ORIGINAL RESEARCH PAPER

Biochemistry

ROLE OF ARTIFICIAL INTELLIGENCE IN NUTRITION; CAN IT REPLACE EXPERT NUTRITIONIST/ DIETICIAN?

KEY WORDS:

Dr. Srilatha Bashetti	Associate professor, Department of Biochemistry, Apollo Institute of Medical Sciences & Research, Hyderabad, Telangana, India.
Dr. Raghavendra Rao M. V*	Professor, World Academy Of Medical Sciences, Netherlands Europe *Corresponding Author
Mr. Ganesh Bheemanaboina	Ph.D Scholar, Department Of Biochemistry, Saveetha Institute Of Medical & Technical Sciences, Chennai, Tamil Nadu.
Dr. Abdur Rahman	Assistant Professor, Department Of Biochemistry, Dr. Patnam Mahender Reddy Institute Of Medical Sciences, Chevella, Telangana.
Dr. Neetha Kundoor	Professor, Department of Biochemistry, Apollo Institute of Medical Sciences & Research, Hyderabad, Telangana, India.
Dr. Keerthan Reddy Thanam	Medical Intern, Apollo Institute of Medical Sciences & Research, Hyderabad, Telangana, India.
Dr Shreekar Reddy Surkanti	Medical Intern, Apollo Institute of Medical Sciences & Research, Hyderabad, Telangana, India.

ABSTRACT

Good nutrition with physical activity contributes to maintain healthy and fit body, reduces the risk of various health complications like diabetes, hypertension, obesity, cardiac diseases and cancer. Artificial intelligence is known as computers act like a human and in a fraction of time it takes a person to do it. Human existence improved a lot in a variety of ways by artificial intelligence. AI is a boom in various fields including health care. It is helping to understand the complex phenomena of biological system, diagnoses of various diseases, predicting the related clinical outcomes and also help in designing the novel treatment/therapies. AI had even encroached the field of nutrition for better health by developing various applications. In the field of AI, Artificial Neural Networks (ANNs) are widely used current modelling technique, it is a model created inspired by human brains natural neuron structure. Various AI-based apps in planning nutritional meal for either prevention, control or treat certain diseases like cancer, CVD, etc; and metabolic disorders like DM, obesity, etc; are under trial and a few are in practice. AI algorithms are capable of analysing vast volumes of data and offering insights into nutrition and health. It can't offer recommendations that are tailored to each person's needs, interests, and health circumstances and can modify these recommendations as necessary. AI can't also offer motivation and emotional support, both of which are frequently essential for making long-lasting dietary adjustments. The limitation of AI in nutrition can be justified by stating that AI doesn't specifically focuses on user's own requirements.

INTRODUCTION:

Healthy and fit life is possible only by having nutritional food. Good nutrition with physical activity contributes to maintain healthy and fit body, reduces the risk of various health complications like diabetes, hypertension, obesity, cardiac diseases and cancer. Healthy diet may not only reduce the risk but may also prevent us from many diseases. Unhealthy eating contributes to weight gain, obesity, type 2 diabetes and many more health complications on the other hand poor nutrition leads to poor health and frequent illness (1). Balanced diet, with proper time intervals and regular physical activity in short, disciplined life is the only solution to lead a disease-free healthy life. In the modern era new technology emerged to suggests the diet to be consumed, to avoid and the nutritional value of the food we are consuming. One such application is the product of artificial intelligence (AI).

Artificial Intelligence was first proposed by John McCarthy in 1956 Software intelligence or Machine is referred to as artificial intelligence. Artificial intelligence as the ability of an artificial entity to solve complicated problems using its own intelligence. Computer science and Physiology are amalgamated in artificial intelligence. Artificial intelligence is known as computers act like a human and in a fraction of time it takes a person to do it. By applying general knowledge to particular situations, artificial intelligence seeks to push the boundaries of practical computer science and create systems that are flexible, adaptable, and capable of creating their own analyses and problem-solving methods. Human existence improved a lot in a variety of ways by artificial intelligence. AI is a boom in various fields including health care. It is helping to understand the complex phenomena of biological system, diagnoses of various diseases, predicting the related clinical outcomes and also help in designing the novel treatment/therapies. AI had even encroached the field of nutrition for better health by developing various applications. Applications of AI in the field dietetic and nutrition is fairly new. Food choices are negatively influenced by a busy lifestyle, bad habits, and low self-control (2,3). The features of AI in designing the clinical nutrition application aim to provide information related to diet intake, diet interpretation apt to the person's health condition and also provides feedback related to the diet consumed. Various mobile apps, wearable technologies are the products of AI helps in tracking the information related to diet intake and suggests diet and uses tele-health mode for the assessment of nutrition at remote.

AI is one of the computer applications which independently or partially dependently performs certain functions mimicking the human intellect. Similar functions can be ported to the applications in the field of nutrition too. In recent years, the use of smartphones to track food consumption or

compute the nutritional value of food's has expanded due to the increasing number of food consumption tracking and recommendation apps in the app stores, and the great potential of smartphone's to be a useful tool (4). Nowadays in app stores, many apps are focused on health and fitness. In the major app stores, there were 32,500 mobile health apps available in 2017 and this number is continuing to rise (5). Apps can play an important role in simplifying the tracking of health-related behaviours and weight management (6). Moreover, the usage of smartphones and rapid development of artificial intelligence (AI) technologies have enabled new food identification systems for dietary assessment, which are significant for the prevention and treatment of chronic diseases such as type 2 diabetes mellitus, cardiovascular disease, and overcoming health issues such as obesity (7). Furthermore, food intake behaviour (e.g., assessment of calorie intake, nutritional analysis, and eating habits) can be analysed if food items or categories are recognized. The major domains designed using AI in nutrition apps are optimization of diet, risk predictions, analysing patterns of diet and recognition of food images.

Optimization of diet – this technology was developed by Israeli investigators, commercialized with Day Two mobile app. This app focuses on the post-prandial glycaemic response (PPGR) followed by carbohydrate meal. Initially diet based one-week data was collected including demographical data, blood glucose levels, HbA1C (Glycosylated haemoglobin), cholesterol and considered the lifestyle activities like sleep, physical activity, etc; in about 900 healthy and fit individuals. The diet was customised as per the dietitian's designed diet based on participants preferences and their constraints. Further a trail was performed on 26 healthy individuals as prediction arm (technology based) and expert arm (Dietitian -designed diet) as hypothesized good diet showed low PPGR and bad diet resulted in high PPGR values and when compared the significance of the results derived from expert and prediction arm were almost similar (8).

Food image recognition- deep learning technology was used in nutrition for recognizing the food images. Initially researchers designed the models that were recognizing about about 50,000 food images, which recorded 78-92% of accuracy (9). Later upgraded the tool to top 5 accuracies i.e computer makes top 5 guesses and this particular model gave even more better results with 91-98% of accuracy. The limitation of the model is that it could only detect of identify the labelled food items included in the catalogue. AI technology could identify only the training dataset with a finite number of food items those labelled and couldn't give any information of the unlabelled or not included in the training dataset.

In the field of AI Artificial Neural Networks (ANNs) are widely used current modelling technique, it is a model created inspired by human brains natural neuron structure. Initially this model was created with a aim of evaluating the biochemical results with both by the clinical data and reference intervals (10). Later used to check the cross contamination of cell cultures of intact mammalian cells done by using mass spectrometric fingerprinting technique (11). Further ANNs is also being successfully getting used in pharmaceutical analysis (12). Also used in predicting relationship of Mediterranean diet pattern with cognition and clinical characteristics (13). There are various studies in the field of biomedical research using advance methods of AI, applied to study the composition of food products, optimization in production of nutrients, to study the effects of nutrients in relation to the functioning of human body in disease and health. In accordance to the studies delivering extra-ordinary results by application of AI in bio-medical nutrition field, AI is also applied in the process of decision making in nutrition and fitness. AI is playing an appreciable role in providing precision nutrition. Communication technology and health information are merged with AI to promote and control nutritional health of different groups of different populations. Decision making algorithm helps in planning nutritional meal/ planning the dietary menu, it helps in choosing healthy food for healthier life. It helps in changing their eating habits to lead a healthy life (14).AI has being successfully used to plan the meal/diet or pregnant women and Children. The most common complication during pregnancy is gestational diabetes mellitus, learned to contribute to the morbidity and mortality of both mother and infant (15). This gave rise to many mobile apps suggesting the proper diet and precautions to be taken during pregnancy. AI is an efficient tool, presently used to suggest proper diet (precision-meal) during pregnancy. Role of AI in child nutrition is to suggest the meal for healthy growth and detect or identify malnutrition. Gene-based personalized nutrition had been successfully introduced in certain models but even this has certain limitations as not just genetic factors many other factors should be taken into consideration while planning personalized diet that includes individuals' physical activities, metabolomics/ gut microbiomics, etc; nutrigenetics fail to provide precision nutrition for the above mentioned reasons (16).

Role Of Ai In Various Disease Conditions: Various AI-based apps in planning nutritional meal for either prevention, control or treat certain diseases like cancer, CVD, etc; and metabolic disorders like DM, obesity, etc; are under trial and a few are in practice. AI in planning nutritional meal for cancer patients- nutritional support is very important for cancer patients as chemotherapy hits the immune system and worsens the patient condition leading to weight loss, malnutrition, frequent illness and infections. It is observed that the use of AI in planning the nutritional meal for cancer patients or in their nutritional monitoring is very scarce. There are certain mobile applications trying to provide adequate nutritional management when this is combined with AI may contribute greatly in management of these huge data related to the nutritional management of cancer patients (17). AI has been used also in planning nutritional diet for patients with cardiovascular diseases (CVD) (18) This project developed an automated menu planner aiming to promote prevention of CVD. This app was built by using genetic algorithms. This gives personalized advice on the lifestyle aspects it includes data related to risk factors, nutrition to promote quality of life and further to reduce the risk of chronic diseases. AI is also used in planning of diet for weight loss and obesity (19). To achieve this ANNs an important tool of AI is used which calculates resting energy expenditure (REE) to provide adequate dietary prescription (20). This is giving quite satisfactory results helping weight loss with improve quality of life. There are AI based studies in diagnosis of diabetes mellitus but AI- based nutritional approach studies to treat or control diabetes are yet to be explored.

AI had played an appreciable role during the recent pandemic too, thanks to the technology it delivered huge data on mortality and morbidity precisely and the AI powered apps had helped in self-monitoring of the patients by suggesting nutritional diet to built-in the immunity and lower the infections thereby reducing the complications and mortality. Certain studies using AI had established the findings that the population those on high non-vegetarian diet had more complications and noted high mortality rate than those on vegetarian diet (21).

Continuous monitoring of human physical activities and nutrition, alongside the promising integration of AI, necessitates the rapid and reliable analysis of numerous variables generated during monitoring this scenario. To achieves this, information technology, various sensors, nanotechnology and the emergence of computer, iphones,

smartphones, etc; are used. AI has the capability to grasp and comprehend linear and nonlinear connections among the dependent or independent variables. It achieves this by building a mapping of input and output that is strictly linear, which uncovers and makes understandable hidden information that is extremely valuable for making decisions. Even though AI is not currently extensively utilized in the realms of nutrition and fitness, there is evidence suggesting that it has great potential in aiding individuals with dietary and physical goals.

Undoubtedly, AI had proved its efficiency even in the field of nutrition and health. It is witnessed by various AI based nutritional apps commercialized and well in use. AI is already being utilised in nutrition and dietetics to guide people towards healthier eating choices. AI-powered apps, for instance, may analyse a person's diet and offer individualised meal planning and nutritional guidance. AI can also be used to monitor a person's food intake and offer ongoing dietary advice. There's an assumption made that Artificial intelligence (AI) has the potential to completely replace the human nutritionists and dieticians in the next five to ten years. AI has a greatest and permanent limitation that it could never, ever replace a human brain and expert dietician or nutritionist as one cannot deny the fact that almost all the nutritional apps are built on the data provided by expert nutritionists. This technology can provide only a generalized information fed related to particular condition or disease complications but could not take an independent decision and deliver suitable suggestions on individual basis. Human dieticians and nutritionists add a depth of knowledge and expertise that AI cannot replace, even if AI algorithms are capable of analysing vast volumes of data and offering insights into nutrition and health. Nutritionist can offer recommendations that are tailored to each person's needs, interests, and health circumstances and can modify these recommendations as necessary. Nutritionist can also offer motivation and emotional support, both of which are frequently essential for making long-lasting dietary adjustments. The limitation of AI in nutrition can be justified by stating that AI doesn't specifically focuses on user's own requirements.

CONCLUSION:
AI had proved its efficiency even in the field of nutrition and health. It is witnessed by various AI based nutritional apps commercialized and well in use. Various AI- based apps are designed with the aim to provide details related to nutritional management in various metabolic related and other diseases. AI algorithms are capable of analysing vast volumes of data and offering insights into nutrition and health. It can't offer recommendations that are tailored to each person's needs, interests, and health circumstances and can modify these recommendations as necessary. AI can't also offer motivation and emotional support, both of which are frequently essential for making long-lasting dietary adjustments. The limitation of AI in nutrition can be justified by stating that AI doesn't specifically focuses on user's own requirements.

REFERENCES:
1. Sahnur Irmak Department of Food Engineering of the University of Ege Izmir Olive Research Institute, University Caddesi, Bornova. J Food Nutr Health 2020 Volume 3 Issue 1).
2. Brug, J., Debie, S., van Assema, P., & Weijts, W. (1995). Psychosocial determinants of fruit and vegetable consumption among adults: Results of focus group interviews. Food Quality and Preference, 6(2), 99–107.
3. Koenigstorfer, J., Groeppel-Klein, A., & Kamm, F. (2014). Healthful food decision making in response to traffic light color-coded nutrition labeling. Journal of Public Policy & Marketing, 33(1), 65–77.
4. Kalinowska, K., Wojnowski, W., & Tobiszewski, M. (2021). Smartphones as tools for equitable food quality assessment. Trends in Food Science & Technology, 111, 271–279. https://doi.org/10.1016/j.tifs.2021.02.068.
5. Ferrara, G., Kim, J., Lin, S., Hua, J., & Seto, E. (2019). A focused review of smartphone diet-tracking apps: usability, functionality, coherence with behavior change theory, and comparative validity of nutrient intake and energy estimates. JMIR mHealth and uHealth, 7(5), e9232.
6. Chen, J., Cade, J. E., & Allman-Farinelli, M. (2015). The most popular smartphone apps for weight loss: A quality assessment. JMIR mHealth and uHealth, 3(4), e104.
7. Min, W., Jiang, S., Liu, L., Rui, Y., & Jain, R. (2019). A survey on food computing. ACM Computing Surveys (CSUR), 52(5), 1–36. https://doi.org/10.1145/3329168.
8. Zeevi D, Korem T, Zmora N, Israeli D, Rothschild D, Weinberger A, et al. Personalized nutrition by prediction of glycemic responses. Cell.2015; 16395):1079-94.
9. Shen Z, Shehzad A, Chen S, Sun H, Liu J. Machine learning based approach on food recognition and nutrient estimation. Procedia Comput Sci.2020; 174:448-53.
10. Kaput J, van Ommen B, Kremer B, Priami C, Monteiro JP, West M, et al.. Consensus statement understanding health and malnutrition through a systems approach: the ENOUGH program for early life. Genes Nutr. (2014) 9:378. 10.1007/s12263-013-0378-y [PMC free article] [PubMed] [CrossRef] [Google Scholar]
11. Morine MJ, McMonagle J, Toomey S, Reynolds CM, Moloney AP, Roche IC, et al.. Bi-directional gene set enrichment and canonical correlation analysis identify key diet-sensitive pathways and biomarkers of metabolic syndrome. BMC Bioinform. (2010)11:499. 10.1186/1471-2105-11-499 [PMC free article] [PubMed] [CrossRef] [Google Scholar]
12. Morine MJ, Tierney AC, van Ommen B, Daniel H, Toomey S, Roche IM. Transcriptomic coordination in the human metabolic network reveals links between n-3 fat intake, adipose tissue gene expression and metabolic health. PLoS Comput Biol. (2011) 7:e1002223. 10.1371/journal.pcbi.1002223 [PMC free article] [PubMed] [CrossRef] [Google Scholar].
13. Tran Quoc Bao Tran, Clea du Toit, Sandosh Padmanabhan^ Artificial intelligence in healthcare—the road to precision medicine.J.Hosp.Manag. Health.Policy Vol 5,September 25, 2021.
14. Chidiebere Hope Nwolise, Nicola Carey and Jill Shawe sagepub.co.uk /journalsPermissions.nav DOI: 10.1177/2055207617726418 journals. sagepub.com/home/dh
15. Juan De Toro-Martín,Benoit J. Arsenault,Jean-Pierre Després andMarie-Claude Vohl. Precision Nutrition: A Review of Personalized Nutritional Approaches for the Prevention and Management of Metabolic Syndrome. Nutrients, 2017 Volume:9,Number:913.
16. Silhavy et al.(2015, . P Silhavy et al. (eds.), Artificial Intelligence Perspectives and Applications, Advances in Intelligent Systems and Computing 347, DOI: 10.1007/978-3-319-18476-0_3
17. Tan C., Chen H., Xia C. The prediction of cardiovascular disease based on trace element contents in hair and a classifier of boosting decision stumps. Biol. Trace Element Res. 2008;129:9–19. doi: 10.1007/s12011-008-8279-4. [PubMed] [CrossRef] [Google Scholar].
18. Lacey, K., & Pritchett, E. (2003). Nutrition Care Process and Model: ADA Adopts Road Map to Quality Care and Outcomes Management. Journal of the American Dietetic Association, 103,1061-1072. http://dx.doi.org/10.1016/S0 002-8223(03)00971-4
19. Emmanuel Disse [a b c], Séverine Ledoux [d], Cécile Bétry [a], Cyrielle Caussy [a b c], Christine Maitrepierre [b], Muriel Coupaye [d], Martine Laville [a b c], Chantal Simon [a b c] An artificial neural network to predict resting energy expenditure in obesity. Clinical Nutrition. Volume 37, Issue 5, October 2018, Pages 1661-1669.
20. Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B, et al. Using artificial intelligence to detect COVID-19 and community-acquired pneumonia based on pulmonary CT: evaluation of the diagnostic accuracy. Radiology.2020;296(2):E65-71
21. HANA: A healthy artificial Nutrition Analysis model during COVID-19 pandemic. Mahmoud Y. Shams,[a] Omar M. Elzeki,[b] Lobna M. Abouelmagd,[c] Aboul Ella Hassanien,[d,f] Mohamed Abd Elfattah,[c] and Hanaa Salem[e] Comput Biol Med. 2021 Aug; 135: 104606. Jun 30. doi: 10.1016/j.compbiomed. 2021.104606).