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Obesity Prediction Machine Learning Model Based On Human Gut Microbiome Data

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ABSTRACT

The human gut microbiome can influence metabolic phenotypes and is linked to the prevalence of obesity, in a multifactorial interplay along with host genetics and environmental factors. However, it is unclear whether these microbial changes precede disease onset to support early diagnosis and the causal relationship and underlying mechanisms remain uncertain. In this vein, we assess the dominant gut microbiota of normal and obese individuals towards the creation of a machine-learning obesity prediction model based on gut microbiome compositions. 1081 fecal samples were obtained from 633 individuals, with a distribution of 440 normal-weight individuals and 193 diagnosed as obese, sequenced and mapped to the Bacteria in the Greengenes database and sorted in 8816 operational taxonomic units. Various machine-learning classification models were evaluated to detect obese individuals. The Shapely Additive Explanations (SHAP) method was deployed to quantify feature importance and the contribution of the microbial units to the prediction. The Multi-Layer Perceptron classifier achieved the best performance with a 0.94 Area Under the Curve (AUC) and 0.95/0.77 Sensitivity/Specificity, after optimal feature selection in k-fold cross-validation and grid-search fine-tuning. The dominant bacteria phyla were Firmicutes (78%), of the families Lachnospiraceae, Ruminococcaceae, and Christensenellaceae, and Bacteroidetes (12%) of the family Bacteroidaceae in obese individuals, which agrees with similar studies within the current literature in the field. In conclusion, these findings demonstrate the prominence of certain bacterial groups in obese individuals, paving the way for the development of personalised obesity detection and prevention models, if enriched with genetic and lifestyle cofactors.

BIOGRAPHY (up to 200 words)

Dimitra Natsidou (Master's student), Anastasia Ntracha (PhD student), Vasilis Charisis, Stelios Hadjidimitriou and Dimitris Iakovakis (Postdoctoral Researchers) conduct research as members of the Signal Processing and Biomedical Technology Unit (SPBTU) in the faculty of Electrical Engineering & Computer Science (AUTH). Leontios Hadjileontiadis is a Professor in Electrical Engineering & Computer Science at AUTH and Professor and Department Chair of Biomedical Engineering at Khalifa University. Their research interests include biomedical engineering, Ai-enabled healthcare applications, digital biomarkers, digital phenotyping, and affective computing. Collectively they have over 200 publications in the field of digital health. Konstantinos Rouskas (Postdoctoral Researcher) is with the Institute of Applied Biosciences of Center for Research and Technology Hellas (CERTH-INAB) and his research interests include nutrigenetics and nutrigenomics.

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