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Extended Abstract

Seasonality of Pneumonia Mortality among Infant children in India: A Joinpoint Analysis

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Abstract

Although there have been significant decreases over the past decade, pneumonia continue to be the primary reasons for child mortality in India, resulting in approximately 190,000 deaths in children aged 1 to 59 months in 2015. Our study focuses on examining trends of seasonal fluctuations of pneumonia mortality among infants from 2018 to 2020 in India and its major states. Our analysis is based on Health Management Information System (HMIS). The national HMIS is a web-based monitoring information system that has been established and used in all states. The infant mortality rates are calculated by dividing the total number of deaths in each population group by the total number of births in India. Joinpoint regression method is applied in our analysis. At the national level, it is seen from the trends of mortality rates that during the winter season in India i.e., from the month of October to the month of February, there is the peak in the mortality rates, and during the month of April, the mortality rates begin to decline and again started to rise from the month of August. The results from the joinpoint analysis at national level in India, shows one joinpoint in each year from 2018 to 2020. For the year 2018, the rate of change of mortality is 2.04% (AMPC -2.04 (CI -3.96, -0.02)) with an 7.23% monthly drop from January to June and 2.49 % monthly rise from June to December.

Keywords: Seasonal Mortality, Infants, Pneumonia, Joinpoint regression, HMIS, India

Introduction

Infant mortality rates are regarded as sensitive markers of a nation's socioeconomic landscape, reflecting its living conditions and economic status. India has witnessed a remarkable reduction in Infant Mortality Rate (IMR) in the past few decades, it reduced from 129 infant deaths to 28 infant deaths per thousand live births. Despite this progress, the statistics reveal that one in

every 36 infants nationally still die within the first year of life (1), this result reveals the infants vulnerability to environmental conditions (2) during their first year results in many complications including respiratory disorders, pneumonia (3).

As per the Cause of Death Statistics report of Registrar General India (2017-19), Pneumonia is one of the leading causes of under age 5 mortalities contributing to 17.5% of deaths in that age group (4). India has the world's highest burden of childhood pneumonia, accounting for over 20% deaths due to pneumonia globally (5). Utilizing subnational input data, researchers calculated that there were approximately 3.6 million cases of severe pneumonia in children under the age of 5 in India in the year 2010 (6).

Pneumonia mortality shows the pattern during the specific period of the year, which confirmed the seasonal variation of pneumonia. In India, Pneumonia mortality exhibited significant seasonal variation. Pneumonia mortality peaks were observed twice a year in July and January (7). Our study focuses on examining trends of seasonal fluctuations of pneumonia mortality among infants from 2018 to 2020 in India and its major states.

Data Source

Limited study on seasonal mortality have been done due to the limited source of data. Interestingly, the Health Management Information System (HMIS), a web-based Monitoring Information System of the Ministry of Health & Family Welfare (MoHFW), Government of India, provides monthly death data for infants. Our analysis is based on Health Management Information System (HMIS). The national HMIS is a web-based monitoring information system that has been established and used in all states. Currently, around 2.25 lakh health facilities (across all States/UTs) are uploading facility wise service delivery data on monthly basis, training data on quarterly basis and infrastructure related data on annual basis on HMIS web portal.

Research Method

The infant mortality rates are calculated by dividing the total number of deaths in each population group by the total number of births in India. We have use death rate per 100,000 live births. These rates are case-fatality rates. At state level, the major states of India including Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Kerela, Maharashtra, Madhya Pradesh, Odisha, Rajasthan and Tamil Nadu have been analyzed. We have applied Joinpoint regression technique in our analysis. Joinpoint regression methods are commonly used to summarize trends in mortality statistics like incidence or mortality rates by

modeling the rates as a function of time using piecewise linear segments on a log scale. The joinpoint regression model for the observations maybe written as: where the $\tau_k's$ are the unknown joinpoints and $a^+ = a$ for $a > 0$ and 0 otherwise.

$$E(y|t) = \beta_0 + \beta_1 t + \delta_1(t - \tau_1)^+ + \cdots + \delta_k(t - \tau_k)^+ \qquad (1)$$

The weighted BIC

The equation for computing the BIC (8) for a k joinpoint model is

$$BIC(k) = \log(SSE_k/n) + 2(k+1)\frac{\log n}{n}$$

where SSE_k is the sum of squared errors of the k-joinpoint model. The term $2(k+1)$ is the penalty coefficient. The k-joinpoint model with the minimum value of $BIC(k)$ is selected as the final model.

Monthly Percent Change (MPC): An important statistic in joinpoint trend analysis is the monthly percent change (MPC). MPC has been used to estimate the rate of change over a specific time. It is calculated by fitting a simple linear regression model to the logarithm of age-adjusted rates.

Preliminary Findings

General trends of pneumonia mortality among infants at national and state level in India.

At the national level, it is seen from the trends of mortality rates that during the winter season in India i.e., from the month of October to the month of February, there is the peak in the mortality rates, and during the month of April, the mortality rates begin to decline and again started to rise from the month of August. The result demonstrates a substantial seasonal trend of pneumonia mortality in India.

State level analysis depicts the different trends for different states. The states like Andhra Pradesh, Assam, Chhattisgarh, Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh show the similar trend as the national level in India. The southern states like Tamil Nadu, Telangana, Maharashtra, Karnataka and Odisha show the mortality peaks in the month of January and again peak in the months of August and September.

Table 1 shows the case fatality rate monthly wise for the year 2018 to 2020. The findings from the joinpoint analysis presented in **Table 2** at national level in India. At national level, one joinpoint is shown for each year in India. In 2018, a substantial **Average Monthly Percent Change (AMPC)** of **-2.04 (CI: 3.96, -0.02)** is found. The **MPC** for the same year is **-7.23**

(CI: -17.52, -2.77) from **January-June**, and **2.49 (CI: -1.08, 15.49)** from **June-December**. From the findings, it can be said that int that the rate of change in mortality for various months in **2018** is **7.23%.** The negative symbol indicates the negative change. From the period **January to June** in 2018, there is **7.23%** monthly decrease in mortality, however form **June to December**, there is **2.49%** monthly increase. For the year **2019,** the rate of change of mortality is **2.57%** with an **8.17%** monthly drop from **January to August** and **24.49 %** monthly rise from **August to December**. In **2020,** the monthly mortality rate decreased by an average of **2.37%** across the entire period. The **Monthly Percent Change (MPC)** increased by **12.84%** and **19.07%** from **January to August** and **August to December**, respectively.

Expected Findings

The findings at the national level are provided. The state level results are under process. After analyzing the state level findings, the variation in seasonal mortality due to pneumonia in various regions of India will be identified. That will provide the more accurate picture of the seasonal pattern of newborn deaths from pneumonia.

Conclusion

Our study demonstrates the need to account for seasonal impacts on infant mortality, highlighting specific months where seasonality appears to be more pronounced, with a high proportion of infants' deaths linked to cold weather, particularly from October to January. A full understanding of the factors contributing to infant mortality is critical for assessing healthcare needs, addressing health inequities, and developing effective measures to improve newborn health.

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Tables and Figure

Table 1: Case fatality rates (per 100,000 live births) monthly wise due to pneumonia among infants in India from 2018 to 2020

Month	2018	2019	2020	Mean
Jan	71.0	59.0	70.2	66.7
Feb	63.0	60.9	66.4	63.4
Mar	65.6	51.4	59.5	58.8
Apr	56.8	48.8	56.4	54.0
May	54.5	40.4	39.2	44.7
Jun	47.5	41.6	37.2	42.1
Jul	45.3	34.1	30.0	36.4
Aug	50.1	33.2	26.9	36.8
Sep	62.5	45.2	35.6	47.7
Oct	58.0	54.7	47.5	53.4
Nov	52.0	67.6	51.8	57.2
Dec	54.0	76.1	49.8	60.0

Table 2: Trends in infant mortality caused by pneumonia in India, monthly percentage change, average monthly percentage change from 2018-2020 using Joinpoint Regression Analysis

Location	Period	Change Month	MPC	AMPC	Lower CI	Upper CI
India	2018 January-June June-December	June	 -7.23** 2.49	-2.04*	-3.96 -17.52 -1.08	-0.02 -2.77 15.49
	2019 January-August August-December	August	 -8.17** 24.49*	2.57*	0.74 -11.77 16.87	4.19 -5.48 39.54
	2020 January-August August-December	August	 12.84** 19.07**	-2.37	-5.45 -20.4 6.2	0.22 -8.51 52.6

MPC = Monthly Percent Change, AMPC = Average Monthly Percent Change, CI = Confidence Interval

*Indicates that the AMPC is significantly different from zero at alpha = 0.05.

**Indicates that the MPC is significantly different from zero at alpha = 0