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A way to improve sustainable wellbeing using artificial intelligence techniques

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Abstract

Malnutrition is a global health issue that affects people of all ages especially children malnutrition can lead to various number of health problems. It is particularly prevalent in low income countries because of factors such as poverty, lack of nutrition food etc., This study aims to classify the malnutrition type, compute deficiency level and suggest suitable measure to patient through mobile app. To accomplish this Artificial Neural Network (ANN) is used to build this model. This study clarifies how predictive model classifies the malnutrition. ANN approach shows the best accuracy in predicting malnutrition deficiency. Global dataset is used to train the model. Pre-processing is done using imputation technique. Feature extraction is done with the help of CNN technique. Model building is done using ANN technique. Deficiency level of malnutrition is calculated with the help of benchmark values. Suitable measures for patients are suggest using mobile app.

Keywords: Malnutrition; AI (Artificial Intelligence); ANN (Artificial Neural Network); CNN (Convolutional Neutral Network); Imputation

1. Introduction

Nutrition is an important part of health and development. It is important to be healthy, in order to have normal growth development and reduce the risk of disease leading to overall health and well-being.

Malnutrition is caused mainly due to lack of essential vitamins, minerals, protein, iodine, iron etc., Malnutrition leads to various health issues. It is particularly prevalent in low income countries because of factors such as poverty, lack of nutrition food etc., Some of the malnutrition focused in this paper is kwashiorkor, marasmus, goitre, anaemia and xerophthalmia. Ensuring sustainability in healthcare and well-being of people can be achieved by using AI Techniques. Mainly children are getting affected by malnutrition 75 to 80% of children suffer from some type of malnutrition. According to world hunger Index 2.5 million people in India de every year due to malnutrition [1].

Artificial intelligence can be used to solve malnutrition problem by developing better food production methods, improving food distribution system, and creating targeted nutrition education programs [2].

Imputation is a technique used to replace the missing values in the dataset by mean values of the corresponding column. This technique is used for data cleaning and it helps to improve accuracy of data analysis. CNN is a kind of network architecture used specifically for image recognition [3]. It is used in feature extraction by extracting features from an input image and the using them to classify the image. CNN is used to extract meaningful features from input image that can be used to classify the image. ANN is used in building the model by using the extracted features from CNNs to create a model and then train the model on dataset. Once the model is trained, it can be used to identify type of deficiency and compute deficiency level.

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2. Related work

In this paper there are five nutrition such as Marasmus, Kwashiorkor, Anemia, Goitre, Xerophthalmia were tablulated for consideration. The ways to identify each nutritional deficiency where tabulated in the following section,

3. Material and methods

3.1. Marasmus & Kwashiorkor

Table 1 Marasmus and Kwashiorkor deficiency

S. N o	Title ofthe paper	Technique used	Merits	Demerit s
1	Malnutrition Detection using Convolutional Neural Network[4]	CNN (Convolutional Neural Network)	Accuracy and Effective	Doesn't define the type of malnutritio n
2	The Modelling of Artificial Neural Network of Early Diagnosis for Malnutrition with Back Propagation Method [5]	(BPNN) Back Propagation Neural Network	Effective, Accurate, Simple tool to assist Doctor.It reduces manual Diagnostic serror.	Poor generalizat ion, Difficult to control training
3	Recommend at ion of Diet to a Patient using AHP and Fuzzy Approach [6]	Analytic Hierarchy Process and Fuzzy Approach	More comprehensive	Fuzzy approach may not be able to capture all of the nuance and complexity of the person'sdiet
4	A Deep Learning Approach to Predict Malnutrition Status of 0-59 Month's Older Children in Bangladesh[7]	Artificial Neural Network	Accurate, It reduces the number of begin malnourished	Specific Focus, Insufficien t number of data.
5	Data Mining Based Prediction of Malnutrition in Afghan Children [8]	Regression Tree Algorithm	Effective, Reduce overall burden	expensive in terms of both time and space.

From the above table, it is observed that the prediction of Marasmus & Kwashiorkor Using CNN algorithm is effective in comparison with others.

3.2. Anemia

Table 2 Anemia deficiency

S. No	Title of the paper	Technique used	Merits	Demerits
1	Anemia Detection Using Ensemble Learning Techniques And StatisticalModels [9]	Ensemble Learning Techniques (knn, ANN,naïve bayes, decision tree)	Highest, Precision, Accuracy	Expensive in terms of both time and space
2	Anemia Diagnosis by Fuzzy Logic Using LabVIEW [10]	Fuzzy Logic	Fast evaluation of disease compared to manual analysis	Fuzzy logic is a complex method and requires Specialized training to use
3	Sickle cell Anemia	Convolutional	Achieved 94.57%	The neural network may

	Detection using Convolution al Neural Network [11]	Neural Network	Testing Accuracy	not be able to generalize well to data that is not similar to the data used to train the network
4	Automatic Sickle Cell Anemia Detection Using Image Processing Technique [12]	Image Processing Technique	Accuracy, Automatic Detection, Technique	Less accurate than other methods of sickle cell anemia detection
5	Mobile Application for Anemia Detection Through Ocular Conjunctiva Image [13]	Deep learning	Its non- invasive method that can be used to screen for anemia	Accuracy of the detection may be affected by factors such as lighting and angle of the camera.

From the above table, it is observed that the prediction of Anemia Using CNN algorithm is effective as it gives good accuracy rate and not expensive in comparison with others.

3.3. Goiters

Table 3 Goitre deficiency

S . No	Title of the paper	Technique used	Merits	Demerits
1	TDTD: Thyroid Disease Type Diagnostics[14]	Support Vector machine (SVM)	Evaluation is approximate	To improving the continuing to work on improving the accuracy of the diagnostictools.
2	Diagnosis Method of Thyroid Disease Combining Knowledge Graph and Deep Learning [15]	Bidirectional Long Short-term memory Network (BSTLM)	It may be more accurate than other methods. Effective for modelling sequential data	It is more complex, less user- friendly for some patients
3	Knowledg e Based Fuzzy Inference System for diagnosis of Diffuse Goitre IEEE [16]	Fuzzy Logic, Neural network, Bayesian inference	Reduce the number of false positives and false negatives.Accurate diagnose the condition based on thesymptoms.	K-FIS can be difficult to implement and interpret. It is not always accurate, and may misdiagnosesome cases of diffuse goitre.
4	Hypothyroidism Prediction and Detection using Machine Learning[17]	Support Vector machine (SVM), Naïve Bayes, Decision Tree	Decision tree Algorithm showed highest accuracy	Expensive to create. Leads to delayed diagnosis of hypothyroidis m.
5	Thyroid Diagnosis from SPECTImages using Convolutional Neural Network with Optimization [18]	CNN(Convolutional Neural Network)	Efficient and Accuracy	Require large amount of data.Doesn't identify all type of thyroid

From the above table, it is observed that the detection of goitre using decision tree gives higher accuracy in comparison with another machine learning algorithm.

3.4. Xerophthalmia

Table 4 Xeropthalmia deficiency

Sr.NO	Title of the Paper	Technique Used	Merits	Demerits
1	Vitamin Deficiency Detection Using Image Processing and Artificial Intelligence [19]	Image processing and Artificial intelligence	Accuracy, Efficiency, Accessibility	Most Expensive. Not able to detect all type of vitamin deficiency.
2	Analysis of colour Vision Deficiency Using Machine Learning [20]	Vector machine, Decision trees, Logistic regression	Auto detect data. Better understand of deficiency.	Not able to provide accurate result
3	Empirical mode decomposition and neural network for the classification of electro retinography data [21]	Artificial Neural Network	Accurate, flexible	Computational cost over fitting
4	An Ophthalmolog y Study on Eye Glaucoma and Retina applied in AI and Deep Learning Technique [22]	Support vector machines, Deep learning	Increased accuracy. Increase speed. Reduced cost.	Data set may be too small. Data set may not be representative of the real world.
5	Explainable Machine Learning for Vitamin A Deficiency Classification in School children [23]	Decision tree Algorithm	Improve accuracy. Identify important features.	Not able to generalize new data. Too complex.

In the above table, detection of Xerophthalmia using Artificial Neural Network is more accurate and more flexible to compare than another Algorithm.

4. Traditional Method to Ensuring Sustainable Well Being

4.1. "Kwashiorkor" Nutritional Deficiency

The main cause of kwashiorkor is insufficient intake of protein or other essential vitamins and minerals. It is most common in developing countries with limited food supply, poor hygiene and insufficient education about the importance of providing adequate nutrition to infants and children. Kwashiorkor is rare in developed countries such as the UK, but occasionally it can occur as a result of severe neglect, long-term illness, lack of knowledge about proper nutrition or a very restricted diet.

Although kwashiorkor can affect people of all ages, it is more common in children than adults. Kwashiorkor can often be diagnosed based on the child's physical presence and questions about their diet and care. However, a blood test and urine test may be completed to rule out other conditions. This may include tests for:

- Measure blood sugar and protein levels.
- Check how well your liver and kidneys are working by testing your urine and blood for anaemia.
- Measure the levels of vitamins and minerals in the body.

Other tests may include measuring growth, calculating body mass index (BMI), and measuring body water content, taking a sample of skin (biopsy) or hair for testing [24]. The main cause of kwashiorkor is insufficient intake of protein or other important vitamins and minerals. It is most common in developing countries with limited food supplies, poor sanitation and a lack of education about the importance of providing adequate nutrition to infants and children.

4.2. . "Marasmus" Nutritional Deficiency

Marasmus is another type of malnutrition that can affect young children in areas of the world where the food supply is unstable. Symptoms of marasmus include thickness and loss of fat and muscle without any tissue swelling (edema) [25]. Marasmus is a deficiency of all macronutrients: carbohydrates, fats and proteins. If you have marasmus, you lack the fuel necessary to maintain normal body function. People with marasmus are visibly exhausted, severely underweight and emaciated. Children may be stunted in size and development. Prolonged marasmus leads to starvation.

Marasmus can affect anyone who lacks overall nutrition, but it especially affects children, especially infants, who need more calories to support their growing bodies. It is more common in developing countries with widespread poverty, and infectious diseases may contribute to calorie restriction. In the developed world, older people in nursing homes and hospitals or people living alone with limited resources are more at risk.

Health care providers will begin by physically examining the person's body. Marasmus has certain physical features, the primary of which begins with visible loss of fat and muscle. People with marasmus look emaciated. Loss of fat and muscle underneath the skin can cause the skin to hang loose in the folds. In addition to appearance, health care providers will measure a person's height or length and upper arm circumference.

Healthcare providers use several different charts to measure a child, Marasmus is defined differently on different charts, but it's always well below average. To use a chart that more people are familiar with, marasmus would be a score below 16 on the BMI. The purpose of scoring is mostly to confirm the diagnosis and assess its severity.

Diagnosis is primarily based on body measurements, which are then scored according to different scoring systems for children and adults. Upper arm circumference and height-to-weight ratio help health care providers assess the severity of malnutrition. Height-for-age ratio helps define growth retardation in children. Health care providers usually recognize the type of malnutrition based on physical symptoms.

The next step will be to run a blood test to identify secondary effects of marasmus, including specific vitamin, mineral, enzyme and electrolyte deficiencies. This will help determine the nutritional needs of the child or adult for supplementary feeding. A complete blood count can also help detect any infections or diseases that can check a stool sample for parasites. Infections will need to be treated separately.

4.3. "Xerophthalmia" Nutritional Deficiency

Xerophthalmia is a condition that causes dry eyes due to a lack of vitamin A. If left untreated, it can progress to night blindness or eye spots. It can even damage the cornea of the eye and cause blindness [26]. It can be treated with vitamin A supplements.

The main risk of xerophthalmia is poverty and lack of adequate diet, especially lack of animal products. Infants and children are at greater risk. The younger the child, the more serious the consequences of vitamin A deficiency. Babies need a lot of vitamin A to grow. Vitamin A deficiency also affects the ability to survive common childhood infections and illnesses such as diarrhoea, measles and respiratory infections. Method of diagnosis of xerophthalmia

- Complete medical history: Your provider will take a medical history that will include information about food intake.
- Complete eye exam: Your provider will perform a thorough eye exam.
- Clinical signs: This means your provider will assess the signs and symptoms that are affecting your eyes (clinical signs).
- Blood tests: These tests will measure vitamin A levels.
- Night Vision and Dark Adaptation Tests: These tests measure how well you can see in dim and darker light and how long it takes your eyes to adjust to the dark.
- Imprint cytology: This technology tests samples from the conjunctiva for ocular surface disease.
- Electroretinogram: This test measures the way your eyes react to light.

4.4. . "Anemia" Nutritional Deficiency

Anemia occurs when you don't have enough red blood cells or your red blood cells don't work as well as they should. Your red blood cells carry oxygen throughout your body. Oxygen fuels your cells and gives you energy. Without healthy

red blood cells doing their job, your body doesn't get the energy it needs to function. While some types of anemia are short-lived and mild, others can last a lifetime. If untreated, anemia can be life-threatening.

People can be born with a certain type of anemia, or they can develop anemia because they have certain chronic diseases. But a poor diet causes iron deficiency anemia, the most common form of anemia. Anemia is a serious global public health problem, particularly affecting young children and pregnant women. WHO estimates that 42% of children under the age of 5 and 40% of pregnant women worldwide are anemic. Methods of diagnosing Anemia [27].

- Complete blood count (CBC): An ACBC is used to count the number of blood cells in a sample of your blood. If you're anemic, your doctor will probably look at the levels of red blood cells in your blood (hematocrit) and haemoglobin in your blood.
- Reticulocyte count: Measures the number of immature red blood cells in your bone marrow. Health care providers measure reticulocytes to see if your bone marrow is producing enough healthy red blood cells.

4.5. "Goitre" Nutritional Deficiency

A goitre is a condition where your thyroid gland becomes enlarged. Your thyroid gland is getting bigger. Your entire thyroid may become enlarged, or one or more small lumps called thyroid nodules may form. A goitre is a condition where your thyroid gland becomes enlarged. Your entire thyroid may become enlarged, or one or more small lumps called thyroid nodules may form [28].

Your thyroid gland is a small, butterfly-shaped endocrine gland located in your neck, below your Adam's apple. It produces the hormones thyroxin (also called T4) and triiodothyronine (also called T3). These hormones play a role in certain bodily functions, including:

- Metabolism.
- Body temperature.
- Mood and excitability.
- Pulse and heart rate.
- Digestion.
- Iodine deficiency:
- Graves' disease

A goitre is an adaptive response of the cells in your thyroid gland to any process that blocks the production of thyroid hormones. While the most common cause of goitre worldwide is iodine deficiency, many conditions can cause it.

- Hashimoto's disease
- Thyroid cancer
- Thyroiditis

Goitre is more common after the age of 40. A family history of goitre or other thyroid disorders increases the risk of goitre. Researchers have also identified genetic factors that may be associated with increased risk, with women being about five to eight times more likely to be diagnosed with thyroid disease than men. The risk in women is about 10 times higher than in men. One reason is that thyroid disorders are often triggered by autoimmune reactions that occur when thebody's immune system starts attacking its own cells. Several tests to diagnose and evaluate goitre

- Physical exam: Your provider may be able to tell if your thyroid is enlarged by feeling for nodules and signs of tenderness in the neck area.
- Thyroid blood test: This blood test measures your thyroid hormone levels to reveal if your thyroid is working properly.
- Antibody test: This blood test looks for certain antibodies that form in some forms of goitre. An antibody is a protein made by white blood cells. Antibodies help defend against invaders (such as viruses) that cause disease or infection in your body.
- Thyroid ultrasound: Ultrasound is a procedure that sends high-frequency sound waves through the body's tissues. Echoes are recorded and transformed into video or photos. Your provider can "see" your thyroid to check its size and whether it has nodules.
- Biopsy: A biopsy is the removal of a sample of tissue or cells to be studied in a laboratory. If you have large nodules in your thyroid gland, you may need a thyroid biopsy. A biopsy is taken to rule out cancer.

- Thyroid uptake and scan: This imaging test provides information about the size and function of the thyroid gland. In this test, a small amount of radioactive material is injected into a vein to create an image of your thyroid gland on a computer screen. Providers do not order this test very often because it is only useful in certain circumstances.
- CT scan or MRI (magnetic resonance imaging) of your thyroid gland: If the
- Goitreis very large or has spread into the chest, a CT scan or MRI will be used to measure the size and extent of the goitre.

5. AI Enable Ways to Improve Sustainable Well Being

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer science systems [2]. Specific applications of the AI include expert systems, natural language processing, and speech recognition and computer vision.
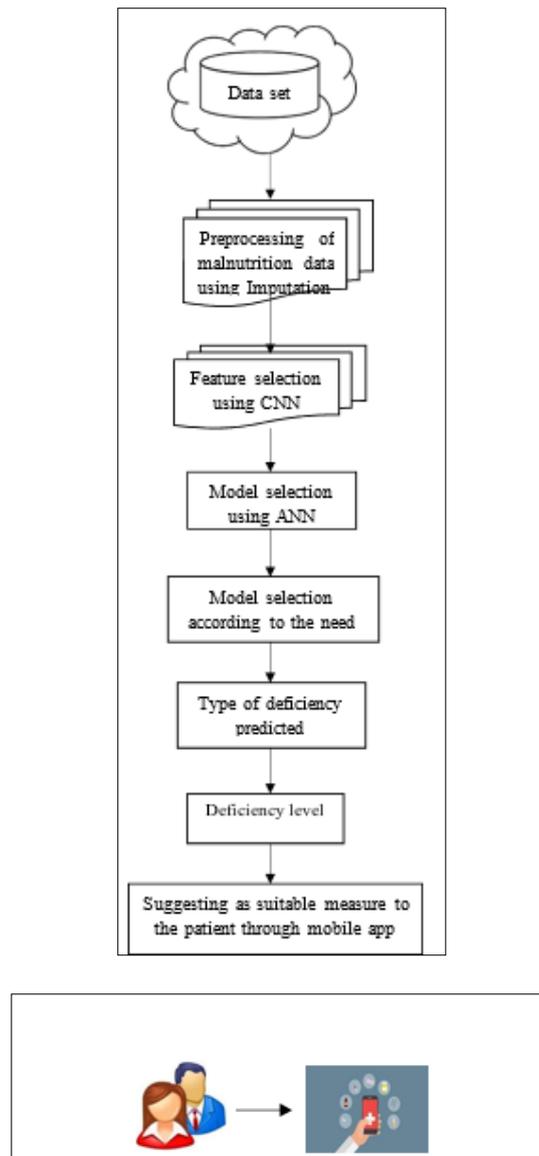

Figure 1 Framework for AI Enabled Sustainable well begin

AI is one of those computer sciences that study how to make machines that can exert as much effort like and well as those done by humans and even enhanced than what the human does.

AI is playing a major role in developing more targeted and modified nutrition interventions, based on an individual's specific dietary needs. It is monitor and predict changes in food availability and prices, in order to better target assistance to those who are most at risk of malnutrition.

It is used to map and track the spread of malnutrition, in order to more effectively target prevention and treatment efforts and used to identify and target social and behavioural factors that contribute to malnutrition, in order to develop more effective intermediation

It can be used to analyse data from various surveys and other health records to identify pattern in nutritional status. Al can be used to analyse dietary pattern and lifestyle choice that may indicates malnutrition. AI in healthcare can enhance prevention care and quality of life, produce more accurate diagnosis and treatment measure.

An AI based malnutrition detection using convolution neural network (CNN) with global malnutrition dataset can be used to solve insufficient number of data problem. In first phase, the data is cleaned to remove noisy data and convert into numeric values using mean imputation and with the help of NumPy library. To keep data in standard from mean normalization of feature scaling is done some features do not have any impact on malnutrition in general. Therefore, the labelling of data and feature extraction is very important. CNN Algorithm plays an important role in extracting features [3]. Model selection is done with the help of Artificial Neural Network Algorithm.

Artificial Neural Network is similar to functioning of human brain. It consists of nodes that are connected with the help of edges. Weights in the edges are adjusted during training period.

There are five model's kwashiorkor, Goitre, Marasmus, Xeropthalmia, Anaemia. The models are selected according to their needs. The bench mark provided by WHO helps the system to define the type of malnutrition.

Type of deficiency is predicted with the help of benchmark values and provided by WHO. Deficiency level defines the level of deficiency as normal, below normal or above normal. Based on results obtained suitable measures are suggested to patient through a mobile app.

6. Conclusion

Thus, the insufficient number of data problem in previous works can be solved using global malnutrition dataset. So far works have been made in determining malnutrition level separately for each type. This paper aim sat identifying five major type malnutrition under one roof. Malnutrition affects millions of people worldwide 75 to80% children suffer from malnutrition [1]. To solve this issue developing healthcare system using AI techniques is the best solution. Furthermore, to fulfil the sustainable development goal (SDG), this paper plays an important role in reducing number of deaths to half by detection of malnutrition. The future works in this paper can be implementation of improved nutrition monitoring system that provides timely alert to the people regarding their foods, medicine, lifestyle related activities using advancedAItechniques.Finally,greatercollaborationbetweennutritionresearched,practitioners and policymakers are needed to ensure that the most effective and equitable interventions are developed and implemented regarding their foods, medicine, lifestyle related activities.

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