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# STATISTICAL ANALYSIS AND INFERENCE ON FOURTEEN MOST EFFECTED COUNTRIES ON POLIO DATA: A ECOLOGICAL STUDY

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## 1.a) ABSTRACT

Data obtained from the website and the source was ourworldindata.org.[1] Fourteen world regions and countries were selected for statistical analysis. The fourteen regions and the countries of the world were Afghanistan, Bangladesh, Egypt, India, Iran, Nigeria, Pakistan, china, Africa, Eastern Mediterranean, Europe, South East Asia, Western pacific and World. The source of the website has the data from 1980 to 2016 about the number of reported polio cases, the number of estimated polio cases and the number of polio cases per million population. In part one the number of estimated polio cases were generally higher than the number of reported polio cases. Statistical analysis like descriptive statistics: Minimum value, Maximum value, mean, standard deviation and variance was calculated. Paired sample t test was performed in the reported and estimated polio cases. In the second part Correlation among these regions were calculated and statistical inferences were formed. In the third part Regression equation linear, multiple and quadratic equation was formed in the three endemic countries Pakistan, Afghanistan and Nigeria.[1]

## 1.b) Introduction

The causative agent of polio is a virus. Polio virus are three in number. Namely Wild polio Virus type one, Wild polio virus type two and wild polio virus type three. Circulating vaccine derived polio virus is formed of the attenuated polio virus they exchange genetic material

with the neighboring virus and can infect humans. In September of 2015 wild type two virus was eradicated. The last case of wild type two was detected in India in 1999. Since 2012 wild type three virus was not found anywhere in the world. Polio virus can infect only humans. Paralysis due to polio occur in less than one percent of the population that were infected with the virus. Polio is mainly spread through fecal oral route so polio virus is mainly present in the environment with poor hygiene,[3]

In late 1980 polio effected more than one thousand individuals daily. For this purpose in 1988 Global polio eradication initiative was formed. Global polio eradication initiative has immunized nearly 2.5 billion individuals. Although the number of polio cases has been decreased by 99%. There are three countries that are still endemic with wild polio virus. They are Pakistan, Afghanistan and Nigeria. Polio is still present in them they act as a reservoir of polio. Nigeria is closing towards the eradication of wild type polio virus as it has been three years, upto date 21/8/2019, that Nigeria has not seen a case of wild polio virus. However a certification of wild polio free status has not been given to the Nigeria.

Polio can be transmitted from these countries to the world if sufficient measures are not taken in these countries[3]

Data was collected from the website [1]. Statistical analysis were performed on the data of the world regions that were mostly effected by the polio. Out of the countries eight countries were chosen Afghanistan, Bangladesh, Egypt, India, Iran, Nigeria, Pakistan, China. Among the world regions 6 regions were chosen for analysis these regions are Africa ,Eastern Mediterranean, Europe, South East Asia, Western pacific and World. These are the regions that were mostly affected. Statistical analysis were performed on the data of the reported number of polio cases , Estimated number of polio cases and the number of polio cases per million population. The data showed the figures from 1980 to the 2016. Afghanistan did not have the data of all the years due to war and uncertain political stability. Similarly its data on polio cases might not be very refined due to the long term wars, security issues and instability.

## STATISTICS AND RESULTS AND DISCUSSIONS

### Part One: Descriptive analysis

### Descriptive of estimated polio cases

Statistics were applied to the estimated number of polio cases from 14 different regions from 1980 to 2016.Estimated polio cases were derived by the method of Tebbens et al.[2]

Statistics like Range, minimum values, maximum values, sum, mean , standarf deviation and variance were calculated.

Descriptives Variables Estimated polio cases in=Afghanistan, Bangladesh, Egypt, India, Iran, Nigeria, Pakistan, china, Africa ,Eastern Mediterranean, Europe, South East Asia, Westren Pacific and World.[7]

**Table 1.1: Showing descriptive statistics of estimated polio cases of 14 countries and regions Descriptive Statistics.**

| | N | Range | Minimum | Maximum | Sum | Mean |
|---|---|---|---|---|---|---|
| Afghanistan | 33 | 13937 | 0 | 13937 | 75881 | 2299.43 |
| Bangladesh | 37 | 3780 | 0 | 3780 | 31569 | 853.22 |
| Egypt | 37 | 15071 | 0 | 15071 | 86947 | 2349.92 |
| India | 37 | 266630 | 0 | 266630 | 2025618 | 54746.42 |
| Iran | 37 | 1344 | 0 | 1344 | 9110 | 246.22 |
| Nigeria | 37 | 13110 | 1 | 13111 | 114237 | 3087.47 |
| Pakistan | 37 | 30315 | 23 | 30338 | 186122 | 5030.31 |
| China | 37 | 67375 | 0 | 67375 | 262467 | 7093.69 |
| Africa | 37 | 35876 | 6 | 35882 | 379112 | 10246.26 |
| Eastern Mediterenean | 37 | 88316 | 38 | 88354 | 486713 | 13154.41 |
| Europe | 37 | 2630 | 0 | 2630 | 18594 | 502.54 |
| South East asia | 37 | 279552 | 0 | 279552 | 2124834 | 57427.94 |
| Westren pacifc | 37 | 79896 | 0 | 79896 | 447576 | 12096.64 |
| World | 37 | 459752 | 46 | 459798 | 3523084 | 95218.49 |
| Valid N (listwise) | 33 | | | | | |

**Table 1.2: Showing descriptive statistics: Standard deviation and variance of estimated polio cases of 14 countries and regions Descriptive Statistics.**

| | Std. Deviation | Variance |
|---|---|---|
| Afghanistan | 4279.073 | 18310467.219 |
| Bangladesh | 1059.859 | 1123300.619 |
| Egypt | 3898.578 | 15198909.648 |
| India | 75354.295 | 5678269757.585 |
| Iran | 370.335 | 137148.341 |
| Nigeria | 3187.012 | 10157042.912 |
| Pakistan | 7263.794 | 52762697.561 |
| China | 16180.276 | 261801317.130 |
| Africa | 10593.105 | 112213871.500 |
| Eastern Mediterenean | 20496.637 | 420112119.199 |
| Europe | 773.758 | 598701.533 |
| South East asia | 78548.881 | 6169926774.567 |
| Westren pacifc | 22006.613 | 484291016.897 |
| World | 129629.128 | 16803710916.769 |
| Valid N (listwise) | | |

**In the estimated polio cases mean and standard deviation are as under**

In the country wise descending list of mean number of estimated polio cases and the standard deviation show a similar pattern.

**Country wise**

India> China> Pakistan> Nigeria> Egypt> Afghanistan> Bangladesh> Iran.

**Region wise estimated polio cases mean and standard deviation are as under**

Region wise there is slight difference in the in the descending order of the mean estimated polio cases and the standard deviation.

**Mean**

World> South east Asia> Eastern Mediterranean > western pacific> Africa> Europe.

**Standard deviation of regions**

World> South east Asia> western pacific > Eastern Mediterranean >Africa> Europe

**Descriptive polio cases per million population**

Statistics were applied to the polio cases per million population from 14 different regions from 1980 to 2016.

Statistics like Range, minimum values, maximum values, sum, mean, standard deviation and variance were calculated Descriptives variables of Polio cases per million population in=Afghanistan Bangladesh Egypt India Iran Nigeria Pakistan China Africa Eastern Mediterranean Europe South East Asia Western pacific World.[7]

**Table 1. 2.1: Showing the descriptive statistics of the 14 countries and regions of polio cases per million population Descriptive Statistics.**

| | N | Range | Minimum | Maximum | Sum |
|---|---|---|---|---|---|
| Afghanistan | 32 | 168.122860 | .000000 | 168.122860 | 894.308702 |
| Bangladesh | 36 | 5.3478413 | .0000000 | 5.3478413 | 44.0873789 |
| Egypt | 36 | 46.421249 | .000000 | 46.421249 | 251.761817 |
| India | 36 | 53.413315 | .000000 | 53.413315 | 370.591906 |
| Iran | 36 | 4.7740259 | .0000000 | 4.7740259 | 27.6590406 |
| Nigeria | 36 | 19.654399 | .005519 | 19.659918 | 201.428582 |
| Pakistan | 36 | 53.52519 | .18192 | 53.70712 | 290.58542 |
| China | 36 | 9.5486097 | .0000000 | 9.5486097 | 45.7564112 |
| Africa | 36 | 13.318351 | .018124 | 13.336475 | 133.421946 |
| Eastern Mediterenean | 36 | 45.877020 | .105669 | 45.982689 | 225.923185 |
| Europe | 36 | .52956134 | .00000000 | .52956134 | 4.23907237 |
| South East asia | 36 | 36.987240 | .000000 | 36.987240 | 257.695297 |
| Western pacific | 36 | 8.7708712 | .0000000 | 8.7708712 | 53.8339135 |
| World | 36 | 92.33539572 | .14227603 | 92.47767175 | 690.34111934 |
| Valid N (listwise) | 32 | | | | |

**Table 1.2.2: Showing descriptive statistics of 14 countries and regions Mean, standard deviation and variance of polio cases per million population.**

| Descriptive Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | Variance |
| Afghanistan | 27.94714694 | 51.019902317 | 2603.030 |
| Bangladesh | 1.224649415 | 1.4258382012 | 2.033 |
| Egypt | 6.99338381 | 12.229609815 | 149.563 |
| India | 10.29421960 | 14.360339811 | 206.219 |
| Iran | .768306682 | 1.2135053873 | 1.473 |
| Nigeria | 5.59523839 | 4.471324353 | 19.993 |
| Pakistan | 8.0718173 | 12.47313449 | 155.579 |
| China | 1.271011422 | 2.4119680400 | 5.818 |
| Africa | 3.70616517 | 3.632137846 | 13.192 |
| Eastern Mediterenean | 6.27564403 | 10.324109090 | 106.587 |
| Europe | .1177520102 | .16260081633 | .026 |
| South East asia | 7.15820271 | 9.878444585 | 97.584 |
| Western pacific | 1.495386487 | 2.4446982438 | 5.977 |
| World | 19.1761422038 | 25.85455249163 | 668.458 |
| Valid N (listwise) | | | |

**Mean and standard deviation of the polio countries per million population**

In mean and standard deviation the descending order of the countries are same.

Afghanistan>India>Pakistan>Egypt>Nigeria>china>Bangladesh>iran.

**Mean of the regions of polio per million population**

In mean and standard deviation there is a slight difference In the descending order

World>South East Asia>Eastren meditrenean>Africa>western pacific>Europe

**Standard deviation of the regions of polio per million population**

World>Eastern Meditrenean>South East Asia>Africa>western Pacific>Europe.

**Descriptive of reported polio cases**

Statistics were applied to the reported number of polio cases from 14 different regions from 1980 to 2016. Statistics like Range, minimum values, maximum values, sum, mean, standard deviation and variance were calculated.

Descriptives variables Reported polio cases in =Afghanistan Bangladesh Egypt India Iran Nigeria Pakistan China Africa Eastern Mediterranean Europe South East Asia Western pacific world.[7]

**Table 1.3.1: Showing descriptive statistics of 14 countries and regions of reported polio cases.**

| Descriptive Statistics | | | | | | |
|---|---|---|---|---|---|---|
| | N | Range | Minimum | Maximum | Sum | Mean |
| Afghanistan | 33 | 1991 | 0 | 1991 | 11256 | 341.09 |
| Bangladesh | 37 | 540 | 0 | 540 | 4695 | 126.89 |
| Egypt | 37 | 2153 | 0 | 2153 | 12435 | 336.08 |
| India | 37 | 38090 | 0 | 38090 | 293713 | 7938.19 |
| Iran | 37 | 192 | 0 | 192 | 1322 | 35.73 |
| Nigeria | 37 | 1872 | 1 | 1873 | 20944 | 566.05 |
| Pakistan | 37 | 4313 | 21 | 4334 | 28105 | 759.59 |
| China | 37 | 9625 | 0 | 9625 | 48658 | 1315.08 |
| Africa | 37 | 5121 | 5 | 5126 | 66512 | 1797.62 |
| Eastern Mediterenean | 37 | 12588 | 34 | 12622 | 72849 | 1968.89 |
| Europe | 37 | 475 | 0 | 475 | 3556 | 96.11 |
| South East asia | 37 | 39936 | 0 | 39936 | 309175 | 8356.08 |
| Western pacific | 37 | 11420 | 0 | 11420 | 75302 | 2035.19 |
| World | 37 | 65695 | 42 | 65737 | 537164 | 14517.95 |
| Valid N (listwise) | 33 | | | | | |

**Table 1. 3.2: Showing the descriptive statistics: Standard deviation and variance of reported polio cases of 14 countries and regions of the world**

**Descriptive Statistics**

| | Std. Deviation | Variance |
|---|---|---|
| Afghanistan | 604.863 | 365859.648 |
| Bangladesh | 150.734 | 22720.655 |
| Egypt | 556.707 | 309922.688 |
| India | 10682.315 | 114111857.547 |
| Iran | 52.574 | 2763.980 |
| Nigeria | 430.600 | 185416.053 |
| Pakistan | 1011.191 | 1022506.414 |
| China | 2456.784 | 6035789.521 |
| Africa | 1500.616 | 2251848.464 |
| Eastern Mediterenean | 2876.868 | 8276370.877 |
| Europe | 135.603 | 18388.044 |
| South East asia | 11118.604 | 123623351.910 |
| Western pacific | 3261.155 | 10635132.213 |
| World | 18368.863 | 337415138.886 |
| Valid N (listwise) | | |

**In the reported polio cases country wise mean and standard deviation are as under**

**Mean**

India>china>Pakistan>Nigeria>Afghanistan>Egypt>Bangladesh>Iran

**Standard deviation**

India>china>Pakistan>Afghanistan>Egypt>Nigeria>Bangladesh>Iran

**In the reported polio cases region wise mean and standard deviation** are as under

**Mean and standard deviation**

In the region wise descending order of the mean and standard deviation are the same

World> South East Asia> Western Pacific>Eastern Mediterranean>Africa> Europe

**1.4) T-Test**

Paired at CRITERIA=CI (.9500)

**Table 1.4.1: Showing the paired sample t test of the 14 countries and regions in the estimated and reported polio cases.**

| Paired Samples Test[7] | | | | | |
|---|---|---|---|---|---|
| | | Paired Differences | T | df | sig |
| Pair 1 | Estimated polio cases Afghanistan – Number of reported paralytic polio cases Afghanistan | 3261.27745 | 3.062 | 32 | .004 |
| Pair 2 | Estimated polio cases Africa – Number of reported polio cases Africa | 11504.26994 | 5.608 | 36 | .000 |
| Pair 3 | Estimated polio cases Bangladesh – Number of reported paralytic polio cases Bangladesh | 1030.442 | 4.844 | 36 | .000 |
| Pair 4 | Estimated polio cases china – Reported paralytic polio cases china | 10431.23669 | 2.519 | 36 | .016 |
| Pair 5 | Estimated polio cases of Eastern Mediterranean – Reported polio of Eastern Mediterranean | 17061.270062 | 3.861 | 36 | .000 |
| Pair 6 | Estimated polio cases of Egypt – Number of reported polio cases of Egypt | 3128.07031 | 3.666 | 36 | .001 |
| Pair 7 | Estimated polio cases of Europe – Reported polio cases of Europe | 627.142 | 3.735 | 36 | .001 |
| Pair 8 | Estimated polio cases of India – Reported polio cases of India | 68372.037975 | 4.402 | 36 | .000 |
| Pair 9 | Estimated polio cases of Iran – Reported polio cases of Iran | 316.447 | 4.029 | 36 | .000 |
| Pair 10 | Estimated polio cases of Nigeria – Reported polio cases of Nigeria | 3466.095030 | 5.413 | 36 | .000 |
| Pair 11 | Estimated polio cases of Pakistan – Reported polio cases of Pakistan | 6356.036805 | 4.154 | 36 | .000 |
| Pair 12 | Estimated polio cases of south east Asia – Reported polio cases of south east Asia | 71555.29182 | 4.426 | 36 | .000 |
| Pair 13 | Estimated polio cases of western pacific – Reported polio cases of western pacific | 16368.37031 | 3.235 | 36 | .003 |
| Pair 14 | Estimated polio cases of world – Reported polio cases of world | 117812.818779 | 4.410 | 36 | .000 |

In the paired sample t test fourteen country regions were selected: the estimated and the reported polio cases were compared in the t test. In all the paired sample t test P significant 0.05> then all the values of P. So it can be inferred that there is a significant difference between the estimated and reported polio cases. So the real number of polio cases that were estimated and the reported polio cases vary greatly and less number of polio cases were reported in every country.

Estimated polio cases was calculated by the Tebbens et al[2].

**Part two Corelation statistics**

**2) Correlation**

**Corelation among estimated polio cases in different regions**

Correlation Statistics were applied to the estimated number of polio cases from 14 different regions from 1980 to 2016.

Descriptives Variables Estimated polio cases in=Afghanistan, Bangladesh, Egypt, India, Iran, Nigeria, Pakistan, china, Africa ,Eastern Mediterranean, Europe, South East asia, Westren pacifc and World.[7]

**Table 2.1.: A showing the correlation in the estimated polio cases in 14 world countries and regions Correlations**

| | | Afghanistan | Bangladesh | Egypt | India | Iran | Nigeria | Pakistan |
|---|---|---|---|---|---|---|---|---|
| Afghanistan | Pearson Correlation | 1 | .171 | .635** | .756** | .655** | .266 | .590** |
| | Sig. (2-tailed) | | .341 | .000 | .000 | .000 | .135 | .000 |
| | N | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Bangladesh | Pearson Correlation | .171 | 1 | .325* | .415* | .298 | .717** | .347* |
| | Sig. (2-tailed) | .341 | | .050 | .011 | .073 | .000 | .035 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Egypt | Pearson Correlation | .635** | .325* | 1 | .816** | .785** | .334* | .879** |
| | Sig. (2-tailed) | .000 | .050 | | .000 | .000 | .044 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| India | Pearson Correlation | .756** | .415* | .816** | 1 | .743** | .408* | .781** |
| | Sig. (2-tailed) | .000 | .011 | .000 | | .000 | .012 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Iran | Pearson Correlation | .655** | .298 | .785** | .743** | 1 | .266 | .820** |
| | Sig. (2-tailed) | .000 | .073 | .000 | .000 | | .111 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Nigeria | Pearson Correlation | .266 | .717** | .334* | .408* | .266 | 1 | .377* |
| | Sig. (2-tailed) | .135 | .000 | .044 | .012 | .111 | | .021 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Pakistan | Pearson Correlation | .590** | .347* | .879** | .781** | .820** | .377* | 1 |
| | Sig. (2-tailed) | .000 | .035 | .000 | .000 | .000 | .021 | |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| China | Pearson Correlation | .591** | .140 | .925** | .756** | .795** | .132 | .895** |
| | Sig. (2-tailed) | .000 | .408 | .000 | .000 | .000 | .435 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Africa | Pearson Correlation | .739** | .518** | .821** | .863** | .743** | .661** | .812** |
| | Sig. (2-tailed) | .000 | .001 | .000 | .000 | .000 | .000 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Eastern Mediterranean | Pearson Correlation | .719** | .253 | .949** | .807** | .763** | .324 | .900** |
| | Sig. (2-tailed) | .000 | .131 | .000 | .000 | .000 | .050 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Europe | Pearson Correlation | .529** | .233 | .807** | .584** | .879** | .268 | .800** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sig. (2-tailed) | .002 | .166 | .000 | .000 | .000 | .109 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| South East Asia | Pearson Correlation | .745** | .426** | .819** | 1.000** | .742** | .415* | .784** |
| | Sig. (2-tailed) | .000 | .009 | .000 | .000 | .000 | .011 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Western pacific | Pearson Correlation | .711** | .193 | .955** | .850** | .794** | .250 | .902** |
| | Sig. (2-tailed) | .000 | .253 | .000 | .000 | .000 | .136 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| World | Pearson Correlation | .769** | .376* | .907** | .974** | .789** | .406* | .865** |
| | Sig. (2-tailed) | .000 | .022 | .000 | .000 | .000 | .013 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |

**Table 2.1.B: showing the correlation in the estimated polio cases in 14 world countries and regions.**

| **Correlations** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **china** | **Africa** | **Eastern Mediterranean** | **Europe** | **South East Asia** | **Western pacific** | **World** |
| Afghanistan | Pearson Correlation | .591 | .739 | .719** | .529** | .745** | .711 | .769** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .002 | .000 | .000 | .000 |
| | N | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Bangladesh | Pearson Correlation | .140 | .518 | .253* | .233* | .426 | .193** | .376* |
| | Sig. (2-tailed) | .408 | .001 | .131 | .166 | .009 | .253 | .022 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Egypt | Pearson Correlation | .925** | .821* | .949 | .807** | .819** | .955* | .907** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| India | Pearson Correlation | .756** | .863* | .807** | .584 | 1.000** | .850* | .974** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Iran | Pearson Correlation | .795** | .743 | .763** | .879** | .742 | .794 | .789** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Nigeria | Pearson Correlation | .132 | .661** | .324* | .268* | .415 | .250 | .406* |
| | Sig. (2-tailed) | .435 | .000 | .050 | .109 | .011 | .136 | .013 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Pakistan | Pearson Correlation | .895** | .812* | .900** | .800** | .784** | .902* | .865 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| China | Pearson Correlation | 1** | .728 | .920** | .782** | .758** | .964 | .859** |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 | .000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Africa | Pearson Correlation | .728** | 1** | .871** | .702** | .864** | .839** | .914** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Eastern Mediterenean | Pearson Correlation | .920** | .871 | 1** | .812** | .808** | .977 | .919** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Europe | Pearson Correlation | .782** | .702 | .812** | 1** | .585** | .779 | .701** |
| | Sig. (2-tailed) | .000 | .000 | .000 | | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| South East asia | Pearson Correlation | .758** | .864** | .808** | .585** | 1** | .850* | .974** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Westren pacifc | Pearson Correlation | .964** | .839 | .977** | .779** | .850** | 1 | .941** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| World | Pearson Correlation | .859** | .914* | .919** | .701** | .974** | .941* | 1** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlation among Estimated polio cases in different countries and regions of the world**

The correlation among different countries and regions of the estimated number of polio cases is as under (Estimated number of polio cases is omitted with each sentence as this will too much elobrate the article)

**At P≤0.05**

Correlation in Afghanistan and Pakistan is 0.590. Afghanistan, Iran is 0.655. Afghanistan, south east asia is 0.745.

Afghanistan and Pakistan the estimated number of polio cases is great and so is the case with Afghanistan and Iran, as they are the neighboring countries and the conditions among the countries are much more same for the virus replication. However the real estimated correlation would be much more among those countries because the real data obtained from the Afghanistan is under doubt because of the long war fought between Afghanistan and soviet union and the Taliban and the united states. So the real vaccination campaign and the

data would have given us much more correlation. A positive correlation between these countries and especially the porous border between these countries show that the virus has travelled along the borders of the countries. In Pakistan at the border of Afghanistan the area is tribal region, where government has little control and the people of tribal area has family relation with Afghanistan. They frequently visited each other so the virus had got the chance of travelling in the border of the nearby countries.[8]

**Egypt at P≤0.05**

Egypt has perfect positive correlation with India as 0.816. Egypt has almost a perfect positive correlation with Iran as 0.785. Egypt has also a perfect positive correlation with Pakistan. Although Egypt does not touch the border with any of the countries the estimated polio cases in the Egypt has a perfect positive correlation with these countries. It shows that the virus and the vaccination campaign have similar trends in these countries.

**Iran at P≤0.05**

Iran, Afghanistan has positive correlation of 0.655. Iran, Egypt correlation 0.785. Iran India correlation 0.743. Iran has the most perfect positive correlation with Pakistan 0.820.

Among all the countries Iran has the perfect positive correlation with Pakistan, exceeding 0.8 limit which shows a very high level of relationship between these countries. Due to the adjoining border of the two countries and high correlation between the two countries it can be concluded that the virus has travelled between these two countries.[8]

**Nigeria**

Nigeria only shows good correlation with Bangladesh as 0.717 at P≤0.005. Nigeria correlation with Afghanistan is not significant as 0.266. Nigeria does not show a perfect positive correlation with other countries.

**Pakistan at P≤0.05**

Pakistan, Afghanistan correlation 0.590. Pakistan has very low correlation with Bangladesh 0.347.

Pakistan and Egypt has a perfect positive correlation of 0.879. Pakistan and India has a correlation of 0.781. Pakistan, Iran 0.820. Pakistan, south east asia 0.784.
Pakistan has a very low correlation with Nigeria as 0.377 at P≤0.01.

**China at P≤0.05**

China, Afghanistan correlation is 0.591. China, Egypt correlation is 0.925. China, India correlation is 0.756. China, Pakistan correlation 0.895. China, Eastern Mediterranean correlation 0.920.

Among all the countries China has perfect positive correlation with Pakistan. As the two countries have the most friendly relationship and the people can easily travel among the two countries[8], so the virus must have travelled between the two countries and infected the human population. Although China has huge population and so does India has but the most perfect correlation is with Pakistan. This is because China has some restriction along the India border so the virus did not get the same chance to travel among China and India as with China and Pakistan.

**2.1) Correlations among reported polio cases in different regions**

Correlation Statistics were applied to the reported number of polio cases from 14 different regions from 1980 to 2016.

Descriptives Variables Reported polio cases in =Afghanistan Bangladesh Egypt India Iran Nigeria Pakistan China Africa Eastern Mediterranean Europe Southeast Asia Western pacific world.[7]

**Table 2.1.2. A): Showing the correlation in the reported polio cases in 14 world countries and regions.**

| Correlations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Afghanistan** | **Bangladesh** | **Egypt** | **India** | **Iran** | **Nigeria** | **Pakistan** |
| Afghanistan | Pearson Correlation | 1 | .145 | .629** | .748** | .647** | .091 | .576** |
| | Sig. (2-tailed) | | .422 | .000 | .000 | .000 | .614 | .000 |
| | N | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Bangladesh | Pearson Correlation | .145 | 1 | .305 | .387* | .285 | .531** | .306 |
| | Sig. (2-tailed) | .422 | | .066 | .018 | .087 | .001 | .066 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Egypt | Pearson Correlation | .629** | .305 | 1 | .815** | .783** | .173 | .877** |
| | Sig. (2-tailed) | .000 | .066 | | .000 | .000 | .307 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| India | Pearson Correlation | .748** | .387* | .815** | 1 | .740** | .217 | .769** |
| | Sig. (2-tailed) | .000 | .018 | .000 | | .000 | .196 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Iran | Pearson Correlation | .647** | .285 | .783** | .740** | 1 | .082 | .819** |
| | Sig. (2-tailed) | .000 | .087 | .000 | .000 | | .630 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Nigeria | Pearson Correlation | .091 | .531** | .173 | .217 | .082 | 1 | .173 |
| | Sig. (2-tailed) | .614 | .001 | .307 | .196 | .630 | | .307 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Pakistan | Pearson Correlation | .576** | .306 | .877** | .769** | .819** | .173 | 1 |
| | Sig. (2-tailed) | .000 | .066 | .000 | .000 | .000 | .307 | |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| China | Pearson Correlation | .494** | .319 | .914** | .744** | .723** | .164 | .859** |
| | Sig. (2-tailed) | .003 | .055 | .000 | .000 | .000 | .331 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Africa | Pearson Correlation | .632** | .610** | .765** | .824** | .637** | .583** | .719** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Eastern Mediterranean | Pearson Correlation | .711** | .221 | .948** | .800** | .758** | .151 | .895** |
| | Sig. (2-tailed) | .000 | .189 | .000 | .000 | .000 | .373 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Europe | Pearson Correlation | .391* | .146 | .631** | .418* | .686** | .035 | .614** |
| | Sig. (2-tailed) | .025 | .389 | .000 | .010 | .000 | .835 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| South East asia | Pearson Correlation | .737** | .400* | .818** | 1.000** | .739** | .225 | .774** |
| | Sig. (2-tailed) | .000 | .014 | .000 | .000 | .000 | .181 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| Western pacific | Pearson Correlation | .637** | .319 | .953** | .843** | .746** | .214 | .879** |
| | Sig. (2-tailed) | .000 | .054 | .000 | .000 | .000 | .203 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |
| World | Pearson Correlation | .746** | .385* | .908** | .973** | .774** | .248 | .851** |
| | Sig. (2-tailed) | .000 | .019 | .000 | .000 | .000 | .140 | .000 |
| | N | 33 | 37 | 37 | 37 | 37 | 37 | 37 |

**Table 2.1.2.B): Showing the correlation in the reported polio cases in 14 world countries and regions.**

| **Correlations** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **China** | **Africa** | **Eastern Mediterranean** | **Europe** | **South East Asia** | **Western pacific** | **World** |
| Afghanistan | Pearson Correlation | .494 | .632 | .711** | .391** | .737** | .637 | .746** |
| | Sig. (2-tailed) | .003 | .000 | .000 | .025 | .000 | .000 | .000 |
| | N | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Bangladesh | Pearson Correlation | .319 | .610 | .221 | .146* | .400 | .319** | .385 |
| | Sig. (2-tailed) | .055 | .000 | .189 | .389 | .014 | .054 | .019 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Egypt | Pearson Correlation | .914** | .765 | .948 | .631** | .818** | .953 | .908** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| India | Pearson Correlation | .744** | .824* | .800** | .418 | 1.000** | .843 | .973** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .010 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Iran | Pearson Correlation | .723** | .637 | .758** | .686** | .739 | .746 | .774** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Nigeria | Pearson Correlation | .164 | .583** | .151 | .035 | .225 | .214 | .248 |
| | Sig. (2-tailed) | .331 | .000 | .373 | .835 | .181 | .203 | .140 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Pakistan | Pearson Correlation | .859** | .719 | .895** | .614** | .774** | .879 | .851 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| China | Pearson Correlation | 1** | .733 | .864** | .553** | .750** | .965 | .849** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Africa | Pearson Correlation | .733** | 1** | .785** | .444** | .829** | .824** | .879** |
| | Sig. (2-tailed) | .000 | | .000 | .006 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Eastern Mediterranean | Pearson Correlation | .864** | .785 | 1** | .613** | .801** | .940 | .907** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Europe | Pearson Correlation | .553* | .444 | .613** | 1* | .418** | .562 | .509** |
| | Sig. (2-tailed) | .000 | .006 | .000 | | .010 | .000 | .001 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| South East Asia | Pearson Correlation | .750** | .829* | .801** | .418** | 1** | .846 | .975** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .010 | | .000 | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| Western pacific | Pearson Correlation | .965** | .824 | .940** | .562** | .846** | 1 | .936** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | | .000 |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| World | Pearson Correlation | .849** | .879* | .907** | .509** | .975** | .936 | 1** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .001 | .000 | .000 | |
| | N | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlations among reported polio cases in different countries**

Reported number of polio cases and the correlation between them is as under (correlation among different reported polio cases of the world is omitted with each sentence as this will elaborate the article).

In reported number of polio cases among different countries.

**Afghanistan at P≤0.05**

Afghanistan and Egypt correlation is 0.626. Afghanistan and Pakistan correlation is 0.576.

**Egypt at P≤0.05**

Egypt and India correlation is 0.815. Egypt and Iran correlation is 0.783. Egypt and Pakistan 0.877.

**Iran at P≤0.05**

Iran and Afghanistan correlation is 0.647, Iran and Egypt correlation is 0.783. Iran and India is 0.740. Iran and Pakistan is 0.819.

**Nigeria**

Nigeria has not significant correlation with any other country.

**Pakistan**

Pakistan and Afghanistan correlation is 0.576. Pakistan and Egypt is 0.877. Pakistan and India correlation is 0.769. Pakistan and Iran correlation is 0.819.

**China**

China has a perfect positive correlation with Pakistan as 0.859 at P≤0.05

South East Asia and Pakistan has nearly perfect positive correlation as 0.744 at P≤0.05.

South East Asia and Afghanistan has correlation of 0.737 at P≤0.05.

South East Asia and India has the most perfect correlation as 1.00 at at P≤0.05.

South East Asia and Iran has a perfect correlation of 0.739 at P≤0.05.

India has a correlation of 0.744 at P≤0.05.

Iran has a correlation of 0.723 at P≤0.05.

Africa , Western pacific correlation is 0.824 at P≤0.05.

Africa and South East Asia has a correlation of 0.829 at P≤0.05.

Western Pacific and china has a perfect correlation of 0.965 at P≤0.05.

Western Pacific and Eastern Mediterranean has a correlation of 0.940 at P≤0.05.

Western pacific and Europe has a correlation of 0.5256 at P≤0.05.

**Correlations among reported polio cases per million population in different regions**

Correlation Statistics were applied to the polio cases per million population from 14 different regions from 1980 to 2016.

Descriptives variables of Polio cases per million population in=Afghanistan Bangladesh Egypt India Iran Nigeria Pakistan China Africa Eastern Mediterranean Europe Southeast Asia Western pacific World.[7]

**Table 2.3.1.A): Correlations among reported polio cases per million population in different regions and countries**

**Correlations**

| | | Afghanistan | Bangladesh | Egypt | India | Iran | Nigeria | Pakistan |
|---|---|---|---|---|---|---|---|---|
| Afghanistan | Pearson Correlation | 1 | .212 | .592** | .744** | .623** | .254 | .547** |
| | Sig. (2-tailed) | | .244 | .000 | .000 | .000 | .160 | .001 |
| | N | 32 | 32 | 32 | 32 | 32 | 32 | 32 |
| Bangladesh | Pearson Correlation | .212 | 1 | .353* | .430** | .323 | .607** | .316 |
| | Sig. (2-tailed) | .244 | | .035 | .009 | .055 | .000 | .060 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Egypt | Pearson Correlation | .592** | .353* | 1 | .823** | .840** | .314 | .907** |
| | Sig. (2-tailed) | .000 | .035 | | .000 | .000 | .062 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| India | Pearson Correlation | .744** | .430** | .823** | 1 | .803** | .370* | .805** |
| | Sig. (2-tailed) | .000 | .009 | .000 | | .000 | .026 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Iran | Pearson Correlation | .623** | .323 | .840** | .803** | 1 | .186 | .865** |
| | Sig. (2-tailed) | .000 | .055 | .000 | .000 | | .278 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Nigeria | Pearson Correlation | .254 | .607** | .314 | .370* | .186 | 1 | .290 |
| | Sig. (2-tailed) | .160 | .000 | .062 | .026 | .278 | | .086 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Pakistan | Pearson Correlation | .547** | .316 | .907** | .805** | .865** | .290 | 1 |
| | Sig. (2-tailed) | .001 | .060 | .000 | .000 | .000 | .086 | |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| China | Pearson Correlation | .472** | .371* | .925** | .776** | .804** | .296 | .902** |
| | Sig. (2-tailed) | .006 | .026 | .000 | .000 | .000 | .080 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Africa | Pearson Correlation | .675** | .583** | .838** | .874** | .715** | .645** | .790** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Eastern Mediterranean | Pearson Correlation | .657** | .254 | .959** | .805** | .797** | .305 | .911** |
| | Sig. (2-tailed) | .000 | .134 | .000 | .000 | .000 | .071 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Europe | Pearson Correlation | .384* | .191 | .662** | .466** | .699** | .161 | .643** |
| | Sig. (2-tailed) | .030 | .265 | .000 | .004 | .000 | .348 | .000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| South East Asia | Pearson Correlation | .734** | .441** | .826** | 1.000** | .801** | .376* | .809** |
| | Sig. (2-tailed) | .000 | .007 | .000 | .000 | .000 | .024 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| Western pacific | Pearson Correlation | .614** | .375* | .959** | .859** | .812** | .374* | .914** |
| | Sig. (2-tailed) | .000 | .024 | .000 | .000 | .000 | .024 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |
| World | Pearson Correlation | .720** | .392* | .943** | .937** | .830** | .401* | .903** |
| | Sig. (2-tailed) | .000 | .018 | .000 | .000 | .000 | .015 | .000 |
| | N | 32 | 36 | 36 | 36 | 36 | 36 | 36 |

**Table 2.3.1.B): Correlations among reported polio cases per million population in different regions and countries.**

| **Correlations** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **China** | **Africa** | **Eastern Mediterranean** | **Europe** | **South East Asia** | **Western pacific** |
| Afghanistan | Pearson Correlation | .472 | .675 | .657** | .384** | .734** | .614 |
| | Sig. (2-tailed) | .006 | .000 | .000 | .030 | .000 | .000 |
| | N | 32 | 32 | 32 | 32 | 32 | 32 |
| Bangladesh | Pearson Correlation | .371 | .583 | .254* | .191** | .441 | .375** |
| | Sig. (2-tailed) | .026 | .000 | .134 | .265 | .007 | .024 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Egypt | Pearson Correlation | .925** | .838* | .959 | .662** | .826** | .959 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| India | Pearson Correlation | .776** | .874** | .805** | .466 | 1.000** | .859* |
| | Sig. (2-tailed) | .000 | .000 | .000 | .004 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Iran | Pearson Correlation | .804** | .715 | .797** | .699** | .801 | .812 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Nigeria | Pearson Correlation | .296 | .645** | .305 | .161* | .376 | .374 |
| | Sig. (2-tailed) | .080 | .000 | .071 | .348 | .024 | .024 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Pakistan | Pearson Correlation | .902** | .790 | .911** | .643** | .809** | .914 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| China | Pearson Correlation | 1** | .802* | .883** | .596** | .781** | .967 |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Africa | Pearson Correlation | .802** | 1** | .856** | .514** | .878** | .892** |
| | Sig. (2-tailed) | .000 | | .000 | .001 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Eastern Mediterranean | Pearson Correlation | .883** | .856 | 1** | .644** | .806** | .948 |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Europe | Pearson Correlation | .596* | .514 | .644** | 1** | .467** | .602 |
| | Sig. (2-tailed) | .000 | .001 | .000 | | .004 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| South East Asia | Pearson Correlation | .781** | .878** | .806** | .467** | 1** | .862* |
| | Sig. (2-tailed) | .000 | .000 | .000 | .004 | | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| Western pacific | Pearson Correlation | .967** | .892* | .948** | .602** | .862** | 1* |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| World | Pearson Correlation | .888** | .935* | .957** | .592** | .939** | .964* |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

**Table 2.3.1.C) Correlations among reported polio cases per million population in different countries and world.**

| **Correlations** | | |
|---|---|---|
| | | world |
| Afghanistan | Pearson Correlation | .720 |
| | Sig. (2-tailed) | .000 |
| | N | 32 |
| Bangladesh | Pearson Correlation | .392 |
| | Sig. (2-tailed) | .018 |
| | N | 36 |
| Egypt | Pearson Correlation | .943** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| India | Pearson Correlation | .937** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| Iran | Pearson Correlation | .830** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |

| | | |
|---|---|---|
| Nigeria | Pearson Correlation | .401 |
| | Sig. (2-tailed) | .015 |
| | N | 36 |
| Pakistan | Pearson Correlation | .903** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| China | Pearson Correlation | .888** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| Africa | Pearson Correlation | .935** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| Eastern Mediterenean | Pearson Correlation | .957** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| Europe | Pearson Correlation | .592* |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| South East Asia | Pearson Correlation | .939** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| Western pacific | Pearson Correlation | .964** |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| World | Pearson Correlation | 1** |
| | Sig. (2-tailed) | |
| | N | 36 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | |
| *. Correlation is significant at the 0.05 level (2-tailed). | | |

**Correlation among reported polio cases per million population in different regions.**

Correlation among different polio cases per million population is as under[7] (Polio cases per million population is omitted with each sentence as this will elaborate the article too much)

**Afghanistan at P≤0.05**

Afghanistan and Egypt the correlation is 0.592. Afghanistan and India has a correlation of 0.744. Afghanistan and Iran has a correlation of 0.623. Afghanistan and Pakistan has a correlation of 0.547.

**Iran at P≤0.05**

Iran and Afghanistan has a correlation of 0.623. Iran and Egypt has a correlation of 0.840.

Iran and India has correlation of 0.803. Iran and Pakistan has a correlation of 0.865. Iran and China has a correlation of 0.804. Iran and Europe has a correlation of 0.699.

**Nigeria at P≤0.05**

Nigeria has a good correlation only with Bangladesh as 0.607.

**Pakistan at P≤0.05**

Pakistan and Afghanistan has a correlation of 0.547. Pakistan and Egypt as 0.907. Pakistan and India as 0.805. Pakistan and Iran has a correlation of 0.865. Pakistan, South East Asia correlation is 0.809.

**China at P≤0.05**

China and Pakistan has a correlation of 0.902. China and Iran has correlation of 0.804. China and India has a correlation of 0.776. China and Egypt as 0.925.

Eastern Mediterranean and China 0.883 at P≤0.05.

Eastern Mediterranean and Europe correlation is 0.644 at P≤0.05.

Eastern Mediterranean and South East Asia as 0.806 at P≤0.05.

**3) Part three Regression statistics**

Regression

Regression lines were made only in the polio endemic countries all other regions were exempted as other regions have removed polio virus from their environment.

**3.1) Linear and quadratic reported cases**

The regression equation linear and quadratic were obtained. Multiple linear regression was also obtained. The number of polio cases from 1980 to 2016 were taken into account and regression was obtained among these years.

As the wild polio cases reservoir is present in Afghanistan and Pakistan[3] and Pakistan and Afghanistan share a huge boundary with each other, the movement of people across both the border is enormous.[8] So regression equation in the linear, quadratic and multiple linear regression was plotted against one another. Afghanistan and Pakistan polio cases were calculated by taking either Afghanistan or Pakistan as dependent variable and another independent variable. Regression between the estimated and reported polio cases in the same country was also formed.

By knowing one variable we can roughly predict the cases in another region of the world.

### 3.1.1) Estimation of reported polio cases in Afghanistan by knowing the reported polio cases in Pakistan using linear regression equation.

#### 3.1.1.A) Linear model

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .576 | .332 | .310 | 502.448 |

The independent variable is number of polio cases in Pakistan

Dependent variable is the number of polio cases in Afghanistan,

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig.** |
| Regression | 3881442.906 | 1 | 3881442.906 | 15.375 | .000 |
| Residual | 7826065.821 | 31 | 252453.736 | | |
| Total | 11707508.727 | 32 | | | |
| The independent variable is number of polio cases in Pakistan . | | | | | |

| Coefficients | | | | | |
|---|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** |
| | **B** | **Std. Error** | **Beta** | | |
| Pakistan polio cases | .331 | .084 | .576 | 3.921 | .000 |
| (Constant) | 96.365 | 107.450 | | .897 | .377 |

**Linear regression Equation**

Dependent = Afghanistan polio cases

Independent = Pakistan polio cases

The regression equation for the linear regression is

$y = mx+c$

y = independent variable

x = dependant variable

m = slope of the line

c = intercept

so the equation becomes

$y = mx+c$

The ANOVA table gives us the value of the p significant value as 0.000

By the rule we will accept the equation for the regression only if the value of p which is 0.05> the p significant value in ANOVA table.

So P(0.05)>P(0.000)

So the regression equation can be fit

F(1,31) = 15.375, P =0.000[6]

Another value is the adjusted R square, Adjusted R square is the Percentage of the variance in the outcome variable explained by the predictor variable.

So adjusted R square .310×100=31 or 31% of the variance in cases in Afghanistan can easily be predicted by the polio cases in Afghanistan.

The equation becomes

y = (0.333)(x) + 965.36…… equation A[4]

If we know the cases in Pakistan we can roughly estimate the polio cases in Afghanistan.

By this equation as the wild polio reservoir is only present in Afghanistan and Pakistan so an equation is necessary to predict the cases in it. However due to extended war history of Afghanistan with soviet union and then after nine eleven clashes between Taliban and US army, the real polio data obtained from the Afghanistan is still under question and the error in this data can lead us to a wrong prediction.

**3.1.1.B): Estimation of reported polio cases in Afghanistan by knowing the reported polio cases in Pakistan using quadratic regression equation.**

**Quadratic model**

| **Model Summary** | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .652 | .425 | .386 | 473.806 |

The independent variable is Pakistan polio cases

The dependent variable is Afghanistan polio cases.

| **ANOVA** | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Regression | 4972747.772 | 2 | 2486373.886 | 11.076 | .000 |
| Residual | 6734760.956 | 30 | 224492.032 | | |
| Total | 11707508.727 | 32 | | | |
| The independent variable is Pakistan polio cases. | | | | | |
| **Coefficients** | | | | | |
| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| | B | Std. Error | Beta | | |
| Pakistan polio cases | .871 | .257 | 1.514 | 3.384 | .002 |
| Pakistan ** 2 polio cases | .000 | .000 | -.986 | -2.205 | .035 |
| (Constant) | -64.163 | 124.770 | | -.514 | .611 |

**Quadratic Equation**

**Quadratic Regression**

Due to non linear relationship showed by the polio data in Afghanistan and Pakistan a quadratic equation was determined between these two countries.

The quadratic regression equation is determined by the equation

$y = ax^2+bx+c$

y = dependent variable

x = independent variable

a= coefficient of $x^2$

b = coefficient of x

c = intercept

In the ANOVA table P value 0.05> P(0.000)

So we accept it for the regression equation.[6]

F (2, 30) = 11.076, P = 0.000

(2, 30) these are the degree of freedom

The adjusted R square value is 0.386

Percent of adjusted R square = 0.386×100 = 38.6

Upto 38.6 percent of the variance in cases can easily be predicted by the cases in Pakistan.

The quadratic equation is better than linear equation for the estimation of polio cases as the Adjusted R square is 0.38 as compared to the linear model where Adjusted R square is 0.31.

In this situation Afghanistan is the dependent variable Pakistan is the independent variable Putting the values in equation we get

$y = ax^2+bx+c$

$y = (-0.000147)(x)^2+(0.871)(x)-64.163$…..equation B[4]

y = polio cases in Afghanistan

x = polio cases in Pakistan

For linear and quadratic regression equation estimation of the data between 2000 and 2016 years were used in SPSS however no equation was possible in that case.

In linear model the value of p0.058>0.05 in ANOVA table so the model was not significant and hence the model was not good for estimation.

For the quadratic equation as the value of p 0.076>0.05 so the model was not good for estimation and no equation was possible between the two variables.

**3.1.1.C): Estimating of Afghanistan reported polio cases from Pakistan reported polio cases and Pakistan estimated polio cases from 2000 to 2016 using multiple linear regression analysis**

| Model Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | |
| | | | | | R Square Change | F Change | df1 |
| 1 | .817[a] | .667 | .620 | 18.313 | .667 | 14.043 | 2 |

| Model Summary | | |
|---|---|---|
| Model | Change Statistics | |
| | df2 | Sig. F Change |
| 1 | 14[a] | .000 |

a. Predictors: (Constant), Pakistan number of reported paralytic polio cases from2000 to 2, Pakistan estimated polio cases from 2000 to2016.

| ANOVA[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 9419.726 | 2 | 4709.863 | 14.043 | .000[b] |
| | Residual | 4695.333 | 14 | 335.381 | | |
| | Total | 14115.059 | 16 | | | |

a) a. Dependent Variable: Afghanistan number of reported paralytic cases from 2000 to 2016
b) b. Predictors: (Constant), Pakistan number of reported paralytic polio cases from 2000 to2, Pakistan estimated polio cases from 2000 to2016

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 14.684 | 7.718 | | 1.903 | .078 |
| | Pakistan estimated polio cases from 2000 to 2016 | .485 | .112 | 1.770 | 4.345 | .001 |
| | Pakistan number of reported paralytic polio cases from 2000 to 2 | -.441 | .154 | -1.170 | -2.873 | .012 |

**Coefficients[a]**

| Model | | 95.0% Confidence Interval for B | | Correlations | | |
|---|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | Zero-order | Partial | Part |
| 1 | (Constant) | -1.870 | 31.238 | | | |
| | Pakistan estimated polio cases from 2000 to 2016 | .246 | .725 | .686 | .758 | .670 |
| | Pakistan number of reported paralytic polio cases from 2000 to 2 | -.770 | -.112 | .468 | -.609 | -.443 |

**Coefficients[a]**

| Model | | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| 1 | (Constant) | | |
| | Pakistan estimated polio cases from 2000 to 2016 | .143 | 6.982 |
| | Pakistan number of reported paralytic polio cases from 2000 to 2 | .143 | 6.982 |
| a. Dependent Variable: Afghanistan number of reported paralytic cases from 2000 to 2016 | | | |

**Multiple linear regression**

Estimation of Afghanistan reported polio cases from Pakistan reported polio cases and Pakistan estimated polio cases.

It is significant as in the ANOVA table the value of p 0.05> 0.000 so the model is fit for regression[6]

F(2,14)=14.043,p=0.000

Adjusted R square is 0.620

y=m1x1+m2x2+c

y=( 0.485)x1+(-0.441)x2+14.684….equation C[5]

y=0.485x1-0.441x2+14.684

y= Afghanistan reported polio cases

x1= Pakistan estimated polio cases

x2= Pakistan Reported polio cases

c=14.684

m1=(0.485)

m2=(-0.441)

So by knowing the above variable in a specific year we can calculate the number of reported polio cases in Afghanistan in that year. So the variables from Pakistan can give us prediction of the reported polio cases in Afghanistan.

**3.2) Estimation of reported polio cases in Pakistan by using the reported polio cases in Afghanistan Curve Fit.**

**3.2.A) Estimation of reported polio cases in Pakistan by using the reported polio cases in Afghanistan using Linear regression equation Linear model.**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .576 | .332 | .310 | 873.649 |
| The independent variable is Afghanistan. | | | |

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig.** |
| Regression | 11735071.294 | 1 | 11735071.294 | 15.375 | .000 |
| Residual | 23661159.675 | 31 | 763263.215 | | |
| Total | 35396230.970 | 32 | | | |
| The independent variable is Afghanistan polio cases . | | | | | |

**Coefficients**

| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| Afghanistan polio cases | 1.001 | .255 | .576 | 3.921 | .000 |
| (Constant) | 397.538 | 175.254 | | 2.268 | .030 |

**Linear equation**

Pakistan polio cases as dependent variable while Afghanistan polio cases as independent variable

y = mx+c

y = Polio cases in Pakistan

x = Polio cases in Afghanistan

As p value is 0.05> 0.000 so we can apply regression[6]

F(1, 31)= 15.373 , P= 0.000

y= mx+c

y= (1.001)(x)+ 397.538……equation D[4]

For the data between 2000 to 2016 for liner model analysis were done but no regression line was made between the two variables

As the value of p 0.058>0.05 so the model was not significant, and The model was not a good estimation of dependent variable so no regression equation was possible between the two variables.

**3.2.B) Estimation of reported polio cases in Pakistan by using reported the polio cases in Afghanistan using Quadratic regression equation Quadratic.**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .804 | .647 | .623 | 645.714 |
| The independent variable is Afghanistan polio cases | | | |

**ANOVA**

| | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| Regression | 22887826.986 | 2 | 11443913.493 | 27.447 | .000 |
| Residual | 12508403.983 | 30 | 416946.799 | | |
| Total | 35396230.970 | 32 | | | |
| The independent variable is Afghanistan polio cases . | | | | | |

| Coefficients | | | | | |
|---|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** |
| | **B** | **Std. Error** | **Beta** | | |
| Afghanistan polio cases | 4.694 | .739 | 2.700 | 6.356 | .000 |
| Afghanistan ** 2 polio cases | -.002 | .000 | -2.197 | -5.172 | .000 |
| (Constant) | 106.557 | 141.222 | | .755 | .456 |

**Quadratic Regression equation**

As the value of P 0.005> P 0.000

F(2, 30) = 27.477, P = 0.000

So model is fit for regression

Adjusted R square is 0.623×100= 62.3%

Or 62.3 percent of variance in the dependent variable can be explained by the independent variable it is a good model as compared to the linear model where adjusted R square value is 0.310[6]

$y=ax^2+bx+c$

$y=(-0.002)(x)^2+4.694(x)+106.557$……equation E[4]

For the data chosen between the years 2000 and 2016 no regression was possible because the value of p 0.159> 0.05 so the model was not good for quadratic estimation.

**3.2.C): Estimating of Pakistan reported polio cases from Afghanistan reported polio cases and Afghanistan estimated polio cases from 2000 to 2016 using multiple linear regression analysis Multiple linear regression.**

**Regression**

| Model Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | |
| | | | | | R Square Change | F Change | df1 |
| 1 | .817[a] | .667 | .620 | 18.313 | .667 | 14.043 | 2 |

| Model Summary | | |
|---|---|---|
| Model | Change Statistics | |
| | df2 | Sig. F Change |
| 1 | 14[a] | .000 |

a. Predictors: (Constant), Pakistan number of reported paralytic polio cases from 2000 to 2, Pakistan estimated polio cases from 2000 to 2016

| ANOVA[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 9419.726 | 2 | 4709.863 | 14.043 | .000[b] |
| | Residual | 4695.333 | 14 | 335.381 | | |
| | Total | 14115.059 | 16 | | | |

a) a. Dependent Variable: Afghanistan number of reported paralytic cases from 2000 to 2016

b) Predictors: (Constant), Pakistan number of reported paralytic polio cases from 2000 to 2, Pakistan estimated polio cases from 2000 to 2016

| Coefficients[a] |
|---|

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 14.684 | 7.718 | | 1.903 | .078 |
| | Pakistan estimated polio cases from 2000 to 2016 | .485 | .112 | 1.770 | 4.345 | .001 |
| | Pakistan number of reported paralytic polio cases from 2000 to 2 | -.441 | .154 | -1.170 | -2.873 | .012 |

**Coefficients[a]**

| Model | | 95.0% Confidence Interval for B | | Correlations | | |
|---|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | Zero-order | Partial | Part |
| 1 | (Constant) | -1.870 | 31.238 | | | |
| | Pakistanestimatedpoliocasesfrom2000to2016 | .246 | .725 | .686 | .758 | .670 |
| | Pakistannumberofreportedparalyticpolocasesfrom2000to2 | -.770 | -.112 | .468 | -.609 | -.443 |

**Regression equation analysis**

As the value of p 0.05> 0.000

So the model is suitable for analysis of regression[6]

F(2,14) = 14.043,p=0.000

The adjusted R square is 0.620

Equation

Y =m1x1+m2x2+c

**Estimating of Pakistan reported polio cases from Afghanistan reported polio cases and Afghanistan estimated polio cases**

Y= Pakistan reported polio cases

m1= 0.485

x1= Pakistan estimated polio cases

m2=-0.441

x2= Pakistan number of reported polio cases

C= 14.684

Y= 0.485x1+(-0.441)x2+14.684……equation F[5]

**3.3) Estimation of reported paralytic cases per million population of Pakistan, By knowing the polio cases per million of Afghanistan.**

**Curve Fit**

**3.3.A) Estimation of reported paralytic cases per million population of Pakistan, By knowing the reported polio cases per million of Afghanistan using linear regression.**

**Linear model**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .547 | .300 | .276 | 11.173 |
| The independent variable is Afghanistan polio cases per million population. | | | |

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Regression | 1602.093 | 1 | 1602.093 | 12.833 | .001 |
| Residual | 3745.308 | 30 | 124.844 | | |
| Total | 5347.401 | 31 | | | |
| The independent variable is Afghanistan polio cases per million population. | | | | | |

| Coefficients | | | | |
|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** |
| | **B** | **Std. Error** | **Beta** | |
| Afghanistan polio cases per million population | .141 | .039 | .547 | 3.582 |
| (Constant) | 4.151 | 2.260 | | 1.836 |

| Coefficients | |
|---|---|
| | Sig |
| Afghanistan polio cases per million population | .001 |
| (Constant) | .076 |

**Linear Regression**

Cases in Pakistan per million population = dependent variable

Cases in Afghanistan per million population = Independent variable

Adjusted R square 0.276 or 27.6%

F( 1,30) = 12.833, P= 0.001

As the value of P 0.05> P value calculated 0.000

So we apply the linear model[6]

y=mx+c

y= Polio cases in Pakistan per million population

x=Polio cases in Afghanistan per million population

m =slope

y=(0.141)(x)+4.151…..equation G[4]

**3.3.B) Estimation of reported paralytic cases per million population of Pakistan, By knowing the reported polio cases per million of Afghanistan using quadratic regression Quadratic model.**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .814 | .662 | .639 | 7.889 |
| The independent variable is Afghanistan polio cases per million population. | | | |

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Regression | 3542.429 | 2 | 1771.215 | 28.458 | .000 |
| Residual | 1804.972 | 29 | 62.240 | | |
| Total | 5347.401 | 31 | | | |
| The independent variable is Afghanistan polio cases per million population. | | | | | |

| Coefficients | | | | |
|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** |
| | **B** | **Std. Error** | **Beta** | |
| Afghanistan polio cases per million population | .711 | .106 | 2.761 | 6.720 |
| Afghanistan polio cases per million population ** 2 | -.004 | .001 | -2.295 | -5.583 |
| (Constant) | .787 | 1.706 | | .461 |

| Coefficients | |
|---|---|
| | Sig. |
| Afghanistan polio cases per million population | .000 |
| Afghanistan polio cases per million population ** 2 | .000 |
| (Constant) | .648 |

**Quadratic regression**

For quadratic regression equation adjusted R square is 0.639 so percent of it is 63.9%.

Which shows a better fit regression equation then the linear regression where adjusted r square value is 0.276

F(2, 29) = 28.458, P=0.000

As P value 0.05>0.000 so we accept it for regression[6]

Quadratic regression equation

$y = ax^2+bx+c$

y= Polio cases in Pakistan per million population.

x = Polio cases in Afghanistan per million population

$y=(-0.004)X^2+0.711X+0.787$…… equation H[4]

**Estimation of reported Afghanistan polio cases per million population using Pakistan reported polio cases per million population**

**3.4.A) Estimation of reported Afghanistan polio cases per million population using reported Pakistan polio cases per million population using liner regression Linear Model.**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .547 | .300 | .276 | 43.404 |
| The independent variable is Pakistan polio cases per million population. | | | |

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Regression | 24176.085 | 1 | 24176.085 | 12.833 | .001 |
| Residual | 56517.858 | 30 | 1883.929 | | |
| Total | 80693.943 | 31 | | | |
| The independent variable is Pakistan polio cases per million population. | | | | | |

| Coefficients | | | | |
|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** |
| | **B** | **Std. Error** | **Beta** | |
| Pakistan polio cases per million population | 2.126 | .594 | .547 | 3.582 |
| (Constant) | 10.748 | 9.051 | | 1.188 |

**Coefficients**

| | **Sig.** |
|---|---|
| Pakistan polio cases per million population | 001 |
| (Constant) | 244 |

**Linear regression equation**

Afghanistan polio cases per million population = dependent

Pakistan polio cases per million population = independent

Percent of Adjusted R square for linear regression is 0.276×100=27.6%

ANOVA p value is less than 0.05 so the model is acceptable for regression.

P:0.05>0.001 so the model is acceptable[6]

y=mx+c

y= Afghanistan polio cases per million population

x= Pakistan polio cases per million population

y=(2.126)x+10.748…….equation I[4]

**3.4.B) Estimation of reported Afghanistan polio cases per million population using reported Pakistan polio cases per million population using quadratic regression**

**Quadratic Model**

| Model Summary | | | |
|---|---|---|---|
| **R** | **R Square** | **Adjusted R Square** | **Std. Error of the Estimate** |
| .697 | .486 | .451 | 37.815 |

The independent variable is Pakistan polio cases per million population.

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Regression | 39224.767 | 2 | 19612.383 | 13.715 | .000 |
| Residual | 41469.177 | 29 | 1429.972 | | |
| Total | 80693.943 | 31 | | | |

The independent variable is Pakistan polio cases per million population.

| Coefficients | | | | |
|---|---|---|---|---|
| | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** |
| | **B** | **Std. Error** | **Beta** | |
| Pakistan polio cases per million population | 7.698 | 1.794 | 1.982 | 4.292 |
| Pakistan polio cases per million population ** 2 | -.122 | .038 | -1.498 | -3.244 |
| (Constant) | -5.992 | 9.424 | | -.636 |

| Coefficients | |
|---|---|
| | Sig. |
| Pakistan polio cases per million population | .000 |
| Pakistan polio cases per million population ** 2 | .003 |
| (Constant) | .530 |

**Quadratic Regression**

**For quadratic regression equation**

As the p value in ANOVA table is 0.000 which is 0.005>0.000 so the model is acceptable for regression

F(2, 29)= 13.715, p =0.000

Percent Adjusted R square is 0.451×100=45.1%.

As the Adjusted R square value 0.451 is greater so it is a good model then linear model where adjusted r square value is 0.276[6]

$y = ax^2+bx+c$

$y=(-0.122)x^2+7.69(x)-5.992$….. equation J[4]

**4. Linear regression for the endemic countries between the estimated and reported polio cases**

**4.1) Regression**

In this section linear regression equation was made between the Estimated polio cases and reported polio cases. Three countries that are endemic with polio virus: Pakistan, Afghanistan and Nigeria, Regression equation was made between the reported polio cases and the estimated polio cases. Polio cases from 2001 to 2016 were chosen for this purpose and the regression equation was made between the two countries in these 16 years as this data is the most refined data and the difference between the estimated and the reported polio cases is less. Moreover polio samples obtained in this era are more clear and documented.

**4.1.1) Estimation of estimated polio cases in Nigeria by using the reported polio cases in Nigeria.**

**Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | |
|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change |
| 1 | 1.000[a] | 1.000 | 1.000 | .000012757130138 | 1.000 | 15762598695796720.000 |

**Model Summary[b]**

| Model | Change Statistics | | | Durbin-Watson |
|---|---|---|---|---|
| | df1 | df2 | Sig. F Change | |
| 1 | 1[a] | 14 | .000 | 2.643 |

a. Predictors: (Constant), Nigeria Reported polio cases

b. Dependent Variable: Nigeria Estimated polio cases

**ANOVA[a]**

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2565274.144 | 1 | 2565274.144 | . | .[b] |
| | Residual | .000 | 14 | .000 | | |
| | Total | 2565274.144 | 15 | | | |

a. Dependent Variable: Nigeria Estimated polio cases

b. Predictors: (Constant), Nigeria Reported polio cases

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | **(Constant)** | 2.396E-006 | .000 | | .544 | .595 |
| | **Nigeria Reported polio cases** | 1.110 | .000 | 1.000 | 125549188.352 | .000 |

a. Dependent Variable: Nigeria Estimated polio cases

**Linear Regression Equation**

Nigeria estimated polio cases =y

Y= dependent variable

Nigeria reported polio cases = x

X= Independent variable

Adjusted R square 1.00

The 1 value shows perfect positive correlation

Percentage of adjusted R square 1.00×100=100

The ANOVA table shows no significant value this is because the difference in the estimated and the reported value is small. The mean square error is zero, so the software eliminates the p value significant and the F value. It shows a perfect correlation so the line is best fit for the linear regression.[6]

y= mx+c

y=(1.110)(x)+0.000002…. equation K[4]

as the c value is very small so we can write the equation as

y=(1.110)(x)

**4.1.2) Estimation of estimated polio cases in Pakistan by knowing the reported polio cases in Pakistan**

[DataSet1]

| Model Summary[b] | | | | | | |
|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | |
| | | | | | R Square Change | F Change |
| 1 | 1.000[a] | 1.000 | 1.000 | .000004205058502 | 1.000 | 630503947831 8680.000 |

| Model Summary[b] | | | | |
|---|---|---|---|---|
| Model | Change Statistics | | | Durbin-Watson |
| | df1 | df2 | Sig. F Change | |
| 1 | 1[a] | 14 | .000 | 2.137 |
| a. Predictors: (Constant), Pakistan Reported polio cases | | | | |
| b. Dependent Variable: Pakistan estimated polio cases | | | | |

| ANOVA[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
| 1 | Regression | 111488.963 | 1 | 111488.963 | 6305039478318681.000 | .000[b] |
| | Residual | .000 | 14 | .000 | | |
| | Total | 111488.963 | 15 | | | |
| a. Dependent Variable: Pakistan estimated polio cases | | | | | | |
| b. Predictors: (Constant), Pakistan Reported polio cases | | | | | | |

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -3.157E-006 | .000 | | -1.781 | .097 |
| | Pakistan Reported polio cases | 1.110 | .000 | 1.000 | 79404278.715 | .000 |

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | 95.0% Confidence Interval for B | | Correlations | | |
| | | Lower Bound | Upper Bound | Zero-order | Partial | Part |
| 1 | (Constant) | .000 | .000 | | | |
| | Pakistan Reported polio cases | 1.110 | 1.110 | 1.000 | 1.000 | 1.000 |
| a. Dependent Variable: Pakistan estimated polio cases | | | | | | |

**Linear regression equation**

Pakistan estimated polio cases =y

Y=dependent variable

Pakistan reported polio cases = x

X= independent variable

The ANOVA table shows that the p 0.05>0.000

So the line is fit for regression[6]

F(1, 14)= 6305039478318, P=0.000

The F value is very large so the line is best fit for linear regression.

Percent of Adjusted R square value is 1.00×100=100.

Adjusted R square value is 1

It is also a perfect positive correlation.

Y=mx+c

y =(1.110)(x)-0.000003…. equation L[4]

for the data chosen between 2000 and 2016 the adjusted R square values for linear model was 0.847 and adjusted R square for quadratic equation were 0.844 so the best data was from 2001 to 2016.

**4.1.3) Estimation of Afghanistan estimated polio cases by knowing the reported polio cases of Afghanistan**.

| Model Summary[b] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | |
| | | | | | R Square Change | F Change | df1 |
| 1 | .993[a] | .987 | .986 | 2.487829563559886 | .987 | 1058.256 | 1 |

| Model Summary[b] | | | |
|---|---|---|---|
| Model | Change Statistics | | Durbin-Watson |
| | df2 | Sig. F Change | |
| 1 | 14[a] | .000 | 1.151 |
| a. Predictors: (Constant), Afghanistan Reported polio cases | | | |
| b. Dependent Variable: Afghanistan Estimated polio cases | | | |

| ANOVA[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 6549.857 | 1 | 6549.857 | 1058.256 | .000[b] |
| | Residual | 86.650 | 14 | 6.189 | | |
| | Total | 6636.507 | 15 | | | |
| a. Dependent Variable: Afghanistan Estimated polio cases | | | | | | |
| b. Predictors: (Constant), Afghanistan Reported polio cases | | | | | | |

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 1.203 | 1.031 | | 1.167 | .263 |
| | Afghanistan Reported polio cases | 1.086 | .033 | .993 | 32.531 | .000 |
| a. Dependent Variable: Afghanistan Estimated polio cases | | | | | | |

**Linear regression equation**

Afghanistan estimated polio cases =y

Afghanistan reported polio cases =x

Y= dependent variable

X= Independent variable

Percent Adjusted R square 0.986×100=98.6

R square value is 0.987

It is also a perfect positive correlation

As the ANOVA value is p: 0.05> 0.000

So it is fit for regression[6]

F (1, 14) = 1058.25, P=0.000

As the F value in this model is large, so it is best fit for linear regression.

Y=mx+c

The liner regression equation for the model is as under

y=(1.086)(x)+1.203….. equation M[4]

The best fit and refined data is from 2001 to 2016 for the regression equation. Data was chosen from 2000 to 2016 which resulted in adjusted R square as 0.903 for linear model and 0.976 for quadratic model. So this data is the most refined for the analysis.

## 5. CONCLUSION

In the estimated polio cases India and china were most affected as they have higher population.

In Endemic countries in estimated polio cases, first Pakistan was most affected then is the case with Nigeria and lastly Afghanistan was most affected. Bangladesh and Iran have the least amount of estimated polio cases.

Region wise South East Asia and Eastern Mediterranean has the most estimated polio cases followed by the western Pacific, Africa and Europe.

### Per million population polio cases

Per million population Afghanistan is most affected by the polio cases, the reason might be the inadequate health infrastructure there in Afghanistan, followed by India and Pakistan, India is greatly affected by the per million population density of polio the reason are the great population density of India and vaccine failure.

### Vaccine failure

Vaccine failure cases occurred in India in 2009.In northern states of India, Wild polio virus transmissions were eliminated but OPV effectiveness in those areas were very low despite the effort that eighty five percent of the population has received more than seven doses of OPV and less than two percent of the population have received less than three doses of OPV.[9,10]

Pakistan has also great polio cases per million population placing it in the third position in the world. The least effected countries are the Bangladesh and Iran.

Region wise Eastern Mediterranean and south East Asia are the most effected regions while western Pacific and Europe are least affected.

**In the reported Polio cases**

Reported polio cases show a general trend from higher population countries and regions towards the lower population density regions like India and China are most effected followed by the Pakistan, Nigeria and Afghanistan. Similarly in the regions of the world South East Asia, western pacific and eastern Mediterranean are the most effected regions.

**Correlation**

Correlation is generally higher in the Neighboring countries sharing the borders like Iran Pakistan has a perfect positive correlation in the polio cases. Similarly China Pakistan has a higher correlation. Similarly India Pakistan has a positive perfect correlation in the estimated polio cases.[8] It shows that polio virus has transmitted from their borders to infect healthy indivuals.

**Regression**

Estimating Of Afghanistan Reported Polio Cases neither linear nor quadratic equation is so accurate because of the low adjusted R square value so equation c using multiple linear regression is the most suitable for calculating the cases.

$y=(0.485)x1+(-0.441)x2+14.684$….equation C

Estimation of reported polio cases in Pakistan both the quadratic equation and multiple linear regression equation are good equations. Equations E and Equation F can be used for the calculation of the reported polio cases in Pakistan. The linear equation D is inadequate for the calculation so only equation E and equation F should be used for this purpose.

$y=(-0.002)(x)^2+4.694(x)+106.557$……equation E

$Y= 0.485x1+(-0.441)x2+14.684$……equation F

Estimation of reported paralytic cases per million population of Pakistan linear regression equation is not a good equation. Equation G is not a good equation for estimation. However equation H is a good equation the curve equation is a good equation for estimation so equation H should be used for the estimation.

$y=(-0.004)X^2+0.711X+0.787$…….H

Estimation of reported Afghanistan polio cases per million population Linear regression model shows lesser accuracy as compared to the quadratic equation so equation J is suitable for estimation of the model.

$y=(-0.122)x^2+7.69(x)-5.992$….. equation J

Estimation of estimated polio cases in Nigeria Equation K is the most suitable and perfect so there is no need to go for non linear equation. Linear equation shows best fit so it is the best fit line

$y=(1.110)(x)+0.000002$…. equation K

Estimation of estimated polio cases in Pakistan Linear model best fits the regression line so only linear model is chosen for this purpose and equation L is the best equation for estimation of the estimated polio cases in Pakistan.

$y =(1.110)(x)-0.000003$…. equation L

Estimation of Afghanistan estimated polio cases Linear model is the best fit line so no need to go for the quadratic equation and equation M should be used for the estimation of the cases.

$y=(1.086)(x)+1.203$….. equation M

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