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Seasonal Variation On Infant Mortality: A Study Based On Pauri Garhwal, Uttarakhand

Nidhi Gairola* • O.K. Belwal

Department of Statistics, H.N.B. Garhwal University, Srinagar-Garhwal (UK) India

*Corresponding author: nidi123gairola@gmail.com

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Abstract: Infant mortality is a key indicator of national health, as it is linked to many factors such as maternal health, quality of life and access to health care facilities, economic conditions, and public health systems. The infant mortality rate (IMR), expressed as the rate per 1000 children born within a year and die before reaching the age of one, has been the subject of many studies and public policies. Uttarakhand's infant mortality rate was decreased 42 to, 40 and 39.1as per NFHS-3 (2005-06), NFHS-4 (2015-16) and NFHS-5 (2020-21) respectively. Infant mortality is considered to be the best indicator of how a society meets the needs of its people. The purpose of this study was to determine the effect of seasonal changes on infant mortality in selected areas in Pauri Garhwal (Uttarakhand). In this study, infant mortality data was collected for six consecutive years (2017-2022) from various health centres in Pauri Garhwal Nagar Palika. Seasonal variation in total infant mortality was analysed using monthly mortality data collected during the study period. Regression models are used to measure seasonal effects on total infant mortality. Data analysis was performed using SPSS software. The frequency of infant deaths in winter month December was very high compared to other seasons. The majority of infant deaths were reported due to cold weather in this study area, especially in November and December. This study concludes that seasonal differences significantly affect infant mortality in Pauri-Garhwal, Uttarakhand, India. Because children are most sensitive to environmental conditions in the first year of life, policy makers should consider the effect of seasonality on infant mortality.

Keywords: Autocorrelation • Infant Mortality • Poisson regression • Seasonal Index • Socio-economic

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 considered one of the clearest indicators of how well a society meets the needs of its population (Newland, 1981). Infant mortality rates are considered sensitive indicators of a country's living and socio-economic conditions. Also, it is a critical indicator of social and economic progress as well as of a country's commitment towards child health and development. Infant 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 (Ministry of Home Affairs, 2014). 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 (Knodel, 1983).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 (Schofield and Wrigley, 1979).

India has experienced an impressive decline in IMR since 1971. During the early period of 1971, the level of IMR was 129 infant deaths per thousand live births and has declined to 33 infant deaths per thousand live births in the year 2017. During 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 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 (SRS, 2017).

A variety of statistical techniques have been used to examine the seasonal pattern of health events. Periodic changes in the weather conditions are well recognized risk factors for seasonal mortality incensement at places where extreme weather conditions can be the cause of hundreds of deaths (Marie et al., 2008). The reduction in infant 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 (Rawat and Belwal, 2016).

The Infant mortality rate, which is a vital part of total deaths, can be calculated for both sexes separately, which increases its accuracy. Besides this, there is some basic limitations of calculation. Thus, it is always necessary to include both in their most accurate and adjusted form. The level of infant mortality in India shows stagnation after independence (Saikira et al., 2010). The target of reducing the infant mortality rate across the country has been achieved. Reduction in infant mortality rate is an indicator of success of MCH services and key to success of family planning programmes. Decline in infant mortality is an indicator of improvement in medical care and socio-economic conditions. In general, children of today are tomorrow’s citizens. The National Health Policy of 1982 was formulated and issued by the Ministry of Health and Family Welfare, Govt. of India with the objective of strengthening the health system in India. India is facing serious challenges in supply of healthcare resources. Kerala has occupied the top slot in terms of health performance among large states, followed by Andhra Pradesh and Maharashtra, whereas Uttar Pradesh and Bihar remained at the bottom, according to the Niti Aayog's second round of Health Index. Uttarakhand was placed at 15th position for 2019-20 in annual health index. The health index compared to rural areas; urban areas are well catered in health services. Even the health problems of urban areas are not less than that of rural areas.

In this paper, we have presented the analysis of seasonal variations of monthly infant mortality data for 6 consecutive years from some selected area of Pauri-Garhwal during the study period.The statistical analysis has been done on the basis of 518 infants death recorded during study period; the poison regression model and negative binomial regression model was utilized to find out relation between IMR and seasonal variation.

Material and Methods

Study Area and Study Period: The present study was focused on a randomly selected area of the district Pauri-Garhwal. The infant mortality data was collected from the district hospital, sub-district hospital, primary health centre (PHC), and community health centre (CHC) for the period of 2017-2022.

Statistical Analysis: Data was entered using Excel spreadsheets, and the acquired results were processed using Software IBM SPSS version 28.0 (Statistical Package for the Social Sciences Inc). 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 auto correlation 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 of<5% was used as the level of significance.

Results and Discussion

In our study, 518 registered infant mortality cases were considered to determine the mortality pattern for the study period 2017–2022, starting from January 2017 and ending in December 2022. Table 1 shows the monthly mortality data of infants of Pauri District during the study period. Out of the total 518 infant deaths, 71 infant deaths occurred in the year 2017, followed by 88 in 2018, 77 in 2019, 33 in 2020, 109 in 2021 and the other 140 infant deaths occurred in the year 2022, respectively.

Figures 1and 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 December, followed by infant mortality in the months of August and November. The month of May showed very less infant mortality. In this area, winters are very cold in November & December. The disease effect on infant mortality was studied and observed that death under 24 hrs due to too cold contributes ~20%, the diseases like sepsis, pneumonia, and extreme fever contribute ~20% while diarrhoea and asphyxia contribute on ~19% and in majorly infant deaths (40%), the reason was not knowndespite that these were reported in winter season. The infant death and disease correlation indicate the majorly death seems due in cold weather conditions in the study area.

Table 1. Infant (0-12 months) deaths Recorded in Pauri Division from 2017-2022

Year	**Month**												
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Total**
2017	0	0	0	9	2	0	8	9	13	6	12	12	71
2018	5	6	9	5	6	5	6	11	6	11	3	15	88
2019	11	10	9	10	4	6	9	1	4	5	4	4	77
2020	2	2	4	1	3	1	1	6	3	3	4	3	33
2021	2	0	2	9	9	19	10	18	9	10	12	9	109
2022	21	12	16	8	5	4	13	8	13	13	14	13	140
Total	41	30	40	42	29	35	47	53	48	48	49	56	518

Table 2. Reason of Infant death

S.No.	Reason	Number of deaths reported
A	**Low Ambient Temperature**	
	Within 24 hrs	105
	Sepsis	66
	Pneumonia	24
	Total A	**195**
B	**Due to hot & humid conditions**	
	Diarrhoea	2
	Asphyxia	96
	Total B	**98**
C	**Other conditions**	
	Extreme fever (febrile seizures)	17
	Unknown/Others	208
	Total C	**225**
	Grand Total (A+B+C)	**518**

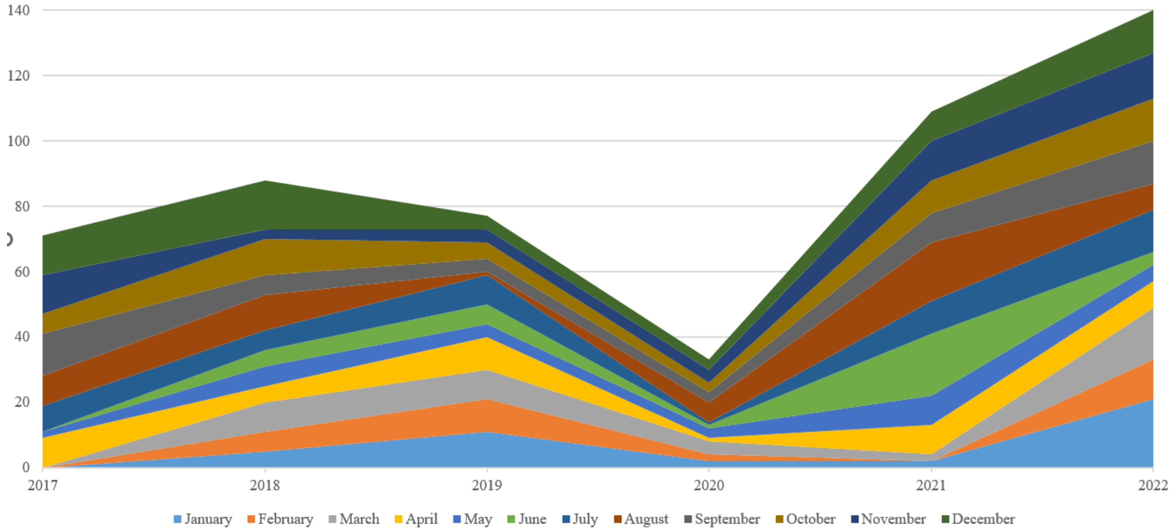

Figure 1: Infant deaths recorded for six consecutive years (month wise) from 2017 to 2022

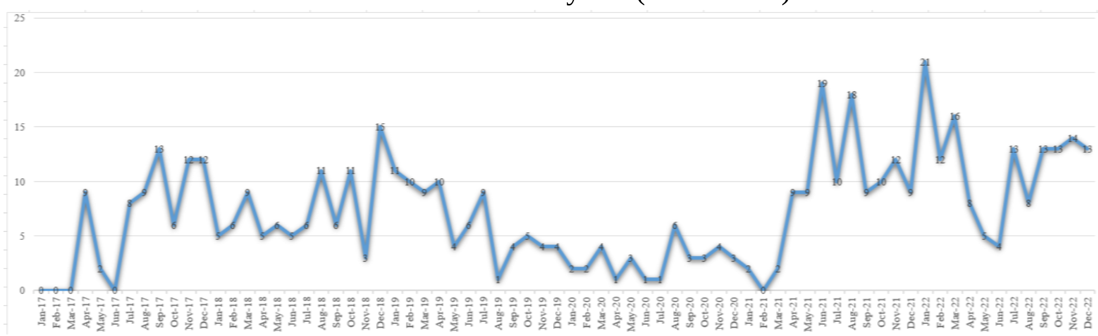

Figure 2. Seasonal variation (month wise) infant mortality for Jan 2017 to Dec. 2022

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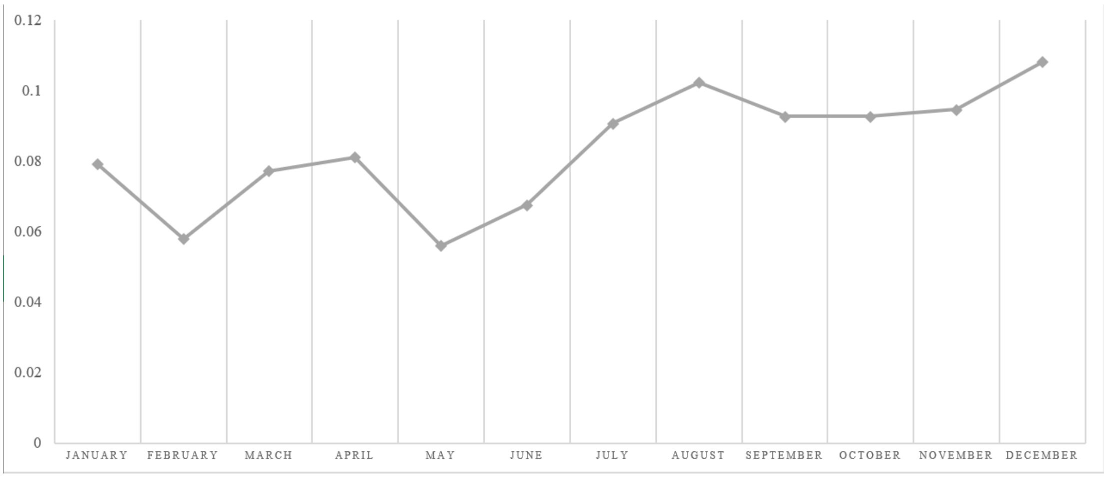

Figure 3. Seasonal indices for monthly infant mortality data from 2017 to 2022

Table 3 shows the estimated auto-correlation for infant mortality data. It indicates the value of estimated auto-correlations between values of monthly mortality at various lags. The auto-correlation 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 auto-correlations 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 auto-correlation is plotted in Figure 3. The figure 4 represents the correlation between disease and the number of infant deaths.

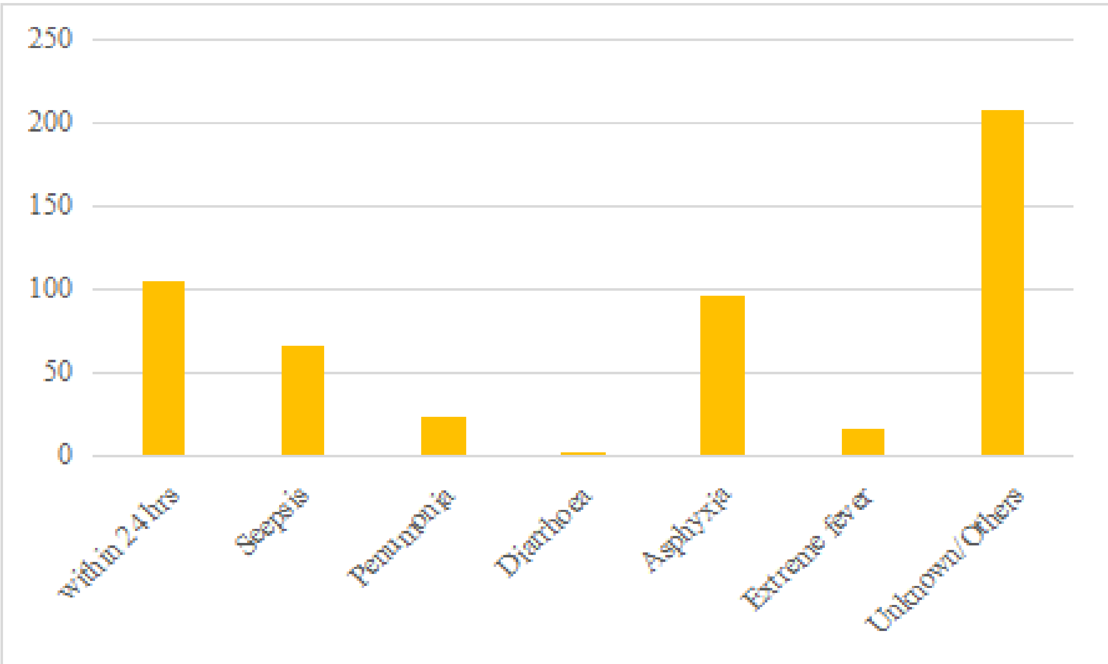

Figure 4. Correlation of disease/symptoms and infant deaths during study period

Table 3. Estimated autocorrelation for monthly mortality data

Lag	**Autocorrelation**	**SE**	**Box-Ljung Statistic**		
			Value	**df**	**Significant value (P)**
1	−0.141	0.115	1.478	1	0.223
2	0.163	0.115	3.632	2	0.164
3	−0.171	0.114	6.022	3	0.112
4	−0.037	0.113	6.132	4	0.188
5	0.081	0.112	6.641	5	0.248
6	−0.151	0.111	8.503	6	0.204
7	0.004	0.110	8.503	7	0.291
8	−0.185	0.110	11.412	8	0.178
9	0.024	0.109	11.484	9	0.245
10	0.211	0.108	15.441	10	0.118
11	−0.060	0.107	15.774	11	0.151
12	0.049	0.106	15.981	12	0.193
13	0.017	0.105	16.001	13	0.248
14	−0.027	0.104	16.060	14	0.311
15	0.041	0.103	16.241	15	0.365
16	−0.030	0.103	16.336	16	0.431

SE: Standard error

Regression Model

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:

$\text{Log}(\lambda i) = \beta 0 + \beta 1Xi$.

where the dependent variable follows the Poisson distribution with a mean $\lambda = \lambda i$. An important characteristic of Poisson distribution was that its mean was equal to the variance. However, in some situations, it was found that variance was greater than the mean; this situation was known as over-dispersion. This problem of over-dispersion 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 Chi-square, and 95% confidence intervals for the coefficients. The negative binomial regression coefficient for the month of December was ($\beta = 0.201$, P= 0.019) which means that the mean incidence of death was extremely high in the month of December with respect to the reference month of June. Furthermore, there was slightly low significant infant mortality in the months of August and November with respect to the reference month June as their negative binomial regression coefficients were $\beta = 0.036$ (P = 0.021) and $\beta = 0.033$ (P = 0.027), respectively. The negative binomial regression coefficients for the month of May ($\beta = -0.349$, P = 0.913) were really small. Hence, we can say that the mean incidence of deaths for the month of May was approximately the same as that of the reference month, June.

Table 4. Parameter estimate table

Parameter (month)	B	SE	Exp (B)	95% Wald CI for Exp (B)		Hypothesis Test		
				Lower	Upper	Wald χ2	df	Significant
Intercept	5.883	1.0011	398.001	55.924	2832.391	35.741	1	0.000
January	−0.011	1.4161	0.991	0.063	15.883	0.000	1	0.713
February	−0.239	1.4161	0.785	0.048	12.622	0.028	1	0.865
March	0.041	1.4161	1.044	0.066	16.726	0.001	1	0.023
April	0.018	1.4162	0.692	0.044	11.093	0.067	1	0.845
May	−0.349	1.4162	0.702	0.045	11.254	0.062	1	0.913
July	−0.191	1.4162	0.826	0.053	13.264	0.017	1	0.883
August	0.036	1.4161	1.034	0.064	16.606	0.001	1	0.021
September	−0.072	1.4162	0.931	0.057	14.918	0.002	1	0.423
October	−0.071	1.4161	0.931	0.057	14.953	0.003	1	0.893
November	0.033	1.4161	1.004	0.062	16.122	0.000	1	0.027
December	0.201	1.4159	1.223	0.075	19.626	0.021	1	0.019
June	0	.	1	.	.	.	.	.

CI: Confidence interval, SE: Standard error

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 Pauri Garhwal. Infant mortality had a propensity to rise in the months from May, followed by February and June. The results showed that, as compared to the reference month June, the incidence of infant deaths is extremely high for the month of December. However, the mean incidence of deaths was slightly higher for the month of August and November as compared to the reference month. Similar findings were reported in the study conducted by Deb et al., (2017) in which most of the infant deaths occurred during the winter season from January to March. Rawat and Belwal,(2016) 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 June. Similar findings were seen in the studies in rural Guinea-Bissau conducted by Nielsen et al. (2017) where 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, (1975) 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 majorly infant death reported due to cold weather in this study area especially November and December. Policymakers must consider the effect of seasons on infant mortality as children in their first year of life are more susceptible to 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 centres of Pauri division, where factors such as post-natal 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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