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Tool to assess appeal–aversion response to graphic warning labels on cigarette packs among US smokers

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ABSTRACT

Introduction Graphic warning labels on cigarette packaging are mandated in 118 countries and are under consideration in the USA. We propose an appeal–aversion assessment tool to help regulators choose among graphic packaging options.

Methods After familiarisation with different cigarette packaging, adult daily smokers (n=338) from San Diego, California, USA completed a discrete choice appeal–aversion purchasing task and provided information on nicotine dependence and sociodemographics (2017–2019). The conjoint analysis estimated the importance and price utility for product attributes (ie, packaging, price, tobacco origin and quitline number). The price premiums that smokers would be willing to pay to avoid purchasing graphic packaging were calculated.

Results Among purchase determinants, the price was the most important attribute (65.5%), followed by packaging design (27.1%). Compared with blank packaging without marketing, branded industry packs had appeal valuations (US\$0.54; 95% CI: US\$0.44 to US\$0.65), whereas graphic warning packs had aversion valuations that varied with the salience of the image (blindness=−US\$2.53, 95% CI: −US\$2.76 to −US\$2.31; teeth damage=−US\$2.90, 95% CI: −US\$3.17 to −US\$2.63; and gangrenous foot=−US\$3.70, 95% CI: −US\$4.01 to −US\$3.39). The aversion was such that 46.2% of participants were willing to pay a 50+% premium over their current cigarette price to have their branded packs rather than a graphic pack. These appeal–aversion valuations were moderated by sex, income and nicotine dependence (p<0.05).

Conclusions Smokers indicated a willingness to pay substantial premiums to avoid purchasing graphic packaging. Results suggest that mandating graphic warnings on US cigarette packs would induce price aversion and may deter cigarette purchasing. Price valuations from this appeal–aversion tool could be useful for regulators to differentiate between graphic warning labels.

INTRODUCTION

To combat the 7 million annual deaths attributable to smoking,[1] the WHO's Framework Convention on Tobacco Control (FCTC) mandates graphic warning labels on cigarette packs and recommends the removal of all tobacco industry branding.[2] Implemented in 118 countries, graphic labels depict the health consequences of smoking and counteract marketing designed to maintain and enhance product appeal.[3] Although the USA is a non-party to the FCTC, in 2011, its regulatory authority over tobacco products, the Food and Drug Administration (FDA), proposed a rule mandating nine different graphic warning labels on cigarette packs.[4] The Tobacco Industry blocked this rule in court on the grounds that it violated their first amendment right to commercial free speech.[5] The FDA has gathered further evidence on the effectiveness of graphic warning labels and has since proposed 13 new images to be required on 50% of the front and back of all cigarette packaging (for a review see refs 6–8).

Cigarette pack branding is a key component of the marketing mix aimed at maintaining brand loyalty. It solicits positive valence which engenders pleasure, thus reinforcing brand appeal and discouraging negative cognitions that might help smokers quit.[9] Removing package branding should remove this inhibiting effect on quitting cognitions.[10] However, appeal cognitions may be only one end of a unidimensional appeal–aversion construct.[9] Should images emphasising the health consequences of smoking replace package branding, smoker's health-related cognitions may shift towards aversion,[11] thus promoting associated quitting cognitions. When considering the appeal or aversive valuations of the pack, it is important to consider competing motivations for tobacco use, particularly those associated with nicotine dependence.[12]

The degree of aversion to a graphic warning label reflects the label's potential effectiveness on smoking behaviour.[13] Most tobacco control campaigns select images based on aggregated assessments of the perceived effectiveness of the warning message.[14] However, operationalisation of perceived effectiveness has varied considerably[15]: some explore ratings of credibility, likeability, and message strength or ability to recall a message[16]; others construe perceived effectiveness as a highly dimensioned construct emerging from both cognitive and emotional components.[17] Despite the presumed multidimensional origin of perceived effectiveness, studies commonly use unidimensional rating scales[15] to assess hypothetical outcomes such as how effective people *think* an image will be at promoting quitting. These scales often use *others* as the referent, although attribution theory[18] suggests that the reference to *oneself* may better predict influences of perceptions on smoking behaviour. To improve the assessment of perceived effectiveness of graphic warning labels, a need exists for a conceptually meaningful behavioural metric to assess how these labels may decrease appeal and increase aversion to cigarette products as a way to discourage smoking.

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The marketing literature details a particular approach (conjoint analysis) to determine the perceived valuation attributed to various elements of a product, including its packaging.[19 20] This partitions the perceived worth of a product into individual part-worth utilities associated with different product attributes.[21] For cigarette packaging, attribute part-worth utilities can be estimated by having smokers make discrete choices between different designs at varying price points and analysing the pattern of those choices. Using this methodology, prices can be generated to reflect the monetary value that a smoker might be willing to pay for different types of package designs. Comparing industry packaging with blank packaging (ie, devoid of all industry marketing) would determine the perceived utility of the additional industry branding on the pack (ie, appeal valuations). Comparing packaging with graphic warning labels with blank packaging would determine the perceived (dis)utility of the warning messages (ie, aversion valuations). These aversion valuations are a quantitative measure of willingness to pay for the product. As such, they are a much more detailed personal response than the perceived effectiveness of the warning. Thus, this appeal–aversion task should be a customisable, price-based tool to help policy-makers choose cigarette packaging that decreases the appeal and increases aversion to cigarette products.

This study investigated price utilities in US smokers across industry packaging (marketing materials intact), blank packaging (marketing materials removed) and graphic packaging (marketing materials replaced with large graphic warning labels). We hypothesise that among US smokers who are not ready to quit, there will be clear price valuations reflecting the relative appeal of industry packs and aversion of graphic warning designs. We expect that among graphic warning designs, aversion valuations will significantly differ by the salience of the graphic warning image. We also hypothesise that the characteristics of the smoker will influence these valuations. We expect that nicotine dependence will be inversely related to the implicit valuations associated with graphic pack designs and that a smoker's income level will be associated with these implicit valuations.[22] Finally, we will explore whether valuations vary by sex or brand appeal.

METHODS
Participants
As part of an ongoing randomised trial on the effectiveness of graphic warning labels, we advertised in San Diego County for volunteer smokers who were not ready to quit, aged 21–65 years, smoked 5+ cigarettes/day from king size, 100 s or 99 s packs of most common brands. This trial is approved by the Human Research Protections Program of the University of California, San Diego and California State University San Marcos. This study uses data collected at a prerandomisation study visit (2017–2019), where eligible smokers completed questionnaires, viewed and handled cigarette packs, and completed a web-based appeal-avoidance assessment of cigarette packaging. Trial recruitment is ongoing and randomisation into the trial was not a requirement for selection into this study.
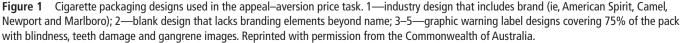
Procedure
After obtaining consent, participants were exposed to five cigarette packs with designs matched to their preferred cigarette brand and variant (eg, Marlboro Kings – Red Label). These were: (1) current industry design that includes branding elements, (2) blank design with a drab-brown background[23] that lacks branding elements beyond a name in a simple font, and (3–5) three graphic warning designs covering 75% of the pack (figure 1). The packaging did not include other attributes (eg, price, tobacco origin or quitline number). The graphic images were used in Australia and licensed from the Australian government. We chose three of eight possible images based on a panel of US smoker's perceptions of an image's likelihood of promoting quitting[24]: foot gangrene (the image that evoked the strongest aversion), and blindness and teeth damage (that evoked a moderate aversion response). We presented packs one-at-a-time, in a counterbalanced randomised order, where participants verbalised reactions to and familiarised themselves with each design. Following this pack handling task, participants completed a computer-based appeal–aversion price task (described below) customised to one of four popular cigarette brands[25] (ie, American Spirit, Camel, Marlboro or Newport). To avoid confounding,[26] the analysis was limited to participants who were regular smokers of one of these four brands. Following the price task, participants completed self-report surveys of smoking behaviour, nicotine dependence and sociodemographics.

MEASURES
Appeal–aversion valuation of package design
We used an established, ecologically valid,[27] discrete choice marketing task known as an adaptive choice-based conjoint which determines the relative importance that consumers place on cigarette pack attributes and the corresponding part-worth estimates of each of those attributes.[21] During the choice task, participants indicated their preferences for varying cigarette packaging constructed from four product attributes: (1) *package design* (five levels: industry design, blank design and three graphic warning designs); (2) *tobacco origin* (two levels: domestic or imported);

Figure 1 Cigarette packaging designs used in the appeal–aversion price task. 1—industry design that includes brand (ie, American Spirit, Camel, Newport and Marlboro); 2—blank design that lacks branding elements beyond name; 3–5—graphic warning label designs covering 75% of the pack with blindness, teeth damage and gangrene images. Reprinted with permission from the Commonwealth of Australia.

(3) *toll-free quitline number* (two levels: absent or present); and (4) *price* (multiple levels, customised by varying within ±33% of self-reported cigarette pack prices). Using a fractional factorial design,[21] participants first constructed their ideal cigarette pack from the set of all available attribute options. Then, we presented a series of three cigarette pack options that varied price and attribute levels away from their ideal pack. Participants were asked to select all options they may purchase. Based on their choices, sets of packs (three at a time) were presented to reflect differences in their chosen attributes and participants were tasked repeatedly with selecting a single pack to purchase. Attribute combinations were varied until clear preferences were identified. This four-attribute design allowed for realistic and meaningful variation to occur during the task, although the quitline and tobacco origin attributes were primarily included as plausible attributes that were expected to have limited impact on purchase preferences. The trade-offs made by participants across attribute choices revealed the importance they placed on each attribute and the amount of utility (eg, pay more) or disutility (eg, pay less) associated with each level of an attribute. This technique identified the appeal price that participants would be willing to pay to keep the industry marketing on their pack and the aversion price that they would pay not to have each of the graphic warning labels on their pack.

Fagerström Test for Nicotine Dependence (FTND)[28]
The FTND is a 6-item self-report measure of the severity of tobacco dependence with scores ranging from 0 to 10 (higher scores reflect greater dependence). In this sample, the FTND had an acceptable reliability (α=0.65).

Design appeal of brand usually smoked
Following previous work,[29] participants rated each of six-word characterisations of their packing design for the usual brand of cigarettes smoked using a 6-point Likert scale (eg, 'The design on the brand of cigarettes I currently smoke is…Stylish, Fashionable, Cool, High quality, Attractive, Appealing'). The reliability in this sample was excellent (α=0.91).

Sociodemographics included age, sex, race/ethnicity, educational attainment and annual household income (added after data collection was underway).

Statistical analysis
To determine the dollar valuations and importance smokers place on the various cigarette pack attributes, we ran a conjoint analysis using a multinomial logit hierarchical Bayesian estimation in Lighthouse studio (V.9.7.2).[30] Product attribute importance scores were estimated and reflect the relative weight of an individual attribute in comparison with other product attributes, with items summing to 100. Estimated part-worth utilities of the pack design were zero-centred and represent the relative preference for that design, with higher values indicating greater preference. We determined the dollar valuation of attribute levels by dividing the difference in price anchors (ie, US$3.00–US$15.00) by the difference in part-worth utilities for these anchors and then multiplying the median of this calculation across each utility score.[31] Difference scores across the attribute levels were then calculated to determine the price utility of the industry and graphic packaging relative to blank packaging. These price utility differences reflect the appeal–aversion valuations attributed to each pack design. To check for sex differences, independent samples t-test were run on the posterior distributions of attribute importance, price utilities and price utility differences. For each set of comparisons, the Benjamini-Hochberg p value adjustment accounted for false discovery rate.

To investigate whether nicotine dependence, sex, income and brand appeal were associated with each of the four-price utility difference scores, we performed a series of least-squares regressions using R (V.3.5.3). All models were adjusted for age, race/ethnicity, education and cigarette brand preference. Multiple imputation under the missing at random assumption was used to estimate missing income data, resulting in single parameter estimates pooled from 30 imputed datasets.

RESULTS
Study population
A total of 399 daily smokers completed the web-based conjoint study. Among these, 45 participants did not smoke one of the four appeal–aversion task brands, 9 had incomplete data and 7 were outliers (5+SD above the mean), leaving 338 in the analytic sample (table 1). Of these, 178 (52.7%) were women with a mean age of 38 years. Almost two-thirds were non-Hispanic White (65.4%) with the rest either Hispanic (13.3%) or other non-Hispanic race ethnicities (21.3%). Most of this population

Table 1 Sample characteristics by sex among adult daily smokers in California: 2017–2019

		Sex	
	Total	Female	Male
Variable	(N=338)	(N=178)	(N=160)
Sociodemographics			
Age (years), mean (SD)	38.23 (11.87)	39.78 (11.68)	36.51 (11.88)
Race/Ethnicity, n (%)			
White, non-Hispanic	221 (65.4)	127 (71.3)	94 (58.8)
Hispanic	45 (13.3)	19 (10.7)	26 (16.2)
Other, non-Hispanic	72 (21.3)	32 (18.0)	40 (25.0)
Education, n (%)			
College or advanced degree	131 (38.8)	77 (43.3)	54 (33.8)
Some college	164 (48.5)	83 (46.6)	81 (50.6)
High school or less	43 (12.7)	18 (10.1)	25 (15.6)
Income (US$), n (%)			
<US$10 000	21 (6.2)	11 (52.4)	10 (47.6)
US$10 000–US$24 999	46 (13.6)	28 (60.9)	18 (39.1)
US$25 000–US$49 999	68 (20.1)	38 (55.9)	30 (44.1)
US$50 000–US$99 999	62 (18.3)	36 (58.1)	26 (41.9)
≥US$100 000	29 (8.6)	16 (55.2)	13 (44.8)
Unknown	112 (33.1)	49 (43.8)	63 (56.2)
Smoking characteristics			
Nicotine dependence, mean (SD)	3.75 (2.25)	3.60 (2.16)	3.92 (2.34)
FTND levels, n (%)			
Low (0–2)	107 (31.7)	60 (33.7)	47 (29.4)
Mid (3–5)	152 (45.0)	83 (46.6)	69 (43.1)
High (6–10)	79 (23.4)	35 (19.7)	44 (27.5)
Cigarettes per day, mean (SD)	11.13 (5.82)	10.66 (5.29)	11.66 (6.32)
Cigarette pack cost (US$), mean (SD)	8.00 (1.52)	8.08 (1.40)	7.91 (1.65)
Brand appeal, mean (SD)	3.77 (1.22)	3.63 (1.24)	3.93 (1.16)
Primary brand, n (%)			
American Spirit	63 (18.6)	37 (20.8)	26 (16.2)
Camel	88 (26.0)	50 (28.1)	38 (23.8)
Marlboro	166 (49.1)	82 (46.1)	84 (52.5)
Newport	21 (6.2)	9 (5.1)	12 (7.5)

Linked Footnotes
FTND, Fagerström Test for Nicotine Dependence.

Table 2 Cigarette pack attribute importance and price utilities of packaging design by sex among daily smokers in California: 2017–2019

	Total	Sex Female	Male	
Variable	**(N=338)**	**(N=178)**	**(N=160)**	**P value***
Attribute importance†				
Price	65.51 (63.49 to 67.52)	63.00 (60.18 to 65.82)	68.29 (65.49 to 71.10)	0.031
Packaging	27.09 (25.24 to 28.94)	29.24 (26.72 to 31.76)	24.69 (22.01 to 27.37)	0.031
Quitline number	3.29 (3.03 to 3.56)	3.51 (3.10 to 3.91)	3.05 (2.73 to 3.37)	0.11
Tobacco origin	4.12 (3.76 to 4.48)	4.25 (3.74 to 4.75)	3.97 (3.46 to 4.48)	0.45
Total	100	100	100	
Price utility‡				
Graphic packaging				
Gangrene	−US$1.98 (−2.14 to −1.82)	−US$2.19 (−2.41 to −1.96)	−US$1.75 (−1.99 to −1.52)	0.016
Teeth damage	−US$1.18 (−1.31 to −1.06)	−US$1.27 (−1.43 to −1.12)	−US$1.08 (−1.27 to −0.90)	0.13
Blindness	−US$0.82 (−0.90 to −0.73)	−US$0.94 (−1.07 to −0.81)	−US$0.68 (−0.79 to −0.56)	0.011
Blank packaging	US$1.72 (1.56 to 1.87)	US$1.93 (1.72 to 2.14)	US$1.48 (1.26 to 1.71)	0.011
Industry packaging	US$2.26 (2.07 to 2.45)	US$2.47 (2.21 to 2.73)	US$2.03 (1.75 to 2.31)	0.031
Total	US$0.00	US$0.00	US$0.00	
Summary				
Price utility difference§				
Graphic packaging				
Gangrene	−US$3.70 (−4.01 to −3.39)	−US$4.12 (−4.53 to −3.70)	−US$3.24 (−3.68 to −2.79)	0.01
Teeth damage	−US$2.90 (−3.17 to −2.63)	−US$3.20 (−3.56 to −2.85)	−US$2.57 (−2.97 to −2.17)	0.027
Blindness	−US$2.53 (−2.76 to −2.31)	−US$2.87 (−3.18 to −2.56)	−US$2.16 (−2.47 to −1.85)	0.007
Blank packaging	*Ref*	*Ref*	*Ref*	
Industry packaging	US$0.54 (0.44 to 0.65)	US$0.54 (0.39 to 0.69)	−US$0.55 (0.40 to 0.70)	0.94

Data are expressed as mean (95% CI).

*From Benjamini-Hochberg corrected independent samples t-tests comparing within row sex differences in respective attribute importance, price utility or difference.

†Attributes represent the different product characteristics of the cigarette pack (ie, price, packaging, quitline number and tobacco origin) and importance scores reflect the relative weight of an individual attribute in comparison with other attributes, with scores summing to 100.

‡Utility scores represent the preference for each packaging design and dollar valuation associated with that preference, with positive values indicating appeal and negative values indicating aversion.

§Price utility difference scores represent the dollar valuation of a respective packaging level relative to blank packing with no marketing.

reported some college education (87.3%) with over a third (38.8%) having completed a degree. The household income question was added during the study and only completed by 226 of our sample. Among these, 39.9% reported an income below US$50 000. On average, participants smoked over half-a-pack of cigarettes per day (mean=11.13; SD=5.82) and paid US$8.00 per pack (SD=US$1.52). Only 23.4% were considered highly nicotine dependent (FTND score ≥6) with just under a third (31.7%) having low levels of dependence (FTND score ≤2). The primary brand smoked by the sample was similar to US[25] smokers with nearly half reporting a Marlboro (49.1%) brand preference with Camel (26.0%) and American Spirit (18.6%) brands well represented. During the orientation to the study packs, most participants self-indicated that they were unfamiliar with graphic warning packaging.

Appeal–aversion assessment of packaging design

On average, nine three-pack sets were presented before clear preferences were identified (mean=8.93; SD=1.89; range=5–13). The most important attribute driving choice preferences (total=100%) was price (mean=65.5%; 95% CI: 63.5% to 67.5%), followed by package designs (mean=27.1%; 95% CI: 25.2% to 28.9%; table 2). Neither the presence nor absence of the quitline number nor the origin of the tobacco were identified as important attributes. Sex differences were observed for price (68.3% for men vs 63.0% for women, p=0.03) and packaging (29.2% for women vs 24.7% for men, p=0.03).

The price utilities represent the estimated valuation for a single package design relative to all other designs. These price utilities sum to zero and should only be interpreted with respect to another utility for a different level within the same attribute.[32] The highest price utility was for the industry branded design (mean=US$2.26; 95% CI: US$2.07 to US$2.44) followed by the blank design (mean=US$1.72; 95% CI: US$1.56 to US$1.87). Graphic package designs had a gradient of price disutility across the blindness (mean=−US$0.82; 95% CI: −US$0.90 to −US$0.73), teeth damage (mean=−US$1.18; 95% CI: −US$1.31 to −US$1.06) and gangrene (mean=−US$1.98; 95% CI: −US$2.14 to −US$1.82) images. Compared with men, women reported higher price utilities for the industry (US$2.47 vs US$2.03, p=0.03) and blank (US$1.93 vs US$1.48, p=0.01) designs and more disutility for the gangrene (−US$2.19 vs −US$1.75, p=0.02) and blindness (−US$0.94 vs −US$0.68, p=0.01) designs.

Using the blank pack as the reference, we computed price utility differences (ie, appeal–aversion valuations). Industry packaging had an average appeal valuation of US$0.54 (95% CI: US$0.44 to US$0.65) meaning that participants were willing to pay this much more to get their cigarettes in an industry pack instead of a blank pack. Conversely, the graphic packs yielded marked differences compared with the blank pack, with average aversion valuations of −US$2.53 (95% CI: −US$2.76 to −US$2.31) for the blindness design, −US$2.90 (95% CI: −US$3.17 to −US$2.63) for the teeth design and −US$3.70

Table 3 Associations with price utility differences across industry and graphic packaging among daily smokers in California: 2017–2019

| | Price utility difference outcome (N=338)* | | | |
| | Industry packaging | Graphic packaging | | |
Regressor†	Industry vs Blank	Blindness vs Blank	Teeth vs Blank	Gangrene vs Blank
Nicotine dependence (FTND)	−0.03 (−0.08 to 0.01)	0.18 (0.08 to 0.28)***	0.20 (0.08 to 0.32)**	0.24 (0.09 to 0.38)**
Brand appeal	0.10 (0.02 to 0.19)*	−0.17 (−0.36 to 0.02)	−0.23 (−0.45 to −0.00)*	−0.27 (−0.53 to −0.01)*
Age	0.01 (0.00 to 0.02)**	−0.02 (−0.04 to −0.01)*	−0.02 (−0.05 to 0.00)	−0.02 (−0.05 to 0.00)
Sex				
Male	Ref	Ref	Ref	Ref
Female	0.02 (−0.17 to 0.22)	−0.76 (−1.19 to −0.32)***	−0.76 (−1.29 to −0.24)**	−1.02 (−1.63 to −0.41)**
Race/ethnicity				
White, non-Hispanic	Ref	Ref	Ref	Ref
Hispanic	0.19 (−0.11 to 0.50)	0.08 (−0.59 to 0.75)	0.25 (−0.56 to 1.06)	0.06 (−0.88 to 1.00)
Other, non-Hispanic	0.18 (−0.07 to 0.43)	−0.11 (−0.67 to 0.44)	−0.15 (−0.82 to 0.52)	−0.03 (−0.80 to 0.75)
Education				
College or advanced degree	Ref	Ref	Ref	Ref
Some college	0.10 (−0.12 to 0.32)	−0.10 (−0.58 to 0.38)	−0.17 (−0.75 to 0.42)	−0.05 (−0.73 to 0.63)
High school or less	0.07 (−0.27 to 0.40)	0.17 (−0.57 to 0.90)	0.25 (−0.64 to 1.14)	0.34 (−0.69 to 1.37)
Income				
<US$10 000	0.48 (0.08 to 0.89)*	−1.69 (−2.58 to −0.79)***	−2.14 (−3.25 to −1.04)***	−2.35 (−3.65 to −1.05)***
US$10 000–US$24 999	0.34 (0.03 to 0.66)*	−0.06 (−0.76 to 0.63)	−0.06 (−0.91 to 0.78)	−0.01 (−1.00 to 0.97)
US$25 000–US$49 999	0.14 (−0.15 to 0.42)	0.22 (−0.41 to 0.85)	0.32 (−0.44 to 1.08)	0.45 (−0.44 to 1.34)
US$50 000–US$99 999	Ref	Ref	Ref	Ref
≥US$100 000	0.49 (0.14 to 0.84)**	−0.83 (−1.66 to −0.01)*	−0.95 (−1.96 to 0.06)	−0.96 (−2.15 to 0.23)
Cigarette brand				
Marlboro	Ref	Ref	Ref	Ref
American Spirit	0.16 (−0.11 to 0.43)	−0.11 (−0.71 to 0.48)	0.62 (−0.10 to 1.34)	0.91 (0.08 to 1.75)*
Camel	−0.73 (−0.97 to −0.49)***	0.28 (−0.25 to 0.81)	0.22 (−0.42 to 0.86)	0.68 (−0.07 to 1.42)
Newport	−1.11 (−1.52 to −0.69)***	−1.46 (−2.38 to −0.54)**	−2.02 (−3.13 to −0.91)***	−0.97 (−2.26 to 0.32)

Data are expressed as β (95% CI).
*p<0.05, **p<0.01, ***p<0.001.
*Represents the mean difference score in packaging design price utilities for affective packaging comparisons.
†Estimates from separate multivariate least-squares regressions pooled across 30 imputed datasets predicting the respective mean difference score in packaging design price utilities.
FTND, Fagerstrom Test for Nicotine Dependence.

(95% CI: −US$4.01 to −US$3.39) for the gangrenous foot design. Compared with men, women reported higher aversion valuations across all graphic packaging (p's<0.05). When aversion valuations were added to the self-reported cigarette pack cost, we found that 55.1% of women (n=98) and 39.4% of men (n=63) would be willing to pay a premium of ≥50% to avoid a pack with graphic imagery. When the difference between the average price utility for the graphic packs and the industry price utilities was computed, the aversion valuation induced was akin to a US$3.59 excise tax (95% CI: US$3.89 to US$3.29).

Differences in appeal–aversion valuations by covariates

The results from regression models for covariates of appeal–aversion valuations (table 3) indicate that each unit increase in the FTND was associated with weakened aversion valuations for blindness (β=US$0.18; 95% CI: US$0.08 to US$0.28), teeth (β=US$0.20; 95% CI: US$0.08 to US$0.32) and gangrene (β=US$0.24; 95% CI: US$0.09 to US$0.38) images; meaning as nicotine dependence increased aversion valuations decreased. Female smokers had higher aversion valuations across all graphic packaging with the gangrene pack having the largest difference between genders (β=−$1.02; 95% CI: −US$1.63 to −US$0.41). Smokers earning <US$10 000 a year had higher aversion valuations for the blindness (β=−$1.69; 95% CI: −US$2.58 to −US$0.79), teeth damage (β=−$2.14; 95% CI: −US$3.25

to −US$1.04) and gangrene images (β=−US$2.35; 95% CI: −US$3.65 to −US$1.05) compared with smokers earning a median income (US$50 000–$99 999). Except for those earning US$25 000–US$49 999, all income categories had higher appeal valuations for the industry designed pack. Further, appeal valuations for industry packaging were stronger for each year increase in age (β=−US$0.01; 95% CI: −US$0.00 to US$0.02) and each unit increase in brand appeal (β=−US$0.10; 95% CI: −US$0.02 to US$0.19). While there were few differences across cigarette brands for the aversion valuations of the graphic warning labels, those who smoked Camel (β=−US$0.77; 95% CI: −US$1.01 to −US$0.53) and Newport (β=−US$1.03; 95% CI: −US$1.45 to −US$0.61) cigarettes had lower appeal valuations of their industry designed packs than did Marlboro smokers.

DISCUSSION

In an environment where cigarettes are packaged with industry marketing, US daily smokers indicated a willingness to pay substantial premiums to avoid graphic packaging compared with blank packaging devoid of marketing. Nearly half (46%) of participants indicated that they were willing to pay at least a 50% premium to avoid graphic warning labels on cigarette packs. Compared with blank packs, graphic packs yielded aversion valuations ranging from US$2.53 to US$3.70. Conversely, compared with blank packaging, industry packaging had an

average appeal valuation of US$0.54, with brands perceived as 'healthier' (eg, American Spirit)[33] having the highest appeal valuation. Sex, income and nicotine dependence influenced the magnitude of price valuations, but the pattern of the effects remained consistent across graphic images with aversion valuations to the graphic packaging emerging in all groups. These findings are consistent with the effects of graphic warnings on smokers' purchasing behaviour[34 35] and provide more evidence for the potential impact of graphic warning labels on US cigarette packs.

Price aversion valuations to graphic packaging were meaningfully large: the gangrenous foot had the greatest impact, followed by the teeth damage and blindness images. These gradations align with research on the negative affect reported for graphic warning labels,[36 37] which may remind smokers of smoking risks and influence purchasing decisions. The social cognitive theory posits that physiological response (eg, negative affect) can determine whether a persuasive message leads to behaviour change,[38] which has been demonstrated with graphic warning labels.[36 39] However, the degree of negative effect provoked by a particular image can be quite variable. Our study's aversion valuations suggest potential changes in purchasing decisions in response to affective and cognitive cues from different pack designs. Systematically manipulating pack designs may help understand affective and cognitive components of packaging that are most predictive of changes in smoking behaviour and provide a means to deconstruct which images work for whom.

US smokers' price aversion valuations for graphic packaging decreased as nicotine dependence increased, an effect that was consistent across warning images. This finding adds to the growing evidence that highly dependent smokers respond differently to graphic warning labels than those who are less dependent. Highly dependent smokers may prioritise continued nicotine use and not fully process the warnings,[40] may be less likely to reduce smoking[41] and may have lower intentions to quit as a result of the labels.[42] This appeal–aversion tool could help identify messages that might influence those who are highly dependent. An examination of point-of-sale purchase behaviour found that less dependent smokers were less likely to purchase cigarettes with graphic labels than more dependent smokers,[34] an effect that could reduce consumption and increase cessation.

We observed several socioeconomic differences in price valuations. Across nearly all metrics, women had higher aversion valuations than men. This is consistent with research showing that women report graphic warning labels as having stronger messages[43] and that, after exposure, they experience more health concerns and quit intentions compared with men.[44] Additionally, compared with smokers with median incomes, smokers with lowest incomes had higher aversion valuations and were willing to pay higher premiums to avoid graphic packaging. This finding adds to the evidence that suggests that low-income smokers are not more sensitive to cigarette prices than those with higher incomes[45] and implies that graphic packaging can influence low-income populations by highlighting health concerns and associated healthcare costs. However, low-income smokers from countries with lower rates of taxation, such as the USA, maybe less influenced by cigarette prices than those in countries with high excise rates.[46 47]

In line with existing research,[13] we observed substantial initial effects of graphic labels, as evidenced by meaningfully large aversion valuations. After repeated exposure these effects may diminish,[48] but graphic imagery may still function as a reminder of health consequences. Further research on such wear-out effects, including changes in aversion valuations after long-term

What this paper adds

What is already known on this subject?
► Implemented in 118 countries and supporting the WHO's Framework Convention on Tobacco Control, graphic warning labels on cigarette packaging depict the health consequences of smoking and counteract marketing designed to maintain and enhance product appeal.
► The degree of aversion to a graphic warning label can indicate the likely relative effectiveness of the graphic image on smoking behaviour.
► Most tobacco control campaigns select images based on aggregated assessments of the perceived effectiveness of the warning message, but the operationalisation of these assessments has varied considerably.

What important gaps in knowledge exist on this topic?
► To improve the assessment of perceived effectiveness of graphic warning labels, a need exists for a conceptually meaningful behavioural metric to assess how these labels may decrease appeal and increase aversion to cigarette products as a way to discourage smoking.
► An appeal–aversion assessment of discrete choice purchasing decisions between different packaging designs at varying price points (eg, conjoint analysis) could determine the monetary valuations attributed to industrial packaging and varying graphic packaging.

What this study adds?
► In an environment with an average self-reported cigarette pack price of US$8.00, analysis of purchase preferences identified that 46% of adult US daily smokers were willing to pay at least a 50% premium to avoid graphic warning labels on cigarette packs.
► Compared with blank packaging devoid of marketing, graphic warning packaging generated aversion valuations that varied with the salience of the image (range: −US$2.53 to −US$3.70); valuations were moderated by sex, income and nicotine dependence.

exposure to graphic image packaging, would strengthen the evidence on the effect of graphic warnings. Our appeal–aversion valuation task, when paired with a longitudinal design, could help examine desensitisation.

These results should be interpreted considering study limitations. We recruited a limited number of smokers from San Diego, California, USA, which has lower smoking rates compared with the rest of the USA.[49] Although most participants indicated being naive to graphic packaging, it is possible that a small proportion was exposed via media or international travel. Our study removed industry imaging and then added graphic warning labels to this blank pack condition but did not include a hybrid condition (industry marketing plus graphic warning) that is common in many countries, although more are transitioning to standardised plain packs. Further, the first 112 participants do not have household income data, and regression model parameter estimates were pooled from 30 imputed datasets. We have qualitative data on aversion from the pack handling task and will validate the aversion valuations against these data. Despite the limitations, the study had several strengths. First, participants were exposed to cigarette packs before completing the appeal–aversion price task, thus anchoring choices to actual products. Further, the price task used an adaptive fractional factorial

design, which efficiently estimated utility scores across a broad array of cigarette packaging attributes. We also created conditions necessary to invoke meaningful trade-offs in the appeal–aversion task by varying the cigarette prices within reasonable limits of the market rate. Other strengths include matching participants to their preferred brand at the price they currently pay, which allowed us to isolate the effects of the packaging design attributes.

In conclusion, we found that graphic warning labels on cigarette packs lead to significant aversion valuations in the price of those packs and that this was moderated by nicotine dependence, sex and income. These aversion valuations appear to reflect the salience of the warning following initial exposure to the images. This study fills a gap in the literature by using a robust market research technique to develop an appeal–aversion tool designed to evaluate the initial impact of graphic health warning labels on perceived prices. These data suggest that mandating graphic warning labels on US cigarette packs could create measurable aversion that may reduce cigarette purchases and potentially decrease smoking behaviour.

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