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Research Article

Role OF Artificial Intelligence to Reduce U5CMR in India

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ABSTRACT

In this digital era data is the new fuel, hence data science is omnipresent. Data scientists are the ones who predominantly depend on AI to identify hidden patterns for better decision making in various sectors. The use of technology in healthcare and medical industry is imperative. Artificial intelligence (AI) and Machine Learning (ML) with the use of data science are providing a platform for medical doctors, biological researchers, and patience to discover insights on health and medical related disorders. According to WHO records as well as the UN's sustainability goals, child mortality is the contemporary issue globally. The present study is to identify the role of AI in eradication of under 5 years Child Mortality Rate (U5MR). The secondary data on child mortality was collected for the last three decades (1990 to 2017) and analyzed with the help of Python in order to predict the child mortality for the next six years (2018 to 2023). The results show that there is a declining trend in child mortality for all 27 identified diseases. Lower respiratory infections and Diarrheal diseases as top two causes of child mortality were also declined. However there is disparity in actual and predicted. Proactive implications of AI (Vaccination reminder, Maternal Education, Nutritional awareness) by the stakeholders could bring down the disparity seen in U5MR in India

Keywords: Data Science; Augmented Intelligence; Machine Learning (ML); Child Mortality; Healthcare

INTRODUCTION

"Artificial Intelligence is our Friend"

The rapid growth of Artificial Intelligence (AI) is extremely changing the way humans work and interact with society. Augmented intelligence in health care is most cited (Long and Ehrenfled, 2020) method which aids in predicting and diagnosis of diseases. Though AI can't replace public health officials and epidemiologists, it can assist in handling voluminous information for better decision making. In June 2019 American Medical Association (AMA) adopted a new policy "Augmented Intelligence in Health Care", giving a basic framework for development of AI which ensures the benefits for physicians, patients and health care groups. Augmented Intelligence is a new conception that focuses on implementing Artificial Intelligence highlighting its design and approach that improves human intelligence instead of replacing it. Thus Augmented Intelligence can be termed as a technology that improves capacity of human information processing (Sharma 2019). Artificial Intelligence is an interdisciplinary field which has the ability to understand patterns, refine and replicate the human mind. This technology is widely used as diagnosis and advisory tool in business, medicine, economics, entertainment, engineering, Genomics, Managing data centers, Social network analysis, Market segmentation, Astronomy, Managing Email, Handwriting recognition, Face recognition, Speech recognition, Information retrieval, Traffic forecasting, Policy Making,

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Opinion leaders and the list goes on (Das et.al,2015) with its increasing area of usage in wide spread. An AI program is called intelligent agents which has a set of sensors and actuators which interact with the environment. Arthur Samuel defines artificial intelligence as a tool that helps computers to learn on its own without any program. AI is transforming every walk of life by integrating information, analyzing data and using the result insights to improve decision making. The algorithms are designed in such a way that decisions are made with real time data. Embedding sensors, digital data and remote inputs combine information from varied sources and respond immediately on those sets of data. The technology is taking its pride because of its massive storage, processing speed and analytics techniques which aid in better handling of data for decision making. Artificial intelligence is the combination of machine learning and data analytics where ML looks for patterns and trends and analytics aid in data handling (Andrew and Erik, 2017). It's estimated that AI technology could increase GDP by $15.7 trillion 14% by 2030 (West and Allen, 2018)

AI in Healthcare

Medicine is considered to be a spectacular field where most of the activities are data driven because of the complexity in transforming traditional multivariate data analysis to data science which embraces the usage of wearables and sensors capturing data real time. With exponential growth of deadly cancer to identification of risk and patient assessment the healthcare industry is ripe for a change. In due prominence of emerging AI in the healthcare market, as of 2018 it's value is $2.1 billion and it is projected to grow $36.1 billion by 2025 with a 50.2% CAGR (Shepherd, 2019). Facilitating AI in healthcare is a new game changer which greatly reduces (50%) the time of a physician indirectly enhancing patient's care. World Medical Innovation Forum (WMIF), has listed the below ten areas where AI has global market opportunity in the medical area.

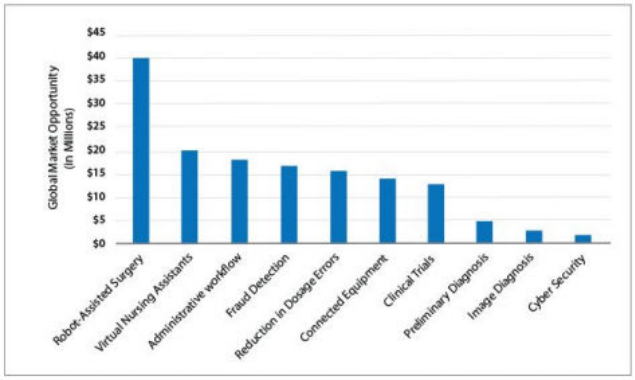

Figure 1: Shows areas where AI has global market opportunity in the medical area.

AI IN INDIAN HEALTHCARE SECTOR

Indian healthcare sector is facing tremendous pressure with a rising number of population which inhibits the people getting proper medical facilities. It's practically insane to suddenly increase the number of healthcare providers instead the government can think of augmenting technology like AI which can assist in such activities.enhance productivity and availability of healthcare professionals (IANS 2017). Shivaram et.al has highlighted the application of AI in detecting prostate cancer, breast cancer using computational methods or additional features which physicians could not do. Child mortality rate can also be reduced to some extent with the help of AI, where Neonatal Sepsis is a major threat of Neonatal mortality which could be easily controlled with the help of time series data from standard noninvasive measurements (MJ Sankar et.al, 2016). This technology assists in hospital readmission, testing, ICU transfers, sepsis prevention, managing claims, improving clinical workflows, collection of information from books and journals improving patient care (Ramjan shaik, 2019). Digitization in healthcare is a challenging task in developing countries like India. Though Indian health care sector accounts for

$100bn, yet it struggles hard to meet the ends. It's becoming very much evident that hospitals could improve medical assistance through digital healthcare with increasing penetration of the internet and smartphones (Rashi, 2016). Apollo Hospitals India in collaboration with Microsoft is working on AI embedded cardiovascular devices which predicts the risk of heart diseases.With rising prominence of AI in healthcare, association between government, technology and healthcare providers. One such initiative is to focus rural health where the Maharashtra government is into partnership with NITI Aayog and Wadhwani AI group. Microsoft Intelligent Networkfor Eye care has been adopted by Telangana state government along with a private Eye institute (Clare and Urvashi,2020). The investment in AI by startups are also increasing at faster phase of $77 million in 2017 and companies like Niramai (ML-Detect breast cancer), ChironX (Deep learning- retinal abnormality), SigTuple (Primary care and first aid), tech giants Microsoft and Google has also partnered with leading hospitals to establish more on diagnostic tools (Singh,2020). Undoubtedly AI can bring efficiency and quality in healthcare provided correct identification of problems and appropriate solutions will make the system more effective Role of technology in healthcare is immense which is not measurable easily. Technology giants like IBM, Google, and Microsoft are playing a significant role in it. Particularly medical doctors, researchers and patients could use Artificial intelligence (AI) and cloud computing to discover biological insights. AI and cloud computing seems to be a great platform in the healthcare industry which helps in treating in a cost effective way (Laï et al., 2020). As per the global data out of 56 million people died in 2017, 10% of them are less than 5 years of age group. According to the World Health Organization (WHO), 5.2 million children who are less than five years old died due to preventable and curable causes in 2019 (Ritchie & Roser, 2019). However there was a deep fall in children's death rate in the last three decades. One child out of every eleven children under the age category of five years old died in 1990, whereas it was decreased to one child out of every thirty-eight in 2019. Even though there is a declining trend on the same, it is imperative to know the contemporary trends in the healthcare sector. Pertinently how the AI playing a crucial role in respect of controlling death is necessary to understand. Further it is understood from the review of literature that there is a role for

AI in the healthcare sector. Therefore, the researchers have strong intention to study the role of AI in the healthcare sector with specific reference to child mortality in India.

Review of Literature

Child Mortality

Children under-five mortality rate (U5MR) is one of the primary factors reflecting the child's health and survival. Also it highlights the development of a nation which includes social, economic and environmental factors where the children and others in the society live. The development of health care and their practices in a nation is also indicated by U5MR (McGuire, 2006). There are various factors which contribute to a child's death before 5 years. Water is one of the major factors for death before 5 years. Unsafe water or water pollution which contributed for U5MR in various countries (Gebretsadik & Gebreyohannes, 2016; Jacoby & Wang, 2003; Kumar & Singhal, 2020; Mutunga, 2004). Diarrheal diseases in children can be primarily attributed to unsafe water. Maternal education which can reduce the likelihood of U5MR (Aheto, 2019; Gebretsadik & Gebreyohannes, 2016). Child and maternal malnutrition another significant factor for children under 5 deaths (Kumar & Singhal, 2020). The malnutrition can be attributed to preceding birth interval, number of child births, family size, contraceptive use, lack of care, preterm / low weight births andscarcity of household resources where parents as well as children have to compete for the little resources available for their survival (Aheto, 2019; Gebretsadik & Gebreyohannes, 2016). The other factor that could be attributed to U5MR is regional disparity in large countries (Aheto, 2019; Kumar & Singhal, 2020). Children who are not breastfed have a higher likelihood ratio for U5MR. Breast Milk has antibodies which acts as an antimicrobial and anti-inflammatory factor that shields children from bacterial and viral infections (Gebretsadik & Gebreyohannes, 2016; Kumar & Singhal, 2020; Shahidullah, 1994).

Measures to Reduce the Child Mortality

Studies indicated that strengthening the existing policies and health care intervention can bring the decline in U5MR (Aheto, 2019; Claeson, Bos, Mawji, & Pathmanathan, 2000). Regular vaccination plays a vital role in the U5MR. The proper understanding of health and nutrition factors among mothers can significantly contribute to child survival. So, improving maternal education for understanding the health and development of children is essential. Community based intervention plays a vital role to understand the demand and supply, also to identify needs and priorities in local health care. Regional disparities can be reduced in U5MR by having stratified health policies and community based intervention (Claeson, Bos, Mawji, & Pathmanathan, 2000).

AI in Healthcare

The exponential growth of IoT and Artificial Intelligence in the field of healthcare giving more scope towards publication in the last decade. Authors have highlighted the application of these technologies in different fields like disease detection, treatment, and patient care, usage of sensor devices and wearables and connectivity. The success factors of these technologies rely on data security, data management and collection, system accuracy (Shah & Chireu, 2018). Singh (2018) focused on identifying the advantage of the disruptive technologies like Artificial Intelligence, Blockchain and Cloud computing in health care. They highlighted the advancement in computational biology, explosion of big data and image processing as a mechanism to improve the diagnosis and treatment with better care at low cost. Caner and Bhatti (2020) explored that technological development on AI will transform the operations and scalability of functional areas of businesses like marketing, finance, operations, customer service, cost reduction and product development in various industries. They have developed a business strategy to implement AI through a thorough review of existing research. They have also discussed the major areas like economics of AI, abilities and limitations of AI, business functions and AI, workforce, regulation and ethics of AI in defining the business strategy.

Chanchaichujit, Tan, Meng, and Eaimkhong (2019) focused on the usage of AI in the treatment of Tuberculosis discussing its limitations and success factors along with suggestions. Alloghani et al., (2020) were of the opinion that medical research relies on machine learning specifically to support vector machines applied in medical imaging, detection and treatment of stroke, cancer and neurology at an early stage. AI has better prediction and precision of diseases irrespective of challenges related to data. Choudhury and Asan (2020) indicated that when AI systems are implemented accurately it enhances patient safety focussing on drug management, safety and satisfaction. Yu, Beam and Kohane (2018) examined the scope of AI in clinical diagnosis including disease identification, diagnosis and treatment. It was highlighted that more than 90 million people worldwide suffer Diabetic Retinopathy leading to blindness. Fundus photography is an effective method to identify patterns and perform early treatments. However health care systems in India also have financial strain in implementing the advances in technological equipment to make the process automated. Atanasov et al., (2018) compared the traditional method of diagnosis vs machine learning which concludes that machine learning models achieved more accuracy with the help of Random Forest models and Support Vector models. (Gómez-González et al., 2020) explored the application of AI in prescribing personalized medicine, public perception on AI in medicine based on existing software, monitoring devices, digital models and augmented reality with robotics. (Thesmar et al., 2019) focused on identifying the pattern and mechanism to deduct the disease early through the claims data along with other real time data. AI algorithms might extract the complex patterns which can be used as personalised services to patients for proactive measures.

Just, Thatcher and Lawry (2018) stated in their paper that AI is expanding its boundaries to augmented intelligence where artificial intelligence helps to improve the efficiency and performance of analytics where later focus is to improve on decision making for leaders in the healthcare industry. Duft, (2019) investigated the existing literature on the application of large-scale artificial intelligence tools in medicine. The authors

highlighted both quantitative evidence on trends and empirical analysis. They used the data collected from CBInsights, GMInsights, Massachusetts Medical Society, McKinsey & Co., and NEJM Catalyst to understand the use of AI by various companies. They have identified the value additions as well as challenges to the organisations that adopted AI.

Lee and Yoon (2021) analysed the existing literature taking two important areas like diagnosis assistance and nursing & managerial assistance where AI can be applied to enhance the diagnosis and prescription mechanism. They also suggested that real-time interventions and remainders on health through digital devices using AI could improve the healthiness of the people. Kerasidou (2020) mentioned that the healthcare industry operates on a relational model where empathy, trust and compassion are much valued. However due to administrative and managerial assistance imposed on the healthcare professionals, they were not able to justify the expectations of the patients. Authors deliberated that, with the advent of AI and other disruptive technology, healthcare professionals will be optimally used to render their services in a better way. Axt (2015) authors focused on the application of ANN in the healthcare system to enhance the efficacy in decision making. The US healthcare system contributes to the economy to the extent of 17%. Wrong diagnosis to the extent of 15% might affect the economy as well as the system more. So an innovative resource ANN if applied effectively might improve the efficacy of the diagnosis.

AI to Have Better Efficacy AI in Reducing Child Mortality

Ryan, (1991) used an expert system (researchers using computer systems like AI) to develop a decision model based on the observations about the mother's behaviour in handling their children. **Li et al., (2013)** made an attempt to establish a BP artificial neural network predicting model to predict and forecast incidence of infectious diarrhea. They have identified that the BP neural network has the high forecasting hit rate which can ideally predict and forecast the effect of infectious diarrhea. **(Thakrar et al., 2018)** explored the reasons for higher rate of child mortality trends in the US in comparison with nineteen comparator nations. They have considered the OECD database of children ages 0-19. They suggested that policy interventions focusing on infants and children aged between 15-19 should address the causes of death, automobile accidents as well as assaults by firearm. Gawande, Indulkar, Keswani, Khatri, & **(Mendes et al., 2013)** studied the temporal trends in overall mortality and hospital morbidity due to diarrheal disease in Brazilian children between 2000 and 2010 and identified a decreasing trend. Galib, Nahar, & Mainul Hossain, (2020) highlighted that along with post birth factors of the child pre-birth factors also play a vital role in identifying the cause for the child mortality. Authors have used machine learning techniques to classify child mortality. They have also mentioned that developing countries like Bangladesh use the pre-birth factors as the effective measures to control the child mortality. (Islam, Usman, Mahmood, Abbasi, & Song, 2020) authors focused on the Ethiopian Demographic Health Survey and Pakistan Demographic health Survey data to understand the pattern of challenging child mortality rate per 1000 live births 74 and 54 respectively for Pakistan and Ethiopia. They have used machine learning classifiers such as Naïve Bayes, Decision Tree, rule induction, random forest and multilayer perceptron to predict the child mortality rate. Nguyen, 2012 made an attempt to analyse child mortality using the data from six hospitals on malaria surveillance systems. Author has used all the symptoms recorded by the hospital while admitting, during the treatment, diagnosis and patient outcomes. Among the various models used logistic regression, random forests, gradient boosting machines and conditional inference trees supported in predicting hospital mortality. Author mentioned that 10-15 variables were highly ranked by various methods which is confirmed with the findings of the previous study. Khare, Kavyashree, Gupta, & Jyotishi, (2017) examined the problem of malnutrition causing infant mortality and designed a prediction model using machine learning technique with the data collected from Indian Demographic and Health Survey (IDHS). They have also made an attempt to use AI in identifying the probable determinants of malnutrition. Silva, Rodrigues, & Ishii, (2020) conducted a research to predict the death of new-born based on particular attributes. They have proposed a method named RIGOR to identify deaths of children who have lost their life within a year of birth. They suggested to the government that monitoring the fetal weight will prevent the child's death. Bitew, Nyarko, Potter, & Sparks, (2020) researched on the spatial variations impacting the under-five mortality using machine learning models. Their focus was on the socio demographic determinants specific to Ethiopia. Findings reveal that household size, time to the source of water, breast feeding status, number of births in preceding years, sex of a child, birth intervals, antenatal care, birth order, type of water source as well as body mass index of the mother plays a vital role in under-five mortality levels. Machine learning model, random forest has shown the better predicting power in their research.

Studies indicated that strengthening the existing policies and health care intervention can bring the decline in U5MR (Aheto, 2019; Claeson, Bos, Mawji, & Pathmanathan, 2000). Regular vaccination plays a vital role in the U5MR. The proper understanding of health and nutrition factors among mothers can significantly contribute to child survival. So, improving maternal education for understanding the health and development of children is essential. Community based intervention plays a vital role to understand the demand and supply, also to identify needs and priorities in local health care. Regional disparities can be reduced in U5MR by having stratified health policies and community based intervention (Claeson, Bos, Mawji, & Pathmanathan, 2000).

DATA AND METHODS

Since the study has the application of technology in the healthcare sector, the data required for this study is secondary in nature. Secondary data involves the published records relating to child mortality, which was collected from WHO website and other sites (**www.ourworldindata.org**). Global Child mortality data (at the age category of 5 years old) for the period of 1990 to

2017 were collected and data have been analysed with the help of Power BI and Python. Power BI was used to draw pictorial representations of child mortality. Python was used to predict the future trend of child mortality in India. Linear regression was used to know the relationship between volume and causes of child mortality. Pictorial representations were used as a tool to discuss the child mortality as well as the need for AI in the process of eradication of the same.

RESULTS AND DISCUSSION

This section presents status and causes of Child mortality in India along with major diseases and its prediction.

CAUSES AND STATUS OF CHILD MORTALITY IN INDIA

Causes for the Child mortality for both male and female have been discussed in the literature. Table 1 provides the list of causes for the child mortality. There are twenty seven causes identified for child mortality. Lower respiratory infections are the main reason for child mortality for all the years of study (1990-2017). Next to Lower respiratory infections, diarrheal diseases cause child mortality from 1990 to 2005. Since 2005 Neonatal preterm birth complications is the second highest cause for child mortality in India. The details of child mortality from 1990 to 2017 have been given in the annexure.

Table 1: Causes of Child Mortality (Less than 5 years old both male and female)

Serial Number	Causes of child mortality
1	Road injuries
2	Tuberculosis
3	Cirrhosis and other chronic liver diseases
4	Digestive diseases
5	HIV/AIDS
6	Diarrheal diseases
7	Lower respiratory infections
8	Meningitis
9	Whooping cough
10	Congenital birth defects
11	Drowning
12	Measles
13	Malaria
14	Neonatal preterm birth complications
15	Neonatal encephalopathy due to birth asphyxia and trauma
16	Neonatal sepsis and other neonatal infections
17	Other neonatal disorders
18	Nutritional deficiencies
19	Diabetes mellitus
20	Chronic kidney disease
21	Hepatitis
22	Neoplasms
23	Fire, heat, and hot substances
24	Exposure to forces of nature
25	Environmental heat and cold exposure
26	Cardiovascular diseases
27	Interpersonal violence

Figure 2: Causes of Child mortality in India from 1990 to 2017

Source: data obtained from worldofdata.com

Figure 3: Child mortality in India from 1990 to 2017

The trend of child mortality is presented in graph 2, which indicates that all the twenty seven categories of child mortality are declining gradually from 1990 to 2017. It is the indication of advancement happening in the healthcare and medical sector. Pertinently, technologies like AI and machine learning (ML) are contributing a lot towards this achievement. (AI is used to understand the various health databases available to understand the pattern. This will help the practitioners to identify the early symptoms and provide personalized recommendations. Studies conducted in Ethiopia proved that machine learning methods along with AI contributed to better government intervention to reduce the child mortality.)

PROJECTION OF CHILD MORTALITY USING PYTHON

The projection of child mortality from 2018 to 2023 for all the twenty seven categories have been done by using python programming. The same has been presented here (Fig. 4 and 5)

Fig. 4: Projection of child mortality from 2018 to 2023

Fig. 5: Projection of child mortality from 2018 to 2023

That there is a declining trend of child mortality in respect of all twenty seven aspects. Graph the projected child mortality results have been presented (Fig. 4 and 5). It is observed 3 provides the projection results with the focus on 2023 and graph 4 provides the projection results with the focus on 2022. Lower respiratory infections are the major cause of child mortality in spite of declining trends. Following diarrhea is the second major cause of child mortality even though there is an overall declining trend on child mortality. Therefore, these two causes of child mortality have been studied with special attention. The results of the projection of lower respiratory infections and diarrhea have been presented in the graph 5 and 6 respectively.

Projection of Lower respiratory infections using python

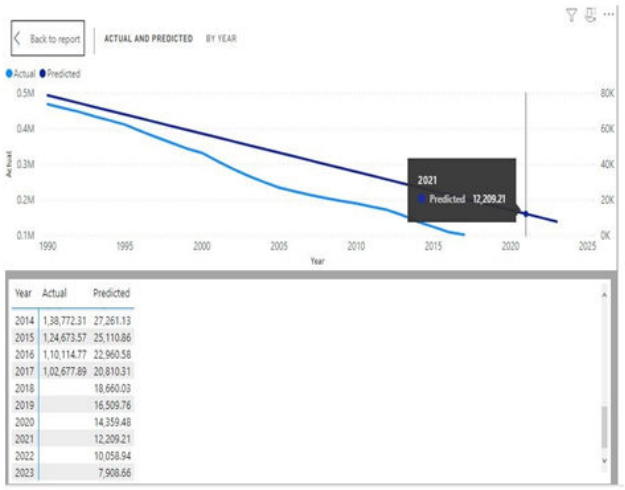

Figure 6: Projection of Lower respiratory infections from 2018 to 2023

Projection of Diarrheal Diseases

Figure 7: Projection of Diarrheal diseases from 2018 to 2023

Figure 7 reveals the actual and projected results of diarrhea disease, which is the second major cause of child mortality in India. The results show clearly that actual and the projection both have declined gradually from 1990 to 2017. There will be a 12,209 child mortality in 2021 (refer graph 6) on account of this disease.

CONCLUSION

The study focused on understanding the pattern and causes of U5MR in India. It is found that twenty seven diseases cause child mortality. Among them Lower respiratory infections, diarrheal diseases and Neonatal preterm are the three prominent diseases that cause U5MR. Projections on two prominent diseases showed a decreasing trend. However, if individual numbers are considered 24, 855 (2023) cases in terms of lower respiratory infections and 12,209 (2021) in terms of diarrheal disease is alarming. Hence there is a need for advanced technology like Artificial Intelligence (AI) and Machine Learning (ML) to be used in understanding the pattern of disease along with the contributing factors. Developed countries including China USA, UK, Germany (Laï et al., 2020) and the like have used AI on the existing databases to train, test and develop a model which can be used to take proactive measures to give personalised suggestions and recommendations to the mothers. Government and other policy makers intervention also required along with Artificial intelligence join hands with mother's intelligence to reduce and eradicate such diseases.

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