Abstract

This doctoral dissertation presents a comprehensive and interdisciplinary analysis of the effects of nicotine on human physiology, metabolism, and behavior, comparing traditional cigarettes and electronic cigarettes as delivery systems. The research integrates experimental investigations with advanced computational modeling, drawing from systems biology, biomedical engineering, and artificial intelligence. This dual approach allowed for a detailed assessment of physiological responses and potential health impacts related to nicotine use in various forms.

The experimental studies focused on young adults and included assessments of body composition, postural control, gait parameters, and cardiovascular reactivity during physical exertion, with comparisons between e-cigarette users, traditional smokers, and non-smokers. Multivariate statistical methods, correlation analysis, and machine learning algorithms were employed to identify significant intergroup differences. Simultaneously, several computational models were developed, including physiologically-based pharmacokinetic (PBPK) models describing nicotine distribution in the body, Markov models simulating addiction processes, and extended population-level models (SIQ+P+E+H+X) to evaluate the long-term effects of tobacco control policies. Additionally, simulation of coil degradation in e-cigarette devices was conducted to assess material transformation and its potential health implications. Machine learning techniques were also applied to identify demographic, familial, and social determinants of smoking behavior and to classify physiological responses based on multimodal biosignal analysis (ECG, PPG, blood pressure).

The findings demonstrate distinct physiological and behavioral profiles across user groups and support the feasibility of predicting health outcomes through integrative data modeling. The dissertation contributes to public health research by proposing data-driven methods for nicotine risk assessment and intervention planning. It is based on a series of eleven scientific publications, five of which have been published or accepted, while six are currently under peer review. All articles are thematically coherent, methodologically consistent, and reflect a substantial individual contribution by the doctoral candidate.

Keywords: nicotine, electronic cigarettes, conventional cigarettes, cardiovascular system, respiratory system, metabolism, postural control, PBPK model, machine learning, biomedical signal analysis

mgr inż. Joanna Chwał
„Wpływ palenia papierosów elektronicznych i tradycyjnych
na wybrane parametry układu oddechowego i sercowo-naczyniowego
pacjentów, na podstawie analizy wektorów danych,
uzyskanych z rejestracji wielomodalnych sygnałów biomedycznych”