SEASONAL VARIATION FOR INFANT MORTALITY: A STUDY OF HARIDWAR DISTRICT OF UTTARAKHAND

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ABSTRACT

The infant mortality rate is an important factor of nation's socio-economic welfare. In the process of development of a state or a nation, infant mortality has been gaining its importance. It is expressed as a rate per 1000 live births of a child born in a specified year dying before reaching the age of one, has become a prime focus for many researches and public policies. Thus, reduction in IMR is likely the most important objective in Millennium Development Goals (MDG).

In the study, for the consecutive 6 years (2008-2013), the seasonal variations of neonatal, post-neonatal and overall infant deaths were analyzed in the Haridwar district of Uttarakhand , State of India. The researcher has relied upon secondary data which have been collected from the CMO Office, Haridwar. The main motivation of the paper is to demonstrate the seasonal variation exhibited by the infant mortality. For the study of seasonal movement, monthly data was used for the period of 2008-2013. Indices of seasonal variations were estimated by the method of simple averages separately for both neonatal and post-neonatal infant deaths. Poisson regression model was employed to measure the seasonal effects on the overall infant deaths.

Key words: Poisson Regression, Seasonal Index, Autocorrelation, Neonatal, Post-neonatal

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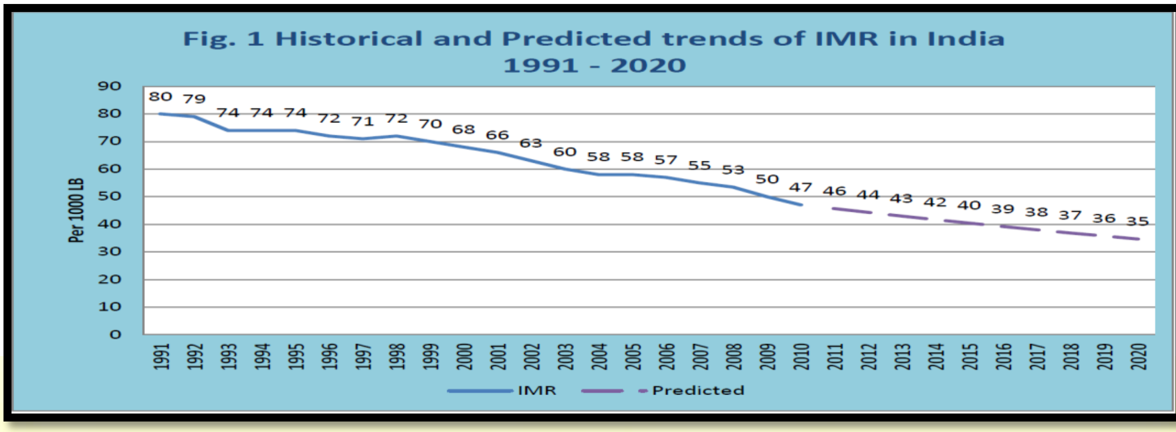
1. Introduction

The infant mortality rate is an important factor of nation's socio-economic welfare. In the process of development of a state or a nation, infant mortality has been gaining its importance. The infant mortality rate- the probability is expressed as a rate per 1000 live births of a child born in a specified year dying before reaching the age of one has become a prime focus for many researches and public policies. One of the essential indicators of social development is infant mortality including child health, mother's health and mother's education. In fact, infant mortality depends on various factors like environment, socioeconomic conditions, geographic location and certain demographics. The infant mortality rate is regarded as one of the most revealing measures of how well a society is meeting the needs of its people (Newland, 1981:5)

As we all know, children are important assets of a nation, hence, reduction in infant mortality rate is likely the most important objective in Millennium Development Goals (MDG). A country's socio-economic development and the quality of life are reflected by its infant mortality rates. It is an outcome rather than a cause and hence directly measures results of the distribution and use of resources, Haines (1995). According to the estimates of UN, about 10 million infant deaths occur annually in the world and India accounts for a quarter of those. Thus, any study in India relating to infant mortality has global significance.

Since 1970s India has experienced an impressive decline in IMR. During early period of 1970's, infant mortality rates i.e. 130-140 deaths per 1000 live births, have declined to as low as 47 deaths per 1000 live births in 2011, figure (1) . The MDG is to reduce child and infant mortality to two-thirds between 1990 and 2015. In the case of India this would imply a reduction of the IMR to 27 and of the U5MR to 32 by 2015. Substantial progress has been made in reducing child deaths, children from poor and disadvantaged households remain disproportionately vulnerable across all regions of the developing world (UNICEF, 2010). Although infant mortality in India had declined dramatically over the past four decades tremendous variations still persist across population sub grouped and geographical areas. Figure (2) shows the variations among Indian states in respect of infant mortality. The reduction in infant and child mortality was declared as the major goal of our official strategy to achieve Health for all.



Source: Infant and Child Mortality in India: Level Trends and Determinants; UNICEF

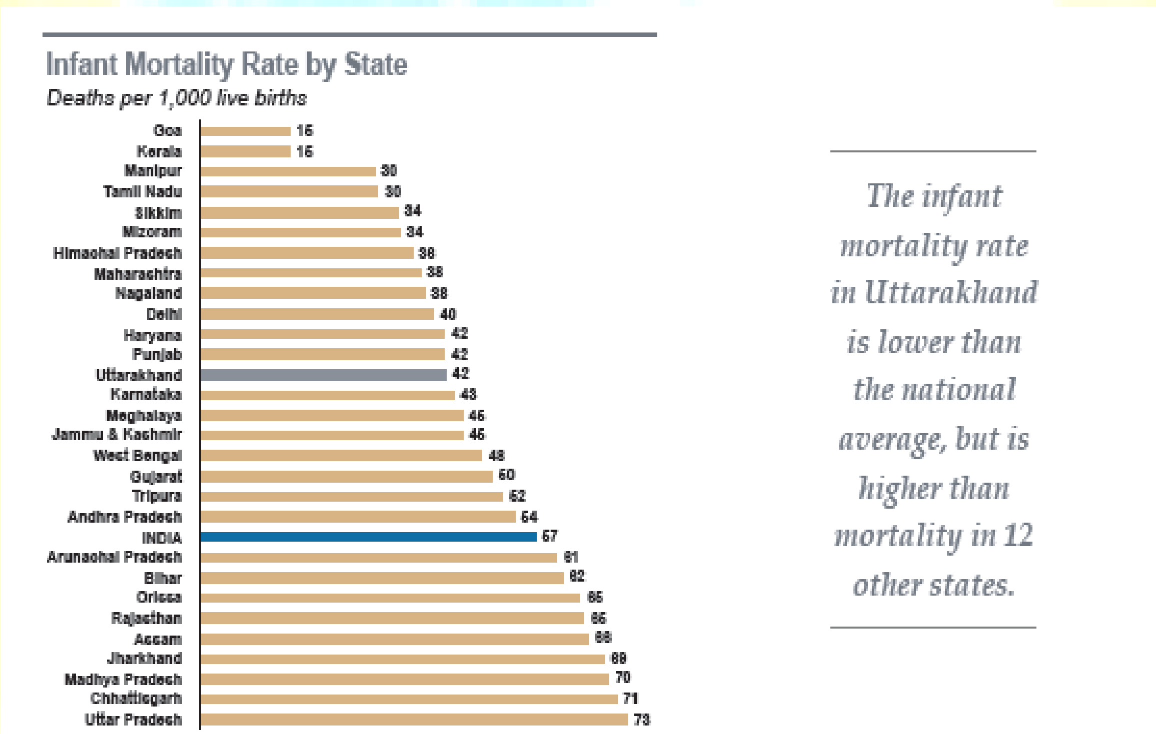


Fig. (2): Infant Mortality Rates by States of India (Source: National Family and Health Survey(NFHS-3) India 2005- 2006, Uttarakhand , May 2008)

Quite a number of studies done earlier focuses on the effect of seasonal variations have on the mortality of children. Mosley & Chin (1984) proposed a conceptual framework which suggests that child survival chances are due to operation of biological, social, economic and environmental forces.

The study of seasonal variations of infant mortality will help the policy makers, officials and decision makers to reduce the rate of infant mortality by implementing appropriate measures and efforts in the months of high infant mortality.

2. Methodology

In the study, infant mortality data was collected for the 6 consecutive years from 2008-2013. The study area is the Haridwar district of Uttarakhand, State of India. The researcher has relied upon the secondary data which have been collected from the CMO Office, Haridwar. For the study of seasonal movement, monthly data was used for the period of 2008-2013. Since, the infant mortality can be studied into two parts, first being the neonatal mortality and second being the post- neonatal mortality. So, separate studies have been done on both the types. Indices of seasonal variations were estimated by the method of simple averages separately for both neonatal and post-neonatal infant deaths. Also, were calculated the estimated auto-correlation between the months at 95% confidence level for the randomness of time series. Poisson regression model was employed to measure the seasonal effects on the overall infant deaths.

3. Study Area

3.1 Demographic Profile of Uttarakhand

Uttarakhand emerged as the 27th state of India on 9th November 2000 after a prolonged struggle, which took roots in the year 1930, leading to the fulfillment of the long cherished dream of the people of this hilly region. Uttarakhand is the ancient term for the central stretch of the Indian Himalayas. There are 13 districts in Uttarakhand which are grouped into two divisions viz. the Kumaon division and the Garhwal division.

The Kumaon division includes six districts:

- Almora
- Bageshwar
- Champawat

- Nainital
- Pithoragarh
- Udham Singh Nagar

The Garhwal division includes seven districts:

- Dehradun
- Haridwar
- Tehri Garhwal
- Uttarkashi
- Chamoli
- Pauri Garhwal
- Rudraprayag

3.2 Study Area: Haridwar District

Fig. 3: Map of Haridwar, Uttarakhand

Haridwar is a district in the state of Uttarakhand, India. Haridwar district, covering an area of about 2,360 km², is in the southwestern part of Uttarakhand, State of India. Its latitude and longitude are 29.96-degree north and 78.16-degree east respectively. It is headquartered at Haridwar which is also its largest city. The district is ringed by the districts Dehradun in the north and east, Pauri Garhwal in the east and the Uttar Pradesh districts of Muzaffarnagar and Bijnor in the south and Saharanpur in the west. Haridwar district came into existence on 28 December 1988 as part of Saharanpur Divisional Commissionary, On 24 September 1998 Uttar

Pradesh Legislative Assembly passed the 'Uttar Pradesh Reorganisation Bill', 1998', eventually the Parliament also passed the Indian Federal Legislation – 'Uttar Pradesh Reorganisation Act 2000', and thus on 9 November 2000, Haridwar became part of the newly formed Uttarakhand (then Uttaranchal), the 27th state in the Republic of India. As of 2011, it is the most populous district of Uttarakhand. Important towns in the district are: Haridwar, BHEL Ranipur, Roorkee, Manglaur, Dhandera, Jhabrera, Laksar, Landhaura and Mohanpur , Mohammadpur.

The climate of Haridwar is noticeably affected by its closeness to the Himalayan ranges particularly the dipping mercury in winter months is a effect of this. The summer months are really hot with the mercury rising to a high of 41^0 C and the winters are totally cold with the mercury dipping to a low approx 4^0 C.

The summer season is from April to June or mid July. The winter season lasts from October to February. And the monsoon season lasts from the month of July to September.

4 Analysis:

4.1 Description of Time Series Under Study:

The following data of Table (1), represents the monthly time series of infant deaths in Haridwar district of Uttarakhand during the period 2008-2013.

Table (1): The Infant Deaths in Haridwar from 2008-2013

	Jan	Feb	Mar	April	May	Jun	July	Aug	Sep	Oct	Nov	Dec
2008	0	32	0	5	27	0	0	0	0	70	2	2
2009	1	2	0	0	4	0	1	1	1	2	2	1
2010	4	6	3	1	1	5	3	5	6	2	1	3
2011	0	0	1	0	6	1	0	8	0	6	12	1
2012	0	0	0	14	14	27	3	0	30	34	6	0
2013	2	4	12	12	18	0	14	18	8	2	0	8

By examining this data we illustrate the following; Data variable is the infant monthly mortality, number of observations is 72 months starting at 1/2008 and finishing at 12/2013.

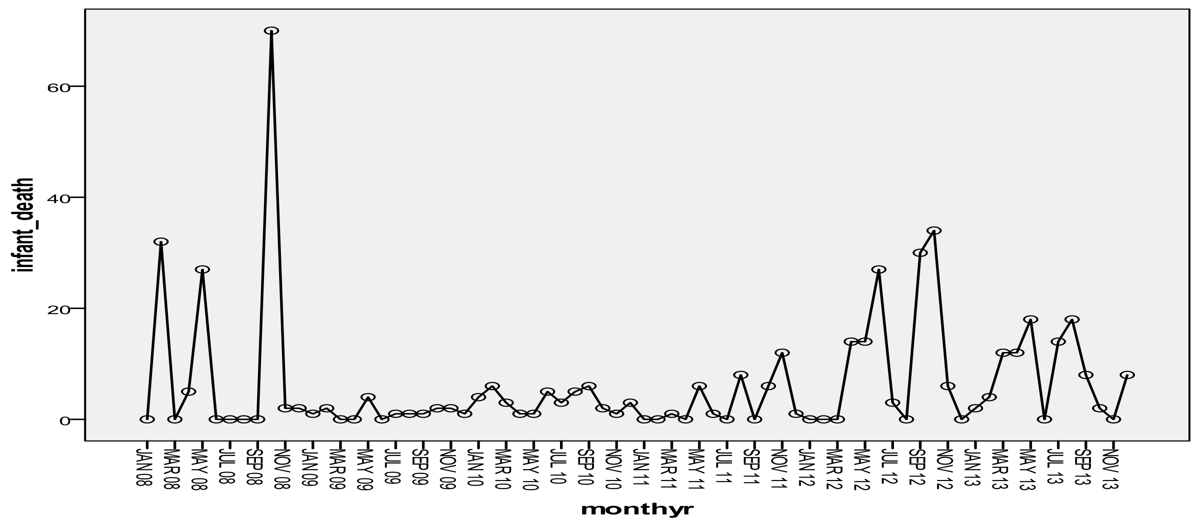


Fig. 4: Time Series Plot for Monthly Infant Mortality in Haridwar from 2008 to 2013

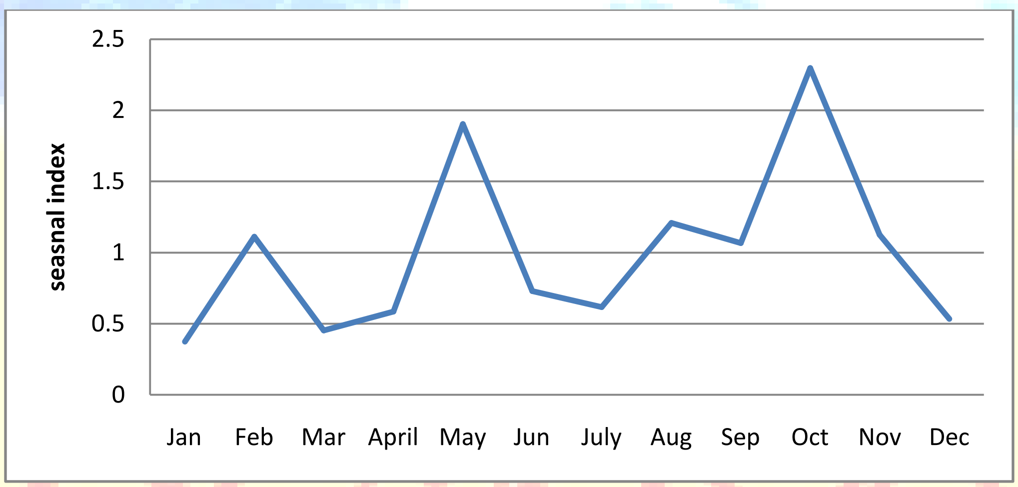


Fig. 5: Seasonal Index for Monthly Infant Mortality from 2008-2013

On analyzing the study data according to the figures (4) and (5), the presence of seasonal effect can be seen, which culminates in winters in the month of October followed by May in summers. The infant mortality can be differentiated in two parts: first being the neonatal and post- neonatal infant mortality. Hence, the study further comprises of studying the both neonatal and post neo-natal infant mortality separately. The neonatal mortality can be defined as the number of neonates dying before reaching 28 days of age, per 1,000 live births in a given year. On the other hand, post- neonatal mortality is defined as the infants dying before reaching the age one, per 1000 live births in a given year.

4.2 Neo- Natal Infant Mortality

From fig. 6, we note that the neonatal mortality culminates in the month of October followed by May and February.

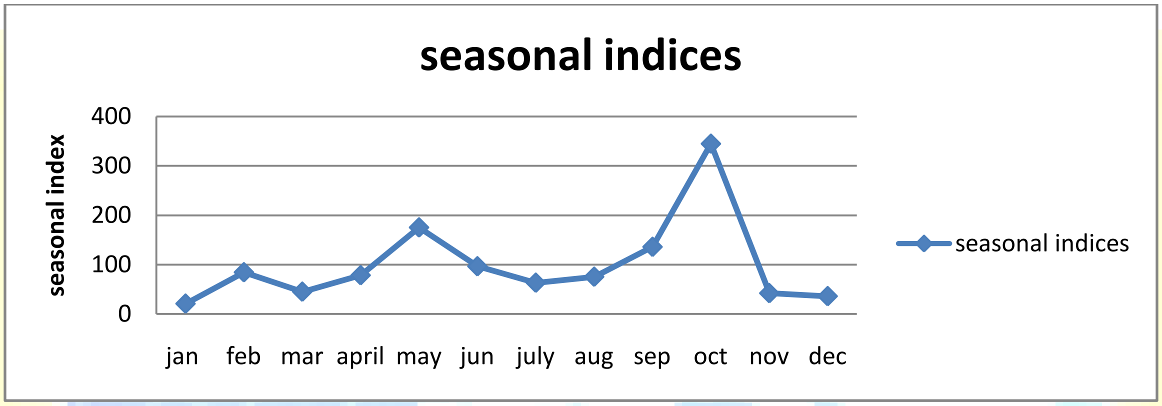


Fig. 6: Seasonal Index for Monthly Neonatal Infant Mortality in Haridwar from 2008 to 2013

The following table 2, shows value of estimated autocorrelations between values of monthly mortality at various lags. The autocorrelation co-efficient at lag k, measures the correlation between values of monthly mortality at time t and t- k. Also, are shown 95% probability limits. In this case, none of the 24 autocorrelations co-efficient are statistically significant, implying that the time series may well be completely random (white noise).

Table (2): Estimated Autocorrelation for Monthly Mortality

			Lower 95.0%	Upper 95.0%
Lag	Autocorrelation	Stnd. Error	Prob. Limit	Prob. Limit
1	0.0794012	0.117851	-0.230984	0.230984
2	-0.0719237	0.118592	-0.232436	0.232436
3	0.0229693	0.119196	-0.233621	0.233621
4	0.0544186	0.119258	-0.233741	0.233741
5	0.228267	0.119602	-0.234416	0.234416

6	0.00651712	0.125507	-0.24599	0.24599
7	0.0045308	0.125512	-0.245999	0.245999
8	0.0898842	0.125514	-0.246003	0.246003
9	-0.0496458	0.126405	-0.247749	0.247749
10	0.0863118	0.126675	-0.24828	0.24828
11	0.101528	0.12749	-0.249875	0.249875
12	-0.0116203	0.128608	-0.252067	0.252067
13	-0.0312243	0.128622	-0.252095	0.252095
14	-0.0118844	0.128727	-0.252302	0.252302
15	0.0168234	0.128743	-0.252331	0.252331
16	-0.0308863	0.128773	-0.252391	0.252391
17	-0.0529676	0.128876	-0.252593	0.252593
18	-0.0702674	0.129178	-0.253185	0.253185
19	-0.058644	0.129708	-0.254223	0.254223
20	-0.00865707	0.130076	-0.254944	0.254944
21	0.00203626	0.130084	-0.25496	0.25496
22	-0.0206539	0.130084	-0.25496	0.25496
23	-0.0167032	0.13013	-0.25505	0.25505
24	-0.055198	0.130159	-0.255108	0.255108

The estimated autocorrelation can be plotted in the fig.7 as given below.

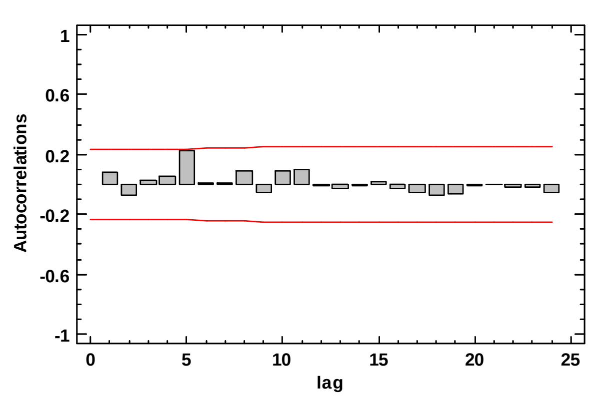


Fig. 7: Estimated Autocorrelation for Monthly Mortality

4.3 Post Neo-Natal Infant Mortality

From fig. 8, we note that the post neonatal mortality culminates in the month of February in followed by May, November and August.

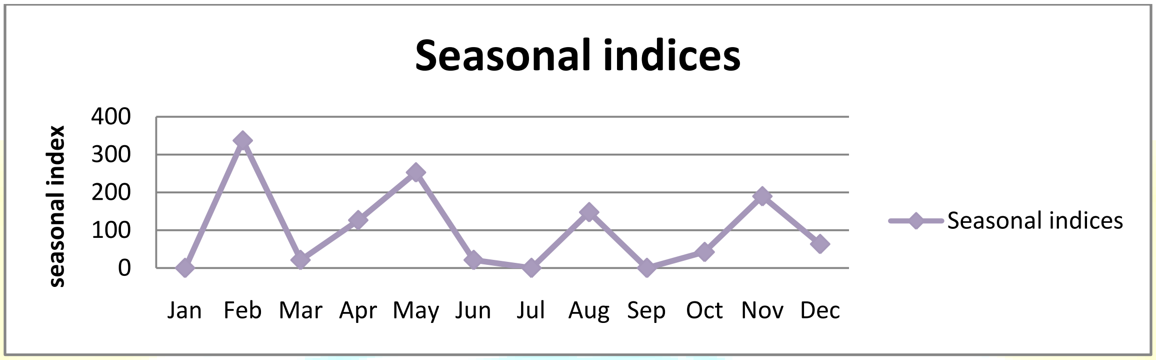


Fig. 8: Seasonal Index for Monthly Neonatal Infant Mortality in Haridwar from 2008 to 2013

The following table (3), shows value of estimated autocorrelations between values of monthly mortality at various lags. The autocorrelation co-efficient at lag k, measures the correlation between values of monthly mortality at time t and t- k. Also, are shown 95% probability limits. In this case, one of the 24 autocorrelations co-efficient are statistically significant, implying that the time series may not be completely random (white noise).

Table (3): Estimated Autocorrelation for Monthly Mortality

			Lower 95.0%	Upper 95.0%
Lag	Autocorrelation	Stnd. Error	Prob. Limit	Prob. Limit
1	-0.00905549	0.117851	-0.230984	0.230984
2	0.157674	0.117861	-0.231003	0.231003
3	0.30699	0.120755	-0.236676	0.236676
4	-0.0934001	0.131147	-0.257044	0.257044
5	-0.0370504	0.132068	-0.258849	0.258849
6	0.118847	0.132212	-0.259132	0.259132
7	0.0246412	0.133688	-0.262024	0.262024
8	0.00283377	0.133751	-0.262147	0.262147

9	0.0501337	0.133752	-0.262149	0.262149
10	0.0217446	0.134012	-0.26266	0.26266
11	-0.0804139	0.134061	-0.262756	0.262756
12	-0.0476484	0.13473	-0.264066	0.264066
13	-0.0332568	0.134963	-0.264524	0.264524
14	-0.0748092	0.135077	-0.264747	0.264747
15	0.0350165	0.135651	-0.265872	0.265872
16	-0.0591892	0.135777	-0.266118	0.266118
17	-0.104032	0.136135	-0.26682	0.26682
18	-0.0304059	0.137235	-0.268975	0.268975
19	-0.0917032	0.137328	-0.269159	0.269159
20	-0.101033	0.138176	-0.27082	0.27082
21	0.0351193	0.139198	-0.272824	0.272824
22	-0.0525047	0.139321	-0.273065	0.273065
23	-0.0808938	0.139596	-0.273603	0.273603
24	0.0486768	0.140245	-0.274876	0.274876

The estimated autocorrelation can be plotted in the fig. 9

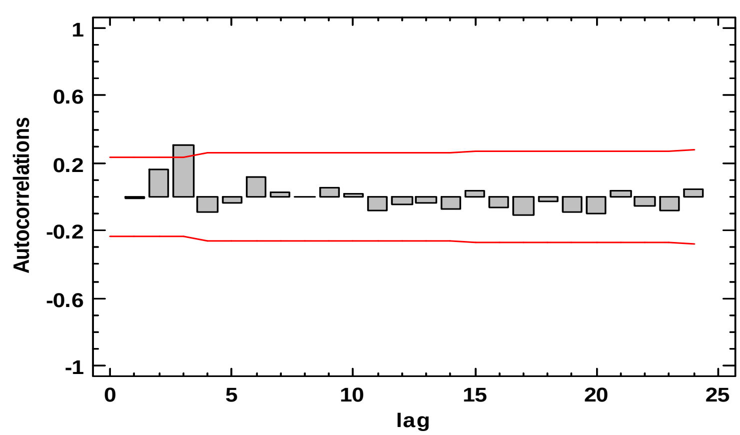


Fig. 9: Estimated Autocorrelation for Monthly Mortality

4.4 Poisson Regression

A Poisson Regression model was fitted to the available data for the overall infant mortality in order to examine the seasonal impact on the risk of infant death during the period of study. The table summarizes the maximum likelihood estimates of the parameters in the model. All the co-efficient for the variables are estimated relative to a selected reference month September. The result of the estimated model indicates that as compared to the reference month September, the mean incidence death was high for the months October and May. Thus, there was statistically significant infant mortality in the months October and May relative to the reference month.

Table 4: Parameter Estimate Table

Parameter	B	Std. error	Exp (B)	95% Wald Confidence Interval for Exp(B)	
				Lower	Upper
Intercept	3.807	.1491	45.000	33.599	60.270
jan	-1.861	.4063	.156	.070	.345
feb	-.022	.2120	.978	.645	1.482
mar	-1.034	.2911	.356	.201	.629
april	-.341	.2312	.711	.452	1.119
may	.442	.1911	1.556	1.070	2.262
june	-.310	.2292	.733	.468	1.149
july	-.762	.2643	.467	.278	.783
aug	-.341	.2312	.711	.452	1.119
oct	.947	.1756	2.578	1.827	3.637
nov	-.671	.2563	.511	.309	.845
dec	-1.099	.2981	.333	.186	.598
sept	0	.	1	.	.

5. Conclusion

Infant mortality is one of the essential indicators of measuring the socio-economic well being of a society. It directly measures the results of distribution and use of resources. The study demonstrated the importance of considering seasonal impact on neonatal and post-neonatal mortality separately. The neonatal mortality has a propensity to rise in the months from October followed by May and February, while the post- neonatal has a propensity to rise in the month of February followed by May and November. The paper seeks to explore the application of Poisson regression model in the study of seasonal variation of infant deaths in the Haridwar district of Uttarakhand. The study includes a period of 6 years, with a total of 454 infant deaths recorded from the year 2006- 2013.

In the paper a Poisson regression model was estimated for the period from 2006-2013. The results show that as compared to the reference month September the incidence of infant death is high for the month October and May.

In the study the importance of considering seasonal impacts on infant mortality was demonstrated. The study also revealed the target months for which consideration of seasonality seems particularly crucial. The policy makers must consider the effect if seasons on infant mortality as children in their first years of life are more susceptible towards environmental conditions.

Understanding the causes of infant deaths is important for assessing the health needs and addressing health disparities and for formulating effective strategies to improve the health of infants

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