Preventive Medicine Reports 47 (2024) 102906

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Short communication

Who uses cigarette price promotions in the U.S.? examining the combined effect of social identities

Kelvin Choi [a,*], William Wheeler [b], Dennis W. Buckman [b]

[a] Division of Intramural Research, National Institute on Minority Health and Health Disparities, 9000 Rockville Pike, Building 3 Room 5W05, Bethesda, MD 20892, USA
[b] Information Management Services, Inc., 1455 Research Blvd, Suite 315, Rockville, MD 20850, USA

ARTICLE INFO

Keywords:
Intersectionality
Cigarette smoking
Tobacco marketing
Adults
Disparities
Surveillance

ABSTRACT

Introduction: Tobacco industry offers price promotions to promote cigarette smoking. Several social identities (e.g., women, people with low socioeconomic status) are independently associated with exposure and use of these promotions. We examined how combinations of social identities relate to use of cigarette price promotions.
Methods: We analyzed data from adults who reported current cigarette smoking and purchased their own cigarettes in the 1995–2019 U.S. Tobacco Use Supplement to the Current Population Survey (n = 35,749). We applied a statistical-learning boosting algorithm followed by weighted logistic regression models with 3-way interactions to identify combinations of social identities related to cigarette price promotion use.
Results: This analysis revealed that use of cigarette price promotions varied greatly by combinations of social identities. For example, estimated 39.80% of Asian female adults living in the Midwest used these promotions in their last purchase. Meanwhile, estimated 2.80% of Asian male 31–45-year-old adults reported the same behavior. Additionally, American Indian/Alaskan Native peoples were indicated in four of the ten combinations of social identities with highest prevalence of cigarette price promotion use.
Discussion: Our approach allowed for discovery of previously less appreciated social identities (e.g., race/ethnicity) related to high probability of using cigarette price promotions. These findings also revealed how combination of social-identity-related power dynamics may shape use of cigarette price promotions. Adopting this perspective in future surveillance and policy evaluation effort will provide better understanding in commercial tobacco use disparities.

1. Introduction

Every year, cigarette smoking claims over 480,000 lives in the United States, with much of smoking-related morbidities and mortalities disproportionately impacting social and economically disadvantaged groups (U.S. Department of Health and Human Services, 2014). Tobacco marketing plays a major role in promoting cigarette smoking (National Cancer Institute, 2008). Price discounting is an important strategy employed by the tobacco companies to promote cigarette smoking, with about 90% of tobacco companies' marketing expenditures were used to provide price discounts in the last decade (Federal Trade Commission, 2021). Internal documents showed that the tobacco industry use price discounting and promotions to reduce the effect of tax increases on tobacco product sales (Apollonio and Glantz, 2020). Additionally, tobacco companies target specific populations when deploying price discounting, e.g., young adults, women, sexual and gender minorities, and in low socioeconomic status were independently associated with greater exposure to and use of cigarette price promotions (Brown-Johnson et al., 2014; Choi and Boyle, 2017; Liber et al., 2022; Osman et al., 2019; Xu et al., 2013). Importantly, cigarette price promotions have been shown to be related to smoking initiation, progression, and continuation (Hamilton-Moseley et al., 2023; Liber et al., 2022). Consequently, cigarette price discounting potentially contributes cigarette smoking disparities.

Conventional multivariable approaches are limited in their ability to examine tobacco use disparities. This is because, as posited in the Intersectionality Theory, a person's experience is the result of the interactions of interconnected multiple identities and their associated power differences. (Crenshaw, 1989) Previous studies have applied this theory in conceptualizing determinants of tobacco use disparities (Sheffer et al., 2022) and in examining tobacco product use behaviors (Amroussia et al., 2020; Choi et al., 2023). However, no studies to date

* Corresponding author.
E-mail address: Kelvin.choi@nih.gov (K. Choi).

https://doi.org/10.1016/j.pmedr.2024.102906
Received 16 June 2024; Received in revised form 5 October 2024; Accepted 11 October 2024
Available online 13 October 2024
2211-3355/Published by Elsevier Inc. This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

have applied this theory to examine exposure and use of tobacco price discounting. Therefore, the current study applied an intersectional perspective to explore how use of cigarette price promotions varies by combinations of social identities. Specifically, we first explored social identities related to cigarette price promotion use. We then examined how cigarette price promotion use varied by different combinations of these identities, which will illustrate the subpopulations that are most burdened by this marketing tactic.

2. Methods

We analyzed data from the U.S. Tobacco Use Supplement to the Current Population Survey (TUS-CPS) conducted between 1995–2019 (National Cancer Institute, 2024). The survey uses a two-stage address-based probability sampling approach to assemble a US nationally representative non-institutionalized adult sample (18 years and older). We restricted the analysis to participants who reported every-day and some-day cigarette smoking and purchasing their cigarettes (n = 35,749). This secondary analysis national survey data did not require review or approval by the National Institutes of Health Institutional Review Board per 45 CFR 46 because it only involved de-identified data and therefore is not considered human subjects research.

The dependent variable was the use of cigarette price promotions. Respondents were asked if they used coupons, rebates, or any other special promotions during their last cigarette purchase (yes/no). The independent variables that reflected important social identities included age, sex, race, ethnicity, educational attainment, annual household income, employment status, US citizenship status, marital status, urbanity, and census region. We included missing income as a category instead of imputing the income for those who did not report their income. This was because there are individuals who are unwilling to report their incomes in the real world. This allowed our algorithm to identify individuals who have a high probability of using cigarette price promotion in the real-world setting.

To explore social identities related to cigarette price promotion use, we first partitioned the data into training (1995–2015) and testing data (2018–2019). We applied a statistical-learning boosting algorithm (Hastie et al., 2009) to the training data while applying sampling weights. The aim of a boosting algorithm was to identify an ensemble of independent variables that have a high probability of correctly predicting the value of the dependent variable. Through this iterative statistical learning process, we estimated a variable importance score for each independent variable. We then pruned the model sequentially, starting from the variable with the lowest to the highest variable importance score, and calculated area under the curve (AUC) statistic for every model against the testing data. We tested whether the difference in AUC between models with k and k-1 variables was statistically significant. The final set of independent variables was chosen by achieving

Table 1
Weight social identities and circumstances overall and by tobacco price promotion use, U.S. Tobacco Use Supplement to the Current Population Survey, 1995–2019.

Social identities and circumstances	Overall		Used price promotions		Did not use price promotions	
	n	Weighted %	n	Weighted %	n	Weighted %
Race/ethnicity: American Indian/Alaskan Native	664	1.9	72	2.0	592	1.8
Race/ethnicity: Asian	812	2.3	60	1.6	752	2.3
Race/ethnicity: Black	3860	10.8	327	8.9	3533	11.0
Race/ethnicity: Hispanic	2466	6.9	206	5.6	2260	7.0
Race/ethnicity: Other/multi-race	619	1.7	69	1.9	550	1.7
Race/ethnicity: White	27,328	76.4	2936	80.0	24,392	76.0
Age: ≤30 years	5578	15.6	562	15.3	5016	15.6
Age: 31–45 years	10,187	28.5	1126	30.7	9061	28.2
Age: 46–60 years	11,940	33.4	1288	35.1	10,652	33.2
Age: >60 years	8044	22.5	694	18.9	7350	22.9
Sex: Male	17,939	50.2	1519	41.4	16,420	51.2
Sex: Female	17,810	49.8	2151	58.6	15,659	48.8
Education: <High school	5429	15.2	567	15.4	4862	15.2
Education: High school diploma/GED	14,139	39.6	1453	39.6	12,686	39.5
Education: Some college, no degree	7741	21.7	841	22.9	6900	21.5
Education: Associate degree	3873	10.8	454	12.4	3419	10.7
Education: Bachelor's degree	4567	12.8	355	9.7	4212	13.1
Income: <US$15,000	6441	18.0	637	17.4	5804	18.1
Income: US$15,000-$29,999	6550	18.3	742	20.2	5808	18.1
Income: US$30,000-$49,999	7150	20.0	790	21.5	6360	19.8
Income: US$50,000-$74,999	5474	15.3	566	15.4	4908	15.3
Income: ≥US$75,000	5877	16.4	507	13.8	5370	16.7
Income: Missing	4257	11.9	428	11.7	3829	11.9
Employment: Employed	20,028	56.0	1956	53.3	18,072	56.3
Employment: Employed, not at work	710	2.0	67	1.8	643	2.0
Employment: Unemployed, looking for work	1668	4.7	209	5.7	1459	4.5
Employment: Unemployed, on layoff	291	0.8	31	0.8	260	0.8
Employment: Not in labor force	13,052	36.5	1407	38.3	11,645	36.3
Citizenship: US born	33,702	94.3	3524	96.0	30,178	94.1
Citizenship: Foreign Born, naturalized citizen	958	2.7	68	1.9	890	2.8
Citizenship: Non-citizen	1089	3.0	78	2.1	1011	3.2
Marital status: Never married	10,041	28.1	995	27.1	9046	28.2
Marital status: Married	13,473	37.7	1422	38.7	12,051	37.6
Marital status: Divorced	8252	23.1	869	23.7	7383	23.0
Marital status: Separated	1484	4.2	156	4.3	1328	4.1
Marital status: Widowed	2499	7.0	228	6.2	2271	7.1
Urbanicity: Metropolitan	25,474	71.3	2636	71.8	22,838	71.2
Urbanicity: Non-Metropolitan	9779	27.4	980	26.7	8799	27.4
Urbanicity: Not identified	496	1.4	54	1.5	442	1.4
Region: Northeast	5215	14.6	485	13.2	4730	14.7
Region: Midwest	8603	24.1	961	26.2	7642	23.8
Region: West	7562	21.2	659	18.0	6903	21.5
Region: South	14,369	40.2	1565	42.6	12,804	39.9

model parsimony without statistically significantly lower AUC than the full model. These analyses were conducted in the caret R package (Kuhn, 2008; Kuhn and Johnson, 2018).

To examine how cigarette price promotion use varied by different combinations of the final set of independent variables, we fitted weighted logistic regression models to the entire dataset including main effects, all two-way and three-way interactions of variables included in the final model with replicate weights to estimate predicted marginal probabilities of price promotion use across three-way interactions of these variables. We limited the models to three-way interactions to avoid small cell sizes. These analyses were conducted in SAS® version 9.4 (SAS Institute: Cary, NC).

3. Results

Table 1 presents the weighted distributions of the independent and dependent variables in the overall analytic population and by use of cigarette price promotions in the last purchase. The AUC statistics showed model fits were similar with 10, 9, 8, and 7 most important variables in the model (AUC ~ 0.59), but it became significantly lower with fewer than 7 variables (AUC < 0.58, $p < 0.05$). These variables are age, sex, race, education, employment status, annual household income, and census region. Fig. 1 shows the combinations of three independent variables that yielded that top ten highest and bottom five lowest predicted marginal of using cigarette price promotions in the last purchase. Supplementary Table S1 shows a full list of predicted marginal probabilities (n = 1,817). The three combinations with the highest predicted marginal probabilities of using cigarette price promotions in the last purchase were: (1) Asian female adults living in the Midwest (39.80%), (2) American Indian (including Alaskan Native) 31–35-year-old adults living the South (36.92%), and (3) adults who were employed but absent from work (e.g., illness/injury, childcare and other family obligations) with high school or general education development (GED) diploma and an annual household income between US$15,000–29,999 (35.45%). The three combinations with the lowest predicted marginal probabilities of using cigarette price promotions in the last purchase were: (1) adults with at least a bachelor's degree and an annual household income between US$30,000–49,999 living in the Northeast (2.95%), (2) Asian male 31–45-year-old adults (2.80%), and (3) Black adults living in the South who did not report annual household income (1.95%).

4. Discussion

The current analysis revealed that, depending on the combinations of their social identities, there were high levels of heterogeneity on using cigarette price promotions among adults who currently smoke. No studies to date have found that race (e.g., Asian and Native American peoples), ethnicity (e.g., Hispanic peoples) and census region were associated with cigarette price promotion use. Intersectionality Theory posits that our findings could be a result of identity-associated power dynamics (Crenshaw, 1989). For example, a majority of U.S. Asian peoples worried about discrimination despite the "model minority" stereotype (Ruiz et al., 2023). Additionally, racial arrest disparities were the worst in the US Midwest (Jewett et al., 2024). Meanwhile, Native Americans continues to suffer from historical trauma (Evans-Campbell, 2008) and federal policies that deprived Native American peoples

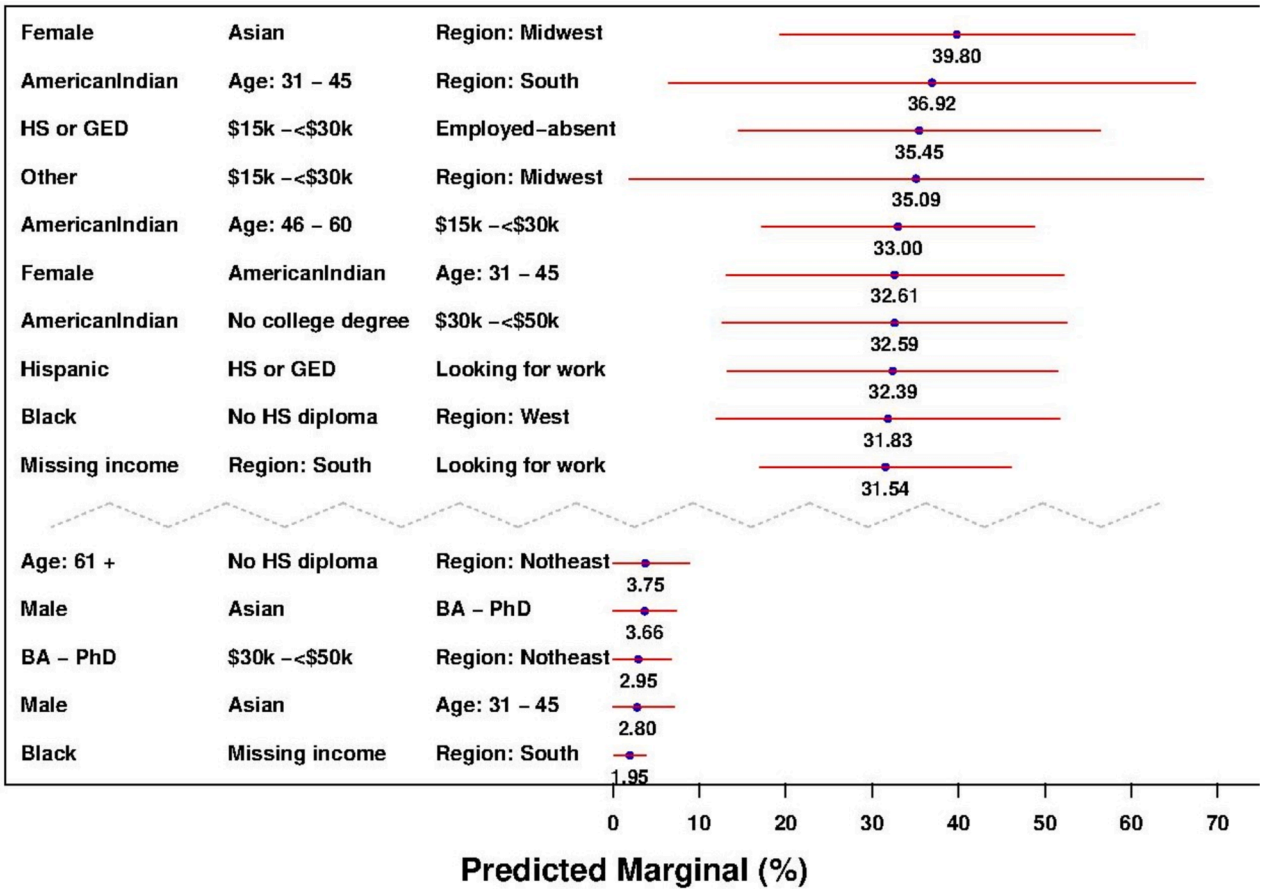

Fig. 1. Combinations of social identities with ten highest and five lowest predicted marginal percent of using cigarette price promotion in the last purchase, 1995–2019 U.S. Tobacco Use Supplement to the Current Population Survey (n = 35,749). Estimates are adjusted for age, sex, race, education, employment status, annual household income, and census region and their two-way and three-way interactions. The x-axis is percent using cigarette price promotion in the last purchase. Note: HS = high school, GED = General Educational Development, BA = bachelor's degree, PhD = doctoral degree.

economic opportunities (Crepelle, 2023). These social forces could increase daily stressors, and prompt increases in cigarette consumption, as shown in our previous study on concern for discrimination and changes in cigarette consumption among Asian Americans (Liu et al., 2023). Provision of cigarette price promotions by tobacco industry, especially with targeting of social and economically peoples (Brown-Johnson et al., 2014), lowers the financial hurdle for increasing cigarette consumption in response to daily stressor. Without these price promotions, individuals may seek healthy alternatives to cope with their stress, which could lead to smoking cessation.

Ribisl and colleagues proposed that a comprehensive cigarette pricing regulation should include excise taxes, minimum prices, and price promotion restrictions (Ribisl et al., 2022). Our findings highlight the benefit of examining combined effects of social identities when examining tobacco use disparities, and perhaps also when evaluating tobacco control policies. To date, New York and New Jersey States, as well as Providence, Rhode Island have prohibited provision of in-store price discounts, distribution and/or redemption of tobacco discount. As more states and localities in the US adopt policies to ban discount coupon redemption and/or price promotions for commercial tobacco, it is important to investigate whether these policies reduce exposure to cigarette price promotions and their impact on smoking behaviors in groups with combinations of social identities associated with high exposure (e.g., smoking cessation). Additionally, it will be important to assess how individuals in these groups shift their use in other cigarette expenditure minimizing strategies (Choi and Boyle, 2017) to truly understand the impact of these policies.

While this study leveraged a large sample size pooling data across multiple waves of TUS-CPS, it has limitations. First, the survey did not assess sexual and gender identities, a known factor associated with tobacco coupon exposure (Liber et al., 2022). Second, the survey lacks detail ancestral information within the Asian respondents, inhibiting us to further examine heterogeneity within this population. Third, given the measure on cigarette price promotion use only assess the last purchase, it is likely to underestimate the prevalence of using cigarette price promotions. Fourth, the current study focused on the use of cigarette price promotions among those who purchased cigarettes. Therefore, our findings may not be generalizable to exposure to these price promotions among adults in general. Fifth, the survey only included coupons, rebates, and other special promotions as examples of price promotions. Therefore, it was unclear if participants included "special price when you buy 2 packs" type of promotions in their responses, which could lead to underestimation of the prevalence of price promotion use. Finally, the data were collected over 20 years when the tobacco marketplace changed dramatically. However, it is noteworthy that disparities in cigarette smoking by social identities persisted over time (Choi et al., 2023).

Despite these limitations, our findings have public health implications. By applying an intersectional perspective to examine use of an important cigarette marketing strategy, we found substantial heterogeneity depending on the combinations of social identities. These findings illustrated the subpopulations who are most burdened by this marketing strategy, and how regulations on cigarette price promotions may reduce international disparities in cigarette smoking. Additionally, we provided a novel approach for future public health surveillance and policy evaluation to better understand health disparities.

5. Funding statement

This work is supported by the National Institute on Minority Health and Health Disparities Division of Intramural Research. Comments and opinions expressed in this article belong to the authors and do not necessarily reflect those of the US Government, Department of Health and Human Services, National Institutes of Health, and National Institute on Minority Health and Health Disparities.

6. Contributorship Statement

KC and DWB conceptualized the study; KC acquired the funding; WW acquired the data and analyzed the data; all authors interpreted the findings; KC drafted the manuscript; all authors critically reviewed the manuscript and approved the final version for publication.

CRediT authorship contribution statement

Kelvin Choi: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **William Wheeler:** Writing – review & editing, Validation, Supervision, Software, Project administration, Methodology, Investigation, Conceptualization. **Dennis W. Buckman:** Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102906.

Data availability

The data are publicly available.

References

Amroussia, N., Gustafsson, P.E., Pearson, J.L., 2020. Do inequalities add up? Intersectional inequalities in smoking by sexual orientation and education among U.S. adults. Prev Med Rep 17 (101032).

Apollonio, D.E., Glantz, S.A., 2020. Tobacco Industry Promotions and Pricing After Tax Increases: An Analysis of Internal Industry Documents. Nicotine Tob Res 22, 967–974.

Brown-Johnson, C.G., England, L.J., Glantz, S.A., Ling, P.M., 2014. Tobacco industry marketing to low socioeconomic status women in the U.S.A. Tob Control 23, e139–e146.

Choi, K., Boyle, R.G., 2017. Changes in cigarette expenditure minimising strategies before and after a cigarette tax increase. Tob Control 27, 99–104.

Choi, K., Jones, J.T., Ruybal, A.L., McNeel, T.S., Duarte, D.A., Webb Hooper, M., 2023. Trends in Education-Related Smoking Disparities Among U.S. Black or African American and White Adults: Intersections of Race, Sex, and Region. Nicotine Tob Res 25, 718–728.

Crenshaw, K., 1989. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. University of Chicago Legal Forum 1989, 139–167.

Crepelle, A., 2023. Federal Policies Trap Tribes in Poverty. Human Rights Magazine, American Bar Association, Washington, D.C.

Evans-Campbell, T., 2008. Historical trauma in American Indian/Native Alaska communities: a multilevel framework for exploring impacts on individuals, families, and communities. J Interpers Violence 23, 316–338.

Federal Trade Commission, 2021. Cigarette Report for 2020. Federal Trade Commission, Washington, DC.

Hamilton-Moseley, K.R., McNeel, T.S., Choi, K., 2023. Cumulative cigarette discount coupon exposure and trajectories of cigarette smoking: a longitudinal analysis in US adults. Tob Control Apr 3:tc-2022-057801.

Hastie, T., Tibshirani, R., Friedman, J., 2009. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd ed. Springer, New York, New York.

National Cancer Institute, 2008. *The Role of the Media in Promoting and Reducing Tobacco Use.* Tobacco Control Monograph No. 19. U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute, Bethesda, MD.

National Cancer Institute, 2024. Tobacco Use Supplement of the Current Population Survey (TUS-CPS), in: Department of Health and Human Services (Ed.), Rockville, MD.

Jewett, P.I., Gangnon, R.E., Hing, A.K., Henning-Smith, C., Chantarat, T., Areba, E.M., Borowsky, I.W., 2024. Racial Arrest Disparities in the USA by Rural-Urban Location and Region. J Racial Ethn Health Disparities 11, 2355–2377.

Kuhn, M., 2008. Building Predictive Models in R Using the caret Package. J Stat Softw 28, 1–26.
Kuhn, M., Johnson, K., 2018. Applied Predictive Modeling. Springer, New York, NY.
Liber, A.C., Sanchez-Romero, L.M., Cadham, C.J., Yuan, Z., Li, Y., Oh, H., Cook, S., Warner, K.E., Henriksen, L., et al., 2022. Tobacco Couponing: A Systematic Review of Exposures and Effects on Tobacco Initiation and Cessation. Nicotine Tob Res 24, 1523–1533.
Liu, T., Phan, L., Chen-Sankey, J., Ajith, A., Hacker, K., Jewett, B., Choi, K., 2023. Race, Concern About COVID-19 Discrimination, and Cigarette Smoking Behavior: Comparison Between US Asian and White Adults Who Use Commercial Tobacco. J Racial Ethn Health Disparities 10, 1955–1961.
Osman, A., Queen, T., Choi, K., Goldstein, A.O., 2019. Receipt of direct tobacco mail/email coupons and coupon redemption: Demographic and socioeconomic disparities among adult smokers in the United States. Prev Med 126, 105778.
Ribisl, K.M., Golden, S.D., Huang, J., Scollo, M., 2022. Addressing lower-priced cigarette products through three-pronged comprehensive regulation on excise taxes, minimum price policies and restrictions on price promotions. Tob Control 31, 229–234.
Ruiz, N.G., Tian, Z., Klein, H., 2023. Discrimination Experiences Shape Most Asian Americans' Lives. Pew Research Center, Washington, D.C.
Sheffer, C.E., Williams, J.M., Erwin, D.O., Smith, P.H., Carl, E., Ostroff, J.S., 2022. Tobacco-Related Disparities Viewed Through the Lens of Intersectionality. Nicotine Tob Res 24, 285–1228.
U.S. Department of Health and Human Services, 2014. The Health Consequences of Smoking – 50 Years of Progress. A Report of the Surgeon General. . U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, Atlanta, GA.
Xu, X., Pesko, M.F., Tynan, M.A., Gerzoff, R.B., Malarcher, A.M., Pechacek, T.F., 2013. Cigarette price-minimization strategies by U.S. smokers. American Journal of Preventive Medicine 44, 472–1446.