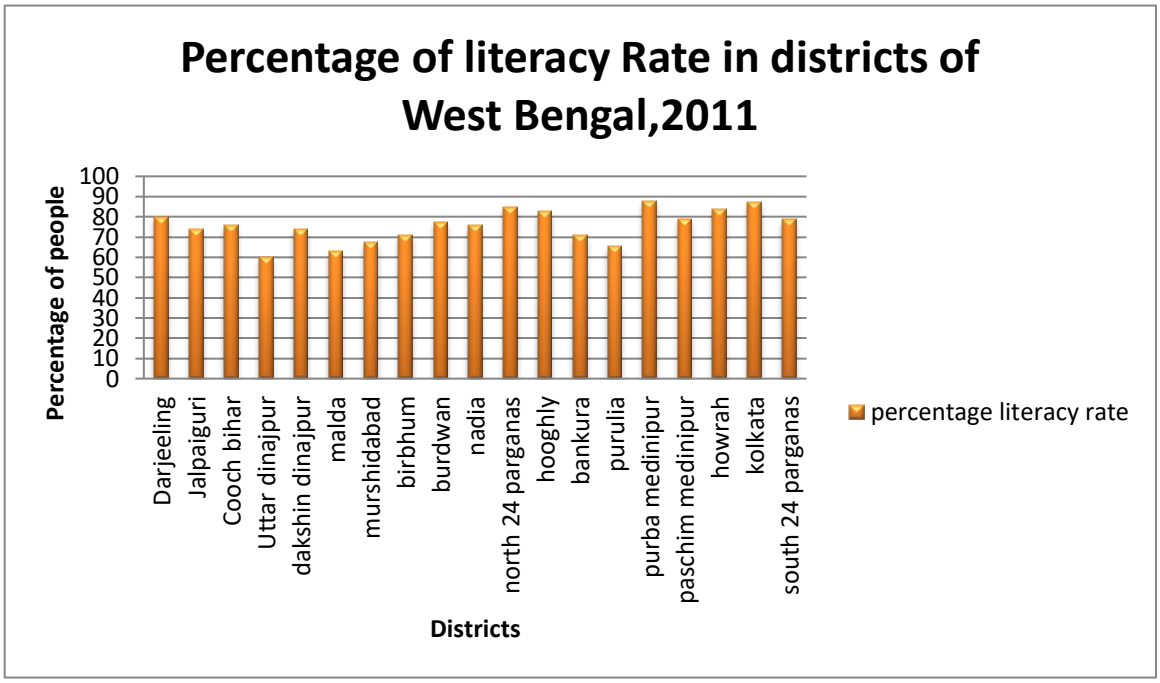
Mean of urban male literacy rate = $\frac{1678.39}{19}$ =88.33; Mean of urban female literacy rate = $\frac{1517.9}{19}$ =79.89;

Mean of rural male literacy rate = $\frac{1427.44}{19}$ =75.12; Mean of rural female literacy rate = $\frac{1137.7}{19}$ = 61.77.

From the calculated mean values we get the following results, urban literacy rate is greater than the rural literacy rate. Urban areas have average 84.32% literate people while rural areas of West

Bengal have 68.54% literate people. Then comparing literacy rate depending of gender we see that male literate in districts of West Bengal is average 81.62% and female literates are average 69.34%. More specifically, rural male literacy rate is lower than the urban male literacy rate and similar pattern is present in rural female and urban female literacy. Also we see that in rural areas, male literacy rate has greater average than female literacy rate, and urban areas also have male literacy rate greater average than female literacy rate.

Figure 5:



In the figure-5 percentage literacy rate is represented. The figure-5 is displayed below, here it is seen that the highest percentage of literate citizen resides in Purba Medinipur and the percentage is 87.66% and the lowest percentage of literate citizen is 60.13 % residing in Uttar Dinajpur.

Also we will go through the comparison between literacy rate of the year 2001 and 2011 in districts of West Bengal. The following table is represented the comparison as follows-

Table 6:

District wide comparison of literacy rate of 2001 and 2011

District	Literacy rate					
	Person (%)		Male (%)		Female (%)	
	2001	2011	2001	2011	2001	2011
Burdwan	70.18	76.21	78.63	82.42	60.95	69.63
Birbhum	60.48	70.68	70.89	76.92	51.55	64.14

Bankura	63.44	70.68	70.89	80.05	49.43	60.05
PurbaMedinipur	74.9	87.02	84.91	92.32	64.42	81.37
PaschimMedinipur		78		85.26		70.50
Howrah	77.01	83.31	83.32	86.95	70.11	79.34
Hooghly	75.11	81.8	82.59	87.03	67.21	76.36
North 24 Pargans	78.07	84.6	83.92	87.60	71.72	80.34
South 24 Parganas	69.45	77.51	79.19	83.35	59.01	71.40
Kolkata	80.86	86.31	83.79	88.34	77.30	84.06
Nadia	66.14	74.97	72.31	78.75	59.58	70.98
Murshidabad	54.35	66.59	60.71	69.95	47.63	63.09
Uttar Dinajpur	47.89	59.07	58.48	65.52	36.51	52.17
DakshinDinajpur	63.59	72.82	72.82	78.37	54.28	67.01
Malda	50.28	61.73	58.8	66.24	41.25	56.96
Jalpaiguri	62.85	73.25	72.83	79.95	52.21	66.23
Darjiling	71.79	79.56	80.05	85.61	62.94	73.33
Cooch Bihar	66.3	74.78	75.93	80.71	56.12	68.49
Puruliya	55.57	64.48	73.32	77.86	36.50	50.52

Source: Census of India (2011)

Computing Means of literacy rate (in percentage) we get-----

Mean of total literacy in 2001= $\frac{1125.67}{17}$ = 66.22 ; in 2011 = $\frac{1350.55}{18}$ = 75.03

Mean of male literacy in 2001= $\frac{1270.56}{17}$ = 74.73 ; in 2011= $\frac{1451.7}{18}$ = 80.65

Mean of female literacy in 2001 =$\frac{966.56}{17}$ = 56.86 ; in 2011 = $\frac{1243.14}{18}$ = 69.06

In case of total literacy , literacy rate has increased in 2011 compared to 2001. Similarly male literacy and female literacy also have increased in 2011 compared to 2001.

Computing Standard deviation of literacy rates we get ------

S.D. of total literacy in 2001 = 9.34 and in 2011= 8.05

S.D. of male literacy rate in 2001 =8.49 and in 2011= 7.34

S.D. of female literacy in 2001 = 11.2 and in 2011 = 9.32

From the results we see that female literacy in both the years has very high variations. While male literacy has comparatively less variation in both the years. The variation in total literacy rate is greater in 2001 that in 2011. Same result is seen in the male literacy rate and the female literacy rate.

Figure 6-a:

In figure 6-a we have illustrated the variation in literacy rate in districts of West Bengal of the year 2001 and 2011, and also compared them. Thus we see that in 2001 Howrah has the highest literacy rate and Dakshin Dinajpur has the lowest literacy rate. In context of 2011 we see that Purba Medinipur has the highest literacy rate and Dakshin Dinajpur has lowest literacy rate. Hence both in 2001 and 2011 Dakshin Dinjpur has the lowest literacy rate, the percentage in 2001 is 47.08% and in 2011 is 57.09%.

The figure 6-a is displayed below----------

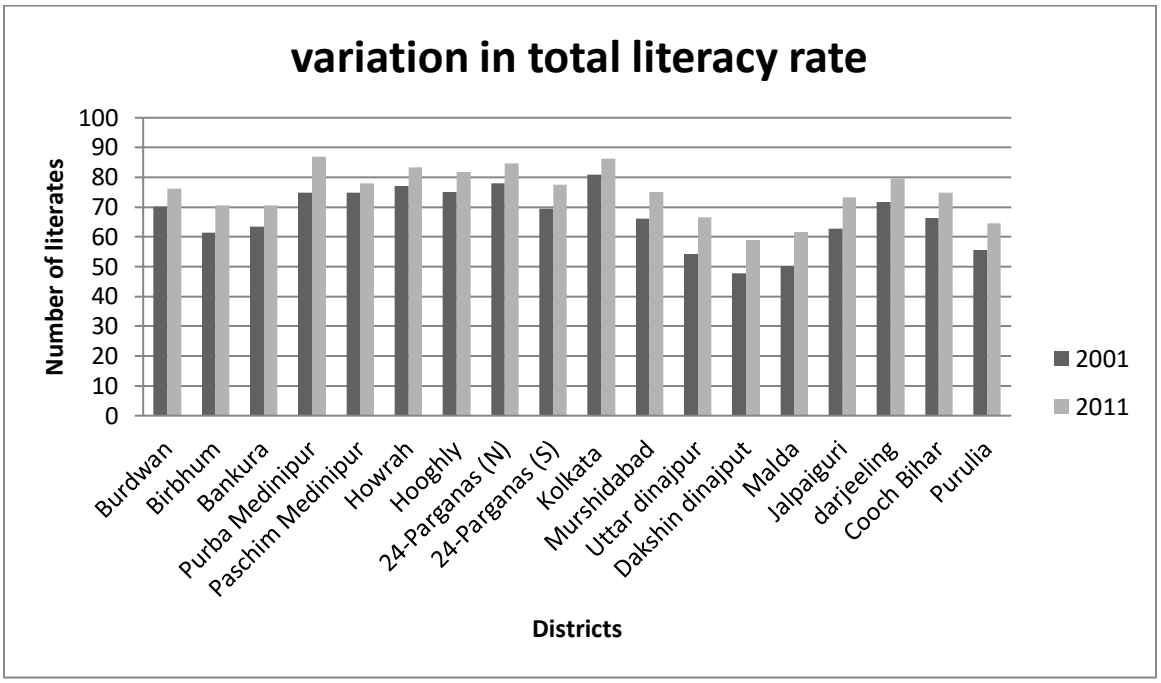
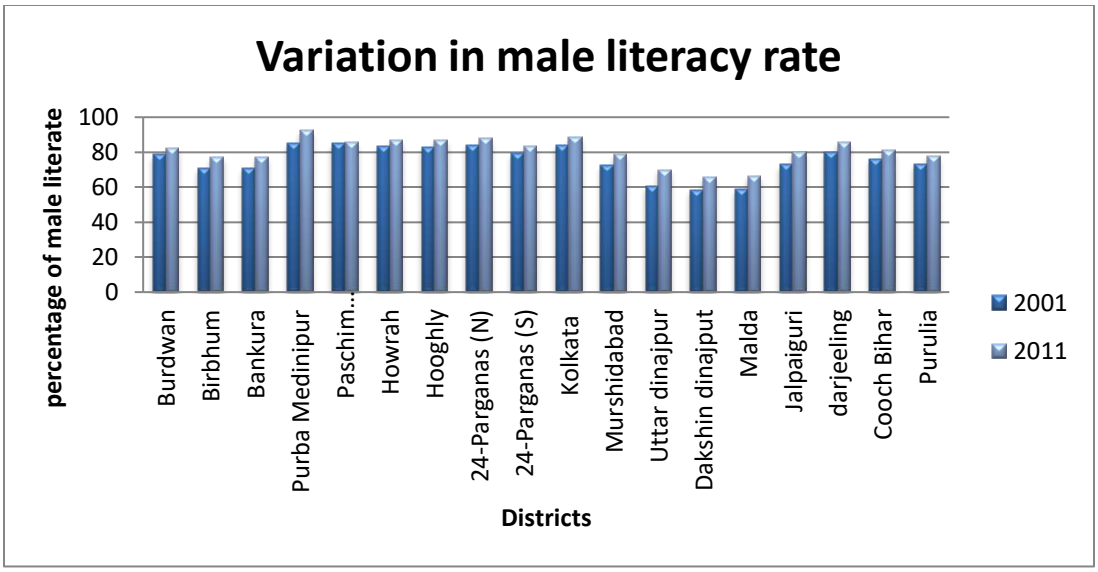
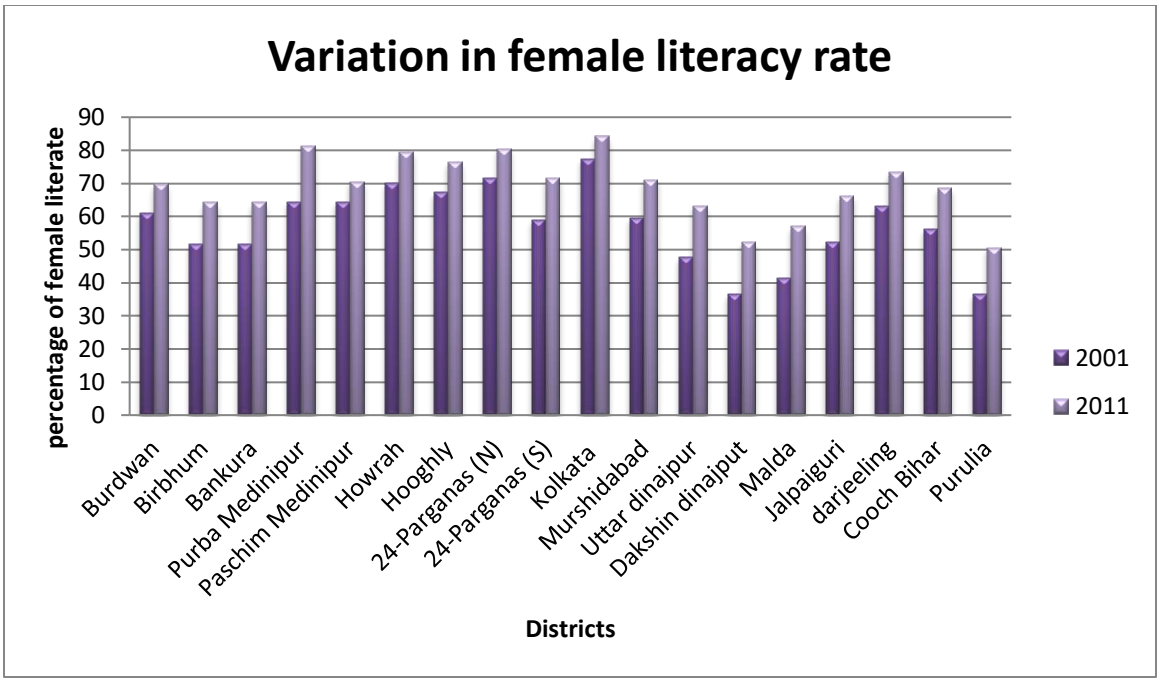


Figure 6-b:



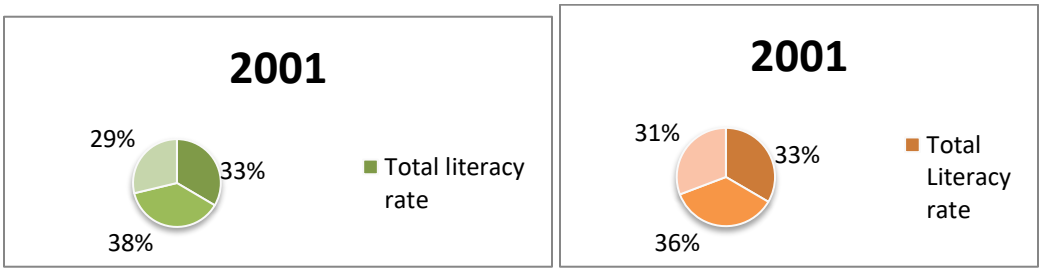
In figure 6-b we have illustrated the variation in male literacy rate in West Bengal of 2001 and 2011. Here we see that in 2011 Dakshin Dinajpur has the lowest and Medinipur (Purba Medinipur and Paschim Medinipur) has the higherst literacy rate. The highest percentage of male literate was 84.91% and the lowest percentage is 58.48%. In 2011 the lowest percentage of male literate is 65.52% residing in Dakshin Dinajpur while the highest percentage of male literate is 92.32% residing in Purbamedinipur. So DakshinDinajpur, in both years has the lowest rate of male literacy.

Figure 6-c:



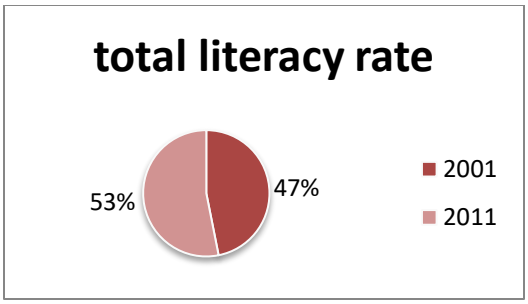
In figure 6-c we have shown the variation in female literacy rate in districts of est Bengal of the year 2001 and 2011. In 2001 the lowest female literacy rate was 36.5% which was in Puruliya district. The highest female literacy rate was 77.3% residing in Kolkata. In 2011 the lower most female literate was in Pururliya and the percentage was 50.52% and the highest literacy rate was 84.06% residing in Kolkata. So in both years the district with highest literacy rate is Kolkata and the district with the lowest literacy rate is Pururiya.

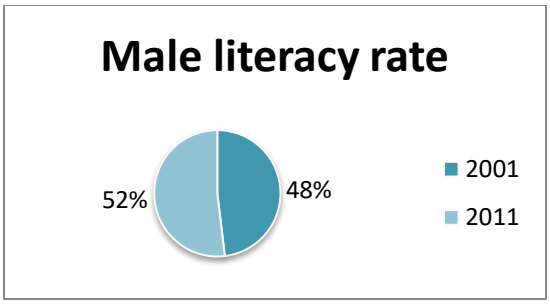
Figure 6-d:

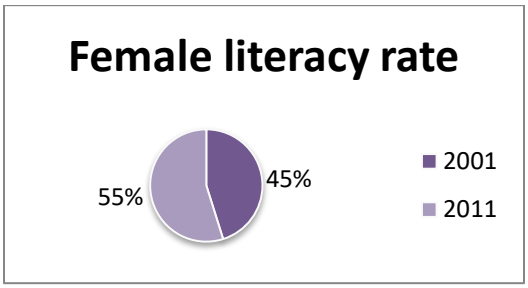


In the figure of figure 6-d the total percentage the total literacy rate, male literacy rate and female literacy rate has shown. Both the years of 2001 and 2011 has shown separately.

Figure 6-e:







In figure 6-e, we have illustrated the percentage comparison of total literacy rate, male literacy rate and female literacy rate of the year 2001 and 2011. In each cases we notice that compared to 2001, in 2011 literacy rate has increased.

Now we will go through the available health facilities in different districts of West Bengal. Also the availability of health facilities in rural areas of West Bengal will be examined.

Table 7:

Number of available Medical Institutes in districts of West Bengal, 2014

District	Department of health and family welfare, Govt. of West Bengal (numbers)								State govt, hospitals (numbers)	Local body (numbers)	Govt. Of India (numbers)	NGO/ Private (numbers)	Total
	Medical college hospital	District hospital	Subdivisional hospital	State General hospital	Other hospital	Rural hospital	Block primary hospital	Primary health centre					
Bankura	1	1	1	0	1	19	3	69	2	0	2	32	131

Bardhaman	1	1	3	0	0	22	12	106	4	0	18	159	326
Birbhum	1	1	1	0	1	15	4	68	3	0	3	50	147
Dakshin Dinajpur	0	1	1	0	0	7	1	18	1	1	0	14	44
Darjiling	1	3	1	0	3	9	3	22	7	1	1	13	64
Howrah	0	1	1	6	1	13	2	43	6	0	1	172	246
Hooghly	0	1	3	1	1	17	1	60	7	2	1	264	358
Jalpaiguri	0	2	1	1	1	13	1	39	3	0	42	42	145
Cooch Bihar	1	0	4	0	2	8	4	29	2	0	1	21	72
Kolkata	5	0	0	0	21	0	0	0	9	6	8	400	449
Malda	1	0	1	0	1	16	0	34	2	1	1	36	93
Murshidabad	1	0	4	0	1	17	10	70	5	2	1	118	229
Nadia	1	1	2	3	4	14	3	47	3	0	1	90	169
North 24 Parganas	1	2	3	7	0	18	4	51	6	11	3	180	286
Paschim Medinipur	1	1	2	0	2	25	4	81	4	1	3	137	261
PurbaMedinipur	0	2	3	1	0	15	9	51	0	0	1	160	242
Puruliya	1	0	1	0	1	18	2	54	2	0	2	23	104
South 24 Parganas	1	1	3	4	0	21	9	50	0	5	1	153	258
Uttar Dinajpur	1	0	1	1	0	6	3	19	1	0	0	21	53
Total	18	18	36	24	40	273	75	913	67	30	57	2139	3690

Source: Bureau of applied economics and statistics-Health report on March, 2015

To estimate the average number of medical institutes existing in different districts of West Bengal we will use the district wise mean values of numbers of medical institutes.

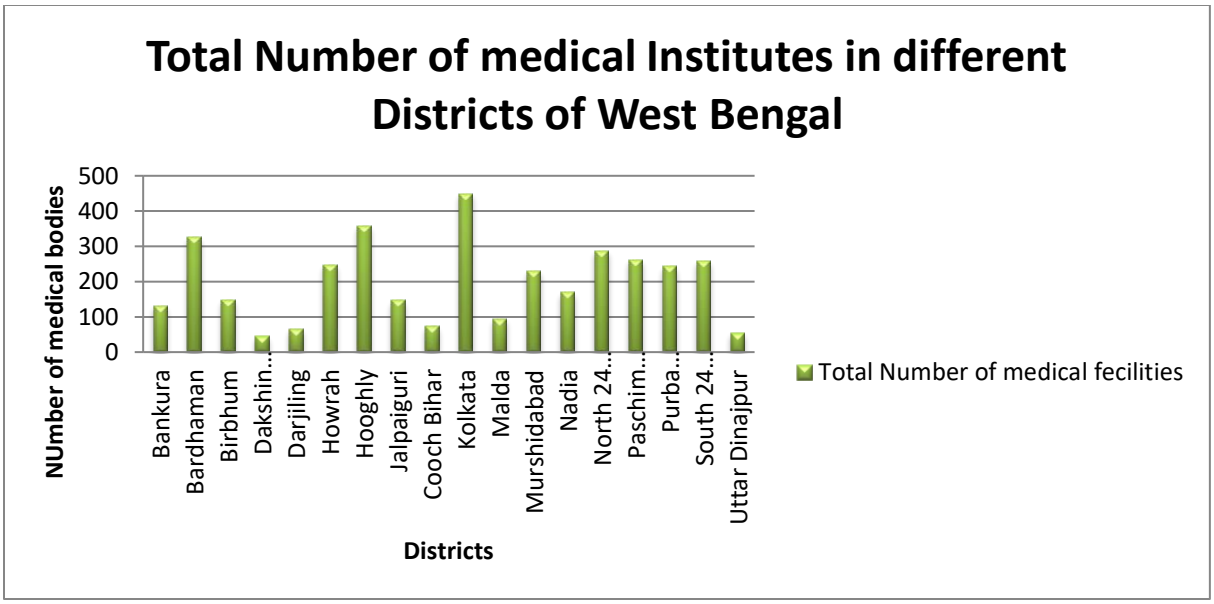
Calculating mean values we get----------

Bankura = $\frac{131}{12}$ = 10.91; Bardhaman = $\frac{326}{12}$ =27.16; Birbhum = $\frac{147}{12}$ = 12.25; Dakshin Dinajpur = $\frac{44}{12}$ = 3.67; darjiling = $\frac{64}{12}$ = 5.33; Howrah= $\frac{246}{12}$ = 20.5; Hooghly = $\frac{358}{12}$ = 29.83; Jalpaiguri= $\frac{145}{12}$ = 12.08; Cooch Bihar = $\frac{72}{12}$ = 6; Kolkata = $\frac{449}{12}$ = 37.41;Malda= $\frac{93}{12}$ = 7.75; Murshidabad = $\frac{229}{12}$ = 19.08; Nadia = $\frac{169}{12}$ = 14.08; North 24 Parganas = $\frac{286}{12}$ = 23.83; Paschim medinipur = $\frac{261}{12}$ = 12.75; Purba Medinipur = $\frac{242}{12}$ = 20.17; Puruliya = $\frac{104}{12}$ = 1.87; South 24 Parganas = $\frac{258}{28}$ = 21.5; Uttar Dinajpur = $\frac{53}{12}$ = 4.12.

From the calculated mean values we can get the average numbers of medical institutes present in districts of West Bengal. From the result we can conclude that Puruliya has the lowest average number of medical institutes which is 1.87. Kolkata has the highest average number of medical institutes which is 37.41.

Figure 7:

In the below figure we represent the number of medical institutes available in the districts of West Bengal. Here we see that Kolkata has the highest number of medical institutes including Govt hospitals and private hospitals. The number of medical institutes in Kolkata is 449. The lowest number of medical institute is 53 located in Uttar Dinajpur.



Now we will particularly focus on medical facilities in rural areas.

Table 8:

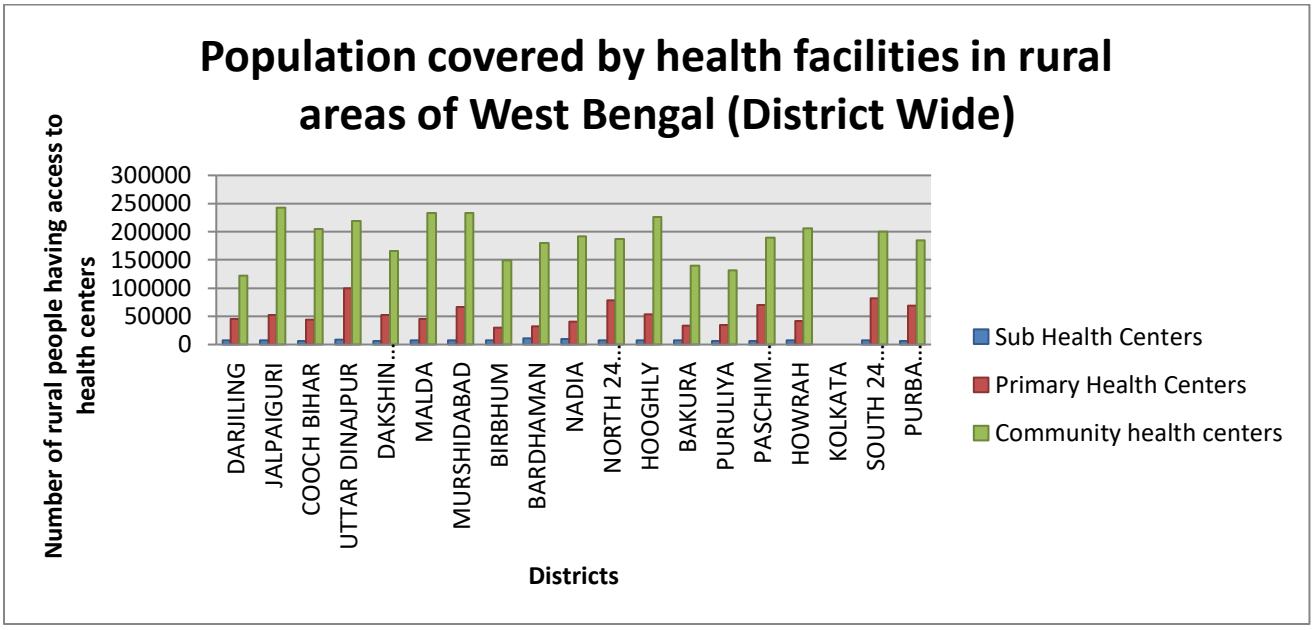
Average population Covered by Health Facilities in rural areas of West Bengal, 2012

	Average population covered by		
Districts	Sub health centers	Primary health centers	Community health centers
Darjiing	7700	4487	122527
Jalpaiguri	7081	52415	245375
Cooch Bihar	6447	44473	205032
Uttar Dinajpur	8233	99526	219646
DakshinDinajpur	6532	52250	166205
Malda	7904	45900	233302
Murshidabad	7998	66296	233218
Birbhum	7239	30531	149038
Bardhaman	11056	32291	179618
Nadia	10288	40859	191454
North 24 Parganas	7217	78764	186931
Hooghly	6960	53461	226280
Bankura	7134	33279	139614
Puruliya	6086	35043	131700
PaschimMedinipur	6555	70220	188966
Howrah	7802	41192	206407
Kolkata	NA	NA	NA
South 24 Parganas	7247	82033	200254

PurbaMedinipur	6779	69362	185133
West Bengal	7709	50300	188994

Source: Statistical Handbook of West Bengal,2015

Figure 8:



In this table we represent the numbers population covered by sub health centers, primary health centers and community health centers in rural areas. In case of sub health centers Bardhaman district has the highest number population covered by sub health centers. In rural areas of Bardhaman district there are 11056 people who have access to sub health centers. And the lowest number of people having access sub health centers is 6447 located in Cooch bihar district. Population with primary health center facility is highest in number in the district of Uttar dinajpur and the number is 9956 people. The lowest number of population accessing primary health center is 30531 located in Birbhum district. The highest and lowest number of population having community health centers is 242375 and 122527 located in the district of Jalpaiguri and Darjiling respectively.

Now we will perform multiple linear regression analysis to find out the relation among the number of children vaccinated, literacy rate and availability of health facilities. In our regression analysis the number of children getting vaccinated is the endogenous variable and the exogenous variables are literacy rate and availability of health facilities. Our regression model is three variable multiple regression model.

Table9:

Percentage of fully vaccinated children, number of medical institutes and percentage of literate citizen in the districts of West Bengal, 2011

Districts	Percentage of fully vaccinated children (%)	Percentage of literate citizen (%)	Number of available medical institutes
Darjiling	86.5	79.92	64
Jalpaiguri	81.5	73.79	145
Cooch Bihar	86.5	75.49	72
Uttar Dinajpur	76.7	60.13	53
Dakshin Dinajpur	86	73.86	44
Malda	80.5	62.71	93
Murshidabad	67.8	67.53	229
Birbhum	67.2	70.9	147
Bardhaman	70.8	77.15	326
Nadia	92	75.58	169
North 24 Parganas	56.4	84.95	286
Hooghly	84	82.55	358
Bankura	89.3	70.95	131
Puruliya	83.8	65.38	104
PaschimMedinipur	77.4	79.04	261
Howrah	81.5	83.85	246
Kolkata	73.9	87.14	449
South 24 Parganas	70.8	78.57	258
Purba Medinipur	79.3	87.66	242

In determining the interrelation among number of vaccinated children, number of literate citizen and available health facilities this study fits the multiple linear regression. In our multiple linear regression analysis number of vaccinated children is the dependent variable and literacy rate and availability of health facility are explanatory variable. The model is specified as follows:

$Y_i=\alpha+\beta_1X_{1i}+\beta_2X_{2i}+\varepsilon_i$ ……(i)

Where, i=1,2,…,19

Y_i = percentage number of fully vaccinated children

X_{1i}=percentage number of literate citizen

X_{2i}=number of available medical institutes

α= intercept term

β_1 and β_2=slope coefficient

ε_i=disturbance term

Estimating the equation (i) by OLS estimator we get –

$\hat{Y}=\alpha+\beta\hat{}_1X_{1i}+\beta\hat{}_2X_{2i}$ …….(ii)

$\hat{\alpha},\beta\hat{}_1$ and $\beta\hat{}_2$ are the numeric estimate of α, β_1 and β_2 respectively.

$\hat{Y}_i$ gives the numeric estimate of Y_i for different values of X_i.

And obtain the estimate of residual $e_i = \varepsilon_i$

$e_i = Y_i-\hat{Y}_i = = Y_i-\hat{\alpha}- \beta\hat{}_1X_{1i}-\beta\hat{}X_{2i}$ ……..(iii)

Estimated values are :

$\bar{Y}$= 77.47

$\bar{X}_{1i}$=75.64

$\bar{X}_{2i}$=194

$\sum x_{1i}2$=1149.167 $\sum x_{2i}2$=233496 $\sum x_{1i}y_i$=-79.8413 $\sum x_{2i}y_i$=-9680.2 $\sum x_{1i}x_{2i}$=10995.82

Estimated value of slope coefficients:

$\beta\hat{}_1$=0.394 $\beta\hat{}_2$= 0.048 $\hat{\alpha}$ = 38.35

Hypothesis testing:

Now we will check the significance of our model as well as significance of the slope parameters.

For testing the significance of $\beta\hat{}_1$ we have to test the validity of null hypothesis (H_N) that the value of β_1 is zero against the alternative hypothesis (H_A) is greater than zero (as we have a prior knowledge that β_1 is positive). We set our hypothesis as:

H_N :$\beta\hat{}_1$ =0

H_A :$\beta_1\hat{}>0$ (One tail test)

Here Standard error of $\beta_1\hat{}$is 0.30878 .

Now, we have to compute t-value, which is denoted by t*. The formula used for computation of t* is:

t* $=\frac{\beta\hat{}_1-\beta_1\hat{}}{SE\ (\beta^1\hat{})}=\frac{\beta_{1i}}{SE\ (\widehat{\beta^1})}$ (Under H_N : $\beta_1=0$) [SE ($\beta_1\hat{}$) refers to standard error of $\beta_1\hat{}$]

$=\frac{0.394-0}{0.30878}$ = 1.276

Estimated value of t* is 1.276. Now we have to compare the value of t* with the critical value t-value from the t-table for significance of λ (under one-tailed) and degrees of freedom n-2. Here n is the number of observation i.e., 19 .

At 5% level of significance:t_λ, (n-3) is 1.746

We can see that |t*| <t_λ, (n-3), i.e., absolute value of computed-t is lesser than the value of critical-t at 5% level of significant λ and degrees of freedom 16.

So, null hypothesis (H_N) is accepted, which conclude that $\beta\hat{}_1$ is not statistically significant at the 5% level of significance λ.

For testing the significance of β_{2i} we have to test the validity of null hypothesis (H_N) that the value of $\beta_2\hat{}$is zero against the alternative hypothesis (H_A) is greater than zero (as we have a prior knowledge that $\beta_2\hat{}$ is positive). We set our hypothesis as:

H_N :$\beta_2\hat{}$ =0

H_A :$\beta_2\hat{}$ >0 (One tail test)

Here Standard error of $\beta_2\hat{}$ is 0.021.

t* = $\frac{\beta_2\hat{}-\beta}{SE\ (\beta\hat{}_2)}$ (Under one tailed test)

$=\frac{\beta_2\hat{}}{SE\ (\beta\hat{}_2)}$($H_N$: $\beta_2\hat{}_i$ =0)

$= \frac{-0.048}{0.021}$ = -2.286

|t*| = 2.286

Estimated value of t* is 2.286. Now we have to compare the value of t* with the critical value t-value from the t-table for significance of λ (under one-tailed) and degrees of freedom n-3. Here n is the number of observation i.e., 19 .

At 5% level of significance:t_λ, (n-3) is 1.746

We can see that |t*| >t_λ, (n-3), i.e., absolute value of computed-t is greater than the value of critical-t at 5% level of significant λ and degrees of freedom 16.

So, null hypothesis (H_N) is rejected, which conclude that $\beta\hat{}_2$ is statistically significant at the 5% level of significance λ.

As the coefficient $\beta_2\hat{}$ is statistically significant we will measure the goodness of fit of $\beta_2\hat{}$ with the squared-r i.e., r^2. So the formula of r^2 is –

$r^2 = \frac{\beta_2\hat{} \sum x_{2i}y_i}{\sum y_i\hat{}2}$

Now $\beta_2\hat{}$ = -0.048; $\sum x_{2i}y_i$ = -6980.2; $\sum y_i\hat{}2$ = 1386.68

$r^2 = \frac{-0.048*-6980.2}{1386.68}$ = 0.24

So the value of r^2 is 0.24, thus we can say that $\bar{X}^2$ explains only 24% of $\bar{Y}^2$.

For examining overall significance of the estimated regression model we will apply F-test.

Formula of computing F* is:

$F^* = \frac{ESS/k}{\frac{RSS}{(n-k-1)}}$

Here, ESS =$\sum \beta\hat{}_1 \sum x_{1i}y_i + \sum \beta\hat{}_2 \sum x_{2i}y_i$ = -366.5066

RSS = $\sum e_i\hat{}2$ = 1753.1876

k = number of slope parameters = 2

n= number of observation = 19

$F^* = \frac{-366.5066/2}{1753.1876/16} = -1.6724$

Estimated value of F* is -1.6724. Now we have to compare the value of F* with the critical value F- value from the F-table for significance of λ (under one-tailed) and degrees of freedom 2,16. Here n is the number of observation i.e., 19.

At 5% level of significance: F_{λ}, [k, (n-k-1)] is 19.43

We can see that $F^* < F_{\lambda}$, [k, (n-k-1)], i.e., value of computed-F is greater than the value of critical-t at 5% level of significant λ and degrees of freedom [2,16].

So the model is not overall significant.

In this result section, we have analyzed the vaccination routine of UIP recommended by WHO, where we see there is 8 vaccines for infants and children and Vit A doses. Next we analyzed the performance of 5 vaccines-BCG, DPT3, Polio, TT(PW), Measles over past few years and we see that in 2006-07 the achievement of immunity vaccination of children and infants has the highest average and 2008-09 has the lowest and the variation in implementation of immunity vaccination is lowest in 2008-09 and 2007-08 the variation in vaccination is the highest. Also the district wide variation and comparison of performance of these vaccines in West Bengal was performed, where we see that from 2009-10 to 2010-11 the average achievement of vaccination had increased for TT(PW), DPT, BCG and decreased for Polio and Measles and variations in vaccination had decreased from 2009-10 to 2010-11 for TT(PW), BCG, Polio AND Measles but increased for DPT. Next we compared the vaccination rate of BCG, DPT3, Polio (3 doses including Polio 0 and Measles with the full vaccination coverage (full vaccination refers to BCG, DPT3, Polio including Polio 0 and Measles) and also we have gone through the district wide variation of Vit A intake and number of children with no vaccination at all. Here we see that the average number of children taking BCG vaccine was 95.67, 3 injections of DPT was 90.83, Polio vaccine including Polio0 was 85.33, Measles vaccine was 88.65 and the average number of fully vaccinated children (taking BCG, 3injections of DPT, Polio including Polio0 and Measles) was 78.9. So the average number of fully vaccinated children was lower than average number of each individual vaccine intakes. Also the district wide variation of vaccine intake was highest in the case of full vaccination

compared to the variation in individual vaccines. Taking account the supply side variables, we examined the literacy rate where we analyzed rural-urban literacy, and male-female literacy and total literacy rate also the district wide variation of them. Here we see that average number of literate person in West Bengal was 75.64, average number of literate people in urban areas was 84.32 and in rural areas was 68.54, and average number of male literate in West Bengal was 81.62 while female literate was 69.34. Also the urban male literacy rate was higher than the rural male literacy rate and similar pattern can be seen in rural female and urban female literacy rate. In comparing of literacy rate of 2001 and 2011 in districts of West Bengal we see that the average of total literacy was 66.22 in 2001 and 75.03 in 2011, in 2001 the average of male literacy was 74.73 and in 2011 was 80.65, the female literacy was 56.86 and 69.06 respectively. So we see that compared to 2001 the average of total literacy, male literacy and female literacy had increased in 2011. The district wide variation of total literacy has decreased in 2011 compared to 2001 and the variation in male and female literacy rate had also decreased in 2011 compared to 2001. Further we examined the available number of medical institutes in districts of West Bengal and the population covered by health facilities in rural areas of West Bengal.

After analyzing our collected data with descriptive statistics and charts, the next step was to find the effect of literacy rate and availability of health facilities on the performance of UIP in West Bengal. For finding the effects we performed three variable linear regression where the explanatory variables are literacy rate and availability of health facilities and the explained variable is the performance of UIP. So the result, of the regression analysis is showing that our explained variable, the performance of UIP does get affected by the availability of health facilities and does not by the literacy rate. Here the estimated of literacy rate is $\hat{\beta_1}$ which is statistically insignificant means the calculated t-value of $\hat{\beta_1}$ is lesser than the tabular value of t at 5% significance level and degrees of freedom 16.So it implies that the value of $\bar{Y}$ is not influenced by $\bar{X}_1$. On the other hand the coefficient of the variable availability of health facilities is $\hat{\beta_2}$ which is statistically significant means the computed t-value of $\hat{\beta_2}$ is greater than the tabular value of t at 5% significance level and degree of freedom 16. Therefore it implies that $\bar{Y}$ is influenced by $\bar{X}_2$. Also testing the overall significance of our model by F-test we see that the computed F-value of the model is lesser than the tabular value of F at 5% significance level and degrees of freedom (2, 16). So here it can be said that the model is overall insignificant.

Concluding the result of our regression analysis we can write that the number of children vaccinated does not get affected by the literacy rate and does get effected by the availability of health facilities. However we have focused particularly on West Bengal and our study is based on the secondary data of only 19 districts, so the power of our test is not that strong. If the analysis was made taking more sample data we could get different results.

Policy Suggestions:

Based on our analysis, this section has represented some policies to overcome the difficulties of implementation of UIP. Those are:

Initiatives should be taken to spread awareness on importance of UIP. Campaigns should be organized in rural areas and also urban slum areas. Also leaflets should be distributed on UIP. There should be enough announcement of dates and venues of vaccination so that every person can be notified. Private organizations and NGOs should also participate more and more in spreading awareness on UIP and also they should organize one-day vaccination programs in the rural areas where there is no accessibility of Govt. health centers.

One of the most concerning problem is, even if there exist health centers in rural or in semi urban areas some of them does not have infrastructure of UIP implementation. So it is needed to focus on building up not only health centers but also suitable infrastructures for child vaccination. Also the hospital environment should be clean and fitting for a child so that he or she does not get infected with more disease while getting vaccination for one. It would be very appreciable if there will be at least one health center with child vaccination infrastructure in every village area. Lack of trained health workers in health centers or in hospitals is another concerning problem. Currently Govt. does not have enough health workers to supervise the large population force. So it is needed to appoint more health workers in vaccination centers. And also to organize training courses for interested people to increase skilled labor power to health sector.

The micro planning regarding UIP should be more effective. Some rural health centers sometimes fall behind of supplies. So having suitable infrastructure and skilled health workers is not always enough.

Initiations should be taken for educating parents about child health. As we have seen in our regression analysis result, even if literacy rate is not effecting child vaccination rate but health education surely does. When parents will be knowledgeable about child health they will be enthusiastic on vaccinating their children and also they will not believe in superstations about child vaccination.

Conclusion:

Present study shows whether child immunity vaccination rate or success rate of UIP in West Bengal does get affected by literacy rate and available health facilities or not.

We have collected data on achievements of Universal Immunization System of 19 districts of West Bengal, literacy rate in districts of West Bengal and the available health facilities of West Bengal. All these data are collected are published or based in the year of 2012.

Focusing on the literacy rate, it is clear from the result of the regression analysis that literacy rate does not have a very significant effect on child vaccination. By literacy we typically mean the bookish knowledge and holding any university or school degree; but the results indicates that literacy is not necessary to understand the importance of child immunity vaccination. Nowadays people from every corner of the state are aware about the importance of making their children healthy. People from urban or rural, slum areas or elite area everyone is participating in this program. The initiatives by Govt. and private organization are helpful to spread awareness in people on UIP regardless of literate or illiterate.

Also the child immunization vaccines are free of cost from the Govt. So vaccinating their children does not put extra burden on people's pocket which really helps people from lower also lower middle class of the society. So they happily come forward and make their children vaccinated. Although anyone can vaccinate their children in any non-Govt. hospital by paying an particular amount of cash. Either way is available.

Here we have a small geographical area to run our analysis and only 19 districts are taken into account. So the power of test is not so strong in our analysis. It is possible the result to be different if we include more samples to our model that is we expand our research area and take data from whole India or may be bigger geographical area.

Now in analyzing the effect of availability of health facilities, we see that UIP does get affected by available health facilities. In a large country like India it is hard to form suitable health infrastructure for UIP in every corner of the country. West Bengal, as largest and most densed state of India face this problem as one biggest obstacle in executing UIP. Till date there are many rural areas do not have access to a single health center. In a report of West Bengal health portal it is seen that, Dakshin Dinajpur district has only 44 medical institutes. Similarly Uttar Dinajpur, Cooch bihar and Darjiling have 53, 72 and 64 medical institutes. These districts have the lower most numbers of medical institutes which is not preferable at all.

Availability of medical facilities is crucial for the UIP because even after getting aware many people do not get their children vaccinated due to absence of health centers in their possible reach. May be they have to travel many kilometers to get vaccination benefits, which is practically not possible; because first, many rural areas do not have fair communication system and second and the most important is money. Rural people do not use to have income or wealth to travel far away from their house and also to suitably carry their children through travelling, they hardly have money to pass by. Even if Govt. provides vaccines free of cost which does not make any hole to the pocket of people but they have to pay for communication. On the other hand, if they have access of health centers in their possible reach i.e., at least health centers in every villages each and every rural people can get their children vaccinated easily.

In our analysis we have two factors affecting UIP to examine. The Literacy rate dose not have very significant effect on UIP where as availability of health facility has a huge impact on success of UIP. But UIP has lot more factors affecting it. As discussed in the literature review section family income, health education of parents, living condition, awareness on UIP, lack of micro planning, lack of health workers, tight budgetary policy of Govt. regarding UIP, lack of medical supplies, absence of suitable infrastructure in rural health centers for implementing UIP, superstation regarding UIP effect the success rate of UIP. So it is important to look into these factors to make any further progress in UIP.

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