MEASURING CHANGES IN PATTERNS OF TOBACCO PRODUCT USE OVER TIME: TRANSITION PROBABILITY APPROACHES

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BACKGROUND

Measuring patterns of tobacco use has typically involved assessing number of units and frequency of use of cigarettes. With the emergence of new types of products (e.g., e-cigarettes, heat-not-burn products), multiple combinations of product use can occur, and this makes the quantification of exposure to tobacco/nicotine and associated outcomes intricate. In addition, measuring transitions in patterns of use over time presents analytic challenges.

OBJECTIVES

- To identify analytic approaches that have been used to characterize patterns and combinations of use of tobacco/nicotine containing products
- To describe the applicability and limitations of these approaches in measuring transitions in product use patterns

METHODS

A scoping review and literature search was conducted on PubMed to identify suitable analytic approaches, using search terms capturing concepts associated with pattern of use behavior (e.g., (tobacco OR smoking OR e-cigarette) AND transitions).

To guide the description of these analytic approaches, use of four broad groups of tobacco/nicotine containing products (Figure 1) was considered with a longitudinal study design to assess patterns of product use over time, where the possibilities of single, dual, or multiple product use, occasional and daily use, initiation, cessation, and switching between products may also be considered.

Figure 1 – Groups of tobacco/nicotine containing products

Conventional cigarettes (CC)

E-Cigarettes (E-Cig)

Heat not Burn (HnB) products (e.g., iQOS)

Other tobacco/nicotine products (OTP)

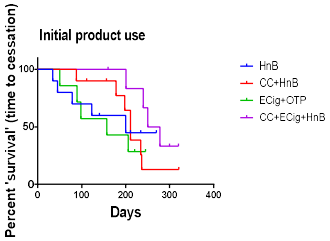
OVERVIEW OF FINDINGS

The review identified 18 relevant articles and four analytical approaches, namely - Kaplan-Meier survival analysis, Markov state transition models, cluster analysis, and latent class/transition analysis.

KAPLAN-MEIER SURVIVAL ANALYSIS

Assesses the time between start of an observation period and a subsequent event ("survival").

Figure 3 (for illustration)



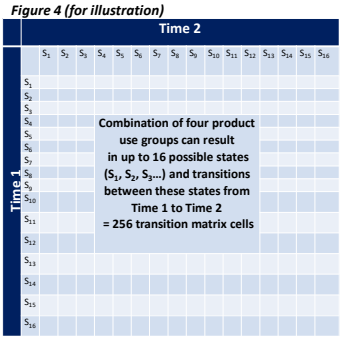
APPLICABILITY TO KEY RESEARCH QUESTIONS: Compact descriptive trajectory of specific use patterns and comparisons across groups. Distribution of time from initiation to cessation of products (Yeomans et al., 2011) or likelihood of adopting use of different products (e.g., time to switch from cigarettes to other combination of uses).

LIMITATIONS: Harder to quantify multiple endpoints. Limited by assumptions regarding temporal changes, competing risks, and unnecessary follow-up duration.

MARKOV STATE TRANSITION MODELS

Assesses changes in the distribution of predefined categories; the transition probability of being in a state 'S_y' at Time 2, conditional on membership in state 'S_x' at Time 1.

Figure 4 (for illustration)



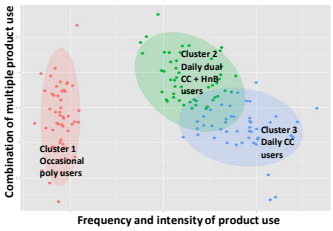
APPLICABILITY TO KEY RESEARCH QUESTIONS: Explanatory modeling and simulations. Can simultaneously estimate the probabilities of transitions between different combinations of product use states (Kaufman et al., 2015).

LIMITATIONS: Complexity of simulating continuous long-term transition patterns. Adding multiple products and indicators of use (e.g., frequency, intensity) would exponentially increase possibilities of observed states, resulting in sparse contingency tables and low precision statistics.

CLUSTER ANALYSIS

Groups individuals into clusters computed on the basis of similarities in observed patterns.

Figure 5 (for illustration)



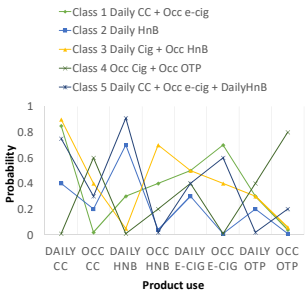
APPLICABILITY TO KEY RESEARCH QUESTIONS: Supports aggregation and classification of product use patterns. Detects distinctive use behavior clusters across multiple products and movement from one cluster to other over time. For example, clusters based on the frequency, intensity, and combination of product use (Primack et al., 2012).

LIMITATIONS: Complexity of tracking continuous transitions. Meaningful clustering dependent on large sample sizes and covariance structure of the clusters.

LATENT CLASS ANALYSIS (LCA) / LATENT TRANSITION ANALYSIS (LTA)

A variant of cluster analysis using a probabilistic model with unknown "latent" parameters for identifying underlying subgroups ("latent classes"). LTA estimates transitions over time in latent class membership.

Figure 6 (for illustration)



APPLICABILITY TO KEY RESEARCH QUESTIONS: Assessing phenotypic use pattern dynamics and their determinants. Simultaneously captures large variety of possibilities of use patterns across multiple products. Enables interpretable profiles to emerge across a continuum of frequency and combination of use and progression between them (Cooke et al., 2017; Huh & Levanthal, 2016).

LIMITATIONS: Model structure and selection may pose challenges depending on number of latent variables in the model. Identical latent classes may not always emerge at all time points (Lanza et al., 2010).

CONCLUSIONS

A scoping review identified four possible analytic approaches to characterize transitions across complex tobacco product use patterns.

Depending on the research question, Kaplan-Meier and Markov state transition approaches may be suited to define and track specific use behaviors over time, whereas cluster and latent class analysis may provide broader interpretable insight into key use patterns across a population.

Future research should consider the feasibility and applicability of these approaches to describe patterns of product use and associated outcomes, especially including the use of novel potential reduced risk products such as e-cigarettes and heat-not-burn products.

References

Cooke, M.E., Nasim, A., Cho, S.B., Kendler, K.S., Clark, S.L. and Dick, D.M., 2016. Predicting tobacco use across the first year of survey of current and former smokers in the US. *International Journal of Clinical Practice*, *65*(10), pp.1043-1054. college. *American Journal of Health Behavior*, *40*(4), pp.484-495.

Huh, J. and Leventhal, A.M., 2016. Progression of poly-tobacco product use patterns in adolescents. *American Journal of Preventive Medicine*, *51*(4), pp.513-517.

Lanza, S.T., Patrick, M.E. and Maggs, J.L., 2010. Latent transition analysis: benefits of a latent variable approach to modeling transitions in substance use. *Journal of Drug Issues*, *40*(1), pp.93-120.

Kaufman, A.R., Land, S., Parascandola, M., Augustson, E. and Backinger, C.L., 2015. Tobacco use transitions in the United States: The National Longitudinal Study of Adolescent Health. *Preventive Medicine*, *81*, pp.251-257.

Primack, B.A., Kim, K.H., Shensa, A., Sidani, J.E., Barnett, T.E. and Switzer, G.E., 2012. Tobacco, marijuana, and alcohol use in university students: a cluster analysis. *Journal of American College Health*, *60*(5), pp.374-386.

Yeomans, K., Payne, K.A., Marton, J.P., Merikle, E.P., Proskorovsky, I., Zou, K.H., Li, Q. and Willke, R.J., 2011. Smoking, smoking cessation and smoking relapse patterns: a web-based survey of current and former smokers in the US. International Journal of Clinical Practice, 65(10), 1043-1054

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