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Machine Learning (ML) in Diet Planning for Type-1 Diabetes - An Overview

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Abstract: Diabetes is a chronic non-communicable disease that has become a significant public health issue for decades globally. Diabetes can slowly destroy the human body from head to leg if not appropriately treated and managed through medication, diet, and physical activities. The pancreas fails to secrete insulin or enough insulin in type-1 diabetes, while the organ secretes the same hormone sufficiently, but the body cannot process it properly in type 2. In this article, the focussed area is type-1 diabetes which is most prevalent among children and adolescents. The article tried to link up with Industry 4.0, which is a great blessing for all of us. Industries got machine learning and other applications that can help predict, analyze, assess, and intervene in diabetes and other deadly diseases. The data on type-1 diabetes can be collected from private and public settings for exploratory data analysis (EDA) followed by model selections (4ML models and saving models). Different machine learning algorithms are usually employed for classification, prediction, and detection despite fluctuating blood sugar records. Various studies showed that an artificial neural network (ANN) would be the best choice for these needful actions having a 34% rate of applications. In addition to these applications, calorie (diet and exercises) assessments can be done much more precisely. In conclusion, learning of machine learning has now become mandatory not only for data science people but also for physicians, dietitians, and healthcare researchers.

Keywords: Diabetes, Type-1 Diabetes, Machine Learning, ML in Diet, Calorie Assessment.

1. INTRODUCTION

According to recent publications, India shows approximately 96 thousand type-1 diabetes cases below 14 years of age, and around 16 thousand new cases are diagnosed in the same population. In India, about 2.5 lakh people are affected by type 1 diabetes. Children with type 1 diabetes need support in various aspects such as using insulin, diet, exercise, or level of physical activities.[1] They need to live normally like others without stigma and all complications due to this disease. As per the Indian Council of Medical Research, there is a need for crucial management of all sides of diabetes, mainly glycemic, i.e., blood glucose control. According to a news report, about 1.1 million people below 20 years of age are affected by type-1 DM globally, with 0.13 million new

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cases each year. The information was published by the international diabetes federation (IDF-ATLAS). [1]

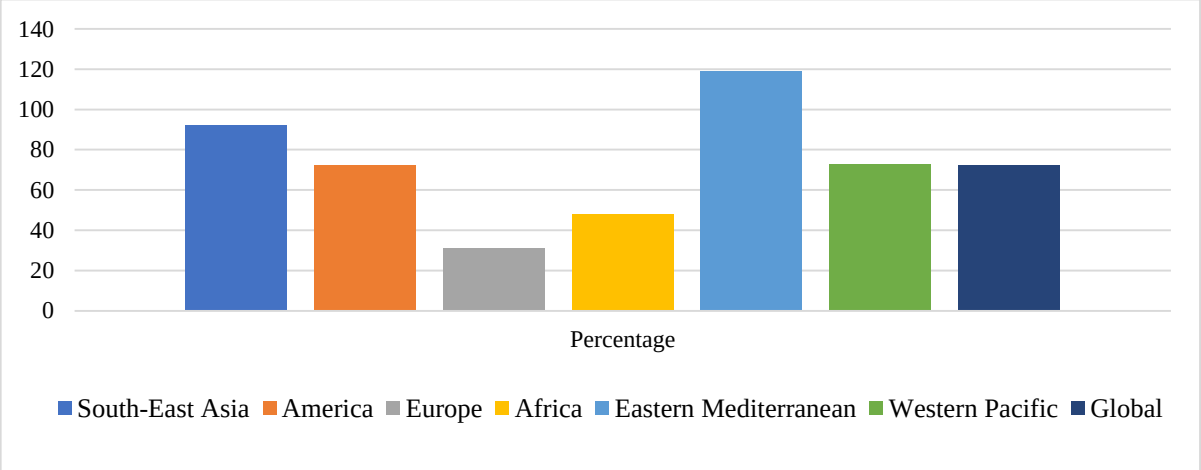

Fig.1. Change in deaths (%) in diabetes as per WHO regions,2019 [2]

Fig. 1 shows the comparison of death by diabetes mellitus by percentage in WHO regions. Eastern Mediterranean is affected chiefly (20% increase than 2000), and Europe regions are the lowest (31%).[2]

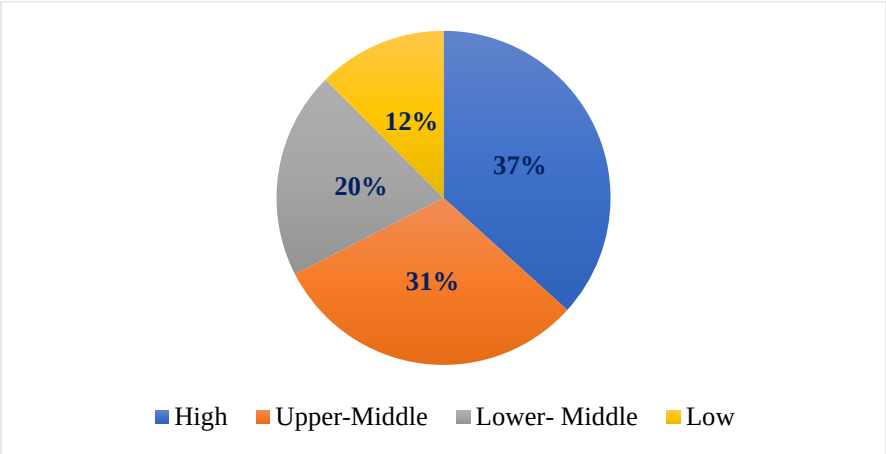

Fig.2. Health expenditure (%) based on world bank income group -2019 [2]

Fig. 2 shows that the health expenditure rate worldwide seems to be a significant factor in non-communicable diseases like diabetes based on the world bank's four income groups. The high-income group is 37%, and Low income is 12% worldwide. [2]

2. METHODOLOGY

This article primarily focuses on machine learning (ML) in diet planning for diabetes, mainly type-1 diabetes mellitus. The aim is to look into the prospects in healthcare and highlight diet

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and nutrition care for diabetic patients. The online search of relevant open-access literature was available in the National Center for Biotechnology Information (NCBI), mainly Pubmed, Directory of Open Access Journals (DOAJ), and Google Scholar was accessed as references. 'Machine learning in diabetes,' 'Role of machine learning in type-1 diabetes, 'Machine learning in dietary assessments,' etc. keywords and phrases used for online searches. [3]

3. RESULTS AND DISCUSSIONS

3.1) Machine learning is a new era for diabetes assessments and treatments.
New technology and its upgradation are always a boon for society. In the current generation of artificial intelligence, machine learning (a subset of ML) has already been integral to learning in the healthcare industry. Industry 4.0 is a great revolution that helps industry, academia, data analysis, public health, and various medical fields. The whole world is affected by diabetes, and the rate of diabetes in India is 10%. Pakistan is the highest at 31%, and Benin is the lowest at 1%, as per IDF 2021. The pancreas fails to secrete insulin or enough insulin in type-1 diabetes, while the organ secretes the same hormone sufficiently, but the body cannot process it properly in type 2. In this article, the focussed area is type-1 diabetes which is most prevalent among children and adolescents. The common problem is an elevated blood sugar level (hyperglycemia) due to a lack of insulin hormone resulting in starving cells.[4] Diabetes, whether type 1 or 2, can be predicted and assessed by machine learning applications. Many data science, public health, and other medical professionals are working on this and its great future in the healthcare industry. Raw data analysis (computations) should be the initial phase, and secondly, exploratory data analysis should be followed by model selections (e.g., 4ML models and Saving models). [5]
3.2) Machine learning classifications and probable applications in type-1 diabetes
For type 1 diabetes, the potential rate of hypoglycemia is 26%, where several ML approaches can be employed for classification, prediction, and algorithm detection. In a study, decision trees were shown to be the most effective method at 6%. At the same time, combinations of ML approaches with specific other applications, such as fuzzy logic and time series, were employed at around 18%. Deep belief network (DBN), variable translation wavelet neural network (VTWNN), and radial basis function neural network (RBFNN) were other categories of machine learning with usage rates of about 2% each. Around 5% of experts in machine learning also favor the use of genetic algorithms, time-sensitive and delay-sensitive artificial neural networks, block-based neural networks, and adaptive neural fuzzy inference systems. Additionally, the highest applicable categories in ML, with a potentiality of 3%, are Gaussian process regression (GPR), combinational neural logic system (CNLS), Bayesian neural network (BNN), Nonlinear autoregressive network plus exogenous inputs (NARX), and Nonlinear autoregressive network (NAR). Comparatively speaking to hypoglycemia, hyperglycemia has received less attention in classification, prediction, and detection, which may be related to the fact that it tends to induce fewer severe short-term consequences. Different machine learning algorithms have been employed despite this constraint. However, the most used machine learning method is ANN, practiced in 34% of all cases. [6]

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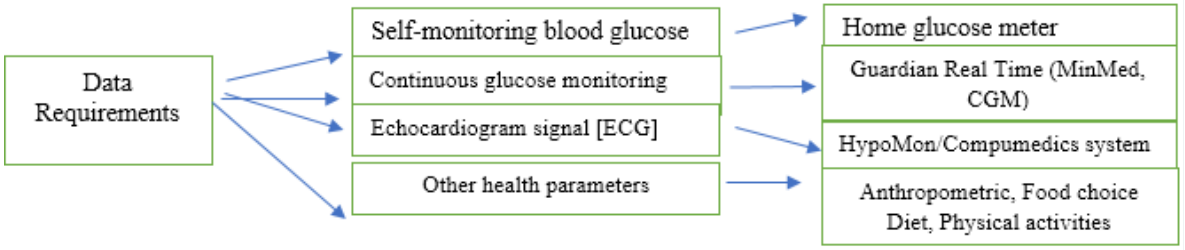

Fig.3. Requirement of data and most useful devices for the blood glucose monitoring

3.3) Machine learning and other parameters

The machine learning techniques have emphasized input parameters as essential data for type -1 Diabetes Mellitus: QT interval, heart rate, BG, heart rate, insulin recommendation, diet follow-up, exercises, or total activities per day. Most research papers have applied a theoretical model recommended by data science experts and doctors, including the American Diabetes Association (ADA). The significant factors are different data types, scalability, order insensitivity, and robustness, which can vary in individual and community settings. Therefore, a model must consider these patients' case differences and track how they change over time. [6],[10]

3.4) Machine learning in dietary assessments and applications

Electronic health records can be kept and periodically analyzed by machine learning models in various settings to suit human needs. In nutrition science, wearable gadgets with gyroscopes and accelerometers can be used to evaluate nutritional intake. An individual's approximate calorie intake and eating habits can be predicted by wrist and hand movements. This forecasting technique can be used to monitor everyday physical activity as well. A self-management decision-support system in healthcare that ML models properly drives the operating system. The great thing is that wearable sensors can monitor blood glucose for treating type-1 and type-2 diabetes mellitus. [9],[10]

3.5) Use of Machine learning in calorie estimation

Since April 2020, Covid-19 waves have been a significant issue to rethink immunity that depends on proper diet. A proper diet means good food that provides all nutrients proportionately to an individual. A trending name in the diet list is 'diabetic diet' for a diabetic patient; however, the name of the diet type does not have significance scientifically unless there are good research papers, mainly randomized control trials (RCT) and grants of patents.
There are many herbs, spices, fruits, and vegetables apart from cereals treated as a natural anti-inflammatory, healing agents that help to receive nutrients daily. [7] Various techniques are also applied through machine learning to estimate calories by measuring the correct quantity of carbohydrates that may affect the diabetic patient. Nutraceuticals cum pharma companies manufacture various dietary supplements, but very few are therapeutic and can be recommended to patients for preventive or critical purposes. The safety parts are always discussed by researchers, dietitians, and physicians despite being popular in the market. [7]

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4. CONCLUSIONS

In the current era of artificial intelligence, machine learning (a subset of AI) has already been an integral part of the healthcare industry. Machine learning is beneficial for predicting, detecting, and future analysis of most noncommunicable diseases, while type-1 diabetes is one of the major concerns. There should be compulsory learning of machine learning for every medical professional. More research is needed to understand the all-out applications and motivate learners in type-1 diabetes. It is expected to contribute significantly to the dietetic world for total diet management, particularly in diabetes.

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