Smoking Reduction Trajectories and their Association with Smoking Cessation

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Introduction

- Smoking is the leading cause of premature death and preventable illness worldwide [9].
- A prior Cochrane review found that reduction interventions are no more or less effective than quitting abruptly [5].
- However, little is known about how people reduce their smoking and which smoking reduction patterns predict better cessation outcomes.

- When people are asked to reduce smoking, how do people choose to do so?
- Are there smoking or demographics associated with certain reduction patterns?
- Which patterns of reduction are associated with better cessation outcomes?

Methods

Data

- Smoking and demographic information from 5 clinical trials of NRT [1, 2, 4, 7, 8]
- Baseline and follow-up (weeks 2, 10, 18, and 26) CPD were recorded
- CPD and expired breath carbon monoxide (CO) collected at week 56
- Anxiety and depression (from SCQoL[6]), and nicotine dependence (FTND[3]) were recorded at baseline
- Participants in the included trials were:
  - enrolled if they smoked ≥ 15 CPD, made a recent quit attempt, were currently unmotivated to quit, and wanted to reduce their smoking.
  - randomly assigned to receive active or placebo NRT (gum or inhaler)
  - told to reduce their smoking as much as possible.

Table 1: Baseline demographic, smoking, and behavioral characteristics.

	Overall	Class 1	Class 2	Class 3
N (%)	1783 (100)	186 (10.4)	803 (45.0)	794 (44.5)
Study Site (%)				
Australia	360 (20.2)	32 (17.2)	159 (19.8)	169 (21.3)
Denmark	340 (19.1)	35 (18.8)	175 (21.8)	130 (16.4)
Germany	353 (19.8)	60 (32.3)	153 (19.1)	140 (17.6)
Switzerland	301 (16.9)	29 (15.6)	139 (17.3)	133 (16.8)
USA	429 (24.1)	30 (16.1)	177 (22.0)	222 (28.0)
Active NRT (%)	900 (50.5)	125 (67.2)	413 (51.4)	362 (45.6)
Sex = Male (%)	798 (44.8)	96 (51.6)	357 (44.5)	345 (43.5)
Age (m(sd))	44.10(10.72)	45.79 (11.41)	44.26 (10.52)	43.53 (10.73)
FTND (m(sd))	6.14 (2.00)	5.60 (2.13)	6.11 (2.01)	6.30 (1.94)
CPD (m(sd))	27.32 (9.73)	25.65 (10.37)	27.42 (9.78)	27.62 (9.50)
SCQoL Anxiety (m(sd))	0.45 (0.85)	0.41 (0.83)	0.41 (0.82)	0.51 (0.90)
SCQoL Depression (m(sd))	0.29 (0.69)	0.29 (0.69)	0.26 (0.67)	0.32 (0.71)

Analysis

1. We estimated smoking trajectories using latent class analysis (LCA) as a function of percent reduction in CPD. Participants were assigned to the most likely latent class.
2. We used regularized regression (i.e., elastic net) under a nested cross validation scheme to predict latent class using baseline and demographic characteristics (see Table 1).
3. We predicted biochemically-verified smoking status (CO $<$ 6ppm) at week 52 using baseline and demographic characteristics, plus latent class.

- Pre-registered protocol: `https://osf.io/qh378/`
- Analytical code: `https://github.com/ajbarrows/mcneil-lca`

Results

Participants

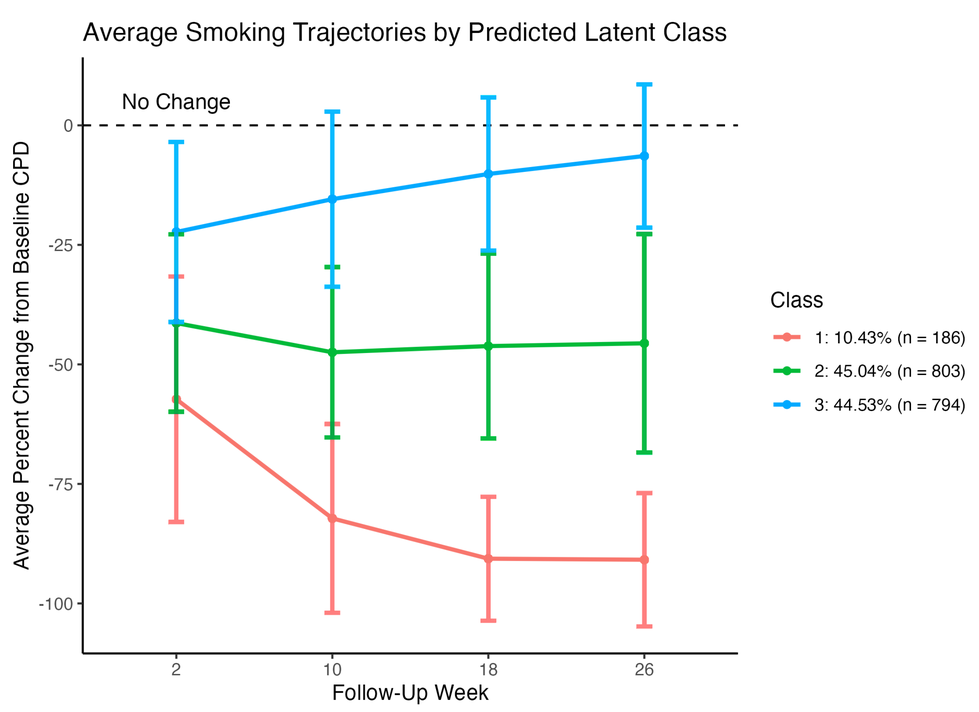
- 108/2066 participants were excluded for missing values.
- Resulting $n = 1783$:
  - From five countries
  - 44.8% male, mean age 44.10 $\pm$ 10.72 years
  - Smoked an average of 27.32 $\pm$ 9.73 CPD

Latent Class Analysis

- Class 1: $\sim$ 10% initially reduced and nearly eliminated smoking
- Class 2: $\sim$ 45% reduced by nearly 50% and remained
- Class 3: $\sim$ 45% initially reduced but reverted to their baseline smoking

Predicting Latent Class

- Demographic data and baseline characteristics (e.g., smoking and quit behavior, FTND, SF-36, trial treatment group) were used as independent variables
- Latent class was used as the dependent variable
- One cross-validated elastic net logistic regression for each latent class (i.e., one-versus-all)
- All models performed better than chance:
  - Class 1 test AUC = 0.766, $p < .001$. Tended to be older with lower anxiety and nicotine dependence, more likely to have received active NRT.
  - Class 2 test AUC = 0.569, $p = .008$ No clear pattern of characteristics.
  - Class 3 test AUC = 0.523, $p < .001$ Inverse of class one: higher nicotine dependence, more likely to have received placebo NRT.



Predicting Smoking Status

- 122/1783 (6.8%) achieved biochemically-verifiable smoking cessation at week 52:
  - Class 1: 70/186 (37.6%); Class 2: 34/803 (4.2%); Class 3: 18/776 (2.3%)
- Elastic net logistic regression predicting smoking cessation using
  - baseline characteristics alone: AUC = 0.632 ± 0.006, $p < .001$
  - baseline characteristics plus latent class: AUC = 0.776 ± 0.010, $p < .001$
- **Adding latent class as an independent variable improved cessation prediction by 14.4%**

Conclusions

- **Examining latent trajectories in smoking behavior among people not motivated to quit revealed three distinct patterns**
- **One of these trajectories was nearly twice as likely as the others to achieve cessation**
- **Smoking reduction in the first two weeks after intervention by $\geq 50\% \rightarrow$ substantially increased cessation likelihood**

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