

# ANALYSIS OF TIME SERIES AND FORECASTING FOR POLIO DISEASE (A CASE STUDY OF PAKISTAN)

Muhammad Rafique Daudpoto, Muhammad Ismail Wassan and  
Dr. Muhammad Akram Ansari

## ABSTRACT:

---

*A series of time measurements usually performed on a previous time period which consists of a series of data points. The threat of natural disaster also plays a role in the delay of the complete eradication of polio. For example, Pakistan is prone to earthquakes and heavy rains of the monsoon. The 2010 floods in Pakistan hit 20 million, most were in the lower socioeconomic percentile. Besides the cases of measles, cholera and dengue fever, the World Health Organization (WHO) reported an increase in polio cases. In November 2010, Pakistan accounted for about 62% of all cases of polio endemic countries, with most new cases to the areas affected by flooding. The secular trend of a long-term movement that has persisted for many years and which indicates the general direction of change of the values observed is the disease of polio in Pakistan. The value of intercept "a" is acquired 17136 and "b" the slope is calculated by (-84.24), resultantly the trend line equation is obtained as  $\hat{Y}=17136+(-85.24)x$ . moreover the co-efficient of determination is 0.476. it is concluding that the polio cases are decreasing by (-85.24) in each year on annually basis and Y estimated values are agreed with total original values.*

---

**Keywords:** Time series, polio, prediction

## Introduction:

Time series analysis consists of mathematical data composed, practical or recorded at further or less usual intervals of time every hour, days, month, quarter or year (Chaudhry and Kamal, 2012). Time series analysis and

meaningful statistics include the time series data analysis methods to extract data from other properties. Time-series forecasting model is used to predict future values based on the previously observed value.

Australian Bureau of Statistics stated in (2005) that, a time series is a compilation of observations of distinct data items obtained during frequent measurements over time. For instance, measuring the worth of retail sales every month of the year would comprise a time series.

Regression analysis, usually one or more independent time-series of current values in a way that was employed as test theories affecting the current values of another time series.

Poliomyelitis has existed for thousands of years, with depictions of the illness in very old art. The illness was first standard as a different situation by Michael Underwood in 1789 (Atkinson W 2009) and the disease that causes it was first famous in 1908, by Karl Landsteiner (Thomas M. 1999).

Polio (also known as poliomyelitis) is a very contagious illness caused by a germ that attacks the nervous system. Children younger than 5 years old are more likely to contract the virus than any other group. Living in areas with limited access to

running water or flush toilets often get people drinking water contaminated with human waste containing virus. Polio virus is usually spread from person to person through fecal matter. Following study is a case study of Polio disease occurring through natural infection, was eliminated from United States by 1979 and the Western hemisphere by 1991.

At the height of the polio epidemic in 1952, about 60,000 cases with 3,000 deaths have also been reported in just United State. Children younger than 5 years old are another group is more likely to contract the virus.

The World Health Organization (WHO) sources collected permanent paralysis only 200 polio infections. However, largely due to the development of the disease it has been eradicated polio vaccine. The WHO survey, in 2010, worldwide polio cases have been reported only in 1352. FATA and Karachi before children are reached with polio immunization missed in challenging areas to focus almost half a million children.

Polio virus was first defined by Michel Underwood in 1789,

which is derived from the Greek word, polios for “gray” and myelos for “spinal cord” (Baicus, A. 2012, Paul & Peach, p. 81-82).

There are three poliovirus serotypes (P1, P2, and P3). Among these, type 2 appears to be the most effective antigen (Ilyas, 2008 and Park, K 2013).

It is often supposed that prevention is better than treat (anonymous) but in some situations prevention is the only option as there is no cure. This applies to the deadly sickness known as “Poliomyelitis, which is a contagious and untreatable illness mainly affecting children under five years of age, leading to irreversible paralysis and possibly death (Khawaja, 2012).

Since Pakistan is one of those three countries in which polio left-tovers common, along with Afghanistan and Nigeria, it is important to address this issue and work on the preventive measures to control its occurrence (Larson, H. J., & Bhutta, Z. A. 2013).

In 2013, 16 polio cases had been indicating that the illness is not entirely eradicated from Pakistan (Bhutta, 2013).

According to Global Polio annihilation proposal (GPEI) located in Geneva reported Pakistan has highest polio cases in world for two successive years. In 2011, 198 cases reported and in 2010, 144 polio cases reported. These cases are maximum in among all three countries which are not polio free till now. Therefore, Pakistan has now been considered a polio danger zone. Pakistan have major share in total identified cases of the entire world i.e., 647. The international community is worried and takes great interest in Pakistan’s polio policy because it is fact that even one case here means a child anywhere around the world remains at risk.

Polio disease has no treat but we can prevent transmission of this virus by immunizing every child through safe and effective polio vaccines. The first-time polio vaccine was introduced by Jonas Salk in 1952. Now a day, two types of vaccine are available; Inactivated Polio Vaccine (IPV) and Oral Polio Vaccine (OPV) (Thomsen A 2014). The Taliban of Afghanistan, issued Fatwa against vaccination as deflect the will of Allah (God) and it is

funded by Non-Muslims especially Americans to unfertile. Muslim population (Warraich H. J. 2009). Pakistan, also have confronted rumors about polio vaccine that it is not Halal and contain pig fat (Thomsen A-2014)

In Pakistan, the vaccination program was successful and going into right direction without any interference for the last 15 years. But in two recent years, polio team workers have been killed in FATA and other areas of Pakistan. The purpose of these killings of polio teams and vaccinators is to achieve attention of international media which led militant groups to believe they can acquire their aims by this interference (Shah 2011M,)

Awareness of parents has an important role in making decision whether to vaccinate their children are not. Polio teams are not well qualified and have not proper knowledge of disease and vaccine which is necessary for trust building in people. This situation is favorable for religious scholars to develop misconception about polio and other vaccines and other medical acts. These religious clerics explained

there is no concept of vaccination in Islam and those who die from these diseases will be martyrs, also claimed vaccines are infidel (AbimbolaS).

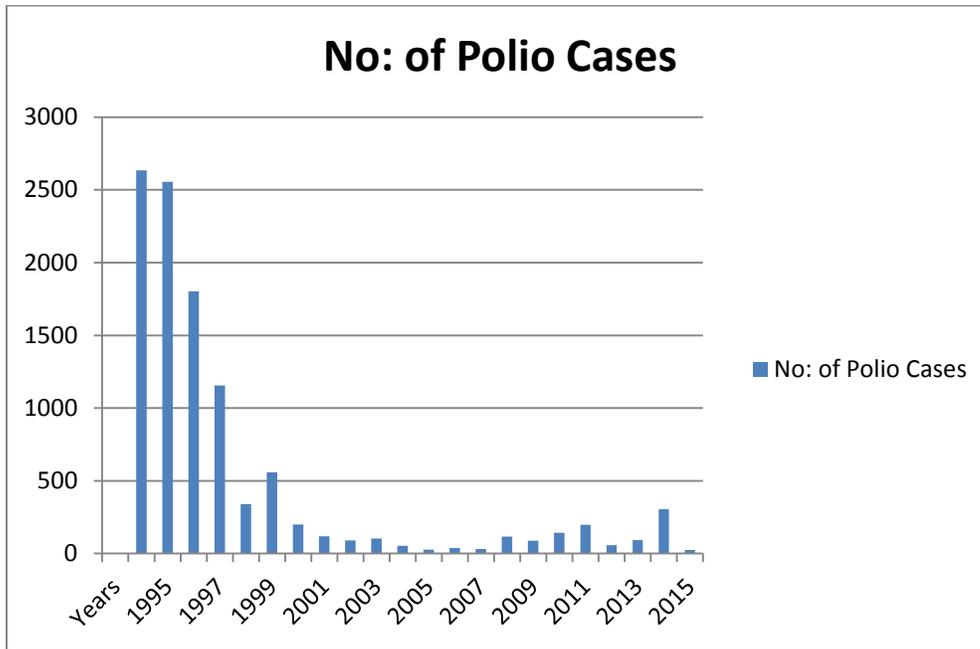
### **Materials and methods:**

Time series analysis technique is used for forecasting the trend line of an orderly arrangement of the statistical data by successive time periods. Secular trend or simply Trend (Long term variation) is used as the general tendency of the time series data to increase or decrease during a long period of time. Secular trend is a smooth, regular and long term movement of a time series. For the measurement of Secular trend the method of least square is used. According to this method a trend line actually a straight line is passed through the plotted points of a given time series data. Such that the sum of squares of the deviations between the actual values and the trend values in actual estimated values of the dependent variable (Y) should be least. Therefore, according to the principle of least squares  $\hat{Y} = a + bx$  is the best equation of linear trend where "a" and "b" are some constants. We can determine a

and b by using the formulas  $a = \frac{\sum y}{n}$  and  $b = \frac{\sum xy}{\sum x^2}$ , where  $x = \text{coded time} = \text{year} - \text{Middle year}$  (for odd number of years) and  $x = \text{coded time} = \text{year} - \text{mid points of two middle year}$ , therefore, we shall assign coded time values for odd number of years as, .....,-10,-9,-8,-7,-6,-5,-4,-3,-2,..... 1,0,1,2,3,4,5,6,7,8,9,10,.....

..... And values for even number of years we shall assign coded time values should be ..... 15,13,11,9,7,5,3,1,0,1,3,5,7,9,11,13,15,17,..... By putting the coded time values and the above mentioned methods of determining "a" and "b" the trend line values of straight line can be obtained.

**Following bar chart showing the results of polio cases reported in Pakistan from 1994 to 2015 provided by Sindh Polio Control Room 2015**



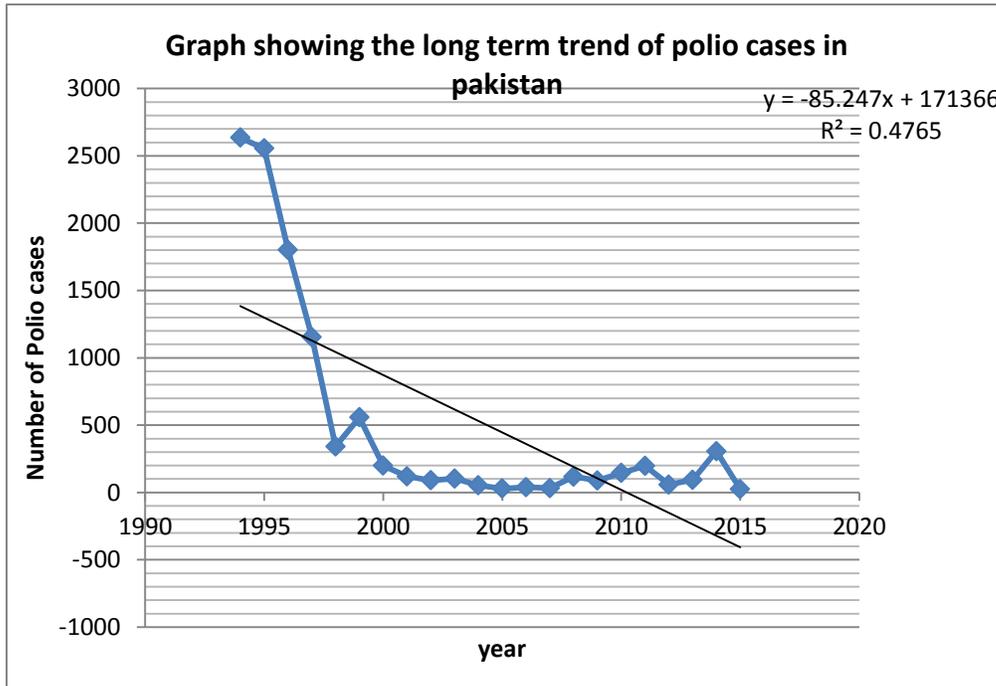
### Results and discussion:

Following table shows the Number of years with corresponding numbers of polio cases. We assigned coded time values as ..... ,5,3,1,0,1,3,5,.....,By putting the coded time values and the above mentioned methods of determining "a" and "b" the trend line ( $\hat{Y}$ ) values of straight line obtained as follows.

**Table No. 1: Computation for linear trend with even number of values**

Year t	Number of polio Cases	Coded Time $x = t - 1994$	$X*Y$	$X^2$	Trend values $\hat{Y}$
1994	2635	-21	-55335	3061962225	2752.88
1995	2555	-19	-48545	2356617025	2614.32
1996	1802	-17	-30634	938441956	2475.76
1997	1155	-15	-17325	300155625	2337.2
1998	341	-13	-4433	19651489	2198.64
1999	558	-11	-6138	37675044	2060.08
2000	199	-9	-1791	3207681	1921.52
2001	119	-7	-833	693889	1782.96
2002	90	-5	-450	202500	1644.4
2003	103	-3	-309	95481	1505.84
2004	53	-1	-53	2809	1367.28
2005	28	1	28	784	1228.72
2006	39	3	117	13689	1090.16
2007	32	5	160	25600	951.6
2008	117	7	819	670761	813.04
2009	89	9	801	641601	674.48
2010	144	11	1584	2509056	535.92
2011	198	13	2574	6625476	397.36
2012	58	15	870	756900	258.8
2013	93	17	1581	2499561	120.24
2014	306	19	5814	33802596	-18.32
2015	25	21	525	275625	-156.88

Following graph shows the long term trend of polio cases in Pakistan occurring several years with trend line.



Pakistan has the highest rate of polio in the region, as well as in the world, due mainly to the hygiene practices that prevail, especially in rural and more remote areas. Although the rate of polio cases has declined considerably in the world during the last couple of decades, the situation has not improved in Pakistan already here health authorities attached little or no importance to address the important issue. During a long period of time, in

order to increase or decrease the general tendency of time is called secular trend or simply the trend. It is regular, long term and smooth movement of a time series. The trend values computed in the table No.1 by putting coded time mentioned in the table, the equation of linear trend and the expected frequency of polio cases are listed in the last column of the table.

Polio cases has decreased in 2007 and reached only the 32,

since had 2635 cases reported in 1994, but was abruptly the next year in 2008, the number of cases reported were 117. It is also alarming to observe that by 2014 reported cases of polio were 306.

In addition, it has been shown that parental awareness especially maternal literacy and knowledge about vaccines and schedules of vaccination, a bad socioeconomic situation, and residence in rural areas all are attributable to the decrease in completion of immunization rates. Parent education is one of the most important determinants of if children will complete their vaccination. In a study of households with both parents in Pakistan it has been exposed that the awareness of the father on the health of the preponderance of vaccination decisions affected, with an effect that is so enormous that some researchers argue to improve education will get better health even more than the provision of health services.

### **Conclusion**

Therefore, the obtained equation is  $\hat{Y} = 17136 + (-85.24)X$ . where middle years are 2004 and 2005 are coded as -1 one for 2004 and +1 for 2005 the units of X are one

year. Trend values are estimated by subtracting X corresponding many years into equation.

And the estimated values are shown in the last column, the trend show that the polio cases are decreasing with 85.24 from the country Pakistan. And all trend values are satisfied with original values. Estimated and original values are graphed in table and diagram

## References:

- Abimbola S, Malik AU, Mansoor GF (2013). The final push for polio eradication: Addressing the challenge of violence in Afghanistan, Pakistan, and Nigeria. *PLOS Medicine*.
- Atkinson W, Hamborsky J, McIntyre L, Wolfe S (eds.). "Poliomyelitis". *Epidemiology and Prevention of Vaccine-Preventable Diseases (The Pink Book) (PDF) (11<sup>th</sup> ed.)*. Washington D. C: Public Health Foundation; 2009. pp. 23144.
- Box, G.E., Jenkins, G.M. and Reinsel, G. C. (1994). *Time Series: Forecasting and Control (3rd edition)*. Prentice Hall. Historical textbook, first edition in 1968. This book had a key influence on the development of modern time series analysis.
- Brockwell, P.J. and Davis, R.A. (1991). *Time Series. Theory and Methods (2nd edition)*. Springer. Covers many mathematical details; but not very broad in terms of applications.
- Brockwell, P.J. and Davis, R.A. (2002). *Introduction to Time Series and Forecasting 2nd edition* Springer.
- Baicus, A. (2012). "History of polio vaccination". *World journal of virology*, Vol. 1, No. 4, pp. 108.
- Bhutta, Z. A. (2013). "Conflict and polio: Winning the polio wars". *JAMA*, Vol. 310, No. 9, pp. 905-906.
- C. Chatfield, *The Analysis of Time Series: Theory and Practice*, Chapman and Hall (1975). Good general introduction, especially for those completely new to time series.
- Edited by Thomas M. Daniel Fred-erick C. Robbins. Editors. *Polio (1<sup>st</sup> ed.)*. Rochester, N.Y.: University of Rochester Press; 1999. p.11. ISBN 9781580460668
- Ilyas, M., Khan, I. A., Malik, G. Q., & Fhansotia, M. (2008). *Public health and community medicine (7th ed.)*
- Khowaja, A. R., Khan, S. A., Nizam, N., Omer, S. B., & Zaidi, A. (2012). "Parental perceptions surrounding polio and self-reported non participation in polio supplementary immunization activities in Karachi, Pakistan": a mixed methods study. *Bulletin of the World Health Organization*, Vol. 90, No. 11, pp. 822-830.
- Larson, H. J., & Bhutta, Z. A. (2013). "Security, Insecurity, and Health Workers: The Case of Polio". *JAMA internal medicine*, Vol. 173, No. 15, pp. 1393-1394.
- Shumway, R. H. and Stoffer, D. S. (2006). *Time Series Analysis and its Applications (2nd edition)*. Springer. A good mix of mathematical details and applications.
- Shah M, Khan M. K., Shakeel S, Mahmood F, Sher Z. (2011). Resistance of polio to its eradication in Pakistan. *PMC Journal* 8:457.
- Thomsen A (2014) Polio What Happens to a Vaccine-Preventable Disease When Vaccination Is Prevented? *The Disease Daily*.
- Warraich H. J. (2009) Religious Opposition to Polio Vaccination. *EID* 15: 978.