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’s 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 deaths per 1000 live births. However, in recent years, there has been a significant reduction in IMR, with the current IMR being much lower.[5]

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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.[9]

A variety of statistical techniques had 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 death.[1,18]
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.[17] 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:

$\log(\lambda_i) = \beta_0 + \beta_1 X_i$

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

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

| Year | 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   |
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 Chi-square, 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 of 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 \( \beta = 0.044, P = 0.037 \) 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.

**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                  |                 |
| Intercept         | 5.986 | 1.0013 | 398.000 | 55.926-2832.392        | 35.748-1        |
| January           | 0.202 | 1.4158 | 1.224   | 0.076-19.625           | 0.020-1        |
| February          | -0.240 | 1.4162 | 0.786   | 0.049-12.623           | 0.029-1        |
| March             | 0.042 | 1.4160 | 1.043   | 0.065-16.727           | 0.001-1        |
| April             | -0.370 | 1.4164 | 0.691   | 0.043-11.094           | 0.068-1        |
| May               | -0.073 | 1.4161 | 0.930   | 0.058-14.917           | 0.003-1        |
| July              | -0.190 | 1.4162 | 0.827   | 0.052-13.267           | 0.018-1        |
| August            | -0.070 | 1.4161 | 0.932   | 0.058-14.957           | 0.002-1        |
| September         | -0.355 | 1.4164 | 0.701   | 0.044-11.255           | 0.063-1        |
| October           | 0.035 | 1.4160 | 1.035   | 0.065-16.607           | 0.001-1        |
| November          | 0.005 | 1.4160 | 1.005   | 0.063-16.124           | 0.000-1        |
| December          | -0.010 | 1.4160 | 0.990   | 0.062-15.882           | 0.000-1        |

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.

References

1. Newland K. Infant Mortality and the Health of Societies. Washington: World Watch Institute; 1981.
2. Annual Health Survey Bulletin of the year 2012-2013 by Office of Registrar General. India. Ministry of Home Affairs; 2014.
3. Knodel J. Seasonal variation in infant mortality: An approach with applications. Ann Historical Demogr 1983;1:208-30.
4. Schofield R, Wrigley EA. Infant and child mortality in England in the late Tudor and early Stuart periods. In Webster (ed.) Health, Medicine and Mortality in the Sixteenth Century. Cambridge: Cambridge University Press; 1979. p. 61-95.
5. Sample Registration System. SRS Bulletin Using the Infant Mortality Data of the Infants during the Year; 2017. Available from: http://censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS_Bulletin-Rate-2017__May_2019.pdf. [Last accessed on 2019 May 20].
6. Marie GC, Gonzalez RT, Palanco IM. Seasonal variation in mortality for five main death causes, Cuba, 19962006. Int J Epidemiol 2008;6:521-525.
7. Rawat R, Belwal OK. Seasonal variation for infant mortality: A study of Haridwar district of Uttarakhand. IJRSS 2016;6:2249-96.
8. Deb AK, Dutta S, Hnichho C, Vanlalpeki M, Phosa HT, Rakhu K, et al. A case control study investigating factors associated with high infant death in Saiha district of Mizoram, India bordering Myanmar. BMC Pediatr 2017;17:23.
9. Nielsen BU, Byberg S, Aaby P, Rodrigues A, Benn CS, Fisker AB. Seasonal variation in child mortality in rural Guinea-Bissau. Trop Med Int Health 2017;22:846-56.
10. Guimarães Netto Dias C. Seasonal variation in infant mortality rates in the City of Salvador, BA, Brazil. Rev Saude Publica 1975;9:285-94.