Population Health Model Code and Inputs

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Contents

1 Overview

This README document provides instructions on how to run the FDA's Population Health Model (PHM) MATLAB code. The version of the code described in this document was developed specifically to quantify the potential public health impact of a tobacco product standard that would regulate nicotine yield by establishing a maximum nicotine level in cigarettes and certain other combusted tobacco products. The model could also be used to run and alternative scenario considering an adjustment in the baseline scenario accounting for the implementation of a product standard to prohibit menthol as a characterizing flavor in cigarettes (assuming that a menthol product standard is implemented two years before the implementation of a nicotine product standard). However, the instructions provided in this document focuses on the implementation of the PHM to estimate the potential public health impact of a nicotine standard without the menthol adjustment.

The PHM MATLAB code was originally developed by Sandia National Laboratories, and later modified and extended by FDA-CTP researchers accounting for new input data and model assumptions. The code, in its current form, allows MATLAB programmers to execute the code, review input and output parameters, and modify the code to incorporate alternative model scenarios and sensitivity analyses.

A detailed description of the PHM framework, inputs parameters, model assumptions, and outputs can be found in Vugrin et al. (2015).[1] The code described in this document, is an updated version of the model implementation presented in Apelberg et al. (2018)[2], accounting for updated input parameters and model assumptions, as described in the peer-reviewed modeling document entitled "Methodological Approach to

[1] Vugrin ED, Rostron BL, Verzi SJ, Brodsky NS, Brown TJ, Choiniere CJ, Coleman BN, Paredes A, Apelberg BJ. Modeling the potential effects of new tobacco products and policies: A dynamic population model for multiple product use and harm. PLoS One. 2015; 10 (3): e0121008-e0121008. doi:10.1371/journal.pone.0121008

[2] Apelberg BJ, Feirman SP, Salazar E, Corey CG, Ambrose BK, Paredes A, Richman E, Verzi SJ, Vugrin ED, Brodsky NS, Rostron BL. Potential public health effects of reducing nicotine levels in cigarettes in the United States. N Engl J Med. 2018/05/03 2018; 378 (18): 1725-1733. doi:10.1056/nejmsr1714617

Modeling the Potential Impact of a Nicotine Product Standard on Tobacco Use, Morbidity, and Mortality in the U.S." (hereafter referred to as FDA's modeling document).

To run the code, users should have MATLAB installed in their computers. It is also recommended that users should have a local copy of the code. The folder "**MATLABCode_NicotineModel**" contains all the files needed to run the code, specifically, MATLAB functions, input data files, and templates to save model outputs. The described code was designed to run a Monte Carlo simulation considering 7,000 iterations. For reference regarding the computational time, it takes approximately 3 hours to run a Monte Carlo simulation in a computer with 2.5 GHz processor and 32.0 GB of RAM.

2 Code Structure

The version of the code described in this document was developed specifically for two tobacco product classes: 1) cigarettes and 2) noncombusted tobacco products, a class that includes smokeless tobacco, e-cigarettes and other ENDS, heated tobacco products, and oral nicotine products.

The code consists of three primary modules: (1) data loading and pre-processing, (2) population updating, and (3) post-processing. Figure 1 illustrates the code structure and lists the functions associated with each of the modules. Please note that some functions included in the folder "**MATLABCode_NicotineModel**" have a different name. For example, "load_rsrc_func" was named as "load_raw_data_initbyyear".

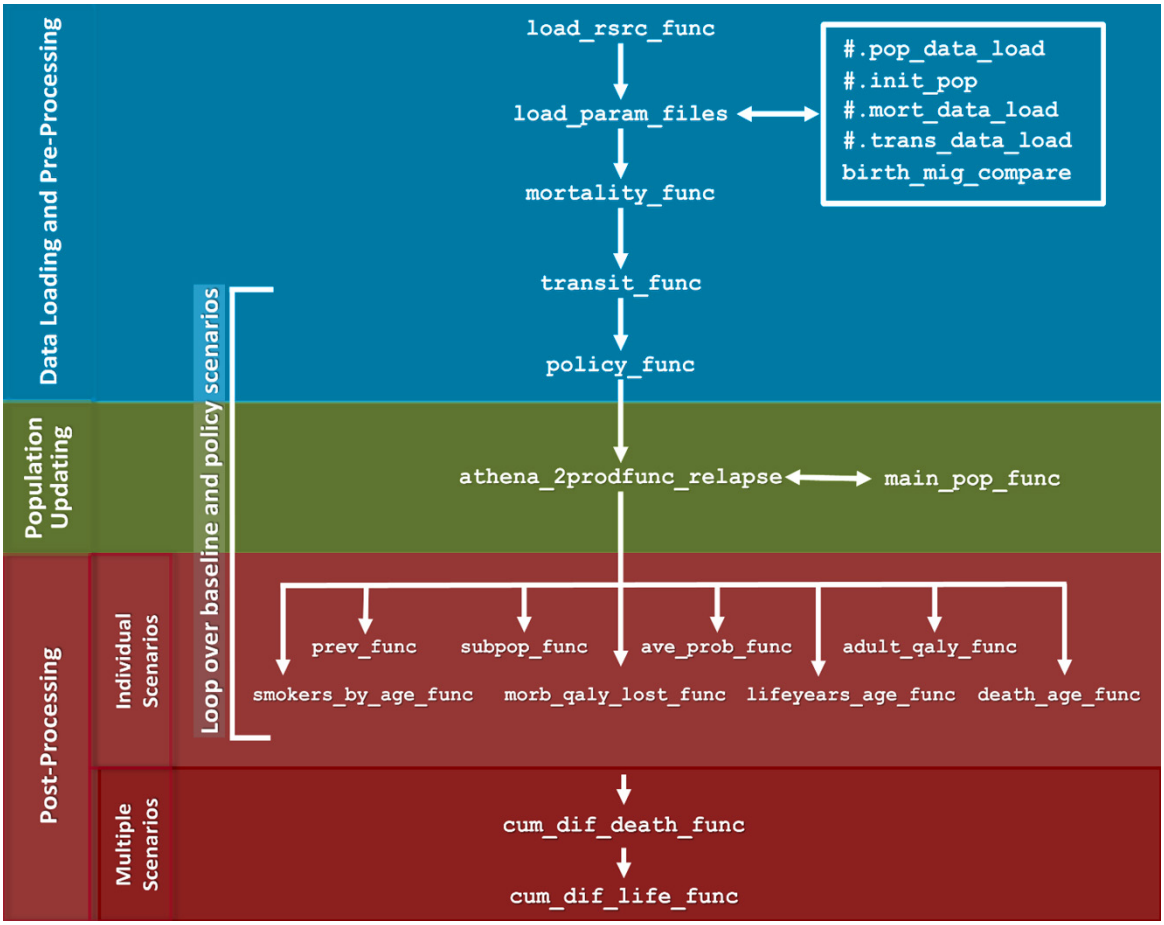

Figure 1. Code structure and functions associated with each code module. *Source: SANDIA User's Manual.*

3 Input Data

Most of the PHM input data can be found in the Excel file "**InputData_Nicotine_Baseline2021.xlsx**". This file is saved in the subfolder "resources" and contains the raw data inputs to create initial population, transition probabilities, tobacco-related mortality metrics, and birth and net migration parameters. Other input parameters derived from empirical evidence and expert estimates were included within the MATLAB functions.

Expert Elicitation (EE) Data: Expert estimates accounting for the behavioral impact of a potential nicotine product standard for tobacco users and non-users were derived from a formal EE conducted in 2018 by the FDA. Seven experts participated in the 2018 EE to provide informed estimates for tobacco use transition parameters in the event of a nicotine product standard. Details and data from the 2018 EE are described in the FDA's modeling document.

Excel allows users to specify regions of a spreadsheet using "names".[3] The code uses the Excel names feature to locate the portion of the spreadsheet that contains the data for the expected input parameters when running the MATLAB code. To limit confusion, the defined Excel names and input parameters are the same.

4 Code Execution

The folder "**MATLABCode_NicotineModel**" contains the MATLAB code and all necessary input files and functions to run the PHM Monte Carlo simulation, considering the following specifications:

- Simulation period: 2021-2100.
- Nicotine product standard implementation: 2027.
- Input data: **InputData_Nicotine_Baseline2021.xlsx**
- Additional input data for the 2018 EE: included in the file **sa_main_mod_2021_NicotineModel.m** (lines 46-186).
- Monte Carlo iterations: 1,000 simulations will be conducted for each expert's set of responses (7,000 in total).

To run the code:

1. Open the file "**ToRun_Baseline2021Policy2027_NicotineModel.m**" within MATLAB. This file calls the file "**sa_main_mod_2021_NicotineModel.m**", which contains:
    a. The expert elicitation data from seven experts (lines 46-186)
    b. Input filename (line 216)
    c. A linked function with mortality assumptions and calculations (line 228).
    d. A linked function needed to specify tobacco use transition probability formulas (line 230)
2. Specify the number of Monte Carlo iterations to run the model. In the current version of the code, 1,000 simulations will be conducted for each expert set of responses (7,000 in total). Users can change the number of simulations per expert by modifying line 34 in file "**ToRun_Baseline2021Policy2027_NicotineModel.m**".

[3] https://support.microsoft.com/en-us/office/create-a-named-range-in-excel-adee78ff-bcf0-4283-8c29-83304ca0c29d

3. In line 54, file "**ToRun_Baseline2021Policy2027_NicotineModel.m**", specify the filename of the pre-built Excel template to be used to save key model outputs. Users can produce a copy of the Excel file template "**NicotineModelResults_EmptyTemplate.xlsx**", rename it, and specify new file name in line 54, before running the model.
4. Execute the file "**ToRun_Baseline2021Policy2027_NicotineModel.m**".

By using a laptop with processor speed of 2.5 GHz and 32.0 GB of RAM, the computational time needed to run 7,000 Monte Carlo iterations is approximately 175 minutes.

5 Model Output Storage

The complete execution of the file "**ToRun_Baseline2021Policy2027_NicotineModel.m**" generates MATLAB figures and tables for users' quick review. Also, it will generate the following two output files:

1. "**MATLAB_NicotineModelResults_2021Baseline2027Policy_Main.mat**": This file contains the raw model outputs, including outputs from each of the 7,000 Monte Carlo iterations.
2. "**NicotineModelResults_EmptyTemplate.xlsx**": Once the simulation is completed, the code populated this Excel file which will contain the main model outputs from the baseline and nicotine standard scenarios, organized using a pre-built format. For the nicotine standard scenario, three metrics are reported: 5^{th} percentile, median (50^{th} percentile), and 95^{th} percentile. It also contains population and mortality projection estimates that are compared with U.S. Census projections (for validation purposes), as well as summary tables for reduction in initiation, increase in quitting smoking, tobacco attributable deaths avoided, life years gained, and QALYs gained.

6 Questions or Comments

Questions or comments including those about accessibility of these files may be directed to US Food and Drug Administration, Center for Tobacco Products, Office of Regulations at ctpregulations@fda.hhs.gov or 1-877-CTP-1373 (1-877-287-1373).