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**A STUDY OF INFANT MORTALITY RATE OF VARIOUS STATES OF
INDIA (2011-2016)**

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Abstract :

In today's developing India we can see commonly one thing premature birth is a biggest cause of infant mortality. Birth in terms of birth complications such as abnormal presentation of the foetus, cord and pre-matured delivery with malnutrition in babies under the age of 1.

To study these changes of death in children, IMR is calculated and rated for different states of India.

KEYWORDS:

- Infant mortality rate
- Birth
- India



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1. Introduction

Assuring public health services is the primary duty of every government and as such, the government has taken steps to maintain public health by opening health centers, hospitals, mobile hospitals, organizing mass awareness camps on health and so on.

As per the index established in 2016 by HAQ (Health care access and quality) out of total 195 countries India's rank is 145 in Health care access and quality.

This is very less as compared to the other countries. Poverty is one of the reasons for poor health. As well as education level and the level of facilities provided by government hospitals are responsible for high infant mortality.



rates.

Here, we will discuss Infant mortality rate (IMR).

2.Methodology:

$$\text{Mean} = \bar{X} = \frac{\sum x_i}{n}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$

$$\text{Coefficient of variance} = \frac{\sigma}{\bar{X}} \times 100$$

$$\text{Combined mean} = \frac{\sum n_i \bar{X}_i}{n}$$

$$\text{Combined Standard Deviation} = \sqrt{\frac{n_1(d_1^2 + s_1^2) + \dots}{n}}$$

$$\text{Z score} = \frac{\bar{X} - \mu}{\sigma}$$

Infant mortality rate (IMR)

Infant mortality is the death of young children under the age of 1. This death toll is measured by the infant mortality rate (IMR). This is the number of deaths of children under one year of age per 1000 live births.



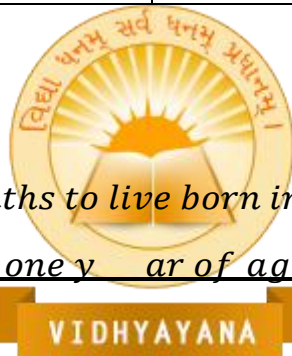
These standard score are the converted into score value on a ten point scale obtained from deciles of standard normal distribution

Standard score	Scale value	Standard score	Scale value
≤ -1.28	1	0 to 0.25	6
(-1.28) to (-0.84)	2	(0.25) to (0.52)	7
(-0.84) to (-0.52)	3	(0.52) to (0.84)	8
(-0.52) to (-0.25)	4	(0.84) to (1.28)	9
(-0.25) to 0	5	≥1.28	10

Also give the score value in scale value

Score value	Scale value
≤ (X̄ - 0.425σ)	1
(X̄ - 0.425σ) to (X̄ + 0.425σ)	2
≥ (X̄ + 0.425σ)	3

Formula to calculate:



$$IMR = \frac{\text{No. of deaths to live born infants under one year of age}}{\text{No. of births}} \times 1000$$

3.Objective

- To identify which states people are having a good health.
- To identify the difference between rural and urban area people's health in Gujarat.

4. DATA ANALYSIS

4.1.Data of Infant Mortality Rate



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STATES/UT	2011	2012	2013	2014	2015	2016
Andhra Pradesh	42.861	41.212	39.000	39.000	37.000	34.000
Arunachal Pradesh	23.242	24.495	23.870	30.000	30.000	36.000
Assam	55.423	55.493	54.000	49.000	47.000	44.000
Bihar	44.073	43.170	42.000	42.000	42.000	38.000
Chhattisgarh	48.061	46.729	46.109	43.000	41.000	39.000
Delhi	27.778	24.854	24.000	20.000	18.000	18.000
Goa	10.700	9.968	9.139	10.000	9.000	8.000
Gujarat	40.536	37.834	36.000	35.000	33.000	30.000
Haryana	44.403	42.267	41.000	36.000	36.000	33.000
Himachal Pradesh	37.513	36.174	34.540	32.000	28.000	25.000
Jammu & Kashmir	40.543	38.880	37.000	34.000	26.000	24.000
Jharkhand	37.000	38.000	37.000	34.000	32.000	29.000
Karnataka	34.519	32.059	31.000	29.000	28.000	24.000
Kerala	12.093	11.758	12.000	12.000	12.000	10.000
Madhya Pradesh	59.332	56.295	54.000	52.000	50.000	47.000
Maharashtra	24.567	25.097	24.000	22.000	21.000	19.000
Manipur	11.291	10.447	9.582	11.000	9.000	11.000
Meghalaya	51.966	49.105	47.199	46.000	42.000	39.000
Mizoram	34.247	34.922	35.031	32.000	32.000	27.000
Nagaland	20.657	18.154	17.910	14.000	12.000	12.000
Odisha	56.548	53.027	51.000	49.000	46.000	44.000
Punjab	30.348	27.655	26.000	24.000	23.000	21.000
Rajasthan	51.610	48.976	47.000	46.000	43.000	41.000
Sikkim	26.456	24.141	22.070	19.000	18.000	16.000
Tamil Nadu	21.823	21.441	21.000	20.000	19.000	17.000
Tripura	29.128	27.690	25.762	21.000	20.000	24.000
Uttar Pradesh	56.752	52.930	50.000	48.000	46.000	43.000
Uttarakhand	35.911	33.805	31.577	33.000	34.000	38.000
West Bengal	31.944	32.004	31.000	28.000	26.000	25.000
Andaman & Nicobar Islands	23.242	24.495	23.870	22.000	20.000	16.000
Chandigarh	20.004	20.337	20.907	23.000	21.000	14.000
D&N Haveli	35.193	32.886	31.344	26.000	21.000	17.000
Daman & Diu	21.811	22.357	19.861	18.000	18.000	19.000
Lakshadweep	23.732	24.242	23.582	20.000	20.000	19.000
Puducherry	18.839	16.686	16.925	14.000	11.000	10.000



4.2 Analysis of Infant Mortality Rate

STATES/UT	MEAN	S.D	d ²	S.D ²
Andhra Pradesh	38.846	3.120	75.322	9.732
Arunachal Pradesh	27.934	4.979	4.983	24.792
Assam	50.819	4.849	426.534	23.512
Bihar	41.874	2.077	137.055	4.314
Chhattisgarh	43.983	3.560	190.894	12.677
Delhi	22.105	4.037	64.984	16.294
Goa	9.468	0.952	428.440	0.907
Gujarat	35.395	3.681	27.335	13.549
Haryana	38.778	4.417	74.160	19.514
Himachal Pradesh	32.205	4.879	4.153	23.804
Jammu & Kashmir	33.404	6.892	10.479	47.499
Jharkhand	34.500	3.507	18.777	12.300
Karnataka	29.763	3.642	0.163	13.264
Kerala	11.642	0.812	343.171	0.660
Madhya Pradesh	53.104	4.425	526.139	19.576
Maharashtra	22.611	2.364	57.094	5.589
Manipur	10.387	0.911	391.249	0.829
Meghalaya	45.878	4.724	246.855	22.316
Mizoram	32.533	3.035	5.601	9.214
Nagaland	15.787	3.625	206.784	13.140
Odisha	49.929	4.605	390.556	21.202
Punjab	25.334	3.376	23.356	11.397
Rajasthan	46.264	3.871	259.138	14.983
Sikkim	20.944	3.969	85.049	15.752
Tamil Nadu	20.044	1.810	102.470	3.278
Tripura	24.597	3.630	31.027	13.175
Uttar Pradesh	49.447	4.926	371.731	24.268
Uttarakhand	34.382	2.266	17.770	5.137
West Bengal	28.991	3.088	1.381	9.538
Andaman & Nicobar Islands	21.601	3.172	73.370	10.062
Chandigarh	19.875	3.061	105.925	9.368
D&N Haveli	27.237	7.174	8.582	51.460
Daman & Diu	19.838	1.881	106.679	3.539
Lakshadweep	21.759	2.332	70.682	5.437
Puducherry	14.575	3.527	243.105	12.440



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STATES/UT	2011	2012	2013	2014	2015	2016
Andhra Pradesh	1.000	0.870	0.696	0.696	0.539	0.302
Arunachal Pradesh	-0.546	-0.447	-0.496	-0.013	-0.013	0.460
Assam	1.990	1.996	1.878	1.484	1.327	1.090
Bihar	1.096	1.025	0.933	0.933	0.933	0.617
Chhattisgarh	1.410	1.305	1.256	1.011	0.854	0.696
Delhi	-0.188	-0.419	-0.486	-0.801	-0.959	-0.959
Goa	-1.534	-1.592	-1.657	-1.589	-1.668	-1.747
Gujarat	0.817	0.604	0.460	0.381	0.223	-0.013
Haryana	1.122	0.954	0.854	0.460	0.460	0.223
Himachal Pradesh	0.579	0.473	0.345	0.144	-0.171	-0.407
Jammu & Kashmir	0.818	0.687	0.539	0.302	-0.328	-0.486
Jharkhand	0.539	0.617	0.539	0.302	0.144	-0.092
Karnataka	0.343	0.149	0.066	-0.092	-0.171	-0.486
Kerala	-1.424	-1.451	-1.432	-1.432	-1.432	-1.589
Madhya Pradesh	2.298	2.059	1.878	1.721	1.563	1.327
Maharashtra	-0.441	-0.400	-0.486	-0.644	-0.722	-0.880
Manipur	-1.488	-1.554	-1.622	-1.510	-1.668	-1.510
Meghalaya	1.718	1.492	1.342	1.248	0.933	0.696
Mizoram	0.322	0.375	0.383	0.144	0.144	-0.250
Nagaland	-0.749	-0.947	-0.966	-1.274	-1.432	-1.432
Odisha	2.079	1.802	1.642	1.484	1.248	1.090
Punjab	0.014	-0.198	-0.328	-0.486	-0.565	-0.722
Rajasthan	1.690	1.482	1.327	1.248	1.011	0.854
Sikkim	-0.292	-0.475	-0.638	-0.880	-0.959	-1.116
Tamil Nadu	-0.658	-0.688	-0.722	-0.801	-0.880	-1.038
Tripura	-0.082	-0.195	-0.347	-0.722	-0.801	-0.486
Uttar Pradesh	2.095	1.794	1.563	1.405	1.248	1.011
Uttarakhand	0.453	0.287	0.111	0.223	0.302	0.617
West Bengal	0.140	0.145	0.066	-0.171	-0.328	-0.407
Andaman & Nicobar Islands	-0.546	-0.447	-0.496	-0.644	-0.801	-1.116
Chandigarh	-0.801	-0.775	-0.730	-0.565	-0.722	-1.274
D&N Haveli	0.396	0.214	0.093	-0.328	-0.722	-1.038
Daman & Diu	-0.659	-0.615	-0.812	-0.959	-0.959	-0.880
Lakshadweep	-0.507	-0.467	-0.519	-0.801	-0.801	-0.880
Puducherry	-0.893	-1.062	-1.044	-1.274	-1.510	-1.589



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Andhra Pradesh	9	9	8	8	8	7
Arunachal Pradesh	3	4	4	5	5	7
Assam	10	10	10	10	10	9
Bihar	9	9	9	9	9	8
Chhattisgarh	10	10	9	9	9	8
Delhi	5	4	4	3	2	2
Goa	1	1	1	1	1	1
Gujarat	8	8	7	7	6	5
Haryana	9	9	9	7	7	6
Himachal Pradesh	8	7	7	6	5	4
Jammu & Kashmir	8	8	8	7	4	4
Jharkhand	8	8	8	7	6	5
Karnataka	7	6	6	5	5	4
Kerala	1	1	1	1	1	1
Madhya Pradesh	10	10	10	10	10	10
Maharashtra	4	4	3	3	3	2
Manipur	1	1	1	1	1	1
Meghalaya	10	10	10	9	9	8
Mizoram	7	7	7	6	6	5
Nagaland	3	2	2	2	1	1
Odisha	10	10	10	10	9	9
Punjab	6	5	4	4	3	3
Rajasthan	10	10	10	9	9	9
Sikkim	4	4	3	2	2	2
Tamil Nadu	3	3	3	3	2	2
Tripura	5	5	4	3	3	4
Uttar Pradesh	10	10	10	10	9	9
Uttarakhand	7	7	6	6	7	8
West Bengal	6	6	6	5	4	4
Andaman & Nicobar Islands	3	4	4	3	3	2
Chandigarh	3	3	3	3	3	2
D&N Haveli	7	6	6	4	3	2
Daman & Diu	3	3	3	2	2	2
Lakshadweep	4	4	4	3	3	2
Puducherry	2	2	2	2	1	1



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Convert into score value on a ten point

Convert score value into scale value

STATES/UT	MEAN	S.D.	d ²	S.D. ²	SCALE VALUE	C.V.
Andhra Pradesh	8.167	0.752773	7.471111	0.566667	3	9.217624
Arunachal Pradesh	4.667	1.36626	0.587778	1.866667	2	29.277
Assam	9.833	0.408248	19.36	0.166667	3	4.151678
Bihar	8.833	0.408248	11.56	0.166667	3	4.621679
Chhattisgarh	9.167	0.752773	13.93778	0.566667	3	8.212065
Delhi	3.333	1.21106	4.41	1.466667	1	36.3318
Goa	1.000	0	19.65444	0	1	0
Gujarat	6.833	1.169045	1.96	1.366667	3	17.10798
Haryana	7.833	1.32916	5.76	1.766667	3	16.968
Himachal Pradesh	6.167	1.47196	0.537778	2.166667	2	23.86962
Jammu & Kashmir	6.500	1.974842	1.137778	3.9	2	30.38218
Jharkhand	7.000	1.264911	2.454444	1.6	3	18.07016
Karnataka	5.500	1.048809	0.004444	1.1	2	19.06925
Kerala	1.000	0	19.65444	0	1	0
Madhya Pradesh	10.000	0	20.85444	0	3	0
Maharashtra	3.167	0.752773	5.137778	0.566667	1	23.77177
Manipur	1.000	0	19.65444	0	1	0
Meghalaya	9.333	0.816497	15.21	0.666667	3	8.748178
Mizoram	6.333	0.816497	0.81	0.666667	2	12.89205
Nagaland	1.833	0.752773	12.96	0.566667	1	41.06033
Odisha	9.667	0.516398	17.92111	0.266667	3	5.342046
Punjab	4.167	1.169045	1.604444	1.366667	2	28.05708
Rajasthan	9.500	0.547723	16.53778	0.3	3	5.765501
Sikkim	2.833	0.983192	6.76	0.966667	1	34.7009
Tamil Nadu	2.667	0.516398	7.654444	0.266667	1	19.36492
Tripura	4.000	0.894427	2.054444	0.8	1	22.36068
Uttar Pradesh	9.667	0.516398	17.92111	0.266667	3	5.342046
Uttarakhand	6.833	0.752773	1.96	0.566667	3	11.01619
West Bengal	5.167	0.983192	0.071111	0.966667	2	19.02952
Andaman & Nicobar Islands	3.167	0.752773	5.137778	0.566667	1	23.77177
Chandigarh	2.833	0.408248	6.76	0.166667	1	14.40876
D&N Haveli	4.667	1.966384	0.587778	3.866667	2	42.1368
Daman & Diu	2.500	0.547723	8.604444	0.3	1	21.9089



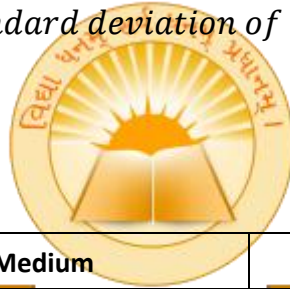
Lakshadweep	3.333	0.816497	4.41	0.666667	1	24.4949
Puducherry	1.667	0.516398	14.18778	0.266667	1	30.98387

Classification of states & UT by scale value

Score value	Scale value	Score value	Scale value
$\leq (\bar{X} - 0.425\sigma)$	1	≤ 4.136151941	1
$(\bar{X} - 0.425\sigma)$ to $(\bar{X} + 0.425\sigma)$	2	4.136151941 to 6.730514725	2
$\geq (\bar{X} + 0.425\sigma)$	3	≥ 6.730514725	3

X and σ refer to mean and standard deviation of the total score and the classification

of the sample units



High		Medium		Low	
STATE	SCALE VALUE	STATE	SCALE VALUE	STATE	SCALE VALUE
Andhra Pradesh	3	Arunachal Pradesh	2	Delhi	1
Assam	3	Himachal Pradesh	2	Goa	1
Bihar	3	Jammu & Kashmir	2	Kerala	1
Chhattisgarh	3	Karnataka	2	Maharashtra	1
Gujarat	3	Mizoram	2	Manipur	1
Haryana	3	Punjab	2	Nagaland	1
Jharkhand	3	West Bengal	2	Sikkim	1
Madhya Pradesh	3	D&N Haveli	2	Tamil Nadu	1
Meghalaya	3			Tripura	1
Odisha	3			Andaman & Nicobar Islands	1
Rajasthan	3			Chandigarh	1
Uttar Pradesh	3			Daman & Diu	1
Uttarakhand	3			Lakshadweep	1
				Puducherry	1



Total scores of all the 35 States are recalculated a three point scale using the standard normal distribution is constructed as above.

Ranking of states & UT

Low		Medium		High	
State	Rank	State	Rank	State	Rank
Goa	1	Mizoram	12	Madhya Pradesh	20
Kerala	1	West Bengal	13	Assam	21
Manipur	1	Karnataka	14	Bihar	22
Chandigarh	2	Himachal Pradesh	15	Odisha	23
Tamil Nadu	3	Punjab	16	Uttar Pradesh	23
Daman & Diu	4	Arunachal Pradesh	17	Rajasthan	24
Tripura	5	Jammu & Kashmir	18	Chhattisgarh	25
Maharashtra	6	D&N Haveli	19	Meghalaya	26
Andaman & Nicobar Islands	6			Andhra Pradesh	27
Lakshadweep	7		Uttarakhand	28	
Puducherry	8		Haryana	29	
Sikkim	9		Gujarat	30	
Delhi	10		Jharkhand	31	
Nagaland	11				

5. Conclusion:

Here, we classified all the state of India in various groups like high, medium and low. Also we find the rank of state by its scale value and using coefficient of variance tools. First three ranks of Infant mortality rate are as follow.

1. Goa, Kerala, Manipur
2. Chandigarh
3. Tamil Nadu



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6.Reference:

- Data collected from NITI AAYOG
government Site: www.niti.gov.in
Link: <http://niti.gov.in/state-statistics>
- Information and introduction collected
from Site: www.wikipedia.com
- Each formula is produced by the center for health statistics,
statistical analysis division.



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