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September 11 - 14, 2022

New Orleans, Louisiana USA



2022_TSRC107_Verron.pdf

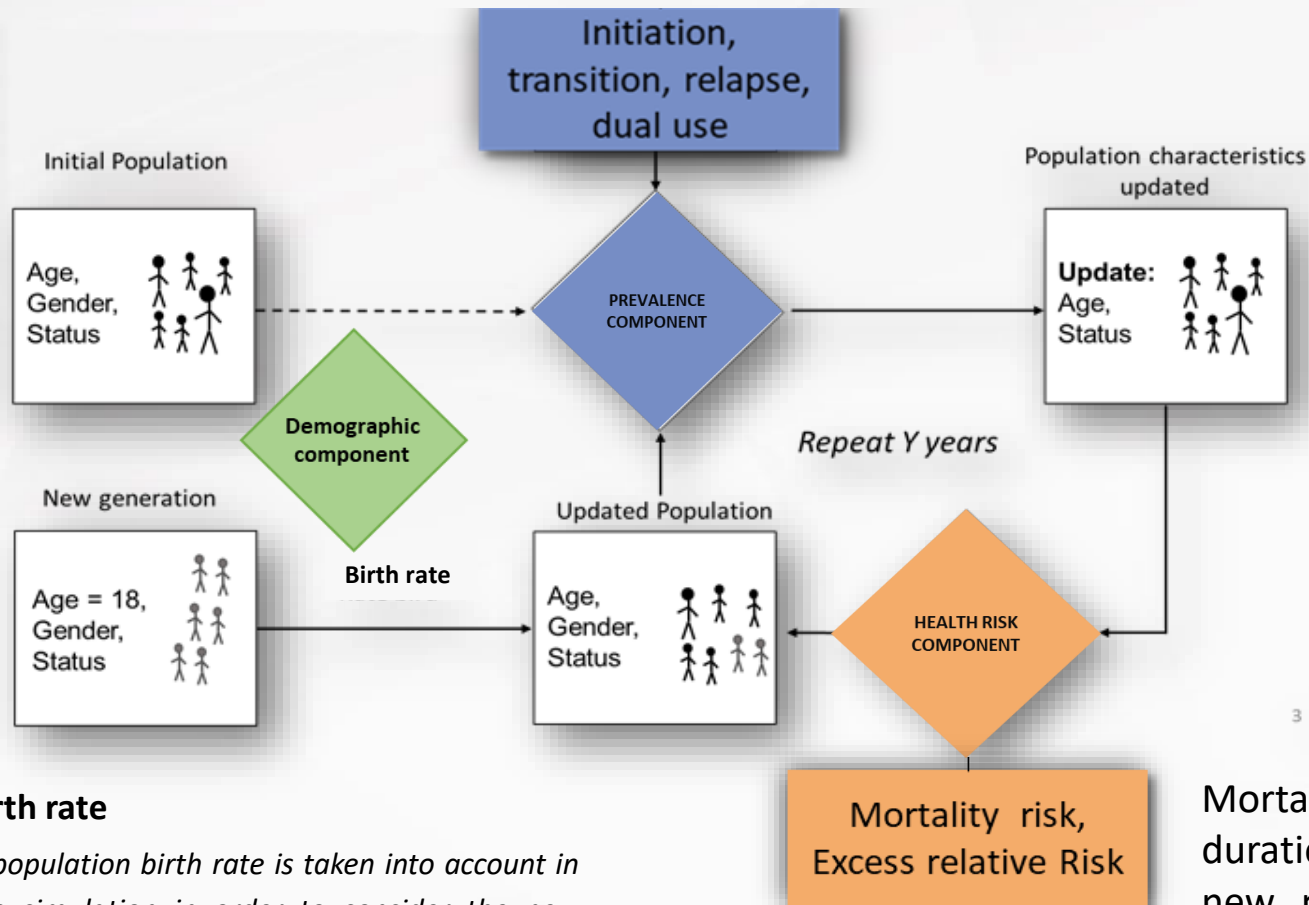
Assessing the US population health impact of introducing a new e-cigarette product into market using intentions to use data



TSRC2022(75) - Document 107_Verron - reviewed by CORESTA

Thomas Verron, Mengran Guo, Thomas Nahde, Grant O'Connell and Xavier Cahours

Dynamic population model (DPM) is an useful approach to assess the potential population health effects of a new product when epidemiological data are not available.



DPM allows impact assessment of product initiation, switching, dual use, and cessation on future prevalence and mortality for a specific population.

Birth rate

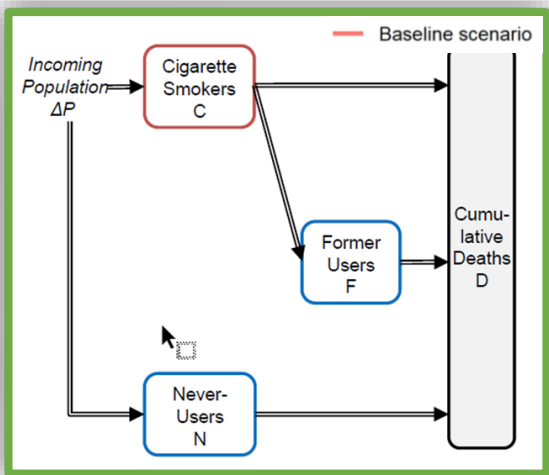
A population birth rate is taken into account in the simulation in order to consider the new generations over a long period of time.

Mortality calculated for each age interval - based on age, duration of smoking, and duration of quit; mortality rates for new product users based on excess relative risk (ERR) estimate, relative to smoking

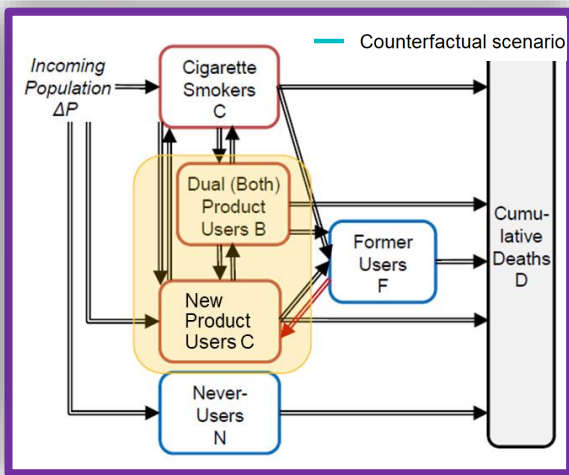
How to predict the impact of a new product category on population health?

By comparing smoking prevalence and mortality risk associated in a **baseline scenario** and a **counterfactual scenario**

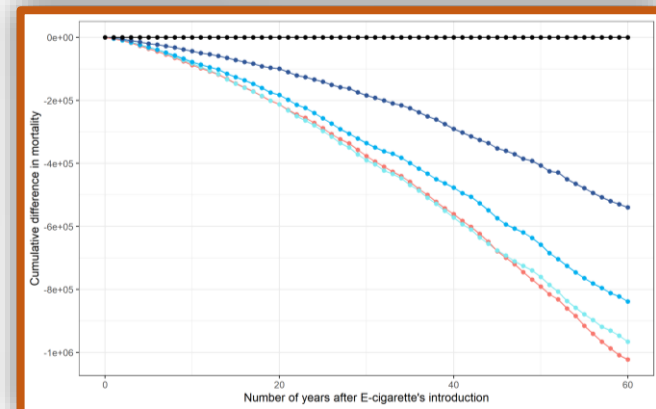
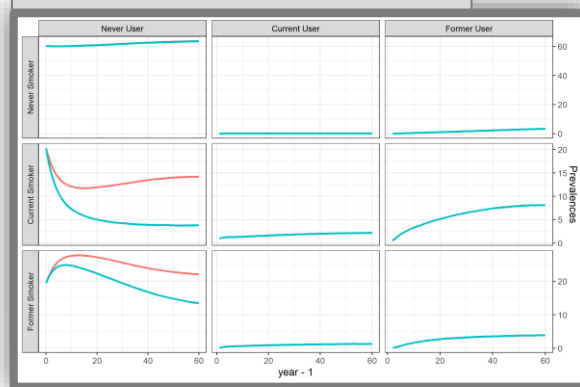
Baseline scenario



Counterfactual scenario



Prevalence over time



Mortality over time

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| N_N | P1 | P2 | | P3 | P4 | | | |
| N_C | | P5 | P6 | | P7 | P8 | | |
| N_F | | P9 | P10 | | P11 | P12 | | |
| C_N | | | | P13 | P14 | | P15 | P16 |
| C_C | | | | | P17 | P18 | | P19 |
| C_F | | | | | P21 | P22 | | P23 |
| F_N | | | | P25 | P26 | | P27 | P28 |
| F_C | | | | | P29 | P30 | | P31 |
| F_F | | | | | P33 | P34 | | P35 |

Transition matrix

Relative Risk

| | |
|-------------|--|
| 0.05 | A reduction in risk of 95% compared to smoking |
| 0.10 | A reduction in risk of 90% compared to smoking |
| 0.20 | A reduction in risk of 80% compared to smoking |
| 0.50 | A reduction in risk of 50% compared to smoking |



Transition matrix

A transition matrix contains the probability to change from one status to another one (initiate, relapse, stop, stay or switch)

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| N_N | P1 | P2 | | P3 | P4 | | | | |
| N_C | | P5 | P6 | | P7 | P8 | | | |
| N_F | | P9 | P10 | | P11 | P12 | | | |
| C_N | | | | P13 | P14 | | P15 | P16 | |
| C_C | | | | | P17 | P18 | | P19 | P20 |
| C_F | | | | | P21 | P22 | | P23 | P24 |
| F_N | | | | P25 | P26 | | P27 | P28 | |
| F_C | | | | | P29 | P30 | | P31 | P32 |
| F_F | | | | | P33 | P34 | | P35 | P36 |

- Initiation
- Relapse
- Cessation
- Stabilisation
- Switch

9 status / 4 transitions per status
 =
36 transition probabilities per matrix

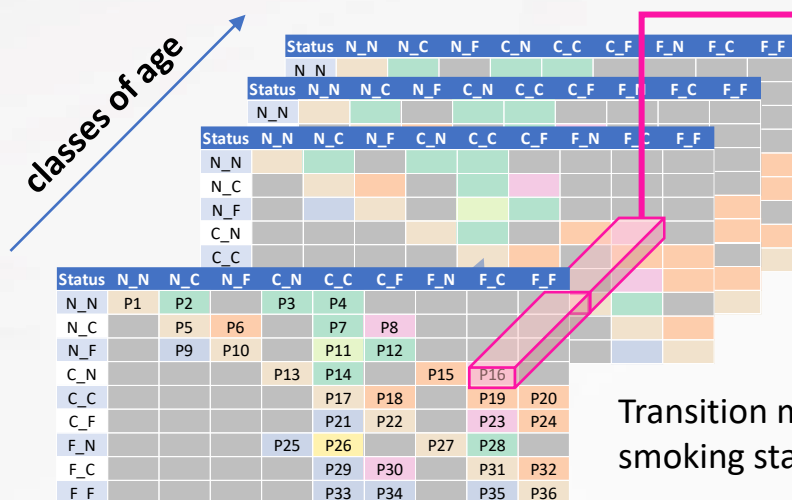
A transition matrix depends on demographic parameters such age, gender...

Transition matrix

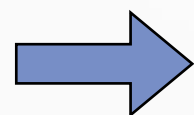
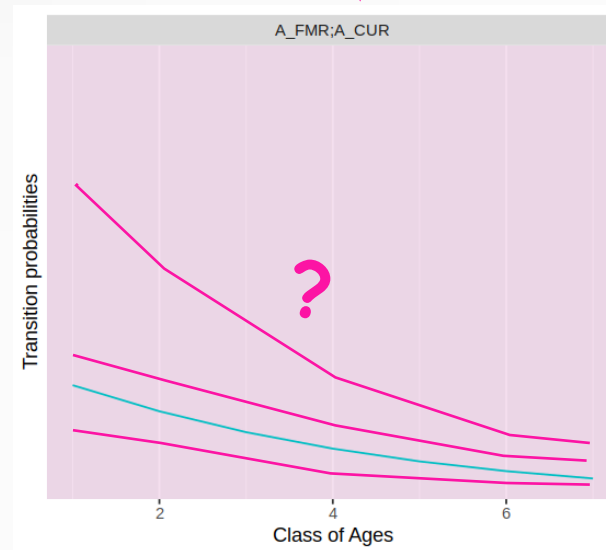
- Transition probabilities are key inputs for population models to determine the net population health impact of introducing a new tobacco product into a market
- In recent years, several publications have discussed the use of computational models to assess the overall population level impact of e-cigarettes in terms of changes in smoking prevalence, all-cause mortality, smoking-related mortality, etc.
- However, transition probabilities regarding product switching, initiation and cessation were often **assumed** in this published computational models.
- In order to project the long-term impact of a new product use on the US population, **transition probabilities representative of the US population are needed to replace assumptions** when developing population models.
- Only **longitudinal survey data provide accurate transition patterns** among adult cigarette smokers, new product users, and dual users by taking into account cigarette smoking and new product use histories and experimental or established use behaviors.

Transition matrix

To develop transitional patterns among different groups of cigarette and/or e-cigarette users, we used the longitudinal data **from wave 2 to wave 3 in the PATH public** use data files



Transition matrix according to smoking status and class of ages

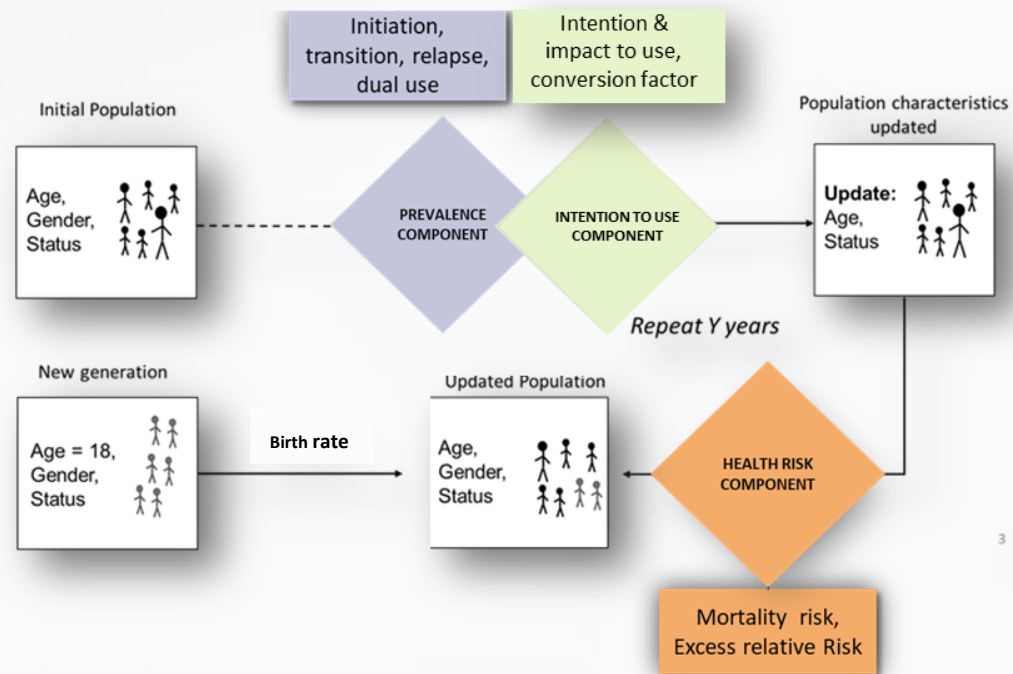
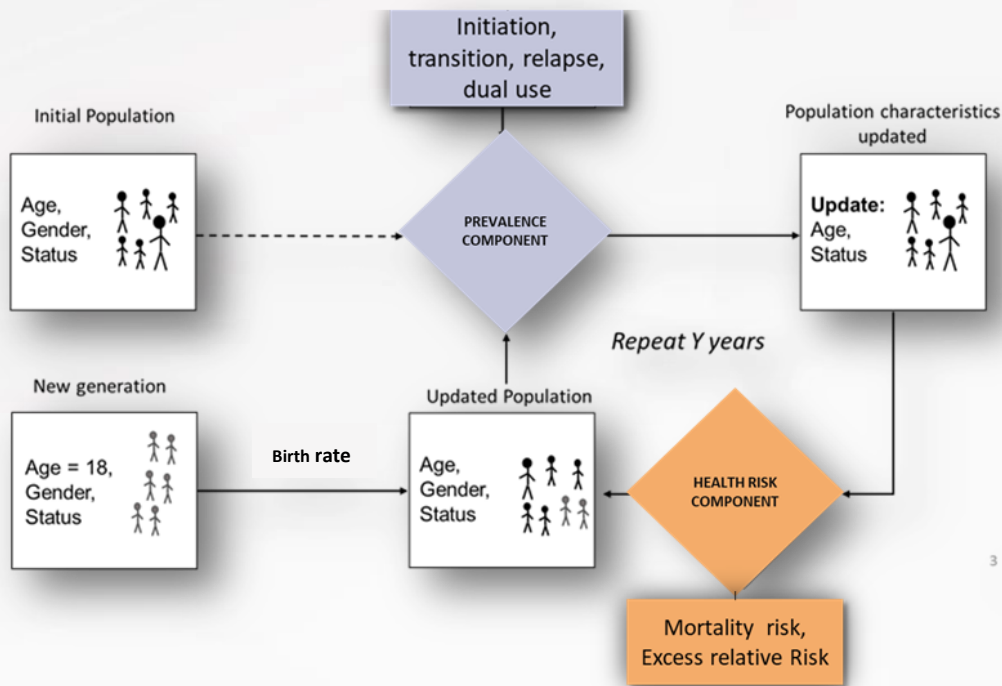


How to update these transitions for a new e-cigarette not yet available on the market?

PREVALENCE COMPONENT

How to update these transitions for a new e-cigarette not yet available on the market?

By adjusting the existing transition matrix with the intention to use the new product



New transition matrix

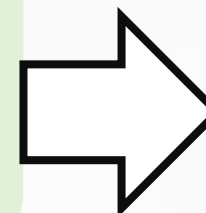
PATH Study

Transition Matrix for e-cigs

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| N_N | P1 | P2 | | P3 | P4 | | | | |
| N_C | | P5 | P6 | | P7 | P8 | | | |
| N_F | | P9 | P10 | | P11 | P12 | | | |
| C_N | | | | P13 | P14 | | P15 | P16 | |
| C_C | | | | | P17 | P18 | | P19 | P20 |
| C_F | | | | | P21 | P22 | | P23 | P24 |
| F_N | | | | P25 | P26 | | P27 | P28 | |
| F_C | | | | | P29 | P30 | | P31 | P32 |
| F_F | | | | | P33 | P34 | | P35 | P36 |



Intention to use Study I2U Matrix for the new e-cig



Transition matrix for e-cigs + the new e-cig

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|------|------|------|------|------|------|------|
| N_N | P1* | P2* | | P3* | P4* | | | | |
| N_C | | P5* | P6* | | P7* | P8* | | | |
| N_F | | P9* | P10* | | P11* | P12* | | | |
| C_N | | | | P13* | P14* | | P15* | P16* | |
| C_C | | | | | P17* | P18* | | P19* | P20* |
| C_F | | | | | P21* | P22* | | P23* | P24* |
| F_N | | | | P25* | P26* | | P27* | P28* | |
| F_C | | | | | P29* | P30* | | P31* | P32* |
| F_F | | | | | P33* | P34* | | P35* | P36* |

Intension to use

“ITU score” is the proportion of person having the **intention to use** the new e-cigarettes according to their status.

Conversion factor

λ is the probability at which a person **performs the action of using** the product.

Impact to use

Impact to use is **the sign** of the impact of the intention to use the new-cigarette on the transition probabilities



Transition matrices updated for a new e-cigarette

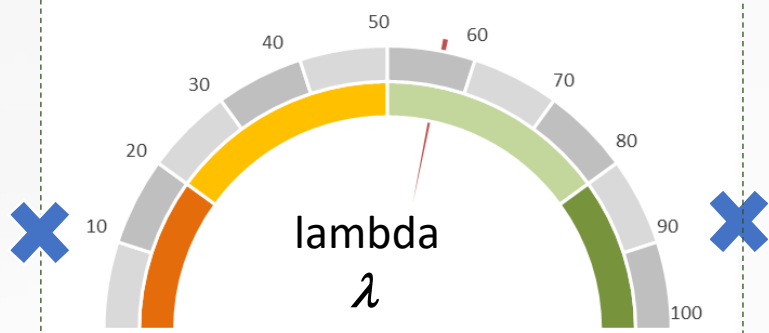
Intension to use

“ITU score” is the proportion of person having the **intention to use** the new e-cigarettes according their status.

| Status | ITU |
|------------|-------------|
| N_N | 0.0% |
| N_C | 2.5% |
| N_F | 0.0% |
| C_N | 5.0% |
| C_C | 2.5% |
| C_F | 5.0% |
| F_N | 0.0% |
| F_C | 2.5% |
| F_F | 0.0% |

Conversion factor

λ is the probability at which a person **performs the action of using** the product.



Impact to use

Impact to use is **the sign** of the intention to use the new-cigarette on the transition probabilities

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| N_N | - | + | | | | | | | |
| N_C | | + | - | | - | - | | | |
| N_F | | + | - | | - | - | | | |
| C_N | | | | - | | | | + | |
| C_C | | | | | - | - | | + | |
| C_F | | | | | | - | | + | |
| F_N | | | | - | - | | | + | |
| F_C | | | | | - | - | | + | |
| F_F | | | | | - | - | | + | |

Note: The intensity of the modification of transition will be proportional to the current transition probability among all the transition impacted in the same direction. Higher is the current transition higher will be the impact. The modification will be ranged from 0 (no intention to use) to $\lambda \times$ ITU score.



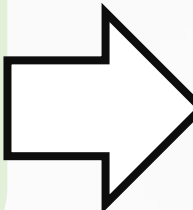
Example of transition matrices updated for a new e-cigarette

PATH Study
Transition Matrix for e-cigs

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-------|------|-----|-------|------|-----|
| C_N | | | | 73.3% | 6.4% | | 18.9% | 1.4% | |



Intention to use Study
I2U Matrix for the new e-cig



Transition Matrix for e-cigs + the new e-cig

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-------|------|-----|-------|------|-----|
| C_N | | | | 69.3% | 6.4% | | 18.9% | 5.4% | |

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-------|------|-----|-------|------|-----|
| C_N | | | | 69.3% | 9.6% | | 18.9% | 2.2% | |

Intension to use

| Status | I2U |
|--------|------|
| C_N | 5.0% |

Conversion factor

$\lambda=80\%$

Impact to use

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| C_N | | | | - | | | | + | |

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| C_N | | | | - | + | | | + | |



Example of transition matrices updated for a new e-cigarette

New-e-cigarette ITU score for Smoker ; Never ENDS user

| Status | IZU |
|--------|------|
| C_N | 5.0% |

 And with a conversion factor

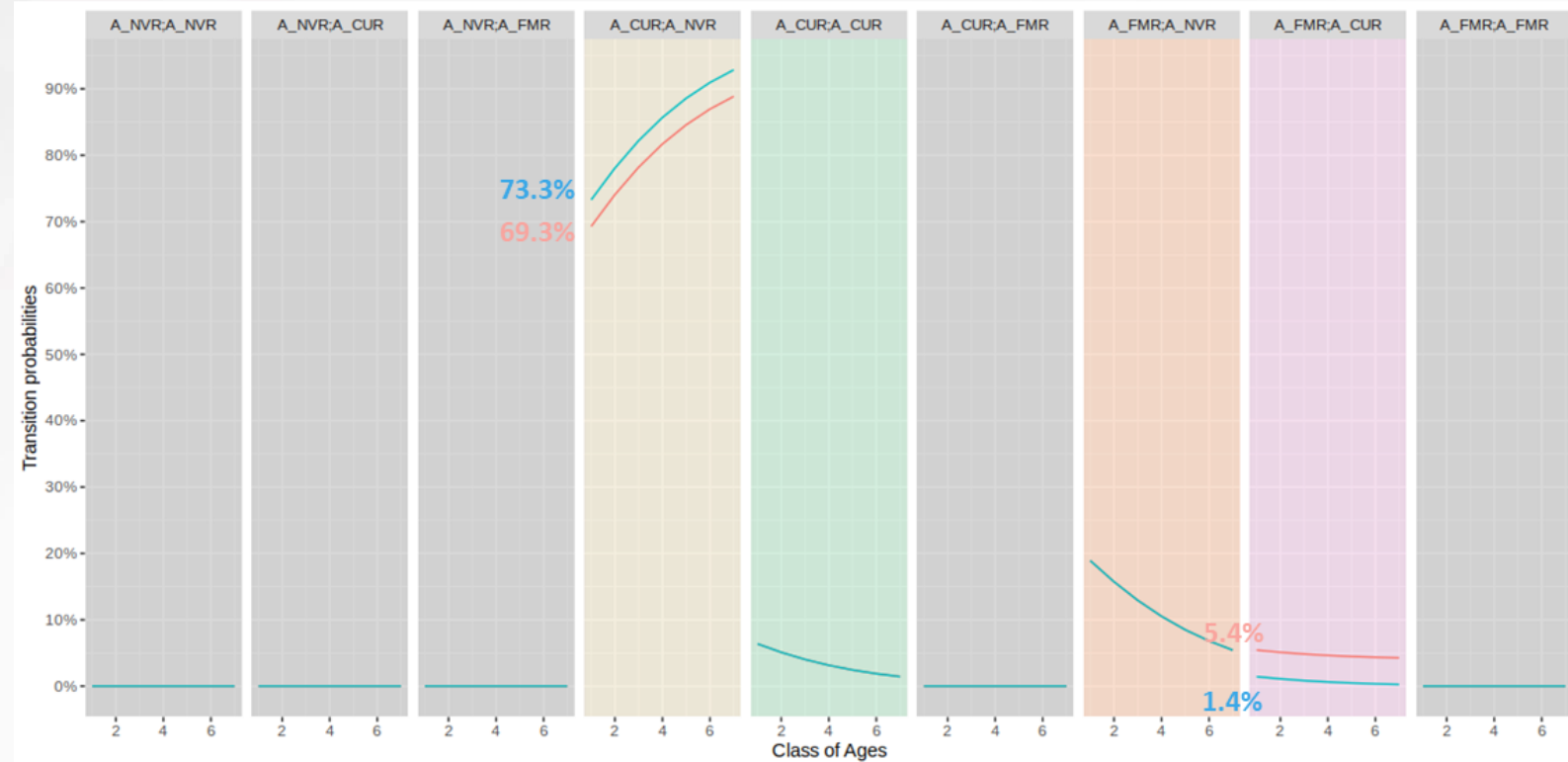
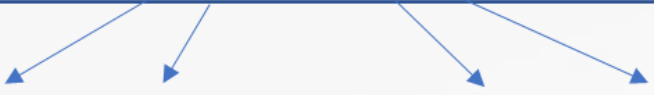
Impact sign of UTI score on transition matrix for C_C

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| C_N | | | | - | | | | + | |

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-------|------|-----|-------|------|-----|
| C_N | | | | 73.3% | 6.4% | | 18.9% | 1.4% | |



| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-------|------|-----|-------|------|-----|
| C_N | | | | 69.3% | 6.4% | | 18.9% | 5.4% | |

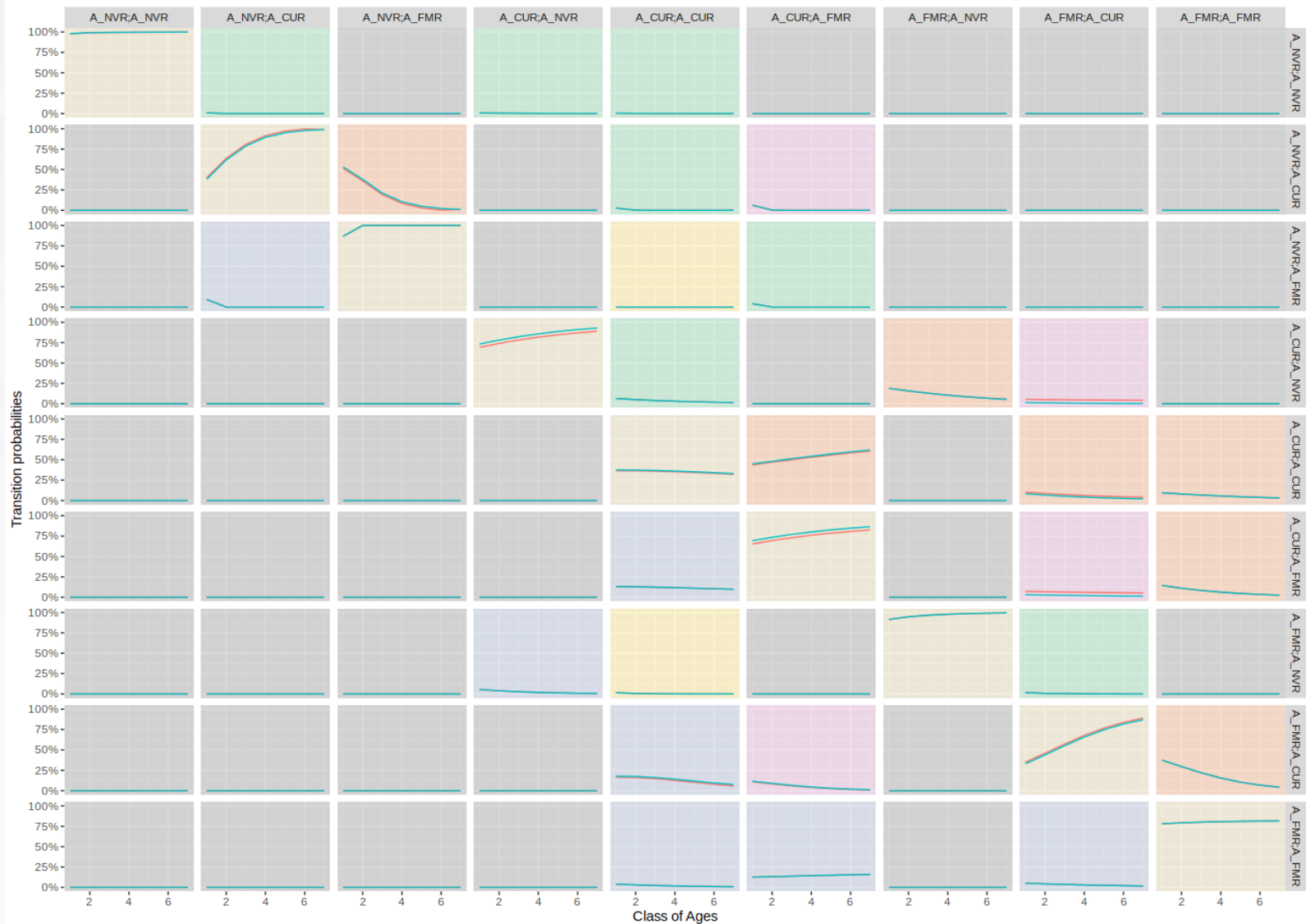


Current transitions
Updated transitions with ITU

PREVALENCE COMPONENT

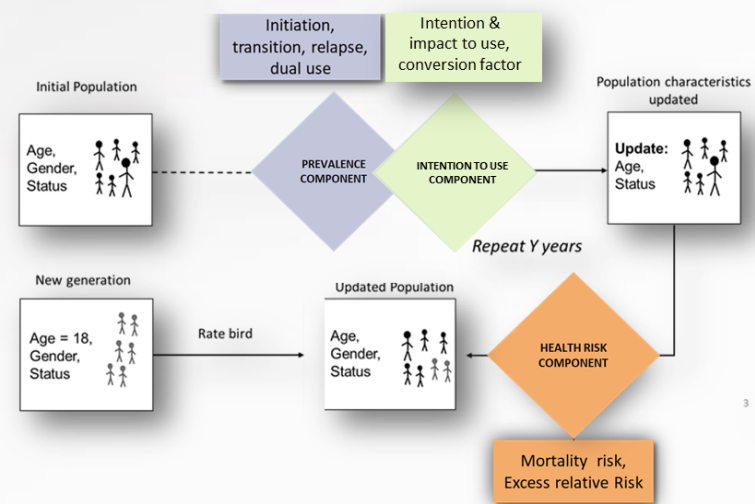
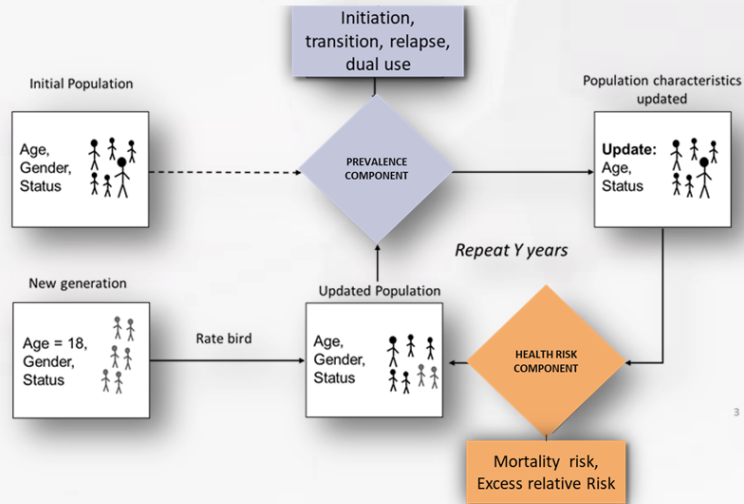
Example: Transition matrices updated for a new e-cigarette

12U
0%
2.5%
0%
5%
2.5%
5%
0%
2.5%
0%



Current transitions
Updated transitions

DPM for a new e-cigarette



1 Base Case

2 Counterfactual Case

3 Counterfactual Case + New Product

Transition matrices

PREVALENCE COMPONENT

| CIG | N | C | F |
|-----|-----|-----|-----|
| N | PNV | PNC | 0 |
| C | 0 | PCC | PCF |
| F | 0 | PEC | PF |

Transition matrices

+

| Status | N | N | N | C | N | F | C | N | C | C | C | F | N | F | N | F | C | F | F | F |
|--------|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|
| N_N | P1 | P2 | P3 | P4 | | | | | | | | | | | | | | | | |
| N_C | | P5 | P6 | P7 | P8 | | | | | | | | | | | | | | | |
| N_F | | | P9 | P10 | P11 | P12 | | | | | | | | | | | | | | |
| C_N | | | | P13 | P14 | | P15 | P16 | | | | | | | | | | | | |
| C_C | | | | | P17 | P18 | | P19 | P20 | | | | | | | | | | | |
| C_F | | | | | | P21 | P22 | | P23 | P24 | | | | | | | | | | |
| F_N | | | | | | | P25 | P26 | | P27 | P28 | | | | | | | | | |
| F_C | | | | | | | | P29 | P30 | | P31 | P32 | | | | | | | | |
| F_F | | | | | | | | | P33 | P34 | | P35 | P36 | | | | | | | |

Transition matrices

+

+

+

| Status | N | N | N | C | N | F | C | N | C | C | C | F | N | F | N | F | C | F | F | F |
|--------|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|
| N_N | P1 | P2 | P3 | P4 | | | | | | | | | | | | | | | | |
| N_C | | P5 | P6 | P7 | P8 | | | | | | | | | | | | | | | |
| N_F | | | P9 | P10 | P11 | P12 | | | | | | | | | | | | | | |
| C_N | | | | P13 | P14 | | P15 | P16 | | | | | | | | | | | | |
| C_C | | | | | P17 | P18 | | P19 | P20 | | | | | | | | | | | |
| C_F | | | | | | P21 | P22 | | P23 | P24 | | | | | | | | | | |
| F_N | | | | | | | P25 | P26 | | P27 | P28 | | | | | | | | | |
| F_C | | | | | | | | P29 | P30 | | P31 | P32 | | | | | | | | |
| F_F | | | | | | | | | P33 | P34 | | P35 | P36 | | | | | | | |

INTENTION TO USE COMPONENT

HEALTH RISK COMPONENT

consumption

Mortality model

consumption

Relative risk


Mortality model

consumption

Relative risk

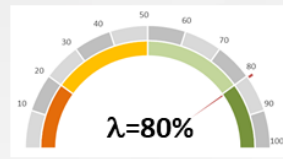
Mortality model

Example of results of three scenarios



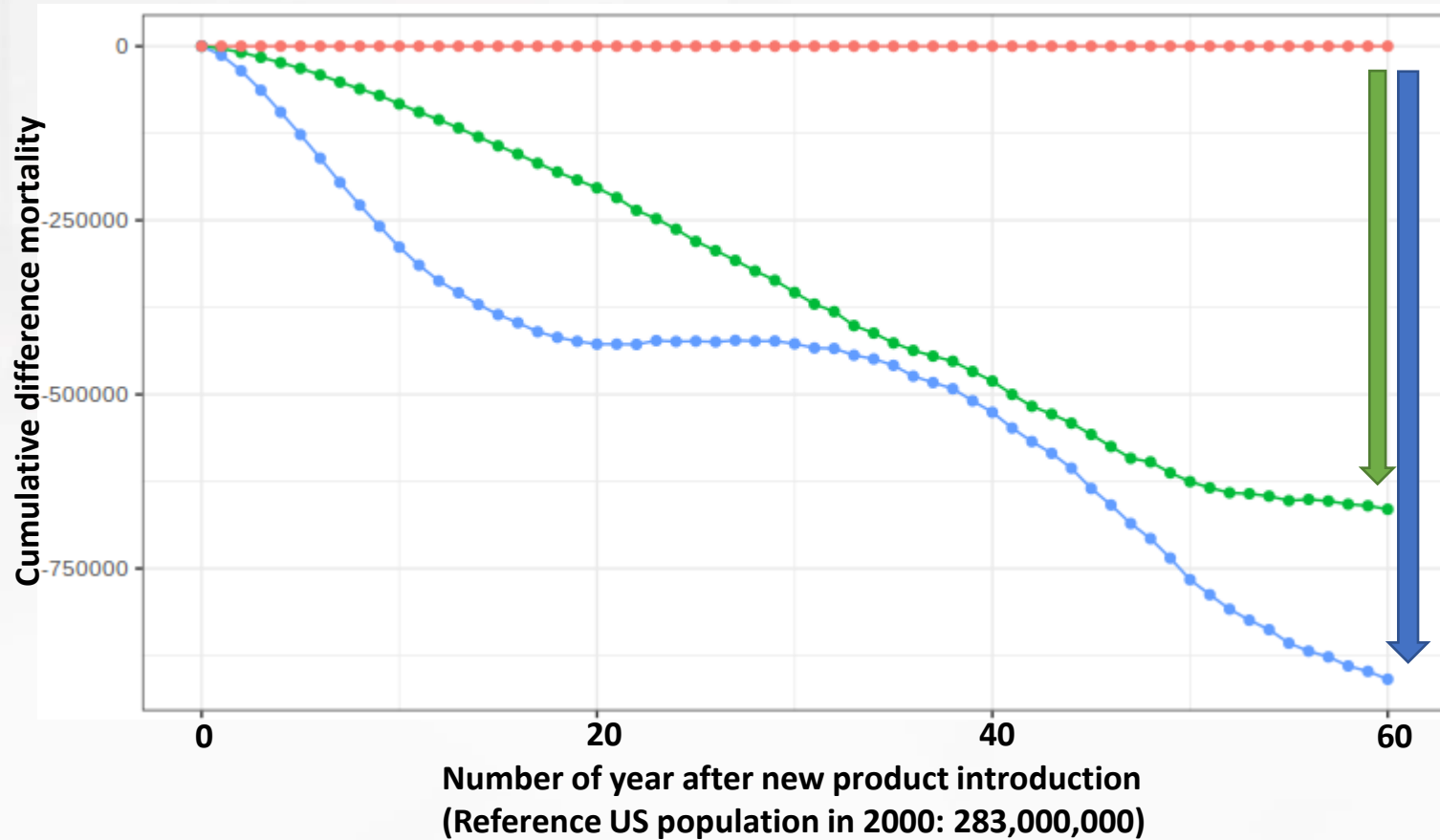
Err = 5 %

| Status | ITU |
|--------|------|
| N_N | 0.0% |
| N_C | 2.5% |
| N_F | 0.0% |
| C_N | 5.0% |
| C_C | 2.5% |
| C_F | 5.0% |
| F_N | 0.0% |
| F_C | 2.5% |
| F_F | 0.0% |



$\lambda=80\%$

| Status | N_N | N_C | N_F | C_N | C_C | C_F | F_N | F_C | F_F |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| N_N | - | + | - | - | - | - | - | - | - |
| N_C | | + | - | - | - | - | - | - | - |
| N_F | | | - | - | - | - | - | - | - |
| C_N | | | | - | - | - | - | + | - |
| C_C | | | | | - | - | - | + | - |
| C_F | | | | | | - | - | + | - |
| F_N | | | | - | - | - | - | + | - |
| F_C | | | | | | | | + | - |
| F_F | | | | | | | | | + |



- 1 **Base case (total death: 42,702,323)**
- 2 **Counterfactual case**
- 664,933 (-1.56%)
- 3 **Counterfactual + New product**
- 908,997 (-2.13%)

Conclusion

- **Dynamics population model (DPM)** is an useful approach to assess the potential population health effects of a new tobacco product compare to cigarette when epidemiological data are not available.
- **Transition probabilities are fundamental inputs** to determine the net population health impact of introducing a new tobacco product into the market
- **For a new e-cigarette, no prevalence data** from longitudinal studies are available to compute the new transition matrices in order to assess the health impact of new product by DPM.
- In this presentation we have showed how the **intention to use** could be implemented in DPM in order to adjust the transition probabilities for a new e-cigarette, and to evaluate its health impact on a population.



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