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# Evaluation of California's 'Tobacco 21' law

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## ABSTRACT

**Introduction** California's law raising the minimum tobacco sales age to 21 went into effect on 9 June 2016. This law, known as 'Tobacco 21' or 'T21', also expanded the definition of tobacco to include electronic smoking devices. This paper describes the T21 evaluation plan and initial evaluation results.

**Methods** An evaluation plan and logic model were created to evaluate T21. A tobacco retailer poll was conducted 7 months after the law went into effect to assess awareness, support and implementation; an online survey of California adults was fielded to provide data on tobacco use and attitudinal changes before and after T21 implementation; and tobacco purchase surveys were conducted to assess the retailer violation rate (RVR). Multivariate models estimated the odds of RVR and odds of being aware, agreeing with and observing advertisements related to T21.

**Results** Seven months after the T21 effective date, 98.6% of retailers were aware of the law and 60.6% supported the law. Furthermore, 66.2% of retailers agreed that people who start smoking before 21 would become addicted to tobacco products. The RVR using youth decoys under age 18 statistically decreased from 10.3% before T21 to 5.7% after T21 ( $P=0.002$ ). Furthermore, the RVR using young adult decoys ages 18–19 was 14.2% (95% CI 9.3% to 19.1%) for traditional tobacco and 13.1% (95% CI 10.2% to 16.1%) for electronic smoking devices.

**Conclusions** Survey findings suggest that the high awareness and support for the law may have contributed to reducing illegal tobacco sales to youth under 18 and achieving widespread retailer conformity with the new law disallowing sales to young adults under 21.

## INTRODUCTION

California has significantly reduced tobacco use since the California Tobacco Control Program began in 1989. California has an adult cigarette smoking prevalence of 10.5% in 2015<sup>1</sup>; however, California still has 3.2 million adult cigarette smokers,<sup>1,2</sup> more than the population of 21 other states.<sup>2</sup> Legislation that raised the legal minimum age for tobacco sales from 18 to 21 years old was enacted in 2016 to further reduce tobacco use initiation and use among youth and young adults. This law, known as 'Tobacco 21' or 'T21', became effective on 9 June 2016. The law also expanded the definition of tobacco products to include electronic smoking devices and required retailers selling electronic smoking devices to obtain a tobacco retail licence from the State of California by 1 January 2017. In order to garner support for the law's passage, active-duty military personnel in the United States Armed Forces were exempted from the new minimum age-of-sale restriction. The law also does not cover American Indian tribal lands.

Since the minimum age of sale for tobacco in California had been 18 years of age for 144 years, a campaign was launched to raise awareness and facilitate implementation of the law. The goals were to educate the public, alert tobacco retailers and help them comply, maintain strong public support and promote the California Smokers' Helpline (CSH).

The campaign used a multipronged approach, including a website portal to rapidly disseminate information, a press conference, a tobacco retailer educational toolkit, paid advertisements and social media posts. The toolkit included training and educational materials and updated state-mandated minimum age-of-sale warning signs. To reach California's diverse tobacco retailer population, select resources were translated into Arabic, Chinese, Korean, Punjabi, Spanish and Vietnamese.<sup>3</sup> The media campaign included point-of-sale advertisements and convenience store posters. Advertising also included print advertisements, digital advertisements and e-blasts. The T21 information campaign launched on 9 June 2016, with an initial cost of US\$542 594.

Studies on the effectiveness of T21 laws are currently limited to local jurisdictions and statistical modelling.<sup>4–7</sup> Studies suggest that laws increasing the minimum age for tobacco sales likely reduce the ability of youth to purchase tobacco products and prevent or delay tobacco use initiation.<sup>5</sup> Research further indicates that T21 laws are a promising strategy and, in future decades, may significantly avert low birth weight, preterm births and chronic diseases.<sup>8</sup> Conceptually, T21 laws are likely to make it more difficult for youth under 18 to obtain cigarettes from older friends.<sup>7,9</sup> Over 33 000 tobacco retailers and vape shops are located in California and approximately 29.2% of them are located within 1000 feet of schools.<sup>10</sup>

## METHODS

To assess the effectiveness and impact of California's T21 law, an evaluation plan and logic model were developed. As part of this plan, a retailer poll was conducted to investigate tobacco retailers' awareness, support and implementation of California's T21. Two online surveys assessed tobacco use prevalence and awareness of paid media advertising. Four statewide tobacco purchase surveys assessed retailer violation rates on tobacco sales. This paper describes the methods and initial results of evaluating the impact of California's T21.

### Evaluation logic model

Figure 1 displays the T21 logic model. Key activities to implement the law are listed in column one.<sup>i</sup>

<sup>i</sup>Activities around educating the American Indian community are currently in the planning stages; evaluation of those activities will not be described here.



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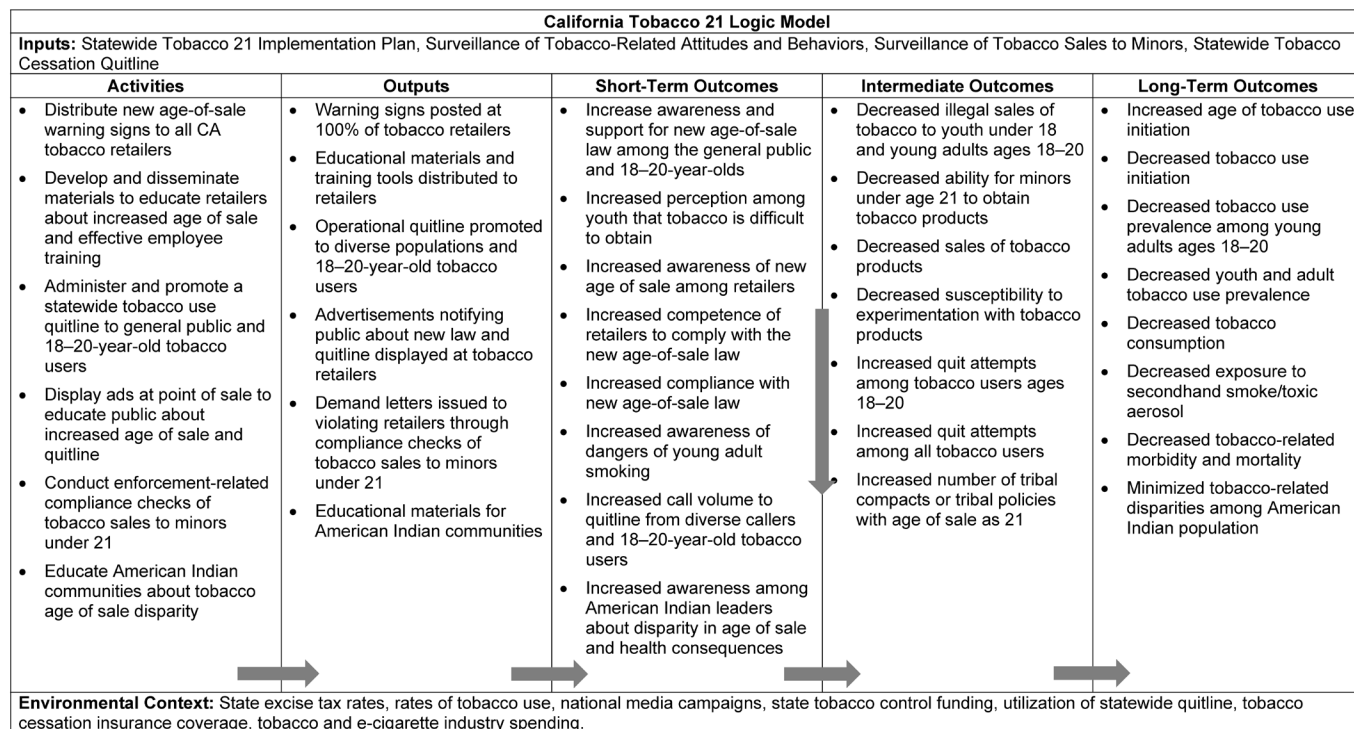


Figure 1 T21 logic model.

The outputs reflect tangible results of each activity. Short-term outcomes include the earliest changes expected, such as increased awareness and support for the law, increased competence of retailers to comply with T21 and increased calls to the CSH. Intermediate outcomes include decreased illegal sales of tobacco to youth and young adults, and increased quit attempts. Long-term outcomes represent the ultimate goals of the law: increasing the age of tobacco use initiation, decreasing tobacco use prevalence and decreasing tobacco-related morbidity and mortality.

### California Tobacco Retailer Poll

#### Sample design

The California Tobacco Retailer Poll (CTRP) was a telephone survey conducted in January 2017, 7 months after T21 became effective. Retailers were randomly sampled from the California Department of Tax and Fee Administration (CDTFA)<sup>ii</sup> tobacco retail licensing list, stratified by region. A sample of 1454 respondents completed the survey. The adjusted response rate was 29.8% with a cooperation rate of 53.5%.

#### Questionnaires and outcomes

Interviews were conducted in English or Spanish using computer-assisted telephone interviewing software. The priority for participation, in order of availability, was the storeowner, managers or supervisors, and clerks. A qualifying question was asked to ensure that retailers currently sell tobacco. Questions included T21 awareness, support and compliance.

<sup>ii</sup>The California Department of Tax and Fee Administration handles the taxes and fees previously collected by the California State Board of Equalisation.

### Online California Adult Tobacco Survey

#### Sample design

The Online California Adult Tobacco Survey (Online CATS) assessed tobacco use behaviour and attitudes, public awareness and exposure to T21 advertisements, with a focus on California's working-age population. Two cycles were conducted, a pre-T21 and post-T21 survey, both fielded by the GfK Group. Samples were drawn from GfK's KnowledgePanel, where panel members are randomly recruited by GfK through address-based sampling methods and then weighted to be representative of California's population. To qualify, respondents had to be between the ages of 18 and 64 years and reside in California. A total of 3071 respondents qualified and completed the pre-T21 survey (62.1% completion rate); in the post-T21 survey, 3065 respondents qualified and completed the survey (65.1% completion rate). More information on the GfK panel sample design is available elsewhere.<sup>11</sup> Individuals ages 18–24 years were included in the analytic sample for both pre-T21 (n=184) and post-T21 survey (n=175).

#### Questionnaires and outcomes

The Online CATS questionnaire asked respondents to report past 30-day use of cigarettes, e-cigarettes, chewing tobacco, big cigars, little cigars or cigarillos, tobacco pipe and hookah. Respondents' reported use of any of these tobacco products for at least 1 day in the past 30 days was classified as a current tobacco user.

Respondents were questioned about recent exposure to two media advertisements informing the public about the change in the minimum legal age-of-sale for tobacco in either English or Spanish and the state-mandated minimum age-of-sale warning signs. Respondents were asked about awareness of T21 before the survey and if they agreed or disagreed with the following statement: 'Raising the legal sale of age for tobacco products will

reduce youth smoking'. Demographic data were also collected, including age, gender, race/ethnicity and household income.

## Tobacco Purchase Surveys

### Sample design

The rate of sale of tobacco to underage youth and young adults was assessed using four surveys with samples drawn from CDTFA's tobacco licensing list:

1. A pre-T21 and post-T21(2) Youth Tobacco Purchase Survey (YTPS), which used decoys ages 15–16 years attempting to purchase traditional tobacco in randomly selected retailers. The final sample for the pre-T21 YTPS was 793 retailers with a 96.1% completion rate, and the post-T21 YTPS was 751 retailers with a 91.8% completion rate (online supplementary table 1).
2. A Young Adult Tobacco Purchase Survey (YATPS), which used young adult decoys ages 18–19 years attempting to purchase traditional tobacco. Retailers were selected using a stratified clustered design that stratified California into 12 regions. Within each region, a random sample of zip codes was selected. All tobacco retailers within the zip code were chosen for YATPS.
3. A Young Adult E-cigarette Purchase Survey (YAEPS), which used young adult decoys ages 18–19 years attempting to purchase electronic smoking devices. To reduce travel costs, zip codes with geographic proximity to the zip codes selected for YATPS were identified and then all tobacco retailers within the selected zip code were chosen for YAEPS.

YATPS and YAEPS survey sample sizes were calculated by using the Substance Abuse and Mental Health Services Administration guidelines with the following inputs<sup>12</sup>: a 40.0% retail violation rate, a design effect of 1.5 to adjust for the sampling design, and a 90.0% eligibility rate and completion rate based on previous cycles of YTPS.<sup>13</sup> The final sample size for YATPS was 1228 retailers and 842 retailers for YAEPS (online supplementary table S1). The YATPS and YAEPS had completion rates of 92.7% and 87.0%, respectively.

### Questionnaires and outcomes

The tobacco purchase surveys were unannounced, non-enforcement-related compliance checks that used a consummated buy protocol in which the decoy selected and purchased the tobacco product. Each survey used a diverse group of decoys. Equal distribution of each gender and age group was attempted to reduce bias.

YTPS and YATPS decoys attempted to purchase cigarettes, little cigars or cigarillos, big cigars or chewing tobacco; YAEPS decoys attempted to purchase cigalikes, e-liquids/e-juice or other electronic smoking device products. The accompanying researcher recorded the retailer type, whether the decoy had been asked their age or to show identification, and tobacco sale. Data were recorded on paper surveys for the pre-T21 YTPS and on handheld electronic devices using SurveyPocket (Survey Analytics, San Francisco, California, USA) for the others.

### Statistical analyses

All analyses were generated using SAS 9.4 (SAS Institute). Analyses were weighted for the probability of selection and accounted for the sample design. A P value of <0.05 was considered statistically significant for this study.

Descriptive statistics were performed for all CTRP outcomes, with results stratified by the interviewees' position. Responses of *strongly support* and *support* were combined to describe overall

support. A similar combination was used for importance, ease and attitudinal belief. Responses of *undecided* or *don't know* were treated as missing data.

Descriptive statistics and significance tests were performed for Online CATS responses to determine changes over time. The household income variable was recoded into a three-category response. Current tobacco use is based on past 30-day usage. Multivariate logistic regression models were conducted to estimate the odds of agreeing with the statement that raising the legal minimum age of sale would reduce youth tobacco use prevalence, odds of being aware of T21, odds of observing the updated minimum age-of-sale warning signage and odds of observing the T21 advertisements, after adjusting for the respondent's gender, race, income and current use of cigarettes, e-cigarettes, little cigars or hookah.

Retail violation rates (RVRs) were calculated statewide and, if applicable, by geographic region. Adjustments were made to standardise the results to an equal distribution of the decoy's gender and age. Multivariate logistic regression models were used to estimate odds of tobacco sales to decoys after adjusting for the clerk's gender, decoy's characteristics (age, race, gender) and retailer type in YTPS, with an additional adjustment for geographic location for YATPS and YAEPS.

## RESULTS

### Process data

Website analytics recorded 40231 visits to the T21 webpage between June and December 2016. The press conference secured more than 50 earned media placements and 13 million impressions through TV, daily papers, Spanish and Asian outlets, and retail trade publications. Over 36000 toolkits were mailed to tobacco retailers and vape shops, 22 trade associations and by certified mail to 33 tobacco companies to raise awareness of the new laws and to promote compliance. Two waves of point-of-sale advertising were conducted: July to September 2016 and January to March 2017. These advertisements (online supplementary Figure S1) were placed at over 800 and then 1400 gas stations and convenience stores, with some overlap among retailers in the two waves. Retailer print and digital advertising were placed in *Convenience Store News*, *Supermarket News* and *California Grocer*. Digital advertising targeting young adults occurred in the second wave. Facebook outreach reached 883452 individuals with positive sentiment expressed via user comments, likes and shares.

### California Tobacco Retailer Poll and Online California Adult Tobacco Survey

Table 1 displays results from the CTRP with 98.6% of retailers aware of the T21 law and 60.6% supporting the T21 law. Furthermore, 66.2% of retailers agreed that people who start smoking before 21 will become addicted to tobacco products. Most retailers thought it was easy to train staff (90.7%) and easy to comply with T21 (85.6%). Over half of retailers reported hearing complaints from individuals under 21 years old at least once a month and nearly a quarter observed monthly 'shoulder tap' buys in which an underage person asks an adult stranger in or outside the store to buy tobacco for them.

Descriptive statistics from the Online CATS are displayed in tables 2 and 3 displays the adjusted OR (AOR) for attitude towards and awareness of T21, observing T21 signs and observing T21 advertising. Current e-cigarette users, ages 18–24 years, have lower odds of agreeing that increasing the minimum age of



**Table 1** Retailer attitudes, compliance and observations 7 months after Tobacco 21 became effective from the California Tobacco Retailer Poll

	Owners (n=481)	Managers (n=646)	Clerks (n=327)	Total (n=1454)
<b>Support, awareness and attitudes</b>				
Awareness of Tobacco 21, % (95% CI)	98.0 (96.6 to 99.3)	99.0 (98.2 to 99.7)	98.7 (97.4 to 100.0)	98.6 (98.0 to 99.2)
Support for Tobacco 21, % (95% CI)	56.7 (52.3 to 61.2)	64.0 (60.2 to 67.7)	59.8 (54.4 to 65.3)	60.6 (58.1 to 63.2)
Agree that people who start smoking before 21 will become addicted to tobacco products, % (95% CI)	60.2 (55.4 to 64.9)	70.7 (66.9 to 74.4)	66.1 (60.5 to 71.7)	66.2 (63.6 to 68.8)
<b>Compliance and training</b>				
New minimum age-of-sale warning sign posted, % (95% CI)	90.9 (88.2 to 93.5)	94.2 (92.4 to 96.0)	94.6 (92.1 to 97.1)	93.2 (91.9 to 94.5)
Easy to train staff to comply with Tobacco 21, % (95% CI)	87.5 (84.4 to 90.5)	93.1 (91.2 to 95.1)	– *	90.7 (89.0 to 92.5)
Easy to comply with Tobacco 21, % (95% CI)	84.0 (80.6 to 87.3)	90.8 (88.5 to 93.1)	77.6 (72.9 to 82.3)	85.6 (83.8 to 87.5)
<b>Customer observations</b>				
Individuals under 21 years of age complaints at least once a month, % (95% CI)	58.9 (54.3 to 63.4)	58.0 (54.0 to 61.9)	56.2 (50.6 to 61.7)	57.9 (55.3 to 60.5)
Observed 'shoulder tap' buys at least once a month, % (95% CI)	24.1 (20.1 to 28.2)	19.4 (16.3 to 22.6)	31.1 (25.7 to 36.4)	23.6 (21.3 to 25.9)

\*Clerks and cashiers were not asked questions regarding staff training.

sale would reduce youth tobacco use (AOR, 0.08;  $P=0.010$ ) and higher odds of observing the minimum age-of-sales sign (AOR, 9.98;  $P=0.013$ ) compared with never/former e-cigarette users. A significant association was also found with current hookah users having higher odds of agreeing that increasing the minimum age of sale would reduce youth tobacco use (AOR, 26.64;  $P=0.018$ ). The models indicated that non-Hispanic Black have significantly higher odds of observing the T21 advertising compared with non-Hispanic Whites (AOR, 9.58;  $P=0.038$ ), and the odds of women observing the T21 advertising were higher than compared with men (AOR, 8.69;  $P=0.027$ ). Little-cigar users have higher odds of observing the T21 advertising compared with former/never little-cigar users (AOR, 8.88;  $P=0.040$ ). Non-significant differences in the odds were observed for awareness of the T21

law. In addition, a non-significant increase in tobacco use from pre-T21 to post-T21 was observed (results not shown).

### Tobacco Purchase Surveys

The YTPS RVR statistically decreased from 10.3% before T21 to 5.7% after T21 ( $P=0.002$ ) using youth decoys. Tobacco-only retailers (eg, smoke shops) violated the law at a significantly higher rate than other tobacco retailers (eg, supermarkets, convenience stores) in the post-T21 YTPS, with a rate of 12.0% ( $P=0.012$ ); nevertheless, the RVR at tobacco-only retailers significantly decreased from the pre-T21 YTPS ( $P=0.006$ ). The YATPS RVR was 14.2% (95% CI 9.3% to 19.1%) and the YAEPS RVR was 13.1% (95% CI 10.2% to 16.1%) using young adult

**Table 2** Attitudes, awareness and observations of Tobacco 21-related questions of California adults, ages 18–24 years, from the Online California Adult Tobacco Survey

	Agree that raising minimum age of sale reduces youth prevalence		Aware of T21 law		Observed minimum age-of-sale warning sign		Observed T21 advertising	
	% (95% CI)	P	% (95% CI)	P	% (95% CI)	P	% (95% CI)	P
Total	61.7 (51.8 to 71.6)	–	63.6 (53.5 to 73.7)	–	39.0 (29.1 to 48.9)	–	12.6 (6.6 to 18.6)	–
<b>Gender</b>								
Male	68.0 (54.5 to 81.5)	0.213	61.3 (46.8 to 75.7)	0.654	37.0 (23.2 to 50.9)	0.695	6.4 (1.3 to 11.4)	0.020
Female	55.5 (41.2 to 69.7)	–	65.9 (51.8 to 80.0)	–	41.0 (27.0 to 55.0)	–	18.8 (8.3 to 29.3)	–
<b>Race/ethnicity</b>								
White	41.7 (24.2 to 59.3)	0.006	66.9 (50.1 to 83.7)	0.428	39.6 (22.3 to 56.9)	0.135	14.5 (2.4 to 26.5)	0.050
Black	91.7 (83.5 to 100.0)	–	66.3 (40.2 to 92.3)	–	24.7 (8.8 to 40.6)	–	36.2 (10.9 to 61.4)	–
Hispanic	65.6 (51.9 to 79.2)	–	67.1 (53.3 to 80.8)	–	48.2 (33.7 to 62.7)	–	10.4 (2.3 to 18.4)	–
Other	82.4 (57.3 to 100.0)	–	43.3 (10.5 to 76.1)	–	DSU	–	3.0 (0.0 to 9.1)	–
<b>Household income</b>								
Under US\$35 000	63.7 (49.7 to 77.6)	0.505	57.0 (42.1 to 71.9)	0.512	33.8 (20.3 to 47.3)	0.821	12.2 (3.7 to 20.6)	0.906
US\$35 000 to US\$84 999	64.4 (47.5 to 81.4)	–	71.0 (53.2 to 88.8)	–	39.4 (22.1 to 56.8)	–	10.6 (1.1 to 20.0)	–
Over US\$85 000	50.0 (27.2 to 72.8)	–	60.1 (37.8 to 82.5)	–	41.5 (18.7 to 64.2)	–	DSU	–
<b>Past 30-day use*</b>								
Cigarettes	56.2 (35.0 to 77.4)	0.569	84.1 (69.4 to 98.7)	0.024	53.6 (32.9 to 74.4)	0.127	29.3 (12.0 to 46.5)	0.008
E-cigarettes	49.8 (27.0 to 72.6)	0.285	73.4 (51.5 to 95.4)	0.410	73.2 (55.7 to 90.7)	<0.001	42.8 (20.6 to 65.0)	<0.001
Little cigars	73.9 (45.9 to 100.0)	0.435	83.4 (67.1 to 99.7)	0.069	68.9 (46.8 to 90.9)	0.014	61.6 (35.9 to 87.3)	<0.001
Hookah	85.8 (70.0 to 100.0)	0.035	90.1 (78.6 to 100.0)	0.006	58.2 (31.5 to 84.9)	0.161	50.2 (24.1 to 76.3)	<0.001

\*Compared with reverse category (ie, past 30-day cigarette user vs not a past 30-day cigarette user).

DSU, data suppressed.

**Table 3** Adjusted OR (AOR) for attitudes, awareness and observation of signs and advertising of T21 among California adults, ages 18–24 years, from the Online California Adult Tobacco Survey

	Agree that raising age of sale reduces youth prevalence	Aware of T21 law	Observed age-of-sale warning sign	Observed T21 advertising
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
<b>Gender</b>				
Male	Reference	Reference	Reference	Reference
Female	0.45 (0.17 to 1.21)	1.63 (0.64 to 4.17)	1.83 (0.72 to 4.63)	8.69* (1.28 to 59.03)
<b>Race/ethnicity</b>				
White	Reference	Reference	Reference	Reference
Black	8.27** (1.67 to 40.93)	0.96 (0.20 to 4.68)	0.44 (0.10 to 1.91)	9.58* (1.14 to 80.79)
Hispanic	2.79 (0.99 to 7.90)	1.22 (0.42 to 3.49)	2.04 (0.72 to 5.77)	1.37 (0.34 to 5.63)
Other	7.32* (1.07 to 49.83)	0.38 (0.07 to 2.08)	0.33 (0.04 to 3.00)	0.18* (0.03 to 0.95)
<b>Household income</b>				
Under US\$35 000	Reference	Reference	Reference	Reference
US\$35 000 to US\$84 999	0.59 (0.20 to 1.76)	2.01 (0.72 to 5.62)	1.69 (0.61 to 4.68)	0.78 (0.23 to 2.68)
Over US\$85 000	0.47 (0.12 to 1.77)	1.16 (0.33 to 4.01)	1.87 (0.50 to 7.08)	2.17 (0.33 to 14.49)
<b>Cigarette user</b>				
Never/former	Reference	Reference	Reference	Reference
Current†	0.51 (0.09 to 2.75)	2.92 (0.51 to 16.74)	0.87 (0.23 to 3.25)	2.37 (0.58 to 9.76)
<b>E-cigarette user</b>				
Never/former	Reference	Reference	Reference	Reference
Current†	0.08* (0.01 to 0.54)	0.62 (0.15 to 2.65)	9.98* (1.63 to 61.27)	5.78 (0.86 to 38.73)
<b>Little-cigar user</b>				
Never/former	Reference	Reference	Reference	Reference
Current†	2.98 (0.34 to 26.49)	0.64 (0.08 to 5.18)	1.93 (0.23 to 16.59)	8.88* (1.10 to 71.39)
<b>Hookah user</b>				
Never/former	Reference	Reference	Reference	Reference
Current†	26.64* (1.76 to 403.08)	4.20 (0.59 to 30.03)	0.31 (0.04 to 2.80)	0.51 (0.06 to 4.39)

\*P<0.05; \*\* P<0.01.

†Current user is defined as past 30-day use of the specified product.

decoys. Geographically, Los Angeles had the highest YATPS RVR at 21.5% (95% CI 8.9% to 34.1%), which is over five times higher than that of the San Francisco Peninsula and Northern Bay region (RVR, 3.3%; 95% CI 2.3% to 4.4%). Riverside had the highest YAEPS RVR with a RVR of 20.5% (95% CI 14.4% to 26.7%). The RVR for each purchase survey is in online supplementary table 2.

Table 4 presents the AOR for the RVRs by store type and region for each purchase survey. In the adjusted models, vape shops (AOR, 3.66; P=0.025) and tobacco-only retailers (AOR, 6.13; P<0.001) have significantly higher odds of selling electronic smoking devices in YAEPS when compared with convenience stores that sell gasoline, the most common type of tobacco retailer. In addition, the odds of selling traditional tobacco in YATPS is significantly lower in Orange (AOR, 0.45; P=0.007), Alameda (AOR, 0.21; P<0.001), the San Francisco Peninsula and Northern Bay regions (AOR, 0.24; P<0.001), the North Coast, Shasta Cascade and Eastern Sierra Nevada region (AOR, 0.50; P=0.063), and the Sacramento region (AOR, 0.15; P<0.001), compared with Los Angeles. When comparing the pre-T21 and post-T21 YTPS, there was a significant change in the AOR for RVR for tobacco-only retailers (P=0.006) and the ‘other’ retailers (P=0.005) compared with convenience stores that sell gasoline when controlled for other factors.

## DISCUSSION

Following Hawaii and California, three states adopted T21 laws in 2017: New Jersey, Maine and Oregon.<sup>14</sup> As demonstrated by the number of localities adopting T21 laws in the USA, there

continues to be strong interest in preventing youth tobacco use.<sup>5 8 14</sup> Momentum for this policy strategy should build if public and retailer support is demonstrated and with additional direct evidence that this strategy reduces youth access and use of tobacco products. While California is in the early phase of implementation, findings indicate the initial implementation was successful.

Preliminary results demonstrate high awareness and support for California’s T21 law among two key audiences: young adults and tobacco retailers. Overall, almost two-thirds (63.6%) of young adults ages 18–24 years were aware of the law and awareness was uniformly high across Hispanics, non-Hispanic Blacks and non-Hispanic Whites. Moreover, more than 60% of young adults agreed that raising the age of tobacco sales to 21 would reduce youth tobacco use. This attitude was significantly stronger among Hispanics and non-Hispanic Blacks than non-Hispanic Whites. E-cigarette users were significantly less likely to agree, suggesting that continued public health education campaigns are needed to communicate the health risks associated with e-cigarettes.

Young adults reported higher observation of the new minimum age-of-sale warning sign (39.0%) than the T21 advertisement (12.6%). Women, non-Hispanic Blacks and current little-cigar users were significantly more likely to have observed the T21 point-of-sale advertising campaign, suggesting that the campaign reached target audiences of interest.

Studies modelling the public health impact of raising the minimum age of tobacco sales to 21 suggest that reducing tobacco use, low and premature births, and chronic diseases rests on achieving strong compliance.<sup>8</sup> Awareness and support for the law, along the continuum of the tobacco retail owners,

**Table 4** Adjusted OR (AOR) for retailer violation rates from the Youth Tobacco Purchase Survey (YTPS), the Young Adult Tobacco Purchase Survey (YATPS) and the Young Adult E-cigarette Purchase Survey (YAEPS)

Retailer type	YTPS			
	Pre-T21 (n=793)	Post-T21 (n=751)	YATPS (n=1228)	YAEPS (n=842)
	AOR† (95% CI)	AOR† (95% CI)	AOR‡ (95% CI)	AOR‡ (95% CI)
Convenience stores with gas	Reference	Reference	Reference	Reference
Convenience stores without gas	0.50 (0.21 to 1.21)	0.80 (0.29 to 2.18)	0.66 (0.32 to 1.35)	0.67 (0.25 to 1.81)
Liquor stores	0.46 (0.20 to 1.04)	0.33 (0.09 to 1.20)	0.75 (0.36 to 1.54)	1.47 (0.63 to 3.43)
Pharmacies	<0.01** (<0.01 to <0.01)	<0.01** (<0.01 to <0.01)	0.20‡ (0.06 to 0.71)	0.23 (0.03 to 2.06)
Small markets	0.61 (0.20 to 1.89)	1.45 (0.56 to 3.73)	0.46‡ (0.25 to 0.84)	0.90 (0.19 to 4.30)
Supermarkets	0.65 (0.25 to 1.71)	0.27 (0.04 to 2.13)	0.27‡ (0.09 to 0.80)	0.11 (0.01 to 1.10)
Tobacco stores§	4.17** (1.98 to 8.77)	1.89 (0.76 to 4.70)	1.33 (0.58 to 3.06)	6.13** (2.38 to 15.77)
Vape shops	–§	–§	–§	3.66‡ (1.18 to 11.35)
Others	2.78‡ (1.15 to 6.73)	0.45 (0.10 to 2.00)	1.00 (0.52 to 1.92)	2.02 (0.69 to 5.96)
Geographical regions				
Los Angeles	–¶	–¶	Reference	1.58 (0.93 to 2.70)
San Diego	–¶	–¶	0.83 (0.46 to 1.52)	1.34 (0.48 to 3.76)
Orange	–¶	–¶	0.45** (0.26 to 0.80)	2.63 (0.57 to 12.19)
Santa Clara	–¶	–¶	1.67 (0.67 to 4.20)	2.46 (0.77 to 7.86)
San Bernardino	–¶	–¶	0.43 (0.18 to 1.01)	1.01 (0.57 to 1.80)
Riverside	–¶	–¶	0.83 (0.41 to 1.72)	Reference
Alameda	–¶	–¶	0.21** (0.11 to 0.40)	0.73 (0.10 to 5.13)
San Francisco Peninsula and Northern Bay region	–¶	–¶	0.24** (0.11 to 0.52)	0.38 (0.06 to 2.26)
Central Valley region	–¶	–¶	0.53 (0.17 to 1.66)	0.38 (0.09 to 1.54)
North Coast, Shasta Cascade and Eastern Sierra Nevada region	–¶	–¶	0.50 (0.24 to 1.04)	1.30 (0.61 to 2.78)
Sacramento region	–¶	–¶	0.24** (0.11 to 0.52)	1.06 (0.49 to 2.29)
Central Coast region	–¶	–¶	0.57 (0.23 to 1.39)	0.89 (0.20 to 3.92)

\*P&lt;0.05; \*\*P&lt;0.01.

†Controlled for retailer type, decoy's age, decoy's gender, decoy's race and clerk's gender.

‡Controlled for retailer type, geographic region, decoy's age, decoy's gender, decoy's race and clerk's gender.

§Vape shops were not in a separate category in the pre-T21 YTPS and were included with 'others' in post-T21 YTPS and YATPS due to small sample size.

¶Regional breakdown not modelled in YTPS due to sampling design.

managers and clerks, are essential for obtaining good compliance with the law. Seven months after implementing California's T21 law, awareness of the law was very high (98.6%) among tobacco retail owners, managers and clerks with more than 60% supporting the law and 66% agreeing that people who start smoking before 21 will become addicted to tobacco products. Furthermore, 85.6% agreed that it was easy to comply with the law and 90.7% stated it was easy to train staff to comply with the law. However, nearly 58% of retailers indicated that they received at least one complaint per month about the law. Particularly troubling is that 23.6% of retailers reported observing shoulder tapping at least once per month, suggesting that educational efforts need to discourage persons over 21 years of age purchasing tobacco products for underage persons.

At this time, tobacco use data among California teens post-T21 law implementation is not available; however, there was a non-significant increase in tobacco use among young adults 18–24 years old post-T21 law implementation. The short length between these two waves of data collection may not have been sufficient to show the effects of T21 on young adults.

Similar to other studies, California's tobacco purchase survey among teens, ages 15–16 years old, reinforces that T21 is a promising strategy for reducing youth access to tobacco products.<sup>5</sup> There was a significant decline in illegal tobacco sales to teens 15–16 years old. Prior to T21, the YTPS RVR had been flat since 2009, suggesting that the T21 law played a role in the

reduction.<sup>15</sup> Particularly encouraging was the significant decline in sales among tobacco-only stores, which decreased from 31.8% to 12.0%.

Tobacco purchase survey data also suggest widespread compliance with the T21 law in terms of tobacco sales to young adults, ages 18–19 years. The YATPS RVR was 14.2% and the YAEPS RVR was 13.1%, which is substantially less than the federal Synar rate of 20.0% in order to avoid penalties to the state's Substance Abuse Prevention and Treatment block grant.<sup>12</sup> Store types whose primary business is the sale of tobacco product (tobacco-only stores and vape shops) were most likely to make an illegal tobacco sale, while pharmacies and supermarkets were the least likely to make a sale. There were large regional variations in compliance with the T21 law; Los Angeles, Riverside, Santa Clara and the Central Valley regions had RVR greater than 15.0%.

This study has several limitations. First, only short-term outcomes are available at this point. While Online CATS is a repeated cross-sectional study, the length of time between waves of Online CATS was not sufficient to show significant changes in behaviour due to T21. Furthermore, it will be difficult to distinguish the effects of T21 and California's tobacco tax increase that became effective on 1 April 2017. Second, due to the cluster sampling design for YATPS and YAEPS, there was a risk that retailers would alert one another to the survey, potentially causing the RVR to be under-reported. Finally, low response rates are an increasingly common problem in telephone surveys and there is a potential for non-response bias<sup>16</sup>;

however, studies have shown that there is not a direct correlation between response rate and validity.<sup>17 18</sup>

## CONCLUSIONS

California is still in the early stages of implementing and understanding the impact of its T21 law. Preliminary results demonstrate that despite the short implementation period, very high awareness about the law was achieved among tobacco retailers and young adults. Survey findings suggest that the high awareness and support for the law may have contributed to reducing illegal tobacco sales to youth under 18 and achieving widespread retailer compliance with T21. As evidenced by retailer compliance in New York City, vigilance and reinforcement are needed to sustain and improve compliance with tobacco sales to those under 21 years of age.<sup>6</sup>

Pursuant to the logic model, further analyses related to tobacco use and the economic impact of the T21 will be performed. Additionally, efforts are in the early planning stages to assess community readiness among California's tribal governments to adopt T21 laws and to support that interest with grant funding and technical assistance support.

## What this paper adds

- ▶ Provides evidence that there is very high awareness and support of California's T21 law among tobacco retailers, training clerks and implementing the law were easy, and the majority of retailers agree that increasing the minimum age of sale will reduce youth tobacco use.
- ▶ Provides evidence that there is very high awareness and support of California's T21 law among young adults across diverse racial/ethnic groups and a majority of young adults agree that increasing the minimum age of sale will reduce youth tobacco use.
- ▶ Provides evidence of a significant reduction in access to tobacco products by teens under 18 years of age following the implementation of the T21 law and fair compliance with the law in terms of tobacco sales to those under 21 years of age.

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## REFERENCES

- 1 California Department of Public Health. *Behavioral risk factor surveillance system, 1988–2015*. Sacramento, CA: California Department of Public Health.
- 2 U.S. Census Bureau. *Annual state resident population estimates for 6 race groups (5 race alone groups and two or more races) by age, sex, and hispanic origin: April 1, 2010 to July 1, 2016*. Suitland, MD: U.S. Census Bureau, 2017.
- 3 California Tobacco Control Program. California Tobacco 21 Law 2016. <https://www.cdph.ca.gov/Programs/CCDPHP/DCCD/CTCB/Pages/Tobacco21.aspx> (accessed 10 Aug 2017).
- 4 Ahmad S. The cost-effectiveness of raising the legal smoking age in California. *Med Decis Making* 2005;25:330–40.
- 5 Kessel Schneider S, Buka SL, Dash K, et al. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tob Control* 2016;25:355–9.
- 6 Silver D, Macinko J, Giorgio M, et al. Retailer compliance with tobacco control laws in New York City before and after raising the minimum legal purchase age to 21. *Tob Control* 2016;25:624–7.
- 7 DiFranza JR, Coleman M. Sources of tobacco for youths in communities with strong enforcement of youth access laws. *Tob Control* 2001;10:323–8.
- 8 Institute of Medicine. In: Bonnie RJ, Stratton K, Kwan LY, eds. *Public health implications of raising the minimum age of legal access to tobacco products*. Washington, D.C., 2015.
- 9 White MM, Gilpin EA, Emery SL, et al. Facilitating adolescent smoking: who provides the cigarettes? *Am J Health Promot* 2005;19:355–60.
- 10 Stanford Prevention Research Center, GreenInfo Network. California community health assessment tool. 2017 <http://websites.greeninfo.org/stanford/cchat/> (accessed 10 Aug 2017).
- 11 GfK Group. KnowledgePanel design summary. 2013 [http://www.knowledgenetworks.com/knpanel/docs/knowledgepanel\(R\)-design-summary-description.pdf](http://www.knowledgenetworks.com/knpanel/docs/knowledgepanel(R)-design-summary-description.pdf) (accessed 10 Aug 2017).
- 12 Substance Abuse and Mental Health Services Administration. *Implementing the Synar regulation: sample design guidance*. U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Substance Abuse Prevention, 2011.
- 13 California Department of Health Care Services, California Department of Public Health. *Annual Synar report FFY 2017: state of California*. Sacramento, CA: California Department of Health Care Services, 2016.
- 14 Campaign for Tobacco Free Kids. States and localities that have raised the minimum legal sale age for tobacco products to 21, 2017. [https://www.tobaccofreekids.org/content/what\\_we\\_do/state\\_local\\_issues/sales\\_21/states\\_localities\\_MLSA\\_21.pdf](https://www.tobaccofreekids.org/content/what_we_do/state_local_issues/sales_21/states_localities_MLSA_21.pdf) (accessed 18 Aug 2017).
- 15 California Department of Public Health, California Tobacco Control Program. *California tobacco facts and figures*. Sacramento, CA: California Department of Public Health, 2016.
- 16 Centers for Disease Control and Prevention. Behavioral risk factor surveillance system: 2015 summary data quality report, 2015. [https://www.cdc.gov/brfss/annual\\_data/2015/pdf/2015-sdqr.pdf](https://www.cdc.gov/brfss/annual_data/2015/pdf/2015-sdqr.pdf) (accessed 13 Nov 2017).
- 17 Holbrook AL, Krosnick JA, Pfent A, et al. The causes and consequences of response rates in surveys by the news media and government contractor survey research firms. In: Lepkowski JM, Tucker NC, Brick JM, eds. *Advances in telephone survey methodology*. Wiley series in survey methodology. Hoboken, NJ: John Wiley & Sons, Inc., 2007:499–528.
- 18 Morton SM, Bandara DK, Robinson EM, et al. In the 21st century, what is an acceptable response rate? *Aust N Z J Public Health* 2012;36:106–8.