Abstract:
Electronic nicotine delivery systems (ENDS) have gained worldwide popularity as an alternative to conventional tobacco cigarettes. It is estimated that 9 million adults in the US regularly use ENDS. Understanding the health impacts of these products is complicated by constantly evolving device technology. Open tank systems with variable power settings can increase ENDS output of vapor/aerosol (delivery of nicotine) and be used with any of the thousands of e-liquids currently available to consumers. Product design features and consumer use patterns (puffing topography) can influence the nicotine profile and the potential for abuse liability. To characterize the nicotine profile across a range of ENDS user conditions, a physiologically-based pharmacokinetic (PK) model for nicotine was calibrated/validated with existing published nicotine PK data collected from individuals using a range of ENDS products and e-liquid nicotine concentrations under standardized and ad libitum device usage conditions. Accounting for delivered dose, nicotine retained, and a plausible range of body weights and renal clearance rates, the area-under-the-curve (AUC), Cmax, and tmax were predicted and found to have reasonable agreement with the upper and lower bounds of PK metrics reported in available ENDS PK studies. The model predictions were comparable to available PK data across a range of ENDS types and e-liquid nicotine concentrations. Self-titration to a desired nicotine level, which influences the consumer puffing profile, is commonly reported among ENDS users. Thus, the PK model was used to assess the ENDS puffing topography profile that would achieve a nicotine dose equivalent to one pack of cigarettes in a day for the scenario of low versus high nicotine e-liquid concentration/ENDS delivery. Not surprisingly, the number of puffs required to achieve the target nicotine dose associated with a pack of cigarettes increased with decreasing nicotine e-liquid concentration/ENDS delivery. This, in turn, can have significant exposure/health implications for other potentially harmful constituents to which consumers may be exposed from the vapor/aerosol. In conclusion, the validated nicotine PK model is a useful tool to evaluate the public health impacts of ENDS by predicting the nicotine profile across a range of plausible ENDS and user conditions, as well as assessing the exposure and health risks of harmful constituents associated with varying consumer topography patterns. It is also anticipated this PK model will be a valuable tool for developing focused clinical studies of ENDS and designing products to minimize the health risks to consumers.