COUNTERFACTUAL EXPLAINABILITY APPROACH TO AN ARTIFICIAL NEURAL NETWORK MODEL TO ASSESS NUTRITIONAL FACTORS ASSOCIATED WITH METABOLIC SYNDROME IN THE AGING POPULATION FROM SOUTHERN ITALY

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Introduction: Metabolic syndrome (MetS) consists of multiple major metabolic disorders, including abdominal adiposity, insulin resistance, dyslipidemia, insulin resistance-induced hypertension, and inflammation [1]. In order to reduce the incidence of metabolic diseases, machine learning methods investigated through counterfactual procedures can be a screening tool for the clinician and an aid to the patient.
Research Question: Define a counterfactual approach as a method of explaining a neural network model built on nutritional variables in the prediction of metabolic syndrome in a cohort of subjects over 65 years old.
Methods: In the 926 older cohort from Southern Italy, the presence of metabolic syndrome was assessed with Foods Frequency Questionnaire (FFQ), and clinical data were acquired. A NN was built with hyperparameter tuning technique using the accuracy as performance parameter to select the best model [2]. Counterfactual analysis was performed in order to understand how characteristics changes can modify the prediction probability of MetS using the NN model prediction [3].
Results: Counterfactual method applied to a neural network for a subject with metabolic syndrome showed an important role of food groups such as Legumes, convenience meals and sugary drinks in modulating the risk of MetS. In particular, increasing the consumption of legumes and reducing convenience foods and sugary drinks were shown to mainly reduce the risk from 0-40%.
Discussion: The counterfactual analysis regarding a subject diagnosed with MetS reflects the known role in the literature of the major macronutrients associated with reducing the risk of metabolic disease itself. Legumes are recognized as protective in the development of metabolic diseases because of their fiber content and bioactive molecules [4]. Consumption of sugary drinks and convenience foods is recognized to be associated with weight gain and concomitant metabolic disorders, such as MetS [5].
Conclusions: The combined use of prediction models supported by artificial intelligence could represent a diagnostic tool for screening on the one hand and for specific assessment of the individual subject based on counterfactual analysis on the other. Finally, the use of such a method can provide a way to access and explain the processes contained in the black box of machine learning processes.

Reference

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Figure 3. Marginal distributions of counterfactuals