Original Article

Effect of Seasonal Variations on Infant Mortality Rate of Some Selected Districts of Jammu Division

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Abstract

Background: The infant and child mortality rates are considered as sensitive indicators of living and socioeconomic conditions of a country. The infant mortality rate is regarded as most of the revealing measures of how well a society is meeting the needs of its people. **Objective:** The purpose of the study is to determine the effect of seasonal variations on the infant mortality in some selected districts of Jammu Division, J&K. **Methodology:** In the present study, infant mortality data were collected for the 6 consecutive years (2013–2018) from different health centers of four districts of Jammu Division and Jammu Municipal Corporation (JMC), J&K. The seasonal variations of overall infant deaths were analyzed using the monthly mortality data collected for the study period. Poisson regression model was employed to measure the seasonal effects on the overall infant deaths. Data analysis was done using software IBM SPSS 24.0. **Results:** In this study, a total of 4443 infant deaths were recorded from selected districts of Jammu Division, J&K, from the year 2013–2018. The prevalence of infant deaths was extremely high in the month of January as compared to the reference month June. Furthermore, the parameter estimates for each of the months along with 95% Wald confidence interval were calculated. **Conclusions:** The present study concludes that seasonal variations significantly affect the infant mortality in Jammu Division, J&K, India. The policymakers must consider the effect of seasons on infant mortality as children in their 1st year of life are more susceptible toward environmental conditions.

Keywords: Autocorrelation, infant mortality, negative binomial regression, Poisson regression, seasonal index

Introduction

Infant mortality is an important indicator of the health of a nation as it is associated with a variety of factors such as maternal health, quality and access to medical care, socioeconomic conditions, and public health practices. The infant mortality rate (IMR) is regarded as one of the most revealing measures of how well a society is meeting the needs of its people.[1] Child mortality is a critical indicator of social and economic progress as well as of a country commitment toward child health and development. Child mortality must be regularly monitored in order to design policies for bringing about improvements in child survival, focusing specifically on the poorest and marginalized social groups.[2]

The IMR is the number of deaths under 1 year of age occurring among the live births in a given geographical area during a given year per 1000 live births occurring among the population of the given geographical area during the same year.

The mortality rate of infants is generally higher than that of other age groups due to the fact that the immature state of infant organs causes infants to have a low adaptation level to the external environment. It has long been recognized that mortality risks are higher during early years of life than others.[3] Seasonality of mortality of diseases is a well-known phenomenon in many regions and countries worldwide. There is high proportion of infant deaths that occur within a couple of weeks after birth; the degree of the influence of monthly fluctuations of births on monthly fluctuations in the number of infant deaths can be significant if births follow a marked seasonal pattern.[4]

India has experienced an impressive decline in IMR since 1971. During the early period of 1971, the level of IMR is 129 infant

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deaths per thousand live births and has declined to 33 infant deaths per thousand live births in the year 2017. In the last 10 years, IMR has witnessed a decline of 36.7% in rural areas and 36% in urban areas. The IMR has declined from 53 to 33 from the year 2008–2017, the corresponding decline in IMR in rural areas from 58 to 37, and for urban areas, it is from 36 to 23. Despite the decline in IMR over the last one decade, one in every 30 infants die at the national level and one in every 27 infants in rural areas and one in every 43 infants in urban areas still die within 1 year of life.[5]

A variety of statistical techniques had been used to examine the seasonal pattern of health events. Periodic changes in the weather conditions are wellrecognized risk factors for seasonal mortality incensement at places where extreme weather conditions can be the cause of hundreds of death.[6] The reduction in infant and child mortality was declared as the major goal of our official strategy to achieve health for all. The study of seasonal effects of infant mortality will help the policymakers, officials, and decision-makers to reduce the rate of infant mortality by implementing appropriate measures and efforts in the months of high infant mortality.[7] In this paper, we present the analysis of seasonal variations of monthly infant mortality data for 6 consecutive years from some selected districts of Jammu Division during the study period.

Methodology

In this study, the infant mortality data were collected for the 6 consecutive years from 2013 to 2018. Out of the ten districts of Jammu Division, UT J&K, India, four districts, namely Jammu, Kathua, Samba, and Udhampur, were randomly selected as the study area for the conduction of our study. In this study, we totally relied upon the secondary data which were collected from the district hospitals, subdistrict hospitals, primary health centers, community health centers, and Municipal Corporation of Jammu Division. Data were entered using Excel spreadsheets, and the acquired results were processed using Software IBM SPSS version 24.0 (Statistical Package for the Social Sciences Inc., Chicago, USA). For the study of seasonal movement, monthly mortality data were used and the indices of seasonal variations were estimated by the method of simple averages for infant mortality. Furthermore, the estimated autocorrelation between the months at 95% confidence level for the randomness of time series was calculated. Poisson regression model and negative binomial regression model were employed to measure the seasonal effects on the overall infant deaths. The probability value <5% was used as level of significance.

Results

Description of time series under study

In our study, 4443 registered infant mortality cases were considered for determining the mortality pattern for the study period 2013–2018 starting from January 2013 and ending at December 2018. Table 1 shows the monthly mortality data of infants of selected districts, namely, Jammu, Kathua, Samba, and Udhampur of Jammu Division, UT J&K, during the study period. Out of the total 4443 infant deaths, 790 infant deaths occurred in the year 2013, followed by 682 in 2014, 756 in 2015, 634 in 2016, 751 in 2017, and the other 830 infant deaths had occurred in the year 2018, respectively.

Figures 1 and 2 present the graphical view of infant mortality data. It was clearly observed that there was a presence of seasonal effects, which culminates in winters in the month of January, followed by infant mortality in the months of March and October. The month of April showed a decline in infant mortality.

Table 2 shows the estimated autocorrelation for infant mortality data. It indicates the value of estimated autocorrelations between values of monthly mortality at various lags. The autocorrelation coefficient at lag k measures the correlation between values of monthly mortality at time t and t-k. In this study, we observed that none of the 16 autocorrelations are statistically significant as $P > 0.05$ in all the cases. Hence, we can say that the time series was completely random (white noise). The estimated autocorrelation is plotted in Figure 3.

Poisson regression

The generalized linear model form of regression analysis used to model count data and contingency tables was the Poisson regression model. This model assumes that the dependent variable has a Poisson distribution. The Poisson regression model was represented in mathematical form as:

$$\text{Log}(\lambda_i) = \beta_0 + \beta_1 X_i$$

where the dependent variable follows Poisson distribution with mean $\lambda = \lambda_i$. An important characteristic of Poisson distribution was that its mean was equal to the variance. However, in

Table 1: The infant deaths in Jammu Division from 2013-2018

Year	Month												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2013	91	65	74	25	66	51	84	75	35	86	61	77	790
2014	72	45	57	38	73	52	34	67	83	52	69	40	682
2015	79	46	43	56	45	112	66	74	44	70	37	84	756
2016	65	38	65	58	46	56	27	43	25	89	69	53	634
2017	93	61	78	54	65	41	45	55	59	56	88	56	751
2018	87	58	98	44	75	86	73	57	33	59	76	84	830

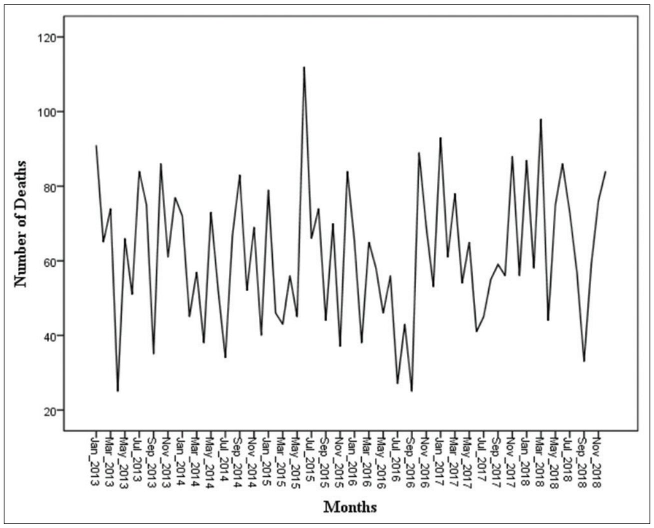

Figure 1: Time series plot for monthly infant mortality from 2013 to 2018

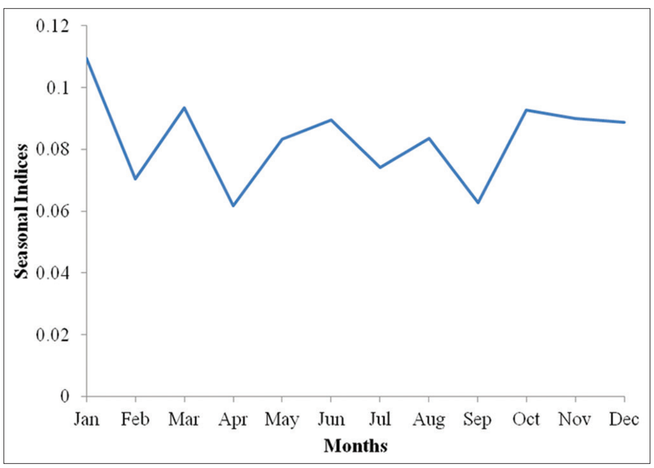

Figure 2: Seasonal indices for monthly infant mortality data from 2013 to 2018

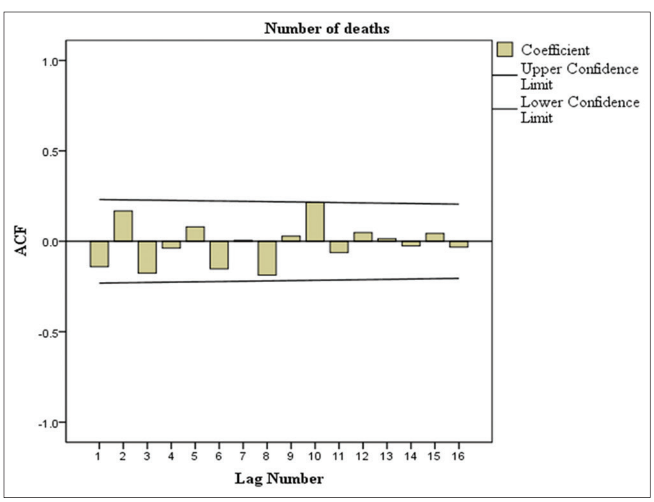

Figure 3: Estimated autocorrelation for monthly mortality

some situations, it was found that variance was greater than the mean; this situation was known as overdispersion. This problem of overdispersion was solved using quasi-likelihood estimation or negative binomial distribution.Table 3 contains the negative binomial regression coefficients for the predictor variable along with their standard error values, Wald's Chisquare, and 95% confidence intervals for the coefficients. The negative binomial regression coefficient for the month of January was ($\beta = 0.202$, $P = 0.017$) which means that the mean incidence death was extremely high in the month of January with respect to the reference month June. Furthermore, there was slightly low significant infant mortality in the months of March and October with respect to the reference month June as their negative binomial regression coefficients were $\beta = 0.042$ ($P = 0.026$) and $\beta = 0.035$ ($P = 0.019$), respectively. The negative binomial regression coefficients for the month of November ($\beta = 0.005$, $P = 0.037$) were really small. Hence, we can say that the mean incidence of deaths for the month of November was approximately the same as that of the reference month June.

Table 2: Estimated autocorrelation for monthly mortality data

Lag	Autocorrelation	SE	Box-Ljung Statistic		
			Value	df	Significant value (*P*)
1	−0.140	0.115	1.479	1	0.224
2	0.168	0.115	3.631	2	0.163
3	−0.176	0.114	6.021	3	0.111
4	−0.038	0.113	6.133	4	0.189
5	0.080	0.112	6.640	5	0.249
6	−0.152	0.111	8.504	6	0.203
7	0.005	0.110	8.506	7	0.290
8	−0.187	0.110	11.415	8	0.179
9	0.028	0.109	11.482	9	0.244
10	0.215	0.108	15.442	10	0.117
11	−0.062	0.107	15.776	11	0.150
12	0.048	0.106	15.984	12	0.192
13	0.015	0.105	16.004	13	0.249
14	−0.025	0.104	16.063	14	0.310
15	0.044	0.103	16.243	15	0.366
16	−0.032	0.103	16.339	16	0.430

SE: Standard error

Discussion

Infant mortality was one of the essential indicators of measuring the socioeconomic well-being of a society. It directly measures the results of distribution and use of resources. The present study seeks to explore the application of Poisson regression model and negative binomial regression model in the study of seasonal variations on infant deaths in the Jammu Division of J&K. The infant mortality had a propensity to rise in the months from January, followed by March and October. The results showed that as compared to the reference month June, the incidence of infant deaths is extremely high for the month of January. However, the mean incidence of deaths was slightly high for the month of March and October as compared to the reference month. Similar findings were reported in the study

Table 3: Parameter estimate table

Parameter (month)	B	SE	Exp (B)	95% Wald CI for Exp (B)		Hypothesis test		
				Lower	Upper	Wald χ^2	df	Significant
Intercept	5.986	1.0013	398.000	55.926	2832.392	35.748	1	0.000
January	0.202	1.4158	1.224	0.076	19.625	0.020	1	0.017
February	−0.240	1.4162	0.786	0.049	12.623	0.029	1	0.871
March	0.042	1.4160	1.043	0.065	16.727	0.001	1	0.026
April	−0.370	1.4164	0.691	0.043	11.094	0.068	1	0.847
May	−0.073	1.4161	0.930	0.058	14.917	0.003	1	0.429
July	−0.190	1.4162	0.827	0.052	13.267	0.018	1	0.893
August	−0.070	1.4161	0.932	0.058	14.957	0.002	1	0.899
September	−0.355	1.4164	0.701	0.044	11.255	0.063	1	0.966
October	0.035	1.4160	1.035	0.065	16.607	0.001	1	0.019
November	0.005	1.4160	1.005	0.063	16.124	0.000	1	0.037
December	−0.010	1.4160	0.990	0.062	15.882	0.000	1	0.746
June	0	.	1	.	.	.	.	.

CI: Confidence interval, SE: Standard error

conducted by Deb *et al*.,[8] in which most of the infant deaths occurred during the winter season of January to March. Rawat and Belwal[7] conducted a study in Haridwar, Uttarakhand, in which they reported that the mean incidence of infant mortality is greater in the month of February and October, followed by the month of May and soon.[7] Similar findings were seen in the studies in rural Guinea-Bissau conducted by Nielsen *et al*.[9] where the infant mortality is greater in the winter season, followed by the summer season. Our findings were in contrast to a study conducted by Guimarães Netto Dias in Salvador, Brazil,[10] where the infant mortality curves tend to rise from March to July. This is perhaps due to the poor sanitation conditions, a factor that is likely to worsen in the winter months characterized by the highest rainfall.

Conclusion

In the present study, the importance of considering seasonal effect impact on infant mortality was demonstrated. The study also revealed the target months for which consideration of seasonality seems particularly crucial. The policymakers must consider the effect of seasons on infant mortality as children in their 1st year of life were more susceptible toward environmental conditions. Understanding the causes of infant deaths was important for assessing the health needs and addressing health disparities and for formulating effective strategies to improve the health of infants.

Limitations

Our study has several limitations because it was based on the secondary data collected from various hospital records, public health centers, and Jammu Municipal Corporation, Jammu, where factors such as postnatal health of mother and place of birth were not recorded properly. Furthermore, factors such as cause of death, geographical conditions of a place, and socioeconomic factors which were responsible for infant mortality were not included in this study.

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Conflicts of interest

There are no conflicts of interest.

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