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## Diagnosing Malnutrition in Preschool Children Using Machine Learning Approach: A Review

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### **Abstract:**

*Child's health is not only the concern of parent but also it is priority of government of every nation to build a strong country. The child may face different health related problems during the preschool age as they are being exposed to the external environment [ (Khare, 2017)<sup>(22)</sup>, (Ula M. U., 2021)<sup>(30)</sup>]. Major health issues are due to lack of nutritional diet which in turn tends to malnutrition. Different health indicators help in finding malnutrition in a child. Depending on symptoms and considering health of a child malnutrition can be treated. The most challenging task for parents is to find symptoms of malnutrition in their child prior so that precautionary measures can be taken. And here the role of technology can be observed. The machine learning technology has already influenced the healthcare industry and is being used by medical professionals in managing clinical data, processing it, early diagnosis of findings.*

**Keywords:** Machine Learning, Healthcare, Malnutrition Diet, Nutrition.

### **1. Introduction:**

The healthcare system is a backbone of growth of any society. The saying is 'A STRONG MIND IN STRONG BODY' which in turn builds a strong nation. It can be observed that every government takes efforts to build a strong healthcare services network to reach to each and every part of society. But due to increasing population it is not possible to reach to every patient with the medical services, especially in developing and underdeveloped countries. And here the technology comes in picture.

The latest technologies have come with a range of solutions for problems faced by the society, especially in healthcare. The AI techniques, with the help of IoT, try to help health workers where they cannot reach right from the diagnosis, suggestions in treatment to taking some

precautionary measures which helps patients to control the situation from worsening it.

There are many areas in medical where now a day Machine Learning techniques are being used for various purpose like diagnosis, clinical data management, planning for medical treatment etc. A research shows that ML models are helpful for medical fields and are helping to patients also in absence of a medical expert to certain extent. These models are much helpful in a situation where a grey area is which leads to certain ambiguity in decision making.

The Paper reviews the maximum available research for role of ML in healthcare with special reference to malnutrition.

## **2. Role of Machine Learning in Healthcare:**

It can be observed that the Information Technology techniques are being used in various areas and have improved the quality of life of human being. Specifically, technologies like Artificial Intelligence (AI) and Internet of Things (IoT) are playing a vital role in healthcare industry and have revolutionized the working styles of healthcare.

Machine Learning technique, a technique of AI, used for decision making. There are various machine learning algorithms [ (Gadekallu, 2021)<sup>(4)</sup>, (El-Hasnony, 2022)<sup>(31)</sup>, (Barragán-Montero, 2021)<sup>(25)</sup>, (Thangamani, 2014)<sup>(27)</sup>, (Russell, 2021)<sup>(10)</sup>], which are categorized under three major headings – Supervised, unsupervised and reinforcement algorithms. Algorithms under these categories are either ‘Data Driven’ or ‘Task Driven’, and have their own characteristics and applications. Machine Learning algorithms learn from patterns in the input data collected for different parameters and generate a result which helps in decision making, which is a kind of explicit programming. They work in stages like data collection, data pre-processing, applying algorithm to develop a model, training model, evaluation of model and at the end give prediction as a result.

Machine Learning is majorly used in healthcare for patient monitoring, early potential diagnosis, decision making about the treatment [ (Strickler, 2022)<sup>(9)</sup>]. A study carried out by Harvard’s School of Public Health, the patient diagnosis using AI to may reduce treatment costs by up to 50% and improve health outcomes by 40% [ (Admin, IBM website)<sup>(76)</sup>]. Different applications of healthcare using machine learning can be given as analysing various medical images for diagnosis of diseases related with heart, brain, cancer detection, fracture detection [ (Kocks, 2023)<sup>(6)</sup>, (Handelman, 2018)<sup>(13)</sup>, (Vijayalaskhmi, 2022)<sup>(15)</sup>, (El-Hasnony, 2022)<sup>(11)</sup>, (Haque, 2021)<sup>(17)</sup>, (L’Imperio, 2023)<sup>(12)</sup>, (Shah, 2023)<sup>(16)</sup>, (Porrás, 2021)<sup>(19)</sup>, (Fang, 2022)<sup>(20)</sup>, (Al-Shawwa, 2019)<sup>(28)</sup>, (Admin, simplilearn website)<sup>(38)</sup>]. It has been found that Machine learning is not only used for improved diagnosis and disease identification [9] but also helps in maintaining more accurate health record [ (Verboven, 2023)<sup>(8)</sup>, (Fenta, 2021)<sup>(24)</sup>] and can be used for future process. These models are helping to improve the medical research and clinical trial [ (Verboven, 2023)<sup>(8)</sup>,

(Strickler, 2022)<sup>(9)</sup>]. Machine learning models are used in healthcare for better diagnosis [ (Verboven, 2023)<sup>(8)</sup>, (Van, 2022)<sup>(29)</sup>]. Not only in diagnosis, but these models are also used for tracking and monitoring health status [ (Strickler, 2022)<sup>(9)</sup>], for avoiding major illness in the future [ (Pienaar, 2023)<sup>(7)</sup>, (Astawa, 2020)<sup>(14)</sup>].

Algorithms under reinforcement also can improve the result by adding new experiences to existing knowledge [ (Pienaar, 2023)<sup>(7)</sup>] which keeps the application up-to-date and can be used in long run. The machine learning not only helps in enhancing diagnostic and treatment process in healthcare [ (Liu, 2022)<sup>(18)</sup>] but also helps to remote areas patient for monitoring and providing telemedicine facility [ (Tagde, 2021)<sup>(1)</sup>, (Gadekallu, 2021)<sup>(4)</sup>]. XGBoost [ (Shi, 2022)<sup>(23)</sup>], random forest [ (Najafloo, 2021)<sup>(5)</sup>, (Strickler, 2022)<sup>(9)</sup>, (NDAGIJIMANA, 2023)<sup>(26)</sup>], support vector machine [SVM][ (Strickler, 2022)<sup>(9)</sup>, (Chaluvadi, 2022)<sup>(21)</sup>,(NDAGIJIMANA, 2023)<sup>(26)</sup>] and the logistic regression algorithms[ (NDAGIJIMANA, 2023)<sup>(26)</sup>] have given best results in healthcare sector for diagnosis of different types of diseases.

The above study of different Machine Learning models being used in healthcare shows that these are not only helpful to healthcare workers but also to patients to take precautionary measures, especially where health workers cannot reach and can help patient at least to maintain the health state till he gets medical aid.

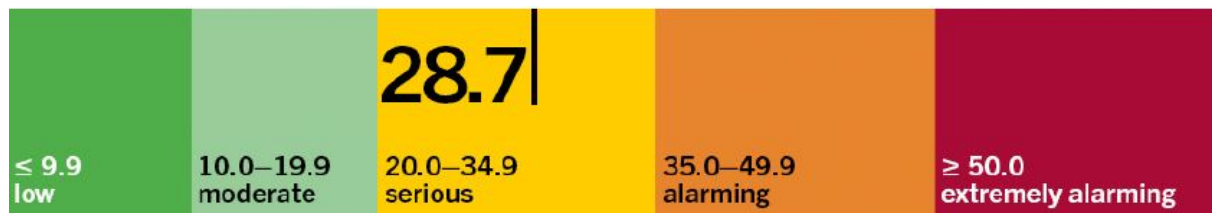
### **3. Malnutrition:**

Malnutrition is the major health issue faced by the most developing and underdeveloped countries and it becomes severe when it is in preschool children. When a child is suffering with malnutrition in his early childhood age, its effect can be permanent and can affect their physical as well as psychological growth. The study shows that malnutrition in early childhood stage have profound effect on their ability to learn, communicate, socialize, reasoning and adapt to their environment

Various international communities and health organizations like ASPEN (American Society for Parenteral & Enteral Nutrition)[ (Sharma, 2020)<sup>(31)</sup>, (Admin, nutritioncare Website)<sup>(39)</sup>] WHO (World Health Organisation)[ (Admin, WHO Website)<sup>(34)</sup>]are working on the issue. A study carried out by WHO in 2020 concluded nearly 149 million children aged between 1 to 5 years are suffering from different causes of malnutrition [ (Admin, who website)<sup>(33)</sup>].while till 2021, 45% deaths of preschool children are due to malnutrition[ (Admin, who website)<sup>(33)</sup>].

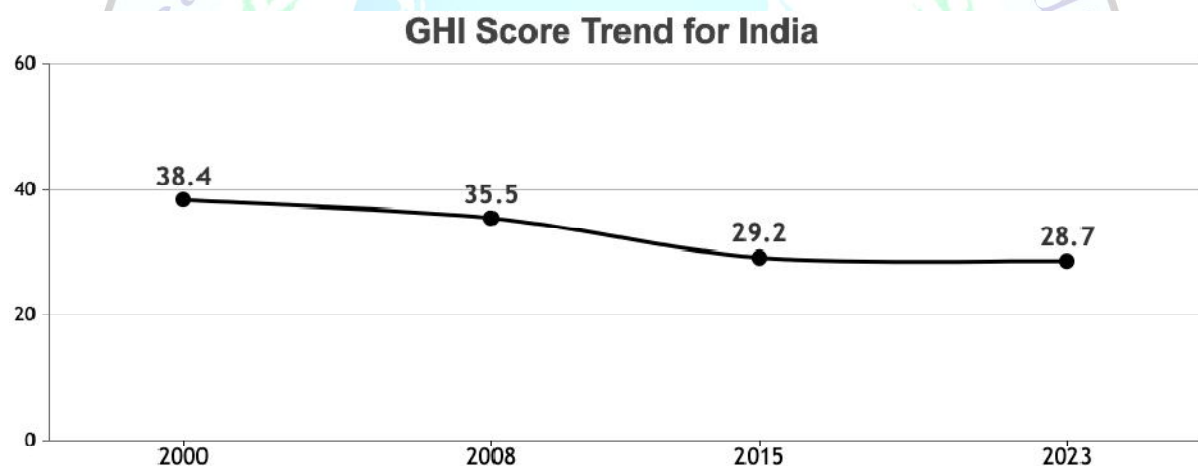
In India also malnutrition in children can be observed as a serious issue. As per one survey carried out by Government of India in November 2021, it is estimated 927606children are severely affected by malnutrition [ (Admin, Outlook India news website)<sup>(35)</sup>]. According to Global Hunger Index (GHI) 2023, a peer-reviewed report, published on an annual basis by Concern Worldwide and

Welthungerhilfe comprehensively measuring and tracking hunger at global, regional, and national levels, India ranks 111 rank out of 125 with GHI score of 28.7 [ (Admin, globalhungerindex Website)<sup>(36)</sup>] as shown in the figure (1). GHI scores are based on the values of four component indicators: undernourishment, child stunting, child wasting, child mortality Considering these four indicator values a GHI score is calculated. The score ranges from 0 to 100 points reflecting the severity of hunger, where 0 indicates no hunger, while 100 is the worst.



**Fig (1) : GHI for India** [(Admin, globalhungerindex Website)<sup>(36)</sup>]

The graph (1) depicts the diminishing trend for the score of GHI, but from the figure (1) one can conclude that still the state of malnutrition in India is in serious state and hence there is need to take precautionary measures.



**Graph (1) : Trend for GHI Score in India**

**3.1. Types of Malnutrition** [(Wajgi, 2022)<sup>(1)</sup>, (Najafloo, 2021)<sup>(5)</sup>, (Fenta, 2021)<sup>(24)</sup>, (Bangare S. &., 2023)<sup>(32)</sup>, (Admin, WHO Website)<sup>(34)</sup>, (Van, 2022)<sup>(29)</sup>, (Sharma, 2020)<sup>(31)</sup>] :

The main 3 types of malnutrition are-

**A] Under Nutrition:**

Here the stunting, wasting and under weight problem arises in children between 1 to 5 year.

**B] Micro Nutrition Deficiencies:**

The deficiency of vitamins and minerals observed in children because of that the growth of child is not according to their age.

**C] Over Nutrition:**

The high nutritional food is the main reason of over nutrition problem which leads to

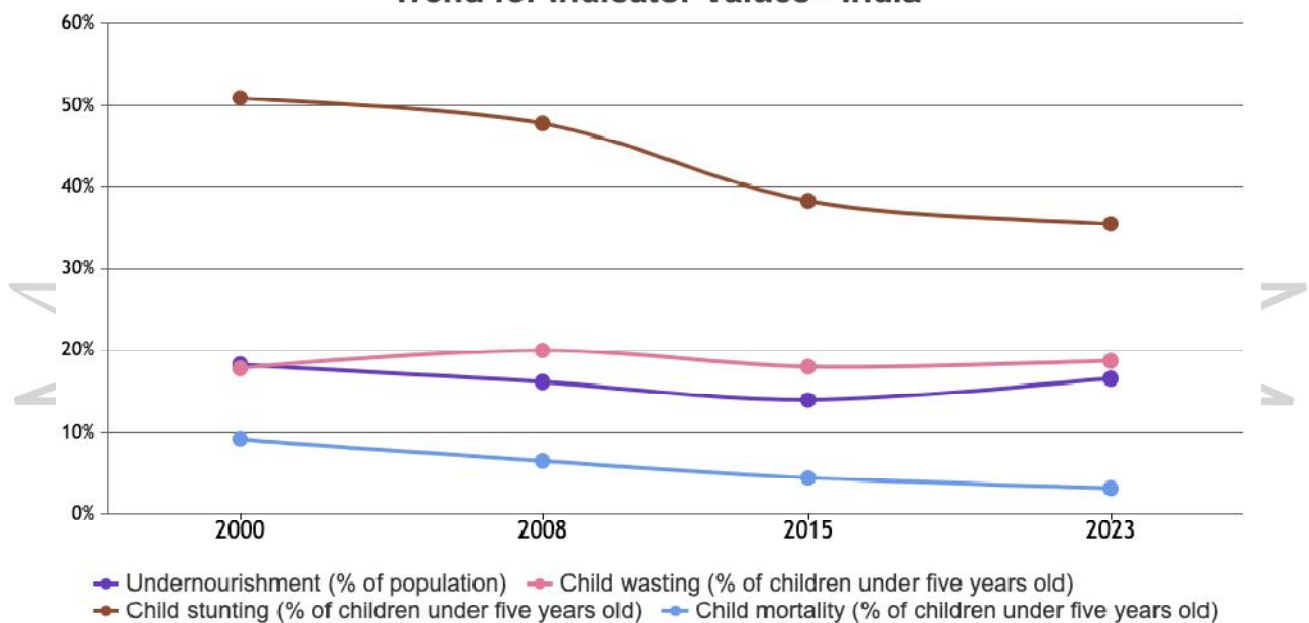
obesity and the overweight related problem seen in child.

### 3.2 Factors leading to malnutrition and Limitations of existing approaches to deal with malnutrition-

Though the main reason for malnutrition are socio-economic factors, poor sanitation and hygienic conditions, lack of awareness about malnutrition, additionally lack of awareness about proper nutritional diet and limited access to healthcare services in remote areas are the major factors. The limit of awareness of knowledge, inadequate infrastructure and resources, the socio-economic factor unbalance, the incorrect co-ordination between doctor and parents, proper sustainable diet plan, regular treatment and check-ups, and most important the patient response be a key point of limitations of existence system mainly [ (Admin, globalhungerindex Website)<sup>(36)</sup>, (Admin, savethechildren Website)<sup>(37)</sup>].

Once the child is diagnosed with malnutrition the treatment is started with proper medication and nutrition, but the treatment as well as effect of malnutrition is long term and it affects overall growth of the child. Hence some precautionary measures are required to be taken at prior stage for which child's early diagnosis is required by considering health parameters of the patient. With the help of an expert the early diagnosis can be done. But due to lack of awareness about malnutrition and scarcity of healthcare facilities parents are helpless, at the same time economical condition of parents is also one of the reason why they avoid taking help from experts. This is where the technology can help them. Next points discuss about how technology can help them in such cases.

**Trend for Indicator Values - India**



**Graph (2) : Trend for indicator Values for various Malnutrition in India**

Though over the period it can be observed that the indicator for different types of Malnutrition is showing diminishing trend, it is time to take some major steps for improving the condition in rural India.

#### **4. Machine Learning for Malnutrition:**

The study of malnutrition shows that it can lead to critical health issues in future, particularly in children from infants to preschool. In such cases parents has to take certain precautions and should try to keep track of child's various health indicator values which helps to find symptoms of malnutrition in the child. But in many developing or undeveloped countries, where GHI is very high, it is not possible for parents to diagnose that their child is suffering with malnutrition and need medical help. In such countries due to lack of sufficient medical facilities and poverty medical facilities are also scarce. In such cases the technology can play a vital role.

Malnutrition in a child can be diagnosed based on certain health indicator count, depending on which the decision is taken regarding the malnutrition. Here Machine learning technique can be used for diagnosis. The model once created and evaluated can be used by any non-medico person for diagnosis. A study proves that Machine learning model can play a major role in clinical study of a patient based on his different health parameters [ (Sharma, 2020)<sup>(31)</sup>].

A Machine Learning model has been developed to diagnose malnutrition in women in Bangladesh and has given better results with the algorithms like Naïve Bayes, Support vector machine (SVM), Decision tree (DT), Artificial neural network (ANN), Random forest (RF)[ (Islam, 2022)<sup>(2)</sup>]. Here the researcher has considered various health attributes data based on which the ML model is designed. While the other researcher, instead of attributes, has developed ML model for facial image to predict BMI using Neural Network [ (Gadekallu, 2021)<sup>(4)</sup>].

In research article titled "Investigation of nutritional status of children based on machine learning techniques using Indian demographic and health survey data", authors has implemented machine learning model to find nutritional status of child [ (Khare, 2017)<sup>(22)</sup>], as well as one other researcher has also developed a ML model using classifier approach to decide determinants for undernutrition in child from age group of 1 to 5 years [ (Fenta, 2021)<sup>(24)</sup>], which can be next step towards diagnosis of malnutrition in the child.

#### **5. Conclusion:**

Machine Learning is a popular technique which provides a variety of algorithms helping in decision making in various fields, and found very helpful in healthcare. In the domain of healthcare also machine learning models are being used in diagnosis of disease based on data or images using image processing algorithms. Malnutrition found in children is affecting their future life in long term and may lead to other diseases as it weakens the overall health of child. Hence early detection of

malnutrition in child is necessary. Also to treat the malnutrition, depending on its type, the expert advice is required which is possible when medical services are easily available at affordable cost. Here the technology can play a major role and help parents for early diagnosis of malnutrition in child where, using a machine learning model, a non-medico person can also help. Development of efficient and accurate machine learning model is required.

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