

A Survey on the Factors Affecting infants' health related issues and Child Mortality using Artificial techniques and Machine Learning algorithms

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Abstract –

Infant mortality has always been a major health issue, so the Indian government is very much concerned in getting the solution of such serious health problems so that the infant mortality rate can be reduced. In healthcare systems the artificial intelligence techniques with machine learning algorithms are proven to be like a wind fall as these may help in making an early prediction of problems related to the infant health state, post birth factors and other issues. Hence, in this paper we are presenting the root causes of various health challenges and the affecting factors, which may lead to morbidity and sometimes maternal and infant mortality too. Further In this survey we aim to compare efficiency of various artificial intelligence and machine learning algorithms and examine the role played by data mining techniques, machine learning and fuzzy logic in the field of healthcare.

Keywords: *Infant Mortality, Health issues, Health Problems, low birth weight, Socio-economic status, infant mortality trends.*

I. Introduction

The huge variety of health issues in the Infants and the mortality has become one of the biggest challenges which further depends on the social standing or class of an individual or group, the demographic factors and health quality indicators in the world. Regardless of the astonishing global progress achieved in the maternal and new-born survival over the last decade, 4.6 million newborns still die in their 12 months of life—approximately 3 million in the first 28 days. The more children under age of 5 in India lose their lives each year as compared to any other country [1].

All over the Country it has seen that the first month of a neonate is very crucial and more than half of these deaths are found during this period only of a neonate which is also called neonatal period this is because the babies are born prematurely and may suffer from some birth time related problems like: Bronchopulmonary dysplasia (BPD) which is extremely serious prolonged lung complaint found in the newborn babies. The neonates and the infants who got effected by Bronchopulmonary dysplasia may result incomplete lung development and some injuries too which may be associated with some other effects, which could be

internal infection in the amniotic fluid of mother, mechanical ventilation, also may require some oxygen therapy.

The initial injury may happen often because of RDS (respiratory distress syndrome) or ARD (acute respiratory distress). However positive-pressure ventilation system and oxygen which has been used for giving treatment in such situations exacerbates the damage and could start growing the symptoms of BPD.

The other severe clinical problem of the growing gastrointestinal section is Necrotizing enterocolitis (NEC). To stop developing the inflammation to bowel necrosis and perforation which sooner or later increase the chances to mortality, the diagnosis of NEC at early stage is required.

The ROP (Retinopathy of prematurity) is a retinaldehyde disease associated with the association of rudimentary retinal vessels of preterm neonates and the required supplementary oxygen given to them. The diagnosis for ROP could be done by eye examinations and treatment [7] is done through laser or with anti-vascular endothelial growth factor treatment [18]. Asphyxia (deprivation of oxygen) or have birth time external environment related neonatal infections that can result in unconsciousness and often death are also the other impacting factors. In India per year 13% or approximately 3.5 million babies are born in the early months of the pregnancies while 28% or approximately 7.6 million babies are born with low to very low birth weight [1].

These factors are increasing the risk of their death in the neonatal period. In India the maternal mortality also continues to be on a higher side, with 167 maternal deaths per one lakh live births which has become the reason of concern about the great requirement of few more effective methods to help controlling it.

In the branch of neonatology, like in the other fields of medical world, some predictive methods are required so that that the possible results of respective subjects according to their characteristics could be forecasted. Though containing about 1% only of all childbirths, the cases of very premature delivery contribute disproportionately to newborn death in the duration of early weeks of their birth, often representing greater than half of it. This is not surprise to see that multiple potential cohort studies are going on and focusing on the same and the main purposes of these studies are to collect database so that some benchmarks may be established, and quality could also be improved.

That would become very important and helpful to be able to predict timely about the probability of survival of a small preterm infant; in fact for the individual infant (i.e., to suggest parentages) and to help a modification of the possible risks among the various groups of infants (for instance; if the comparison of the outcomes has to be done at multiple hospitals). Mainly the Gestational age and birth weight are the two very important predictors through which survival could be predicted in such type of infants. The other affecting features are also there which are frequently considered to make the predictions more refined; and these are: gender of the baby, type of delivery whether it is caesarian or vaginal, need for some artificial respiration or other therapeutic procedures, values of physiological variables, and so on. Now we have a question that how to calculate the illness of the neonates? Is there any scoring system available? The answer is yes and these available scoring systems are as CRIB1, CRIB-II2, SNAP3 and so on. [4–7]. In our survey we have identified many root causes of various health challenges, morbidity and in fact for maternal and infant mortality. Few of them are like Female literacy, Malnutrition, Hygiene in district hospital, Depression, Unbalanced diet during pregnancy, Gender survival, High risk pregnancies, and premature deliveries and the other factors are shown in figure 1.

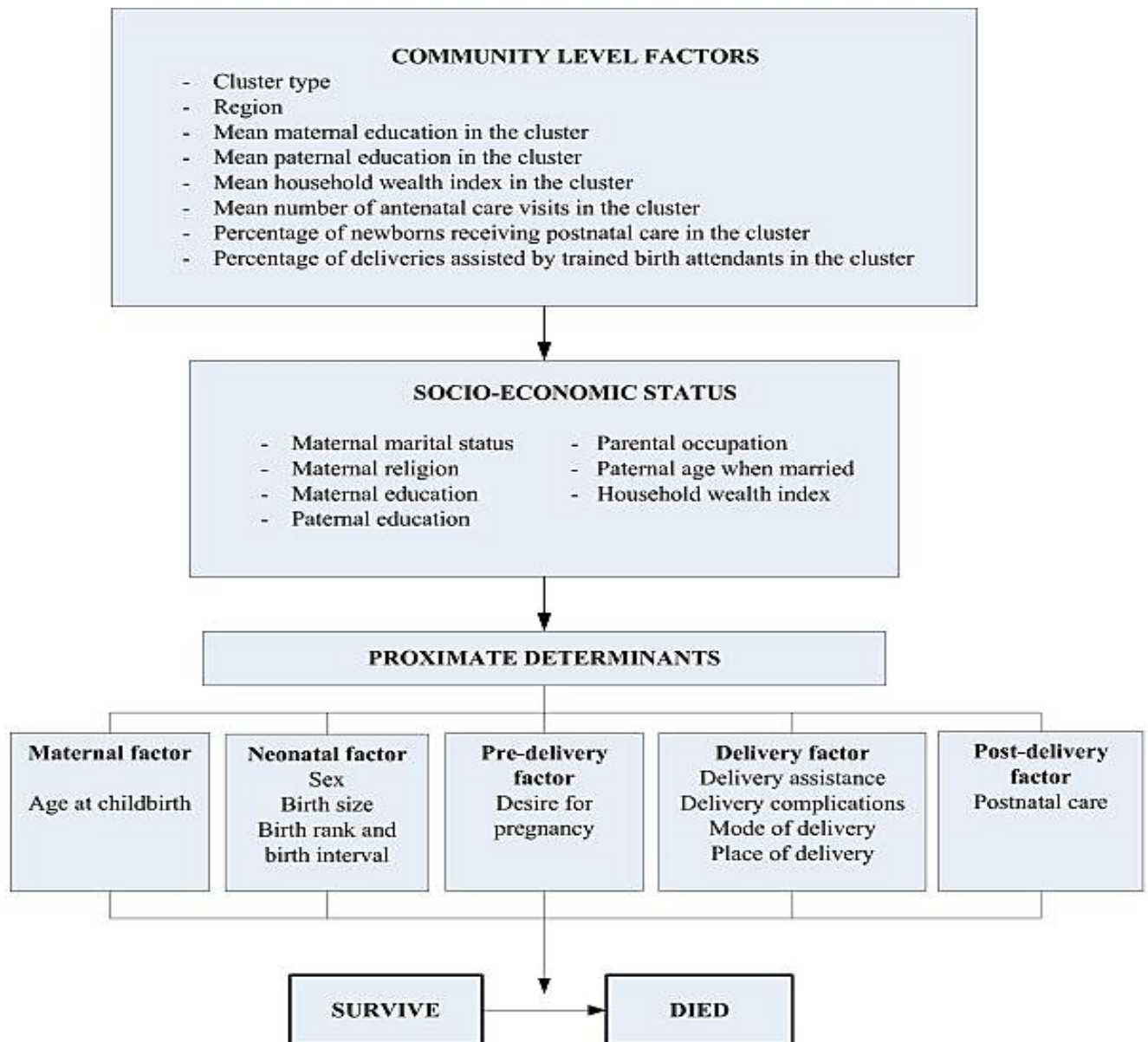


Fig 1: Influencing factors

II. Literature Survey

This literature survey discusses many papers which are related to the affecting factors of infant health and related issues.

Lakshmi. B.N et al presented the importance and the requirement of the standardization of those parameters which are being selected for the data collection in doing study. The authors have presented a comparison in the results which is obtained from the C4.5 classifier on standardized and un-standardized datasets and also have given the C4.5 algorithm's performance, which is being analyzed in terms of the accuracy it has predicted when this algorithm was applied on the database that was created from collected and standardized data of pregnant women. In the medical fields for fulfilling the purpose of diagnosis the decision tree classification method and its algorithms are mostly used and popular. One of the main and primary choices of the classifiers which is also used effectively for classification of pregnancy data they have used in their study is C4.5 Decision Tree algorithm [49].

Tahira Ashraf et al present the predictive ability of two very popular data mining techniques which are ANN (Artificial Neural Network) and LR (Logistic Regression) to predict the risk factors associated with Low Birth Weight. For their studies through which they have shown the comparison of the predictive ability of ANN and LR for the risk factors of Low Birth Weight, these parameters were searched on Google scholar, PubMed, Cochran library, and web of science using the BOOLEAN search strategy.

Aparajita Dasgupta et al. for selecting the sample they have implemented cluster sampling, for identifying the determinants of Low Birth Weight and multiple logistic models, univariate analysis was done. They have also acknowledged that anemia in pregnancy is extensively associated with Low Birth Weight [54].

Santhil Kumar D et al present this study which aims to compare logistic regression (LR) with other data mining algorithms to classify the most influential predictor variables and develop a DSS (decision support system) to facilitate Doctors make better decisions in the case of low birth weight babies. It was determined that the variables that had a strong influence on the prediction of low birth weight were the mother's final weight (in pounds) before pregnancy, the age of the mother, the number of visits to the doctor in three months first, number of previous preterm births [47].

Mukhopadhyay, et al. The applied chi-square test was used for categorical variables and the independent t test was used for continuous normally distributed data and the Mann Whitney U test for biased data to determine the association between each factor. Major risk factors and outcomes between mortality and morbidity in extremely low birth weight infants [55].

Murat Kirişci presented work comparing ANN (Artificial Neural Network) and logistic regression (LR) analysis to identify the factors which affects the birth weight. They evaluated these analyses (ANN and LR) of the method obtained against these available records; these two methods are found to be approximately the same in classification ability. The results they presented in their study showed that in medical diagnosis, neither the ANN nor the logistic regression model could alter the other method. Both can be used in combination to support in making decision. Both models are having potential to make the clinicians understand the risk factors for birth weight and estimate risk [53].

Masaki Ogawa et al. suggested that Univariate analysis was applied to determine what association exists in causative determinants and obstetric complications and unconditional logistic regression was applied to do the multivariate analysis [46].

III. Factors Affecting infants' health related issues and Child Mortality

There are many factors that affecting the infant's health and child mortality, in this survey we are discussing the main factors that affect the infant's health and child mortality. These are premature deliveries, the role of female literacy on child health and its co-relation with prevailing to available healthcare services, health inequalities, Poverty and malnutrition, and Low Birth Weight Infant

A. Premature deliveries

The problem of premature delivery has become a global challenge, as each year many babies are born prematurely, and although the morbidity and mortality have decreased in recent decades, preterm birth continues to play an important role in under-5 mortality. [3]. Increased risk of neonatal morbidity and mortality is associated with low birth weight and short gestation [8]. TLBW (very low birth weight) infants, i.e. those born with a birth weight of less than 1000-1500g, are treated in NICUs (neonatal intensive care units) and their mortality rates are high than [9].

Preterm birth is the leading cause of death in infants and children under 5 years of age. In particular, two factors: low birth weight and low gestational age have a higher risk of death. If a baby is born prematurely, it automatically increases the risk of many complications, in addition can create a risk of long-term illness, even risk of death.

B. The Impact of Women's Literacy on Child Health and its Interaction with Access to Health Services

Women's Literacy always has undergone with multiple research areas, similarly when we focus on health issues of the infants and their mortality rates here as well the Research has unswervingly demonstrated correlations between mother's education and child health, but social privilege or confounding effects of wealth could also be reason which may not be ignored. Besides, that is not clear that what mechanisms are possible options which may bridge the education-health sectors and links, and what will be the effects by accessing the health services [11]. Women literacy is directly creating a huge impact on the lives of their infants, because in our country lot many superstitious activities are imposed on women after they have given birth to a child, so some campaign on a large scale is critically required especially in rural areas. This way an extraordinary opportunity may be generated through which the impact of female education on child health for women could be identified who otherwise would have almost certainly remained deprived of education for the remaining whole life as they live, and an assessment could also be done whether accessibility to the various health services increases or decreases as the advantages conferred by education. As a result, this study helps in identifying a rise in women literacy resulting exclusively by adult education; the risk of morbidity, malnutrition and mortality are found much lesser than among those infants and mothers who are well illiterate.

In addition, when infant mortality was given at approximate time positions, a sharp decrease was observed after the adult education campaign for the adult education group, but no decrease for the blind group i.e literacy or formal education. The endurance benefit bestow by education will substantially be higher among those who doesn't have the access to the various health services or have a poor access. The results of the study also indicate that in reducing the risk of malnutrition and other related health issues, education plays an important role irrespective of its impact on mortality, and these are not dependent of abundance of funds and their family's choice to make their daughters educate.

C. Health inequalities

In our society the health inequalities exist from the last many years and will exist in future too in every population. This is not because of society only, Women, with the aid of using distinctive feature in their reproductive role; usually want greater health care offerings all through their life, on average, than men. Especially at some stage in being pregnant, a lady who's already malnutrition, the Poor people, due to the fact there's quite a few structural and the social elements too (i.e., social health factors), must require greater healthcare services than better elegance wealthy class of society. Equitable health service policy makers are making the efforts to govern those inequalities with the aid of using supplying the chance for all belongs to a society to get best of the health care services. Multiple social elements also are there on which the Improvements in health services depends, and those are like the basic education, employment repute and operating situations of the organization, dietary stage of the person, housing and living situations, additionally the social wages [11]. Given a few

inexorable health inequalities a few of the population, we'd anticipate to get the usage of healthcare offerings is to be maximized amongst people with greater requirement and the desired offerings are to be made to be had to them, together with for females who belongs to poverty section in the society at some stage in their nine months of being pregnant and after delivering a baby for at the least 6 months for the newborn and the new mother. When in reality it has been found that those who are already belongs to rich category of society are getting more as compare to those females who are much need, specially at some stage in their childbearing years, it's a clear indication of an inequitable system. Unfortunately, that is the situation in a number of the nations across the world.

According to the statistics India has greater than twenty percent of the whole maternal mortality load globally and unfortunately has the highest figure related to maternal deaths of any country. Though the decline rate has also been reported to be close to 6% over the past around ten years, the maternal mortality rate is still 187 per 100,000 [11]. At the local level, we mean that both between states and within states there is a lot of inequality between different population groups. Demographic status is also closely linked with access to and implementation of maternal health care in India. India has started many flagship programs over the last two decades, in the direction of family planning and how to improve the accessibility to the health care services to the pregnant women and the new mothers, the most recent one is the National Rural Health Mission (NHRM). Many of these programs are trying a conceptual shift from personalized, vertical interventions to a more universal and incorporated life-cycle approach [21] However, the progress in many states is significantly slower. It has been found in the urban areas or the areas where non-poor residents resides the large population of pregnant women are getting the gynecological care and also trained nurses and attendants at the time of their delivery, while access to these health care services among poor populations still remains low [19,20]. In 2006, 13% of women in the lowest wealth quintile delivered their babies in an institution compared to 84% of women from the highest wealth quintile [11]. Women who are from a SC/ST (Scheduled Caste or Scheduled Tribes) categories and those living in slums in the urban areas also doesn't have sufficient access to the required health care services during their pregnancy or they are not properly aware to the effective utilization of maternal health care.

In the further study as presented by Agnihotri, an improvement in decreasing the infant and child mortality is surely an indicator of progress of any country. But these factors may not evenly benefit male and female children, especially if the girl child is not able to avail the better healthcare facilities and the nutritional diet support. The consequential gender disparity in mortality is a great index of biasness against a girl child. A study related to time series data done on child and infant mortality in majority of Indian states shows a sharp step down in male mortality as there is a decrement in the levels of infant and child mortality. However, gender biasness is well known in some of the states and they use to show support for 'substitution effect', i.e., As a result of increased prenatal choices, female infant mortality rates decline more rapidly. However, here it means that simply improving the mortality rate of "surviving" girls does not mean improving the quality of their survival.

Sakthi Padhi stated that child and infant mortality is not that much simple discussion in fact this is related to a prime concern of the rate of economic growth, level of economic development, or material prosperity. Contiguous conditions which are directly having a concern on child and infant mortality are outside the market domain and are like that this is not possible for these factors to be persuaded by increasing in earnings and obtaining more

power only. The National Family Health Survey (NHFS) provides immense and dappled data through which valuable analysis on the early mortality in Orissa could be possible and it provides a compact experimental substance for further analysis of certain questions such as how about the accessibility and good quality of a extensive variety of public goods and health care services which will be having a direct correlation on premature delivery and mortality.

Further as stated by Bhalotra [14] the impact of cumulative income astonishes on child mortality in India and identified expected mechanisms. In his paper the authors have used statistics and methodologies that are devised to circumvent some of the described problems in the studies done earlier and it investigated methods and providing expansions which were not measured previously. For approximately 150000 infant and children individual data on child mortality was collected, merged and then used by cohort and mode of delivery with a state panel that contains data on cumulative earnings. Identification rests upon evaluating the results of annual deviations in earnings from pattern at the mortality threats of the kids born by the same mother at different-different times, conditional upon some of nation-time various covariates consisting of rain shocks and nation social expenditure. Rural child mortality is countercyclical, the pliability being approximately -0.33. This is notwithstanding the identification that comparatively high risk females turn away from giving birth or go through fetal loss in recessions. It appears in fractions associated with recessions stimulating misery exertions among mothers, in assessment to the case in richer countries, in which they discourage exertions marketplace participation. Healthcare in search of declines in recessions and this seem associated with the cost of opportunity at maternal time. Disaggregation exposes that the common outcomes are pushed through rural families wherein the mother is uneducated or had her first delivery in teenage, and here these are females who are found at most risk; male child is covered from earnings shocks. Exposure to terrible situations with inside the fetal and neonatal duration seems to have a bigger impact on infant mortality than comparable experience with inside the post-neonatal duration.

According to Rohini Ghosh [12], a countdown database was presented to trace neonatal and survival of mother after delivery. According to the Millennium Development Goals, and recently reported that India's progress in reducing neonatal and infant mortality was inadequate. Various articles were accessed on infant mortality and newborns in India via PubMed / MEDLINE. From there the multiple risk factors were reviewed which are associated with neonatal and infant mortality at three key stages: pregnancy, delivery, and postnatal duration [37], [39]. According to reviews, economic inequality works through various means of cultural beliefs and constraints, indirectly related to long-term care behavior and access to medical services, and child mortality in India is slowly declining. Second, cultural issues, customs, and beliefs are having a strong association with high infant mortality and contribute to slowdown in overall survival period of child. An immediate determinant of infant mortality, like, beliefs, Earning Income, and cultural behavior are closely linked to infant health-oriented behavior, prenatal care, childbirth practices and postnatal care in various Indian cultures. In addition to raising awareness of community leaders, they conclude that caregivers should specifically aim to remove hostile perceptions and disabilities in order to improve the survival of their children. There is also a need to develop some new policies and strategies for healthcare education system based on indigenous peoples' suggestions and experiences also address socio cultural barriers. The Infant Mortality Trends in INDIA is shown in figure 2.

The Influencing factors are as follows: Improve the quality of life, Access to high quality health service, Education, Human security and rights, improve environments, and Remove risk factors and determinants of infant health.

D. Poverty and malnutrition

Poverty and malnutrition are among the most critical factors which aggravate the chances of multiple kinds of infections and diseases like pneumonia, diarrhea, and increase the probability of mortality, especially among the infants who had very low weight at the time of their birth [13]. Demographic and epidemiological studies have documented that poor financial status of household, poor nutritional diet status of mother, low female literacy rate, early age at delivery of a mother, bigger family size, low sovereignty of females, and non availability or some time limited access to health care product and services unreasonably increases the risk for the health status of infants and their mothers too [15]–[29]. Also, the authors have spotted a light on a large socioeconomic and interstate disparities in the maternal and child health status and have stated that socioeconomically weaker portions of the population disproportionately go through from underprivileged health issues and are deprived of having an access to the available health care services [30]– [34]. It is shocking to know that the economic inequalities and regional disparities have also grown [35]– [38].

In this paper further authors have presented the regional variations which create a great impact in the determinants of child survival. Under nutrition is highest in the states of Madhya Pradesh, Bihar, Uttar Pradesh, and Rajasthan, where more than half of child population is with very low weight or diminutive. Approximately 50% of children in Maharashtra, Orissa, and West Bengal are found below average weight, while also 50% of children in Assam and Haryana are underdeveloped [41]. There is a marked regional division in India in the use of safe childbirth.

To understand the significance of the research gap that exists in the demographic and epidemiological literature, an effort was made to scrutinize whether geographic section have difficulty in prosperity, Female education, child nutrition or safe childbirth are struggling with high risk towards infant's death; whether there exists some spatial outliers; whether these co-relations have gone through with significant changes over the past tenure. To complement this study, the authors attempted to address these issues using data from large-scale Household Health and Demographic Surveys, such as the National Family Health Survey (NFHS), Family Health Survey (FHS) and the Child and Reproductive Health Survey (DLHS).

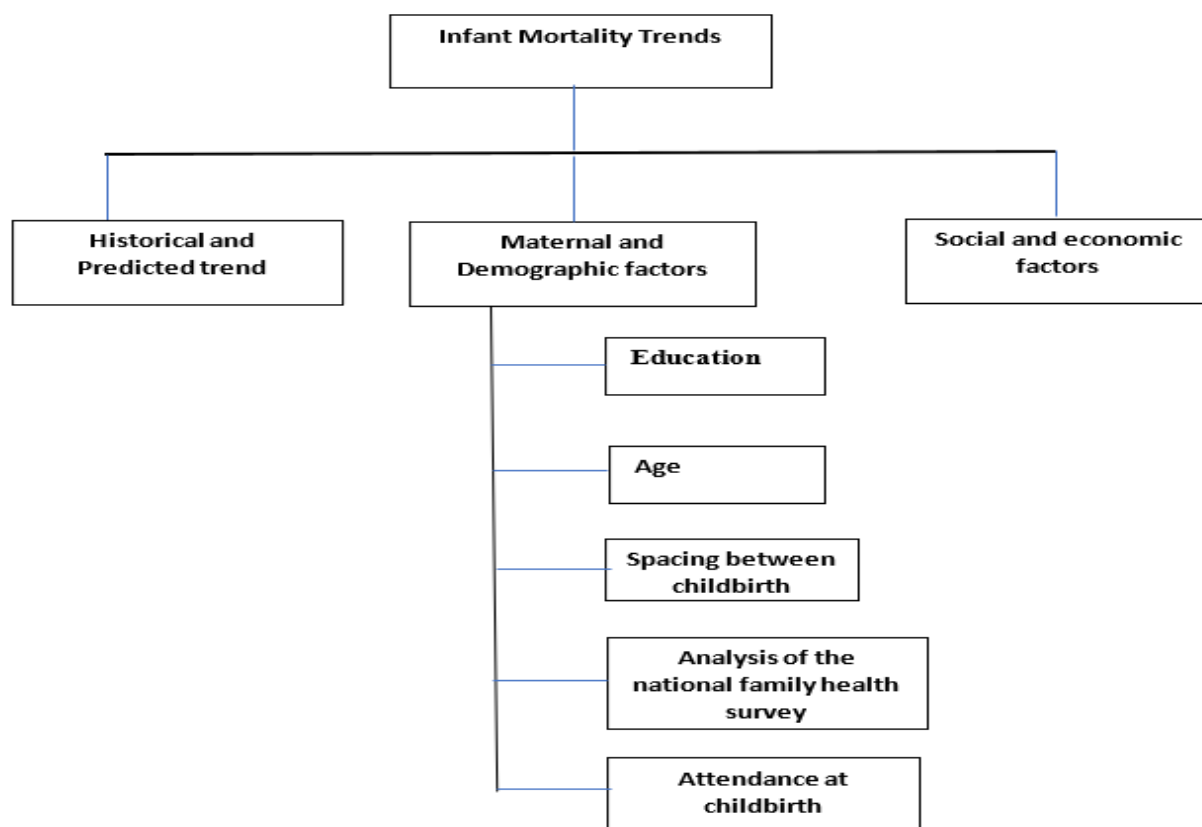


Fig 2: Infant Mortality Trends in INDIA

E. Low Birth Weight Infant

Low birth weight (LBW) is defined as:

- i.** Birth weight of a newborn baby of less than 2500 g,
- ii.** Very low birth weight (VLBW) if it is less than 1500 g, and
- iii.** Extremely low birth weight (ELBW) if it is less than 1000 g.

There are several methods developed for newborns, but they are rarely compared and have not been evaluated in large samples of infants with very low birth weight (VLBW; <1500 g). There is also. Disease risk-adjusted complexity is often used in clinical studies and quality assessments [43]. It is also important to measure the odds and abilities of individual complication scores to distinguish between newborns who may survive and those who may not survive or die in the hospital. Disease assessment complexity is always important for a variety of pediatric, neonatal, and adult applications such as quality assessment, disease severity management in clinical trials, and resource utilization and management studies. National programs such as the ORYX Initiative of the Joint Committee on Accreditation of Hospitals and Related Organizations are based on the condition that assessment of disease severity is controlled. The severity of the illness is a general medical concept, but it can be difficult to assess.

Many models have been developed to measure the severity of newborn illness, with improved calibration and power [43]. However, the applicability and validity of these methods remains questionable. Can they be applied to all newborn populations? For example, scores are created from a specific geographic area. The proportion of low birth weight and very low birth weight infants varied by population used to generate the score. Rapid medical

development in prenatal and neonatal care may have changed the relationship between mortality and score predictors. Measurement bias may exist because most scores require the collection of a wide range of physiological measurements that are not routinely collected at the same intensity in all NICUs. Lead time issues can be due to shipping issues and different supply patterns in the delivery room. Each of these issues can limit the usefulness of these tools.

IV. COMPARITIVE ANALYSIS

In this section of this paper, we present the comparative study among the various machine learning algorithms that have been used for the analyzing the various issues related to the infant health, pregnancy duration of the mother and postnatal health of the infants which may sometimes lead to child mortality [2]. In the Table 1 we have analyzed the various machine learning algorithms and techniques that has been applied by the researchers in their research papers.

TECHNIQUES	ISSUES	USAGE	LIMITATIONS
Logistic regression [47]	Low Birth weight of newborn baby.	Updating the model for new data is easier.	slower and less efficient but transformations and stepwise variable selection techniques may be used to fit logistic regression models.
ANN and logistic regression analysis [53].	factors affecting birth weight	Both models have the potential to help physicians with respect to understanding BW risk factors, risk estimation.	ANN gives more accurate results than LR when estimating BW, because the ANNs may be trained with data acquired in various contexts and can consider local expertise, differences, and other variables with uncertain effects on outcome.
Clustering analysis (k-means algorithm) [48]	Preterm birth prediction	Very efficient for processing large data sets Computational complexity is faster than hierarchical algorithm	K-means algorithm is limited only to numeric data Clusters have complex shape
Naïve's Bayes (Naive bayes algorithm, depends on the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature) [50]	Type of Delivery	Good accuracy, faster than logistic regression	Fails to consider other factors which might contribute in type of delivery. A query with a missing value cannot be processed
Decision tree (J48 algorithm) [51]	Attributes affecting postnatal care	Rules are easier to Efficient technique	Its performance is poor if many complex interactions are present
Association rules (Eclat algorithm) [52]	Preterm birth	It is efficient because it performs BFS to create the frequent itemset	Only 1% of the transactional dataset is used for generating rules
Rule induction (JRip algorithm) [2]	Attributes affecting postnatal care	Interesting rules are generated using most determinant factors	Rules are difficult to understand and is Comparatively less efficient
Decision tree [49]	Voluntary termination of pregnancy	Good accuracy and specificity Uses all data for testing	Comparatively less acceptable than other algorithms in terms of sensitivity
Decision tree (C4.5 algorithm) [49]	Mode of delivery	It is efficient and most preferred. It provides better results as compared to other algorithms. Good performance and easily understandable. It requires no domain experts.	It is not so beneficial on unstandardized data sets.
Decision tree (Iterative Dichotomiser 3) [50]	Mode of Delivery	Good accuracy	Fails to consider other factors which might contribute in mode of delivery A query with a missing value cannot be processed

Table 1: Comparison of various machine learning algorithms and techniques

V. CONCLUSION

The above study implies that multiple issues like Female literacy, Malnutrition, Hygiene in district hospital, Depression, Unbalanced diet during pregnancy, Gender survival, High risk pregnancies, and Premature deliveries and low birth weight are associated with the duration

of pregnancy of a mother and postnatal period which further may affect the infants health and may lead to morbidity and sometimes mortality too. On the basis of various community factors, socioeconomic factors and the other proximate determinants we can also predict the survival or death chances of the infants. Data mining and machine learning techniques have been proved by the researchers to be very efficient in health care Field. In this paper we have presented the survey and comparison among various techniques which focuses on some issues related to the duration of pregnancy and other infants' health issues. It has been observed that for a particular purpose one technique may give accurate results but sometimes might get fail when the objective of the study is little changed. Although the overall good pregnancy outcomes are observed of high frequency of planned pregnancies, it can be concluded that the rate of maternal and prenatal complications is still getting increased. Which generated the requirement for enhancement of techniques through which some more meaningful and profitable results could be extracted from a vast amount of raw data and would help the medical experts to analyze the chances of risks in future and to identify alarming conditions that may proceed to better diagnoses and treatments?

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