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# Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-related perceptions and responses: Results from a continuous tracking survey

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## ABSTRACT

**Objectives** – To investigate the impact of Australia's plain tobacco packaging policy on two stated purposes of the legislation – increasing the impact of health warnings and decreasing the promotional appeal of packaging – among adult smokers.

**Design** – Serial cross-sectional study with weekly telephone surveys (April 2006 to May 2013). Interrupted time-series analyses using ARIMA modelling and logistic regression analyses were used to investigate intervention effects.

**Participants** – 15,745 adult smokers (aged 18 years and over) in New South Wales (NSW), Australia. Random selection of participants involved recruiting households using random digit dialling and selecting the *n*th oldest smoker for interview.

**Intervention** – The introduction of the legislation on 1st October 2012.

**Outcomes** – Salience of tobacco pack health warnings, cognitive and emotional responses to warnings, avoidance of health warnings, perceptions regarding one's cigarette pack.

**Results** – Adjusting for background trends, seasonality, anti-smoking advertising activity, and cigarette costliness, results from ARIMA modelling showed that, two to three months after the introduction of the new packs, there was a significant increase in the proportion of smokers having strong cognitive (9.8% increase, $p=0.005$), emotional (8.6% increase, $p=0.01$), and avoidant (9.8% increase, $p=0.0005$) responses to on-pack health warnings. Similarly, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive (57.5% increase, $p<0.0001$), says something good about them (54.5% increase, $p<0.0001$), influences the brand they buy (40.6% increase, $p<0.0001$), makes their pack stand out (55.6% increase, $p<0.0001$), is fashionable (44.7% increase, $p<0.0001$), and matches their style (48.1% increase, $p<0.0001$). Changes in these outcomes were maintained six months post-intervention.

**Conclusions** – The introductory effects of the plain packaging legislation among adult smokers are consistent with the specific objectives of the legislation in regards to reducing promotional appeal and increasing effectiveness of health warnings.

## ARTICLE SUMMARY

### Article Focus

- Experimental research has shown that plain tobacco packaging can: reduce the appeal of tobacco products to consumers; increase the effectiveness of health warnings; and reduce the ability of packaging to mislead consumers about the harmful effects of smoking.
- Given that the introduction of the tobacco plain packaging legislation in Australia is the first of its kind, no research to date has investigated the impact of plain packaging on these outcomes in a real-world context with mandated plain packs.

### Key Findings

- The introductory effects of the new packs observed in this study are consistent with the specific objectives and expected effects of the plain packaging legislation.
- This is the first study to date to demonstrate an impact of the Australian plain tobacco packs on the salience and impact of on-pack health warnings and negative perceptions about tobacco packs among adult smokers.

### Strengths and Limitations

- Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, possibly leading to some bias in sample composition. However, both of these sampling issues were consistent across the study period, limiting their influence on the observed pattern of results.
- Study strengths are: the use of population-level data collected over a long time period, with a large sample of adult smokers; the use of a time-series approach with multiple data points before the intervention; and the inclusion of important time-related and sample-related potential covariates.

On the 1st of December 2012, Australia became the first country to introduce mandatory plain packaging for all tobacco products.[1] The new plain packs are olive green cardboard packages devoid of all brand design elements, with brand name and quantity written in a standardised font and location on each pack. The new packs continue to carry coloured graphic health warnings covering 90% of the back of packs, with the warnings on the front of pack enlarged from 30% to 75%. Manufacturers were required to produce the new packs from the 1st of October 2012 and they started appearing for sale from that date; approximately 80% of smokers were using plain packs by mid-November.[2]

The plain packaging legislation aims to discourage people from taking up smoking, encourage smokers to give up smoking, and discourage relapse.[1] The stated purpose of the legislation is to regulate the packaging and appearance of tobacco products in order to: (a) reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful effects of smoking. As this was the first time any such legislation had been implemented, the expected outcomes of the new packs were informed by a body of research consisting primarily of experimental studies, summarised in recent reviews.[3-6]

Studies in which participants were presented with mocked-up plain and branded tobacco packs show that plain packaging has the potential to reduce the promotional appeal of a pack, diminish positive perceptions about smokers of cigarettes from that pack, and reduce the appeal of smoking in general.[7-13] Such studies also suggest that health warnings are both more noticeable and more effective when presented on plain rather than branded packs,[14, 15] with researchers suggesting that brand imagery diffuses the impact of health warnings.[16] These results have been corroborated in naturalistic studies in which smokers are assigned to

smoke their normal cigarettes from either plain or branded packs for a period of time, with plain pack smokers reporting increased negative perceptions about to their pack and smoking, along with an increased impact of health warnings.[17, 18] A limitation of these previous studies, however, is the inability to differentiate the impact of plain packaging and the novelty impact of a pack which is simply different to the packs that smokers are used to seeing. No studies to date have been able to investigate the impact of plain tobacco packaging on tobacco pack appeal and the salience and effects of health warnings in the context of mandatory plain packaging, when all packs with which smokers are in contact are devoid of any branding other than a name in a standard font.

In the current study, we use cross-sectional survey data collected weekly for a period of seven years to investigate the impact of the new packaging on adult smokers' responses to the health warnings on their packs and perceptions of their packs. It was hypothesised that, after the introduction of the new packs, smokers would find the health warnings more salient, would have an increased response to the warnings, and would hold less favourable perceptions of their packs. The continuous nature of the data allowed us to track how these outcomes changed after the introduction of the new packs, investigating whether any observed changes were sustained in the six months following their introduction. This approach builds on our previous study evaluating the impact of the introduction of the plain packaging legislation on calls to a smoking cessation helpline.[19] Additionally, given that responses to graphic pack warnings had been tracked since their initial introduction in 2006, we were able to assess changes in these responses in the context of longer-term trends.

## METHOD

**Study Design and Participants**

The Cancer Institute's Tobacco Tracking Survey (CITTS) is a serial cross-sectional telephone survey with approximately 50 interviews conducted per week throughout the year. The CITTS monitors smoking-related cognitions and behaviours among adult smokers and recent quitters (quit in last 12 months) in New South Wales (NSW), Australia's most populous state. Households are recruited using random digit dialling (landline telephone numbers only) and a random selection procedure is used to recruit participants within households (selecting the *n*th oldest eligible adult). Analyses for this study are limited to smokers interviewed between April 2006 and May 2013 (total $n$ = 15,745), with an average response rate of 40% (American Association for Public Opinion Research Response Rate #4).[20] The CITTS is approved by the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). The study was funded by the Cancer Institute NSW.

**Outcome Measures**

Following the introduction of the original graphic health warnings on tobacco packs in March 2006, questions were included in CITTS relating to smokers' responses to the warnings. These questions assessed cognitive response to the warnings ('the graphic warnings encourage me to stop smoking') and emotional response ('with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking'). From April 2007, warning avoidance was also assessed ('they make me feel that I should hide or cover my packet from the view of others'). From October 2011, the salience of the warnings was also assessed ('the only thing I notice on my cigarette pack is the graphic warnings'). All answers were given on a 5-point Likert scale (strongly disagree-strongly agree). Due to distributions of the data, responses were collapsed into a binary variable indicating strong agreement vs. other.

From October 2011 smokers were asked a battery of questions relating to their perceptions of their packs: 'The look of my cigarette pack…' (i) is attractive; (ii) says something good about me to other smokers; (iii) influences the brand I buy; (iv) makes my brand stand out from other brands; (v) is fashionable; and (vi) matches my style (1=strongly disagree-5=strongly agree). Responses were dichotomized into strongly disagree vs. other. Changes in each of these individual items in relation to the introduction of the new tobacco packs were explored, and for the purpose of analysis, we also constructed a variable indicating strong negative pack perceptions (strong disagreement with all of the statements vs. not).

**Covariates**

Data on sex, age, total household income, and educational attainment (low=less than high school; moderate=high school diploma or vocational college; high=tertiary), were included in CITTS. Socio-economic status (SES) was indicated by a variable that combined responses to household income and educational attainment.[21, 22] High SES was defined as having a household income of more than AUD$80,000 (and any education level), or an income of AUD$40-80,000 and moderate-high education. Moderate SES was defined as either an income below AUD$40,000 and high education, or an income of AUD$40-80,000 and moderate education. Low SES was defined as either an income below AUD$40,000 and low or moderate education, or an income AUD$40-80,000 and low education. Those with missing data on one variable were classified based on the other.

Average number of cigarettes smoked per day was used to indicate heaviness of smoking (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day; heavy=more than 20 cigarettes per day). As smokers' responses to graphic health warnings and perceptions of their cigarette packs might conceivably be related to their quitting experiences or propensity

towards quitting, we also included previous quit attempts as a control variable (0=never tried to quit; 1=tried to quit at least once).

Along with demographic and smoking characteristics, respondents' pack perceptions and responses to health warnings might also possibly be influenced by the timing of their interview in terms of variations in anti-smoking advertising activity, changes in the costliness of cigarettes, or shifting social norms.

Respondents' level of exposure to anti-smoking advertising in the three months prior to their interview was measured in terms of Target Audience Ratings Points (TARPs). TARPs are a product of the percentage of the target audience exposed to an advertisement (reach) and the average number of times a target audience member would be exposed (frequency). Hence, 200 TARPs might represent 100% of the target audience receiving the message an average of two times over a specified period, or 50% reached four times. Exposure to advertising over a 3-month period was chosen based on previous research suggesting that advertising effects occur within this time frame.[22, 23] We ascertained TARPs for each of the advertisements broadcast in NSW during the study period based on OZTAM Australian TV Audience Measurements for adults aged 18years and older for free-to-air and cable TV (*M*=1590, *SD*=758).[24]

A variable indicating cigarette costliness[25] at time of interview was calculated as the ratio of the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to 87) to the average weekly earnings in the same quarter (*M*=1.54, *SD*=0.17).[26]

The influence of changing social norms was accounted for by statistically accounting for a time-based trend in the data.

**Statistical analyses**

Two approaches to statistical analysis were used to assess the impact of the new packaging on each outcome. The first approach used interrupted time series analysis, in which data collected at multiple instances over time before and after an intervention is used to detect whether the intervention has an effect significantly greater than the underlying secular trend. The advantages of using this approach include the ability to account for background trends, control for seasonal variations, adjust for auto-correlation in the data (when each value is correlated with the previous value), and to assess changes in the outcome in the context of longer-term trends. We also used logistic regression analysis to compare the likelihood of reporting an outcome for respondents interviewed in the months following the new packaging legislation and those interviewed before the new packs, controlling for socio-demographic and smoking characteristics.

In the time-series analysis, the weekly data were aggregated at the monthly level (to ensure sufficient sample size at each time point), providing indications of the proportion of the sample reporting each outcome. We used autoregressive integrated moving average (ARIMA) analysis in SAS version 9.3[27] to model the effects of the introduction of the new packaging on the outcomes of interest, while accounting for background trends, seasonal variation, the effects of television anti-tobacco advertising, and changes in cigarette costliness. ARIMA modelling was chosen because the data for each of the outcomes of interest were auto-correlated.

ARIMA modelling comprising model investigation, estimation and diagnostic checking followed the methods of Box *et al.*[14] This modelling enables investigation of the size and statistical significance of changes in an outcome after a specified time point, adjusting for background trends and confounders. An indicator term was created to represent the week of the introduction of the intervention (the 'phasing in' of the new packs on 1 October 2012). The potential confounders of anti-smoking advertising activity (TARPs) and cigarette costliness were included in all models. In the models predicting responses to graphic health warnings, terms indicating the months of December and January were also included to account for potential for seasonal variations (not included for pack perception outcomes due to limited data points). Due to the large number of outcomes to be reported, we do not report the effects of these covariates (available from authors on request).

Next, we conducted logistic regression analysis to predict each outcome, using month of interview as the indicator, focusing on the period of the introduction of the new packs (August 2012 – May 2013). The months preceding and following the intervention were represented by a five-level term: (a) the two months preceding the change (August-September, 'pre-plain packs (PP)'); (b) the two months of 'phase-in' (October-November); (c) the two months 'immediate post-PP' (December-January); (d) '3-4 months post-PP' (February-March); and (e) '5-6 months post-PP' (April-May). Demographic and smoking characteristics were included as covariates, along with recent anti-smoking advertising activity. Because changes in cigarette costliness were based on quarterly data, there was a high degree of multi-collinearity between costliness and time of interview (VIF=26), resulting in inflated standard errors and unstable estimates of regression coefficients. We therefore did not to include cigarette costliness as a covariate in these regression models. To provide a point of comparison, these models were also fitted to 2011-2012 data for the same

months. Logistic regression analyses were conducted using Stata v11.[28] Weights were applied in all analyses (using svy commands with 'p' weights) to adjust for a slight over-representation of females, older respondents, and regional residents compared to the NSW population.[29]

## RESULTS

Sample characteristics are shown in Table 1.

### Responses to graphic health warnings

Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of the graphic health warning responses over time. In general, responses to the warnings had been decreasing since their introduction in 2006. Of smokers interviewed in 2006: 21% reported strong cognitive responses to the warnings, decreasing to 12% in 2011; and 20% reported strong emotional response, decreasing to 12% in 2011.

The results of the interrupted time series analyses investigating the impact of the new packaging on responses to graphic health warnings are shown in Table 2. For all models, the residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. After controlling for background trends, seasonality, anti-smoking advertising activity and cigarette costliness, there was a significant increase in the proportion of smokers having strong cognitive, emotional and avoidant responses to graphic warnings after the introduction of the new packs. The increase in the avoidant response occurred two months after the new packs were introduced, and the increase in cognitive and emotional responses occurred after three months. In the time-series analysis, the change in

the proportion of smokers strongly agreeing that the warnings were the only thing they noticed on their packs after the introduction of the new packs was not significant.

The results of the logistic regression analyses predicting responses to the graphic health warnings are shown in Table 3. In the pre-PP period (August/September 2012), 10% of smokers reported a strong cognitive response to the health warnings, this increased significantly to 18% the immediate post-pp period (December/January), remaining at 19% in the 5-6 months post-pp period (April/May). There were no significant differences in the proportion of smokers reporting strong cognitive response over the months of the comparison period. Increases were observed in the proportions of smokers reporting strong emotional response (11% to 26% at 1-2 months post-pp), strong avoidant response (10% to 29% at 1-2 months post-pp), and salience of the warnings (12% to 34% at 1-2 months post-pp). The proportions of smokers reporting these responses remained significantly higher than in the pre-PP period at 3-4 months and 5-6 months post-PP. There were no significant differences in any outcome between smokers interviewed pre-PP and those interviewed during the phase-in period. These effects were independent of any differences between the sample on socio-demographic or smoking characteristics, as well as anti-smoking advertising activity. There were no significant differences in any of these outcomes over the months of the comparison period.

**Pack perceptions**

The monthly proportions of smokers strongly disagreeing with each of the pack attitude items are shown in Figure 2. The results of the interrupted time series analysis show that, three months following the introduction of the new packs, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive,

says something good about them, influences the brand they buy, makes their brand stand out, is fashionable, and matches their style (Table 2). This effect was independent of any influence of long-term background trends, cigarette costliness, or anti-smoking advertising activity.

The results from the logistic regression analysis predicting smokers' strong negative pack perceptions from month of interview are shown in Table 3. The proportion of smokers with a high score on the negative pack perception index (meaning that they strongly disagreed with all the statements about their packs) increased from 15% in the pre-PP period to 58% in the 5-6 month post-PP period. Compared to smokers interviewed in the pre-PP period, those interviewed in the phase-in period, 1-2 months post-PP, 3-4 months post-PP, and 5-6 months post-PP were significantly more likely to have a high score on the negative pack perception index. For the comparison period, there were no significant differences in the proportion of smokers in each month with strong negative perceptions. When the regression analysis was run separately for each pack perception statement, the same pattern of results emerged.

## DISCUSSION

To our knowledge, this is the first study to examine the population-level impact of the new tobacco plain packs on Australian adult smokers' responses to their packs. This is an important first step in evaluating the policy as these outcomes relate closely to the intended purpose of the legislation. In the months following the introduction of the new packs, there was an increase in the proportion of smokers reporting strong cognitive and emotional responses to the warnings, avoidant behaviours related to the on-pack warnings, and salience of warnings. There was also an increase in the proportion of smokers with strong negative perceptions about their packs. These changes were not attributed to variations in exposure to

anti-smoking advertising activity, tobacco prices, secular trends, seasonality or changes in sample composition.

Consistent with the results of experimental research,[14, 15, 17] we found that the introduction of the new packs was associated with an increase in the salience and the self-reported impact of the health warnings, such that smokers were more likely to report that the warnings are the only thing they see on their packs, that they feel they should hide or cover their pack, that the warnings encourage them to stop smoking, and that they make them worry that they shouldn't be smoking. Prominent graphic health warnings on tobacco products have been shown to increase health knowledge and perceptions of risk from smoking,[30, 31] reduce consumption levels and increase cessation behaviour among smokers,[31, 32] and support former smokers in remaining abstinent.[33] Importantly, the impact of graphic health warnings on smoking behaviours appears to be a function of the depth of smokers' cognitive processing of and responses to the warnings (such as those monitored in the current study),[32, 33] suggesting that if plain packaging can intensify smokers' responses to warnings, flow-on effects on consumption and quitting are likely.

Research shows that the impact of pictorial health warnings declines over time.[31, 34] Of note is the fact that the introduction of the new packs appears to have reversed a downward trend in smokers' cognitive and emotional responses to the graphic health warnings that had been occurring since their initial introduction. On the current plain packaging, the warnings are having an equal or greater impact on adult smokers than they have since their inception. Due to the simultaneous introduction of the plain packs and changes in the size and content of the warnings themselves, the relative contribution of the warning and pack changes to this increase in smoker responses cannot be determined in this study. Nonetheless, recent

evidence from eye-tracking studies suggests that plain packing itself can increase visual attention towards warning information on cigarette packs.[35, 36]

Extending experimental evidence on the influence of plain packaging on brand appeal,[7-9, 37] the current study demonstrates an impact of the new packs on adult smokers' perceptions that their own packs are fashionable or attractive, that they match their style or say something good about them to other smokers, or that the pack makes their brand stand out or influences the brand they buy. There is a wide body of evidence from marketing literature that shows how branding and packaging can modify the expected and actual subjective experience of products.[38] Notably, changes in the way smokers perceive their pack have the potential to augment smokers' subjective experience of smoking, leading to a more negative perception of the taste of their cigarettes and less enjoyment in the act of smoking.[7] Indeed, anecdotal evidence suggests that Australian smokers reported their cigarettes tasted worse with the introduction of plain packaging,[39, 40] and smokers smoking from plain packs during the phase-in period perceived their cigarettes to be less satisfying and lower in quality than a year ago.[2] The likely impact of changes in the perceived experience of smoking is an avenue for future studies, but research identifying enjoyment of smoking as a barrier to quitting suggests that smokers who find smoking their less enjoyable might be more likely to try and quit.[41]

The temporal pattern of changes found in this study is consistent with other early evaluations of the impact of the new plain packs. The proportion of smokers reporting negative responses to their packs and the warnings on them increased throughout the phase-in period, corresponding to the increasing proportion of plain packs observed in public venues during that period,[42] and the number of smokers reporting to be smoking from plain packs.[2] The earliest effects of the new packs have been detected during this phase-in period, with declines

in rates of active smoking observed in outdoor dining venues in October-November,[42] and calls to a cessation helpline peaking in November.[19] From the current time-series analysis, smokers' tendency to avoid the on-pack health warnings increased significantly in December, two months after the plain packs started appearing, when plain packs became mandatory for sale. This coincides with an observed decline in rates of pack display and an increase in concealment of packs in outdoor venues.[42] Other changes observed in the current study (cognitive and emotional responses to graphic health warnings, and negative pack perceptions) reached significance in January, at a time when less than 5% of packs observed in outdoor venues were fully-branded.[42] These changes occurred just after an increase in the number of smokers rating their cigarettes as being lower in quality and less satisfying than one year ago.[2] All changes in pack-related responses observed in the current study were maintained at eight months after the first appearance of the new packs.

The strengths of this study include the use of population-level data collected over a long time period, resulting in a large sample of adult smokers. As recommended in a recent review of the plain packaging literature,[5] the use of a time-series approach with multiple data points before the intervention increased the power to detect any effects over and above long-term background and seasonal trends, and the inclusion of important time-related potential covariates decreased threats to the validity of the findings. The logistic regression analyses allowed us to control for any changes in sample composition in regards to demographic characteristics such as SES and smoking levels.

Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, possibly leading to some bias in sample composition. The rate of mobile-only households in Australia was recently estimated at 14%, quantifying concerns about

excluding these individuals.[43] The response rate is similar to that of other population telephone surveys on tobacco use in Australia[44] and the overall rates of quitting are similar to other population studies of NSW smokers[45]. Additionally, both of these sampling issues were consistent across the study period, limiting their influence on the observed pattern of results.

In an environment of strict tobacco promotion prohibition such as Australia, cigarette packaging had become the key tool used by the tobacco industry to attract and retain customers.[46, 47] The purpose of the plain packaging legislation was to deprive tobacco companies of an ongoing opportunity to promote their products in the community. The introductory effects of the plain packaging legislation observed in this study are consistent with the specific objectives of the legislation in regards to increasing the salience and impact of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the fact that tobacco packs are handled every time a smoker takes out a cigarette, those who smoke more than a pack per day were potentially exposed to their new packs almost 4,000 times in the first six months of the legislated changes. The findings of this study suggest that the new packs are decreasing smokers' identification with their packs and making them think more closely about the health warnings contained on them, potentially moving them closer to cessation.

## COPYRIGHT



## COMPETING INTERESTS

SD, TD, JY, DP, DC have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare (1) no support from any third party organisation for the submitted work; (2) no financial relationships with any company that might have an interest in the submitted work in the previous three years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have no non-financial interests that may be relevant to the submitted work.

## CONTRIBUTORSHIP STATEMENT

SD, DP and JY conceived the study. DP and SD acquired the data. SD searched the literature and extracted the data.TD and SD did the analyses. All authors interpreted the data. SD drafted the manuscript. TD, JY, DP and DC contributed to the initial revision of the manuscript. SD, TD, JY, DP and DC contributed to the critical revision of the manuscript before publication. SD is the guarantor. All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

## TRANSPERANCY

SD affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

## ETHICS APPROVAL

The CITTS has ethics approval from the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). All respondents gave informed consent before taking part in the study.

## FUNDING

This study was internally funded by the Cancer Institute NSW.

## DATA SHARING

No additional data available.

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Table 1. Sample characteristics from the Cancer Institute's Tobacco Tracking Survey (CITTS) April 2006-May 2012 (smokers only; *n*=15,745)

| | *N* | % |
|---|---|---|
| **Sex**: | | |
| Female | 8298 | 50 |
| Male | 7503 | 50 |
| **Age**: | | |
| 18-29 yrs | 2405 | 21 |
| 30-55 yrs | 8470 | 48 |
| 55+ yrs | 4924 | 31 |
| **Socio-Economic Status** | | |
| Low | 6577 | 41 |
| Mod | 4071 | 27 |
| High | 4974 | 33 |
| **Smoking** | | |
| Low | 5827 | 41 |
| Mod | 5837 | 38 |
| High | 3473 | 22 |
| **Year:** | | |
| 2006 | 1600 | 10 |
| 2007 | 2289 | 15 |
| 2008 | 2094 | 13 |
| 2009 | 2135 | 14 |
| 2010 | 2146 | 14 |
| 2011 | 2157 | 14 |
| 2012 | 2126 | 13 |
| 2013 | 1254 | 8 |

Notes. *N*s are unweighted, %s are weighted for age, sex, and location

Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide or cover my packet from the view of others (avoidant response); (d) the only thing I notice on my cigarette pack is the graphic warnings (warning salience)

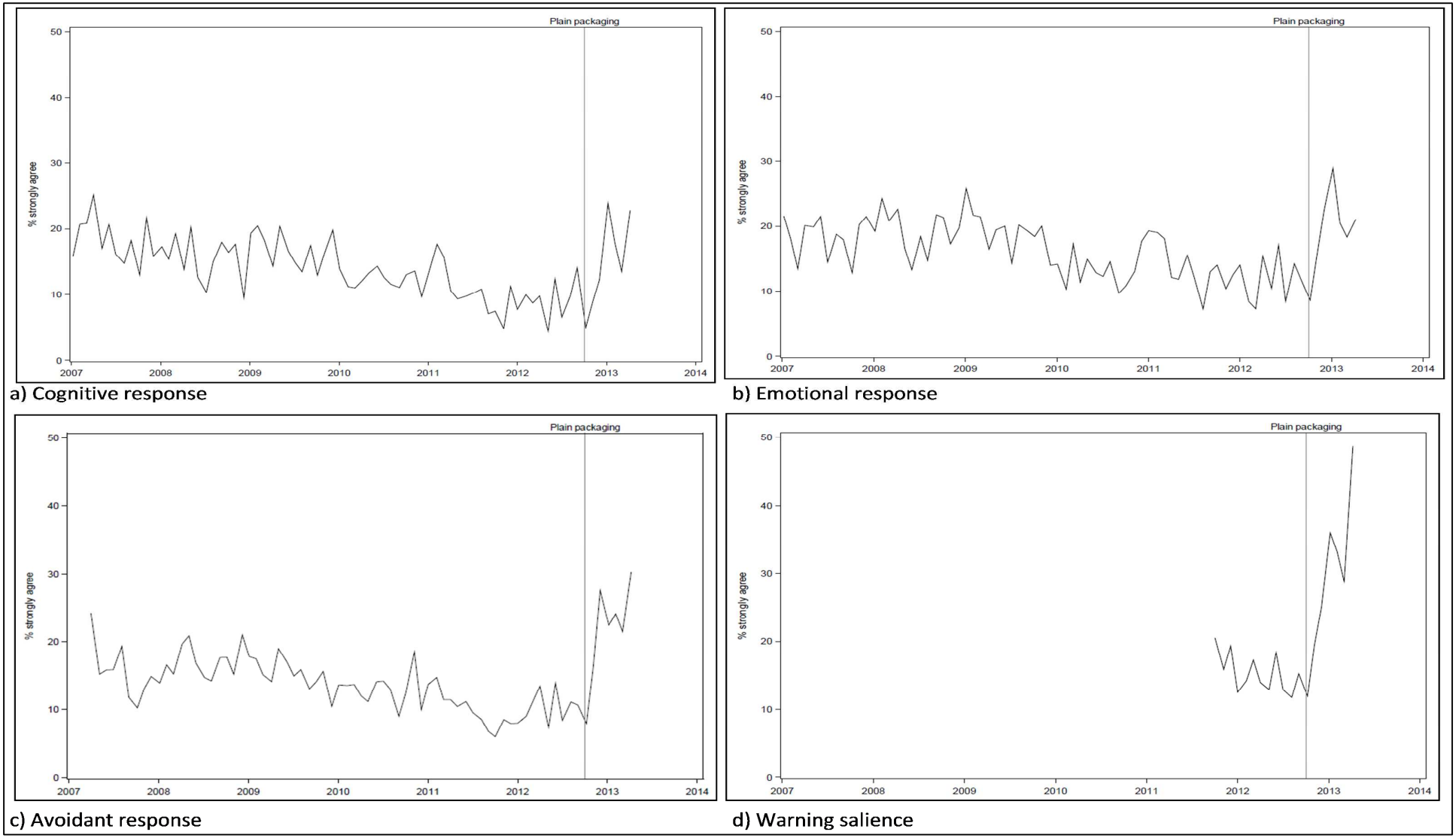
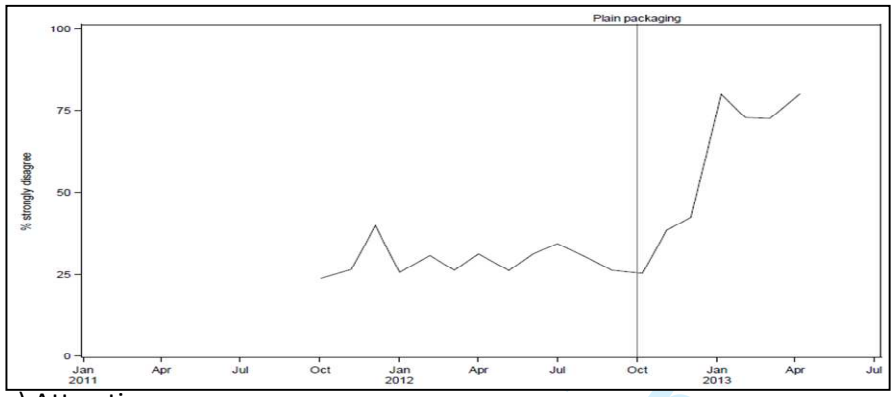
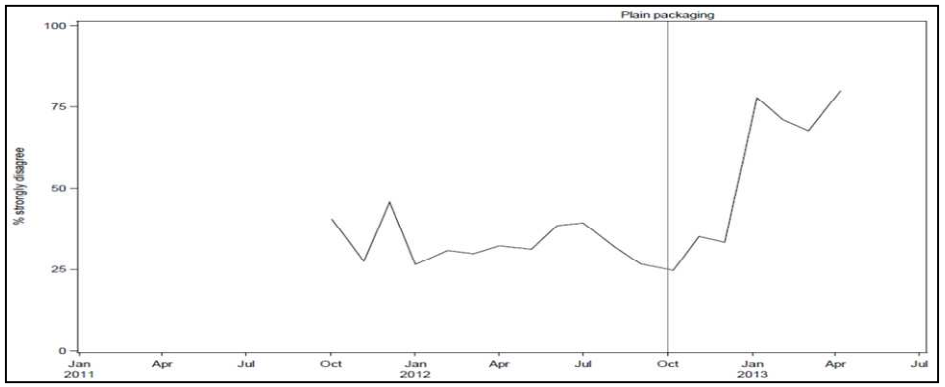


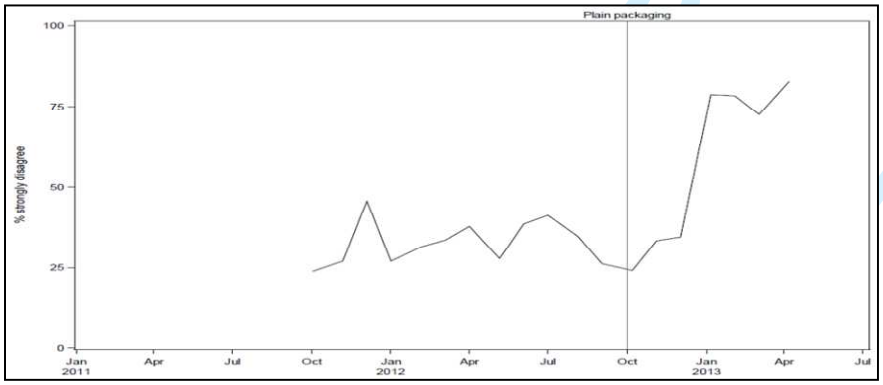
Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style



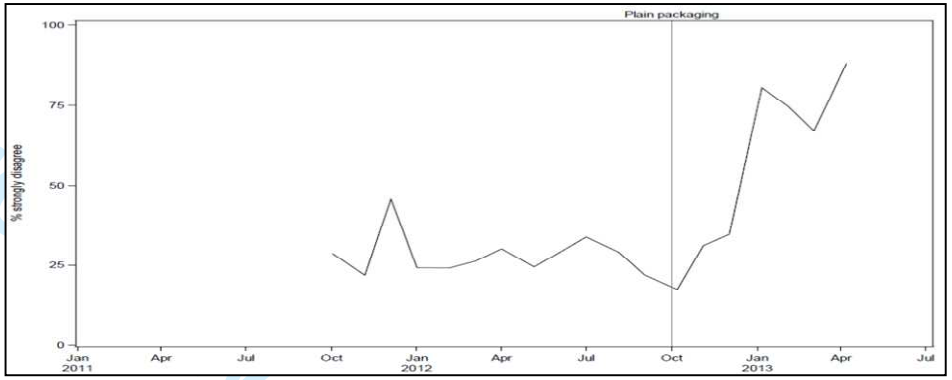

a) Attractive



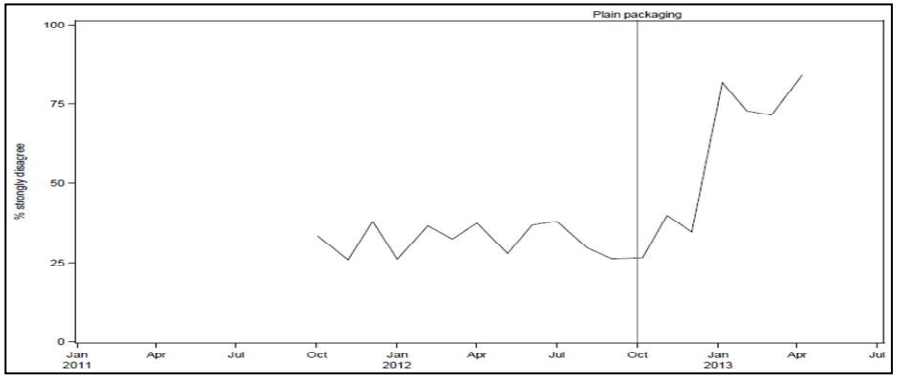

b) Says something good about me



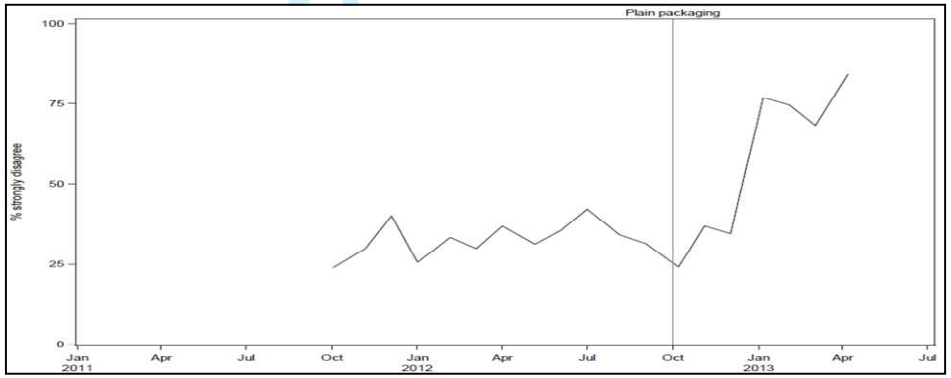

c) Influences the brand I buy




d) Make my brand stand out from others




b) Fashionable




f) Matches my style

Table 2. Results of interrupted time series analyses investigating the impact of new tobacco packaging on smokers' responses to graphic health warnings and pack attitudes

| | | **Increase in % strongly agree (95% CI)** | **P** |
|---|---|---|---|
| **Responses to graphic health warnings** | Cognitive [a] | 9.8 (3.0, 16.5) | 0.005 |
| | Emotional [a] | 8.6 (1.7, 15.4) | 0.010 |
| | Avoidant [b] | 9.8 (4.2, 15.3) | <0.001 |
| | Warning Salience [c] | 2.5 (-10.1, 15.1) | 0.700 |
| | | **Increase in % strongly disagree (95% CI)** | |
| **Pack perceptions** | Attractive [c] | 57.5 (38.0, 77.1) | <0.001 |
| | Says something good about me [c] | 54.5 (36.9, 72.1) | <0.001 |
| | Influences the brand I buy [c] | 40.6 (23.2, 58.0) | <0.001 |
| | Makes my brand stand out [c] | 55.6 (35.0, 76.2) | <0.001 |
| | Is fashionable [c] | 44.7 (28.1, 61.2) | <0.001 |
| | Matches my style [c] | 48.1 (32.2, 64.0) | <0.001 |

Notes. All models adjusted for TARPs, cigarette costliness, and seasonal variations (where possible); full results available from authors on request; all effects occurred at 3-months lag, except for 'avoidant' responses to the graphic health warnings (2-month lag); [a] Data available April 2006 – May 2013; [b] Data available April 2007 – May 2013; [c] Data available October 2011 – May 2013.

Table 3. Logistic regression analyses investigating responses to graphic health warnings and pack perceptions before and after the introduction of the new tobacco packs, as well as in the comparison period

| | | Comparison period (2011-2012) | | | | | Plain packaging period (2012-2013) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | O.R. | C.I. | | P | % | O.R. | C.I. | | P |
| **Cognitive response to health warnings** | **Month:** | | | | | | | | | | |
| | Aug/Sept | 8% | 1 | | | | 10% | 1 | | | |
| | Oct/Nov | 6% | 0.59 | 0.27 | 1.29 | 0.188 | 7% | 0.71 | 0.36 | 1.42 | 0.337 |
| | Dec/Jan | 8% | 1.14 | 0.51 | 2.55 | 0.742 | 18% | 1.97 | 1.18 | 3.30 | 0.009 |
| | Feb/March | 6% | 1.00 | 0.37 | 2.67 | 1.000 | 14% | 1.50 | 0.91 | 2.47 | 0.108 |
| | April/May | 8% | 1.39 | 0.30 | 6.50 | 0.677 | 19% | 2.20 | 1.33 | 3.63 | 0.002 |
| **Emotional response to health warnings** | **Month:** | | | | | | | | | | |
| | Aug/Sept | 8% | 1 | | | | 11% | 1 | | | |
| | Oct/Nov | 14% | 1.56 | 0.87 | 2.80 | 0.137 | 12% | 0.89 | 0.53 | 1.49 | 0.653 |
| | Dec/Jan | 13% | 1.75 | 0.91 | 3.33 | 0.091 | 26% | 2.49 | 1.59 | 3.90 | <0.001 |
| | Feb/March | 7% | 1.05 | 0.47 | 2.35 | 0.911 | 20% | 2.03 | 1.32 | 3.13 | 0.001 |
| | April/May | 13% | 2.42 | 0.70 | 8.41 | 0.164 | 24% | 2.26 | 1.45 | 3.51 | <0.001 |
| **Avoidant response to health warnings** | **Month:** | | | | | | | | | | |
| | Aug/Sept | 8% | 1 | | | | 10% | 1 | | | |
| | Oct/Nov | 8% | 1.06 | 0.50 | 2.22 | 0.887 | 11% | 1.13 | 0.66 | 1.92 | 0.662 |
| | Dec/Jan | 7% | 0.71 | 0.33 | 1.53 | 0.386 | 29% | 3.62 | 2.26 | 5.78 | <0.001 |
| | Feb/March | 10% | 0.98 | 0.39 | 2.43 | 0.961 | 21% | 2.22 | 1.42 | 3.45 | <0.001 |
| | April/May | 10% | 0.71 | 0.18 | 2.86 | 0.631 | 25% | 2.93 | 1.84 | 4.65 | <0.001 |
| **Salience of health warnings** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 12% | 1 | | | |
| | Oct/Nov | 15% | 1 | | | | 15% | 1.28 | 0.78 | 2.08 | 0.326 |
| | Dec/Jan | 15% | 1.19 | 0.59 | 2.38 | 0.623 | 34% | 3.70 | 2.40 | 5.69 | <0.001 |
| | Feb/March | 13% | 1.18 | 0.50 | 2.76 | 0.710 | 32% | 3.29 | 2.19 | 4.93 | <0.001 |
| | April/May | 13% | 1.65 | 0.38 | 7.14 | 0.505 | 36% | 4.18 | 2.74 | 6.39 | <0.001 |
| **Negative Pack Perception Index** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 15% | 1 | | | |
| | Oct/Nov | 14% | 1 | | | | 14% | 1.48 | 1.01 | 2.17 | 0.045 |
| | Dec/Jan | 17% | 1.09 | 0.61 | 1.94 | 0.782 | 45% | 6.73 | 4.64 | 9.76 | <0.001 |
| | Feb/March | 14% | 1.19 | 0.56 | 2.49 | 0.653 | 51% | 7.41 | 5.23 | 10.52 | <0.001 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| April/May | 16% | 1.38 | 0.40 | 4.77 | 0.612 | 58% | 14.48 | 9.58 | 21.89 | <0.001 |

Notes. All models controlled for demographics (sex, age, SES), smoking characteristics (level of smoking, previous quitting history) and anti-smoking advertising activity (TARPs); % are unweighted; O.R=Odds Ratio; C.I=95% Confidence Interval

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | Y/N |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Y |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Y |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Y |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Y |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Y |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Y |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Y |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case | |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Y |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Y |
| Bias | 9 | Describe any efforts to address potential sources of bias | Y |
| Study size | 10 | Explain how the study size was arrived at | Y |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Y |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Y |
| | | (*b*) Describe any methods used to examine subgroups and interactions | Y |
| | | (*c*) Explain how missing data were addressed | Y |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed<br>*Case-control study*—If applicable, explain how matching of cases and controls was addressed<br>*Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Y |
| | | (*e*) Describe any sensitivity analyses | |

Continued on next page

| | | | |
|---|---|---|---|
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Y |
| | | (b) Give reasons for non-participation at each stage | |
| | | (c) Consider use of a flow diagram | |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Y |
| | | (b) Indicate number of participants with missing data for each variable of interest | |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | Y |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Y |
| | | (*b*) Report category boundaries when continuous variables were categorized | |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Y |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Y |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Y |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Y |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Y |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

# Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-related perceptions and responses: Results from a continuous tracking survey



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| | |

# Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-related perceptions and responses: Results from a continuous tracking survey

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## ABSTRACT

**Objectives** – To investigate the impact of Australia's plain tobacco packaging policy on two stated purposes of the legislation – increasing the impact of health warnings and decreasing the promotional appeal of packaging – among adult smokers.

**Design** – Serial cross-sectional study with weekly telephone surveys (April 2006 to May 2013). Interrupted time-series analyses using ARIMA modelling and linear regression models were used to investigate intervention effects.

**Participants** – 15,745 adult smokers (aged 18 years and over) in New South Wales (NSW), Australia. Random selection of participants involved recruiting households using random digit dialling and selecting the *n*th oldest smoker for interview.

**Intervention** – The introduction of the legislation on 1st October 2012.

**Outcomes** – Salience of tobacco pack health warnings, cognitive and emotional responses to warnings, avoidance of warnings, perceptions regarding one's cigarette pack.

**Results** – Adjusting for background trends, seasonality, anti-smoking advertising activity, and cigarette costliness, results from ARIMA modelling showed that, two to three months after the introduction of the new packs, there was a significant increase in the absolute proportion of smokers having strong cognitive (9.8% increase, $p$=0.005), emotional (8.6% increase, $p$=0.01), and avoidant (9.8% increase, $p$=0.0005) responses to on-pack health warnings. Similarly, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive (57.5% increase, $p$<0.0001), says something good about them (54.5% increase, $p$<0.0001), influences the brand they buy (40.6% increase, $p$<0.0001), makes their pack stand out (55.6% increase, $p$<0.0001), is fashionable (44.7% increase, $p$<0.0001), and matches their style (48.1% increase, $p$<0.0001). Changes in these outcomes were maintained six months post-intervention.

**Conclusions** – The introductory effects of the plain packaging legislation among adult smokers are consistent with the specific objectives of the legislation in regards to reducing promotional appeal and increasing effectiveness of health warnings.

## ARTICLE SUMMARY

### Article Focus

- Experimental research has shown that plain tobacco packaging can: reduce the appeal of tobacco products to consumers; increase the effectiveness of health warnings; and reduce the ability of packaging to mislead consumers about the harmful effects of smoking.
- Given that the introduction of the tobacco plain packaging legislation in Australia is the first of its kind, no research to date has investigated the impact of plain packaging on these outcomes in a real-world context with mandated plain packs.

### Key Findings

- The introductory effects of the new packs observed in this study are consistent with the specific objectives and expected effects of the plain packaging legislation.
- This is the first study to date to demonstrate an impact of the Australian plain tobacco packs on the salience and impact of on-pack health warnings and negative perceptions about tobacco packs among adult smokers.

### Strengths and Limitations

- Study strengths are: the use of population-level data collected over a long time period, with a large sample of adult smokers; the use of a time-series approach with multiple data points before the intervention; and the inclusion of important time-related and sample-related potential covariates.
- Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, potentially leading to some bias in sample composition. Response rate was consistent across the study period, limiting the impact on study findings.

On the 1st of December 2012, Australia became the first country to introduce mandatory plain packaging for all tobacco products.[1] The new plain packs are olive green cardboard packages devoid of all brand design elements, with brand name and number of cigarettes written in a standardised font and location on each pack. The new packs continue to carry coloured graphic health warnings covering 90% of the back of packs, with the warnings on the front of pack enlarged from 30% to 75%. Manufacturers were required to produce the new packs from the 1st of October 2012 and they started appearing for sale from that date; approximately 80% of smokers were using plain packs by mid-November.[2]

The plain packaging legislation aims to discourage people from taking up smoking, encourage smokers to give up smoking, and discourage relapse.[1] The stated purpose of the legislation is to regulate the packaging and appearance of tobacco products in order to: (a) reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful effects of smoking. As this was the first time any such legislation had been implemented, the expected outcomes of the new packs were informed by a body of research consisting primarily of experimental studies, summarised in recent reviews.[3-6]

Studies in which participants were presented with mocked-up plain and branded tobacco packs show that plain packaging has the potential to reduce the promotional appeal of a pack, diminish positive perceptions about smokers of cigarettes from that pack, and reduce the appeal of smoking in general.[7-13] Such studies also suggest that health warnings are both more noticeable and more effective when presented on plain rather than branded packs,[14, 15] with researchers suggesting that brand imagery diffuses the impact of health warnings.[16]

These results have been corroborated in naturalistic studies in which smokers are assigned to smoke their normal cigarettes from either plain or branded packs for a period of time, with plain pack smokers reporting increased negative perceptions about to their pack and smoking, along with an increased impact of health warnings.[17, 18] A limitation of these previous studies, however, is the inability to differentiate the impact of plain packaging and the novelty impact of a pack which is simply different to the packs that smokers are used to seeing. No studies to date have been able to investigate the impact of plain tobacco packaging on tobacco pack appeal and the salience and effects of health warnings in the context of mandatory plain packaging, when all packs with which smokers are in contact are devoid of any branding other than a name in a standard font.

In the current study, we use cross-sectional survey data collected weekly for a period of seven years to investigate the impact of the new packaging on adult smokers' responses to the health warnings on their packs and perceptions of their packs. It was hypothesised that, after the introduction of the new packs, smokers would find the health warnings more salient, would have an increased response to the warnings, and would hold less favourable perceptions of their packs. The continuous nature of the data allowed us to track how these outcomes changed after the introduction of the new packs, investigating whether any observed changes were sustained in the six months following their introduction. This approach builds on our previous study evaluating the impact of the introduction of the plain packaging legislation on calls to a smoking cessation helpline.[19] Additionally, given that responses to graphic pack warnings had been tracked since their initial introduction in 2006, we were able to assess changes in these responses in the context of longer-term trends.

## METHOD

## Study Design and Participants

The Cancer Institute's Tobacco Tracking Survey (CITTS) is a serial cross-sectional telephone survey with approximately 50 interviews conducted per week throughout the year. The CITTS monitors smoking-related cognitions and behaviours among adult smokers and recent quitters (quit in last 12 months) in New South Wales (NSW), Australia's most populous state. Households are recruited using random digit dialling (landline telephone numbers only) and a random selection procedure is used to recruit participants within households (selecting the *n*th oldest eligible adult). Analyses for this study are limited to smokers interviewed between April 2006 and May 2013 (total $n$ = 15,745), with an average response rate of 40% (American Association for Public Opinion Research Response Rate #4).[20] The CITTS is approved by the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). The study was funded by the Cancer Institute NSW.

## Outcome Measures

Following the introduction of the original graphic health warnings on tobacco packs in March 2006, questions were included in CITTS relating to smokers' responses to the warnings. These questions assessed cognitive response to the warnings ('the graphic warnings encourage me to stop smoking') and emotional response ('with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking'). From April 2007, warning avoidance was also assessed ('they make me feel that I should hide or cover my packet from the view of others'). From October 2011, the salience of the warnings was also assessed ('the only thing I notice on my cigarette pack is the graphic warnings'). All answers were given on a 5-point Likert scale (1=strongly disagree- 5=strongly agree). The distributions of responses to these items over the study period are shown in Supplementary Figure 1. Responses to these items were used in two ways. The first was collapsing responses for each item into a binary

variable indicating strong agreement vs. not. The second was averaging the responses to these items to create a scale indicating 'Graphic Health Warning Impact', with higher scores indicating greater overall impact (Cronbach's alpha =0.70).

From October 2011 smokers were asked a battery of questions relating to their perceptions of their packs: 'The look of my cigarette pack…' (i) is attractive; (ii) says something good about me to other smokers; (iii) influences the brand I buy; (iv) makes my brand stand out from other brands; (v) is fashionable; and (vi) matches my style (1=strongly disagree-5=strongly agree). Distributions of responses to these items over the study period are shown in Supplementary Figure 2. Responses to each item were dichotomised into strongly disagree vs. not, and they were also reverse scored and averaged to create a scale indicating 'Negative Pack Perceptions' (Cronbach's alpha=0.87), with higher scores indicating more negative perceptions.

**Covariates**

Data on sex, age, total household income, and educational attainment (low=less than high school; moderate=high school diploma or vocational college; high=tertiary), were included in CITTS. Socio-economic status (SES) was indicated by a variable that combined responses to household income and educational attainment.[21, 22] High SES was defined as having a household income of more than AUD$80,000 (and any education level), or an income of AUD$40-80,000 and moderate-high education. Moderate SES was defined as either an income below AUD$40,000 and high education, or an income of AUD$40-80,000 and moderate education. Low SES was defined as either an income below AUD$40,000 and low or moderate education, or an income AUD$40-80,000 and low education. Those with missing data on one variable were classified based on the other.

Frequency of smoking was used to classify smokers as 'daily', 'weekly', or 'less frequent' smokers. Average number of cigarettes smoked per day was used to indicate heaviness of smoking (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day; heavy=more than 20 cigarettes per day). As smokers' responses to graphic health warnings and perceptions of their cigarette packs might conceivably be related to their quitting experiences or propensity towards quitting, we also included quit attempts in the last 12 months as a control variable (1=tried to quit at least once in the last 12 months, 0=did not).

Respondents' pack perceptions and responses to health warnings might also possibly be influenced by the timing of their interview in terms of variations in anti-smoking advertising activity, changes in the costliness of cigarettes, or shifting social norms. Respondents' level of exposure to anti-smoking advertising in the three months prior to their interview was measured in terms of Target Audience Ratings Points (TARPs). TARPs are a product of the percentage of the target audience exposed to an advertisement (reach) and the average number of times a target audience member would be exposed (frequency). Hence, 200 TARPs might represent 100% of the target audience receiving the message an average of two times over a specified period, or 50% reached four times. Exposure to advertising over a 3-month period was chosen based on previous research suggesting that advertising effects occur within this time frame.[22, 23] We ascertained TARPs for each of the advertisements broadcast in NSW during the study period based on OZTAM Australian TV Audience Measurements for adults aged 18years and older for free-to-air and cable TV ($M$=1590, $SD$=758).[24]

A variable indicating cigarette costliness[25] at time of interview was calculated as the ratio of the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette

brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to 87) to the average weekly earnings in the same quarter ($M$=1.54, $SD$=0.17).[26]

The influence of changing social norms was accounted for by statistically accounting for a time-based trend in the data, described below.

**Statistical analyses**

Two approaches to statistical analysis were used to assess the impact of the new packs on each outcome. The first approach used interrupted time series analysis, in which data collected at multiple instances before and after an intervention is used to detect whether the intervention has an effect significantly greater than the underlying secular trend. The advantages of using this approach include the ability to account for background trends, control for seasonal variations, adjust for auto-correlation in the data (when each value is correlated with the previous value), and to assess changes in the outcome in the context of longer-term trends. We also used multiple linear regression analyses to compare the scores for the two constructed scales in the months prior to and following the new packaging legislation, controlling for socio-demographic and smoking characteristics.

In the time-series analysis, weekly data were aggregated at the monthly level (to ensure sufficient sample size at each time point). We assessed the impact of the introduction of the new packs on (a) the proportion of sample strongly agreeing with each of the graphic health warning statements, (b) mean Graphic Health Warning Impact score, (c) the proportion of the sample strongly disagreeing with each of the pack perception statements, and (d) mean Negative Pack Perception score. We used autoregressive integrated moving average (ARIMA) analysis in SAS version 9.3[27] to model the effects of the introduction of the new packaging on the outcomes of interest, while accounting for background trends, seasonal

variation, the effects of television anti-tobacco advertising, and changes in cigarette costliness. ARIMA modelling was chosen because the data for each of the outcomes of interest were auto-correlated.

ARIMA modelling comprising model investigation, estimation and diagnostic checking followed the methods of Box *et al*.[28] This modelling enables investigation of the size and statistical significance of changes in an outcome after a specified time point, adjusting for background trends and confounders. An indicator term was created to represent the week of the introduction of the intervention (the 'phasing in' of the new packs on 1 October 2012). The potential confounders of anti-smoking advertising activity (TARPs) and cigarette costliness were included in all models. In the models predicting responses to graphic health warnings, terms indicating the months of December and January were also included to account for potential for seasonal variations (not included for pack perception outcomes due to limited data points). Due to the large number of outcomes to be reported, we do not report the effects of these covariates (available from authors on request).

Next, we used multiple linear regression analyses to assess changes in scores on the Graphic Health Warning Impact and Negative Pack Perception scales, using month of interview as the indicator, focusing on the period of the introduction of the new packs (August 2012 – May 2013).[29] The months preceding and following the intervention were represented by a five-level term: (a) the two months preceding the change (August-September, 'pre-plain packs (PP)'); (b) the two months of 'phase-in' (October-November); (c) the two months 'immediate post-PP' (December-January); (d) '3-4 months post-PP' (February-March); and (e) '5-6 months post-PP' (April-May). Demographic and smoking characteristics were included as covariates, along with recent anti-smoking advertising activity. Because changes in cigarette

costliness were based on quarterly data, there was a high degree of multi-collinearity between costliness and time of interview (VIF=26), resulting in inflated standard errors and unstable estimates of regression coefficients. We therefore included a variable indicating 'increase in cigarette costliness' in the last 12 weeks (as a percentage of costliness) as a covariate in these models. To provide a point of comparison, these models were also fitted to 2011-2012 data for the same months. An alpha level of 0.05 was used for all statistical tests. Stata v11 was used for the regression analyses.[30]

Due to a slight over-representation of females, older respondents, and regional residents (living outside of the capital city) in the CITTS sample compared to the NSW population,[31] weights were constructed using age, sex, and region of residence to make the sample more similar to the NSW population. Weights were applied in the multiple linear regression analyses (using 'p' weights).

## RESULTS

Response rate for the survey was an average of 40% in the period 2006-2013.

Sample characteristics are shown in Table 1.

### Responses to graphic health warnings

Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of the graphic health warning responses over time. In general, strong agreement about the impact of the warnings had been decreasing since their introduction in 2006. Of smokers interviewed in 2006: 21% reported strong cognitive responses to the warnings, decreasing to 12% in 2011; and 20% reported strong emotional response, decreasing to 12% in 2011.

The results of the interrupted time series analyses investigating the impact of the new packaging on responses to graphic health warnings are shown in Table 2. For all models, the residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. After controlling for background trends, seasonality, anti-smoking advertising activity and cigarette costliness, there was a significant increase in the proportion of smokers having strong cognitive, emotional and avoidant responses to graphic warnings after the introduction of the new packs. The increase in the avoidant response occurred two months after the new packs were introduced (from 10% in September 2012 to 28% in December), and the increase in cognitive and emotional responses occurred after three months (cognitive: from 13% in September 2012 to 20% in January 2013; emotional: from 13% to 27%). In the time-series analysis, the change in the proportion of smokers strongly agreeing that the warnings were the only thing they noticed on their packs after the introduction of the new packs was not significant.

The monthly average of the GHW Impact scale is shown in Figure 3. The results of the interrupted time series analysis investigating the impact of the new packaging on GHW Impact scores are shown in Table 2. The residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. There was a significant increase in scores on the GHW Impact scale two months after the introduction of the new packs, not attributable to background trends, seasonality, anti-smoking advertising activity or cigarette costliness.

The results of the multiple linear regression model predicting scores on the GHW Impact scale are shown in Table 3. Compared to the pre-plain packaging period (August/September 2012), scores on the scale was significantly higher in immediate post-plain packaging period

(December/January) and in the 5-6 month post-plain packaging period (April/May). These effects were independent of any differences between the samples on socio-demographic or smoking characteristics, anti-smoking advertising activity, or increases in cigarette costliness. There were no significant differences in scores on this scale over the months of the comparison period.

**Pack perceptions**

The monthly proportions of smokers strongly disagreeing with each of the pack attitude items are shown in Figure 2. The results of the interrupted time series analysis (Table 2) show that, three months following the introduction of the new packs, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive (from 26% in September 2012 to 80% in January 2013), says something good about them (from 27% to 76%), influences the brand they buy (from 27% to 77%), makes their brand stand out (from 22% to 78%), is fashionable (from 27% to 80%), and matches their style (from 31% to 77%). This effect was independent of any influence of long-term background trends, cigarette costliness, or anti-smoking advertising activity.

The monthly average of the Negative Pack Perception scale is shown in Figure 3, and the results of the interrupted time series analysis investigating the impact of the new packaging on these scores are shown in Table 2. The residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. There was a significant increase in scores on the Negative Pack Perception scale three months after the introduction of the new packs, not attributable to background trends, seasonality, anti-smoking advertising activity or cigarette costliness.

The multiple linear regression model predicting Negative Pack Perception scores over the pp-periods showed that scores on this scale were significantly higher in each of the post-pp periods than in the pre-pp period (Table 3). For the comparison period, there were no significant differences in scores on this scale.

## DISCUSSION

To our knowledge, this is the first study to examine the population-level impact of the new tobacco plain packs on Australian adult smokers' responses to their packs. This is an important first step in evaluating the policy as these outcomes relate closely to the intended purpose of the legislation. In the months following the introduction of the new packs, there was an increase in the proportion of smokers reporting strong cognitive and emotional responses to the warnings, avoidant behaviours related to the on-pack warnings, and salience of warnings. There was also an increase in the proportion of smokers with strong negative perceptions about their packs. These changes were not attributed to variations in exposure to anti-smoking advertising activity, tobacco prices, secular trends, seasonality or changes in sample composition.

Consistent with the results of experimental research,[14, 15, 17] we found that the introduction of the new packs was associated with an increase in the salience and the self-reported impact of the health warnings, such that smokers were more likely to report that the warnings are the only thing they see on their packs, that they feel they should hide or cover their pack, that the warnings encourage them to stop smoking, and that they make them worry that they shouldn't be smoking. Prominent graphic health warnings on tobacco products have been shown to increase health knowledge and perceptions of risk from smoking,[32, 33] reduce

consumption levels and increase cessation behaviour among smokers,[33, 34] and support former smokers in remaining abstinent.[35] Importantly, the impact of graphic health warnings on smoking behaviours appears to be a function of the depth of smokers' cognitive processing of and responses to the warnings (such as those monitored in the current study),[34-36] suggesting that if plain packaging can intensify smokers' responses to warnings, flow-on effects on consumption and quitting are likely.

Research shows that the impact of pictorial health warnings declines over time.[33 37] Of note is the fact that the introduction of the new packs appears to have reversed a downward trend in smokers' cognitive, emotional, and avoidant responses to the graphic health warnings that had been occurring since their initial introduction. On the current plain packaging, the warnings are having an equal or greater impact on adult smokers than they have since their inception. Due to the simultaneous introduction of the plain packs and changes in the size and content of the warnings themselves, the relative contribution of the warning and pack changes to this increase in smoker responses cannot be determined in this study. Nonetheless, recent evidence from eye-tracking studies suggests that plain packing itself can increase visual attention towards warning information on cigarette packs.[38, 39] Future research should assess whether the downward trend in responses to health warnings resumes following the introductory period of plain packaging.

Extending experimental evidence on the influence of plain packaging on brand appeal,[7-9, 40] the current study demonstrates an impact of the new packs on adult smokers' perceptions that their own packs are fashionable or attractive, that they match their style or say something good about them to other smokers, or that the pack makes their brand stand out or influences the brand they buy. There is a wide body of evidence from marketing literature that shows

how branding and packaging can modify the expected and actual subjective experience of products.[41] Notably, changes in the way smokers perceive their pack have the potential to augment smokers' subjective experience of smoking, leading to a more negative perception of the taste of their cigarettes and less enjoyment in the act of smoking.[7] Indeed, anecdotal evidence suggests that Australian smokers reported their cigarettes tasted worse with the introduction of plain packaging,[42, 43] and smokers smoking from plain packs during the phase-in period perceived their cigarettes to be less satisfying and lower in quality than a year ago.[2] The likely impact of changes in the perceived experience of smoking is an important avenue for future studies, but research identifying enjoyment of smoking as a barrier to quitting suggests that smokers who find smoking their less enjoyable might be more likely to try and quit.[44]

The temporal pattern of changes found in this study is consistent with other early evaluations of the impact of the new plain packs. The proportion of smokers reporting negative responses to their packs and the warnings on them increased throughout the phase-in period, corresponding to the increasing proportion of plain packs observed in public venues during that period,[45] and the number of smokers reporting to be smoking from plain packs.[2] The earliest effects of the new packs have been detected during this phase-in period, with declines in rates of active smoking observed in outdoor dining venues in October-November,[45] and calls to a cessation helpline peaking in November.[19] From the current time-series analysis, smokers' tendency to avoid the on-pack health warnings increased significantly in December, two months after the plain packs started appearing, when plain packs became mandatory for sale. This coincides with an observed decline in rates of pack display and an increase in concealment of packs in outdoor venues.[45] Other changes observed in the current study (cognitive and emotional responses to graphic health warnings, and negative pack

perceptions) reached significance in January, at a time when less than 5% of packs observed in outdoor venues were fully-branded.[45] These changes occurred just after an increase in the number of smokers rating their cigarettes as being lower in quality and less satisfying than one year ago.[2] All changes in pack-related responses observed in the current study were maintained at eight months after the first appearance of the new packs, the last data point in the current series.

The strengths of this study include the use of population-level data collected over a long time period, resulting in a large sample of adult smokers. As recommended in a recent review of the plain packaging literature,[5] the use of a time-series approach with multiple data points before the intervention increased the power to detect any effects over and above long-term background and seasonal trends, and the inclusion of important time-related potential covariates decreased threats to the validity of the findings. The regression analyses allowed us to control for any changes in sample composition in regards to demographic characteristics such as SES and smoking levels. We note that the sample for this study consisted of current smokers only, and therefore any smokers who quit in the post-plain packaging period would be excluded. This might have resulted in a sample of smokers somewhat resistant to this intervention, and as such, the estimates provided in this study might be more conservative than if we had also surveyed smokers who quit during this time.

Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, possibly leading to some bias in sample composition. The rate of mobile-only households in Australia, recently estimated at 19%, increased over the years of this study.[46] Recent dual-frame surveys have shown that samples recruited via mobile-phone are more likely to include younger respondents and males than landline samples.[47] The impact of

these demographic differences are likely to be reduced in the current study due to the inclusion of age and gender as covariates, the use of data weighted for these variables where appropriate, and the inclusion of smoking-related covariates related to these demographic characteristics. The response rate of CITTS is similar to that of other population telephone surveys on tobacco use in Australia,[48] and was consistent across the study period, limiting its influence on the observed pattern of results.

In an environment of strict tobacco promotion prohibition such as Australia, cigarette packaging had become the key tool used by the tobacco industry to attract and retain customers.[49, 50] The purpose of the plain packaging legislation was to deprive tobacco companies of an ongoing opportunity to promote their products in the community. The introductory effects of the plain packaging legislation observed in this study are consistent with the specific objectives of the legislation in regards to increasing the salience and impact of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the fact that tobacco packs are handled every time a smoker takes out a cigarette, those who smoke more than a pack per day were potentially exposed to their new packs almost 4,000 times in the first six months of the legislated changes. The findings of this study suggest that the new packs are decreasing smokers' identification with their packs and making them think more closely about the health warnings contained on them, potentially moving them closer to cessation. Future research should extend this study by considering any relationships between smokers' responses to their plain packaging packs and changes in smoking behaviours, investigating whether the introductory effects identified in this study were apparent in youth smokers, and monitoring the impact of plain packaging on perceptions about smoking among non-smoking youth and adults.

## COPYRIGHT



## COMPETING INTERESTS

SD, TD, JY, DP, DC have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare (1) no support from any third party organisation for the submitted work; (2) no financial relationships with any company that might have an interest in the submitted work in the previous three years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have no non-financial interests that may be relevant to the submitted work.

## CONTRIBUTORSHIP STATEMENT

SD, DP and JY conceived the study. DP and SD acquired the data. SD searched the literature and extracted the data.TD and SD did the analyses. All authors interpreted the data. SD drafted the manuscript. TD, JY, DP and DC contributed to the initial revision of the manuscript. SD, TD, JY, DP and DC contributed to the critical revision of the manuscript before publication. SD is the guarantor. All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

## TRANSPERANCY

SD affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

## ETHICS APPROVAL

The CITTS has ethics approval from the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). All respondents gave informed consent before taking part in the study.

## FUNDING

This study was internally funded by the Cancer Institute NSW.

## DATA SHARING

No additional data available.

## FIGURE LEGENDS

Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide or cover my packet from the view of others (avoidant response); (d) the only thing I notice on my cigarette pack is the graphic warnings (warning salience)

Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style

Figure 3: Monthly mean score for Graphic Health Warning Impact and Negative Pack Perception

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Table 1. Sample characteristics from the Cancer Institute's Tobacco Tracking Survey (CITTS) April 2006-May 2012 (smokers only; *n*=15,745)

| | *N* | % |
|---|---|---|
| **Sex**: | | |
| Female | 8298 | 50 |
| Male | 7503 | 50 |
| **Age**: | | |
| 18-29 yrs | 2405 | 21 |
| 30-55 yrs | 8470 | 48 |
| 55+ yrs | 4924 | 31 |
| **Socio-Economic Status** | | |
| Low | 6577 | 41 |
| Mod | 4071 | 27 |
| High | 4974 | 33 |
| **Smoking Frequency** | | |
| Daily | 14025 | 88 |
| Weekly | 950 | 6 |
| Less than weekly | 826 | 6 |
| **Smoking** | | |
| Low | 5827 | 41 |
| Mod | 5837 | 38 |
| High | 3473 | 22 |
| **Quit Attempts in Past 12m** | | |
| None | 9443 | 60 |
| At least one | 6145 | 40 |
| **Year:** | | |
| 2006 | 1600 | 10 |
| 2007 | 2289 | 15 |
| 2008 | 2094 | 13 |
| 2009 | 2135 | 14 |
| 2010 | 2146 | 14 |
| 2011 | 2157 | 14 |
| 2012 | 2126 | 13 |
| 2013 | 1254 | 8 |

Notes. *N*s are unweighted, %s are weighted for age, sex, and regional residence

Table 2. Results of interrupted time series analyses investigating the impact of new tobacco packaging on smokers' responses to graphic health warnings and pack attitudes

| | | **Increase in % strongly agree (95% CI)** | **P** |
|---|---|---|---|
| **Responses to graphic health warnings** | Cognitive [a] | 9.8 (3.0, 16.5) | 0.005 |
| | Emotional [a] | 8.6 (1.7, 15.4) | 0.010 |
| | Avoidant [b] | 9.8 (4.2, 15.3) | <0.001 |
| | Warning Salience [c] | 2.5 (-10.1, 15.1) | 0.700 |
| | GHW Impact [c] | 0.38 (0.05, 0.70) [d] | 0.02 |
| | | **Increase in % strongly disagree (95% CI)** | |
| **Pack perceptions** | Attractive [c] | 57.5 (38.0, 77.1) | <0.001 |
| | Says something good about me [c] | 54.5 (36.9, 72.1) | <0.001 |
| | Influences the brand I buy [c] | 40.6 (23.2, 58.0) | <0.001 |
| | Makes my brand stand out [c] | 55.6 (35.0, 76.2) | <0.001 |
| | Is fashionable [c] | 44.7 (28.1, 61.2) | <0.001 |
| | Matches my style [c] | 48.1 (32.2, 64.0) | <0.001 |
| | Negative Pack Perceptions [c] | 0.21 (0.02, 0.40) [d] | 0.03 |

Notes. All models adjusted for TARPs, cigarette costliness, and seasonal variations (where possible); full results available from authors on request; all effects occurred at 3-months lag, except for 'avoidant' responses to the graphic health warnings and GHW Impact (2-month lag); [a] Data available April 2006 – May 2013; [b] Data available April 2007 – May 2013; [c] Data available October 2011 – May 2013; [d] Increase in Mean score

Table 3. Results from linear regression models predicting Graphic Health Warning Impact and Negative Pack Perceptions from month of interview in the plain packaging and comparison periods

| | | Comparison period (2011-2012) | | | | | Plain packaging period (2012-2013) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | (SD) | β | 95% C.I. | p | M | (SD) | β | 95% C.I. | p |
| **GHW Impact** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 2.67 | (0.93) | Ref | | |
| | Oct/Nov | 2.57 | (0.90) | Ref | | | 2.75 | (0.97) | 0.00 | -0.16 0.18 | 0.932 |
| | Dec/Jan | 2.62 | (0.99) | -0.01 | -0.25 0.21 | 0.847 | 2.88 | (1.16) | 0.09 | 0.07 0.46 | 0.008 |
| | Feb/March | 2.77 | (0.89) | 0.10 | -0.19 0.58 | 0.323 | 2.75 | (1.15) | 0.07 | -0.04 0.39 | 0.110 |
| | April/May | 2.67 | (0.96) | -0.01 | -0.52 0.48 | 0.930 | 2.85 | (1.21) | 0.06 | 0.01 0.34 | 0.043 |
| **Negative Pack Perceptions** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 3.95 | (0.76) | Ref | | |
| | Oct/Nov | 4.03 | (0.60) | Ref | | | 3.96 | (0.75) | 0.02 | -0.47 1.06 | 0.449 |
| | Dec/Jan | 4.11 | (0.64) | 0.06 | -0.43 1.46 | 0.286 | 4.50 | (0.63) | 0.27 | 2.74 4.18 | <0.001 |
| | Feb/March | 4.08 | (0.59) | 0.03 | -1.40 1.88 | 0.775 | 4.58 | (0.61) | 0.37 | 3.14 4.75 | <0.001 |
| | April/May | 4.03 | (0.69) | 0.07 | -1.61 2.80 | 0.598 | 4.64 | (0.63) | 0.40 | 3.87 5.21 | <0.001 |

Notes. GHW=Graphic Health Warnings; M=Mean (range 1-5); SD=Standard Deviation; β=standardised coefficient; C.I.=95% Confidence Interval; models controlled for demographics (sex, age, SES), smoking characteristics (frequency and level of smoking, 12m quitting history), anti-smoking advertising activity (TARPs), and recent increases in cigarette costliness (% increase in past 12 weeks); M's and SD's are unweighted.

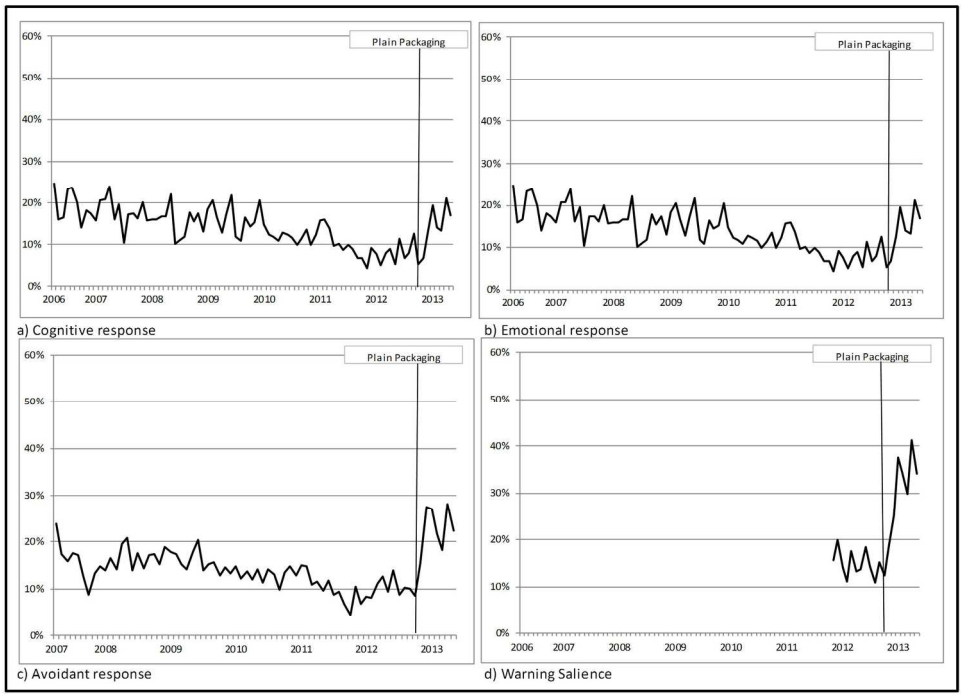



Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide or cover my packet from the view of others (avoidant response); (d) the only thing I notice on my cigarette pack is the graphic warnings (warning salience)
254x190mm (300 x 300 DPI)

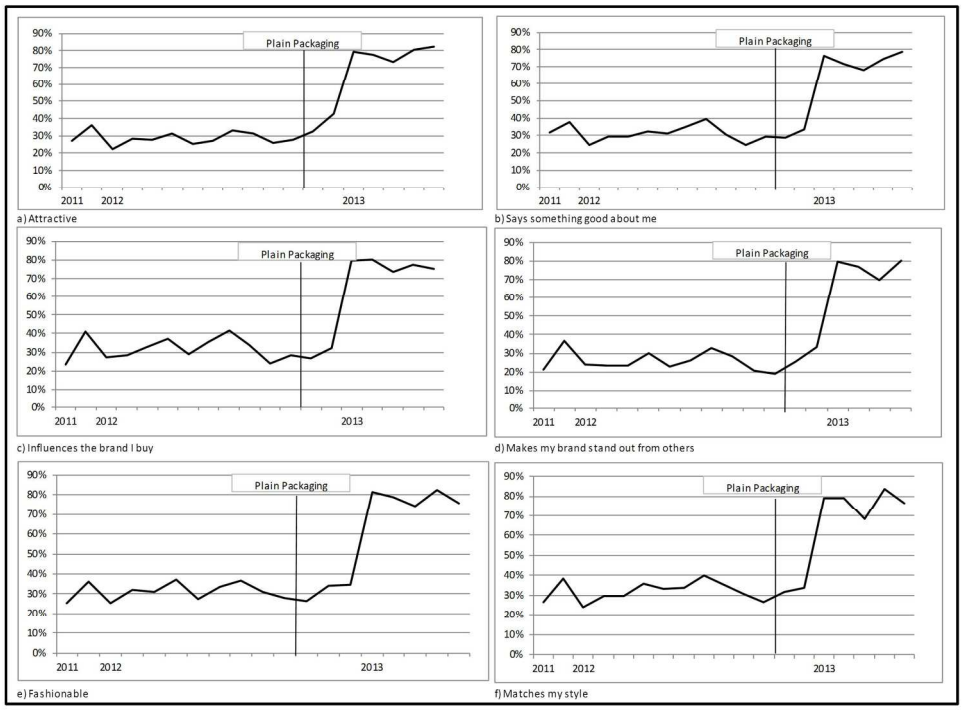



Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style
254x190mm (300 x 300 DPI)

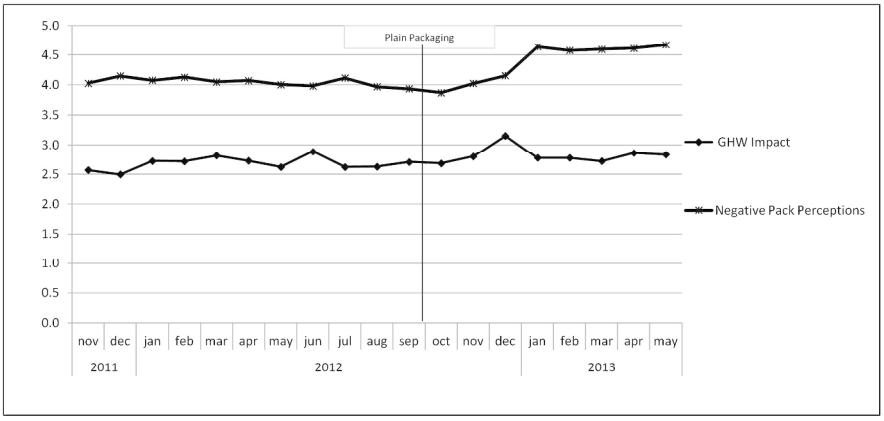
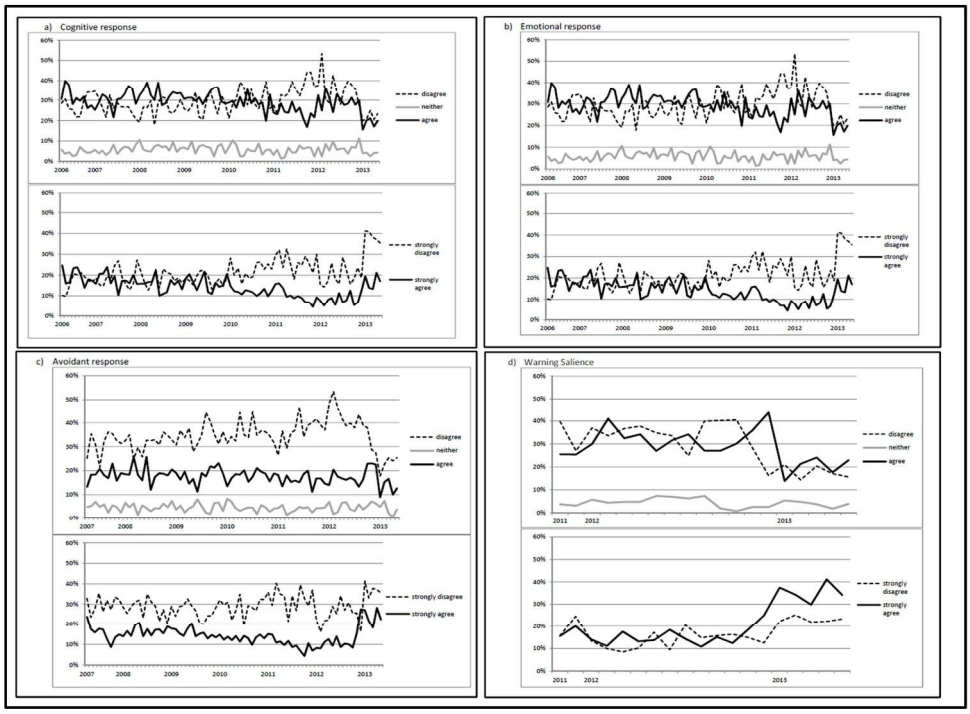
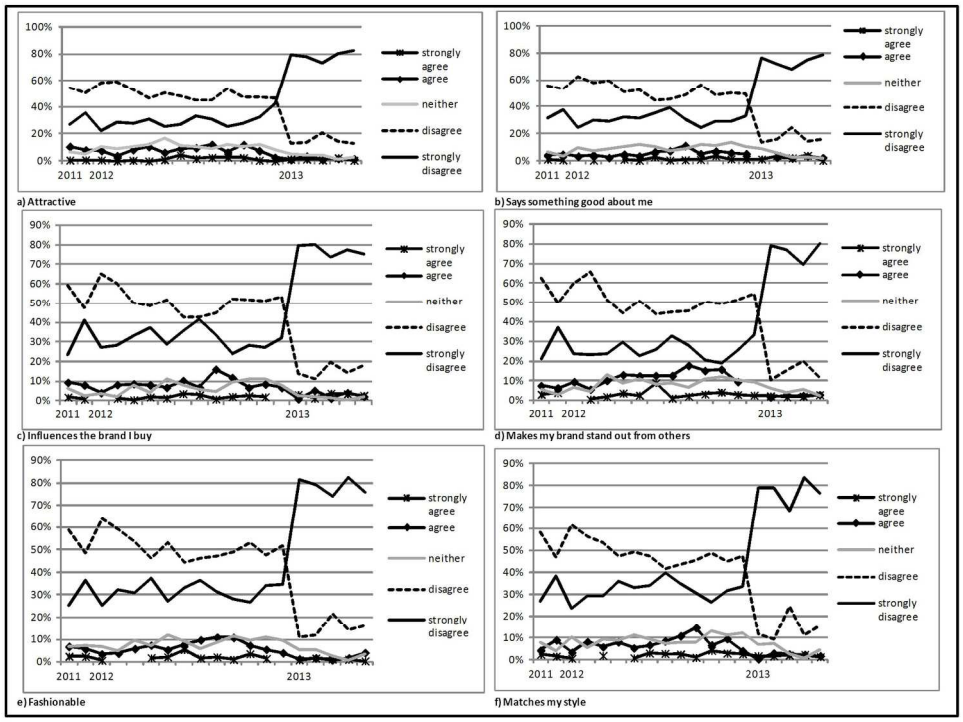



Figure 3: Monthly mean score for Graphic Health Warning Impact and Negative Pack Perception
254x190mm (300 x 300 DPI)




Supplementary Figure 1. Response options for responses to graphic health warnings
254x190mm (300 x 300 DPI)




Supplementary Figure 2. Response options for pack perceptions
254x190mm (300 x 300 DPI)

# Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-related perceptions and responses: Results from a continuous tracking survey

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## ABSTRACT

**Objectives** – To investigate the impact of Australia's plain tobacco packaging policy on two stated purposes of the legislation – increasing the impact of health warnings and decreasing the promotional appeal of packaging – among adult smokers.

**Design** – Serial cross-sectional study with weekly telephone surveys (April 2006 to May 2013). Interrupted time-series analyses using ARIMA modelling and linear regression models were used to investigate intervention effects.

**Participants** – 15,745 adult smokers (aged 18 years and over) in New South Wales (NSW), Australia. Random selection of participants involved recruiting households using random digit dialling and selecting the *n*th oldest smoker for interview.

**Intervention** – The introduction of the legislation on 1st October 2012.

**Outcomes** – Salience of tobacco pack health warnings, cognitive and emotional responses to warnings, avoidance of warnings, perceptions regarding one's cigarette pack.

**Results** – Adjusting for background trends, seasonality, anti-smoking advertising activity, and cigarette costliness, results from ARIMA modelling showed that, two to three months after the introduction of the new packs, there was a significant increase in the absolute proportion of smokers having strong cognitive (9.8% increase, $p$=0.005), emotional (8.6% increase, $p$=0.01), and avoidant (9.8% increase, $p$=0.0005) responses to on-pack health warnings. Similarly, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive (57.5% increase, $p$<0.0001), says something good about them (54.5% increase, $p$<0.0001), influences the brand they buy (40.6% increase, $p$<0.0001), makes their pack stand out (55.6% increase, $p$<0.0001), is fashionable (44.7% increase, $p$<0.0001), and matches their style (48.1% increase, $p$<0.0001). Changes in these outcomes were maintained six months post-intervention.

**Conclusions** – The introductory effects of the plain packaging legislation among adult smokers are consistent with the specific objectives of the legislation in regards to reducing promotional appeal and increasing effectiveness of health warnings.

## ARTICLE SUMMARY

### Article Focus

- Experimental research has shown that plain tobacco packaging can: reduce the appeal of tobacco products to consumers; increase the effectiveness of health warnings; and reduce the ability of packaging to mislead consumers about the harmful effects of smoking.
- Given that the introduction of the tobacco plain packaging legislation in Australia is the first of its kind, no research to date has investigated the impact of plain packaging on these outcomes in a real-world context with mandated plain packs.

### Key Findings

- The introductory effects of the new packs observed in this study are consistent with the specific objectives and expected effects of the plain packaging legislation.
- This is the first study to date to demonstrate an impact of the Australian plain tobacco packs on the salience and impact of on-pack health warnings and negative perceptions about tobacco packs among adult smokers.

### Strengths and Limitations

- Study strengths are: the use of population-level data collected over a long time period, with a large sample of adult smokers; the use of a time-series approach with multiple data points before the intervention; and the inclusion of important time-related and sample-related potential covariates.
- Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, potentially leading to some bias in sample composition. Response rate was consistent across the study period, limiting the impact on study findings.

On the 1st of December 2012, Australia became the first country to introduce mandatory plain packaging for all tobacco products.[1] The new plain packs are olive green cardboard packages devoid of all brand design elements, with brand name and ~~quantity~~ number of cigarettes written in a standardised font and location on each pack. The new packs continue to carry coloured graphic health warnings covering 90% of the back of packs, with the warnings on the front of pack enlarged from 30% to 75%. Manufacturers were required to produce the new packs from the 1st of October 2012 and they started appearing for sale from that date; approximately 80% of smokers were using plain packs by mid-November.[2]

The plain packaging legislation aims to discourage people from taking up smoking, encourage smokers to give up smoking, and discourage relapse.[1] The stated purpose of the legislation is to regulate the packaging and appearance of tobacco products in order to: (a) reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful effects of smoking. As this was the first time any such legislation had been implemented, the expected outcomes of the new packs were informed by a body of research consisting primarily of experimental studies, summarised in recent reviews.[3-6]

Studies in which participants were presented with mocked-up plain and branded tobacco packs show that plain packaging has the potential to reduce the promotional appeal of a pack, diminish positive perceptions about smokers of cigarettes from that pack, and reduce the appeal of smoking in general.[7-13] Such studies also suggest that health warnings are both more noticeable and more effective when presented on plain rather than branded packs,[14, 15] with researchers suggesting that brand imagery diffuses the impact of health warnings.[16] These results have been corroborated in naturalistic studies in which smokers are assigned to

smoke their normal cigarettes from either plain or branded packs for a period of time, with plain pack smokers reporting increased negative perceptions about to their pack and smoking, along with an increased impact of health warnings.[17, 18] A limitation of these previous studies, however, is the inability to differentiate the impact of plain packaging and the novelty impact of a pack which is simply different to the packs that smokers are used to seeing. No studies to date have been able to investigate the impact of plain tobacco packaging on tobacco pack appeal and the salience and effects of health warnings in the context of mandatory plain packaging, when all packs with which smokers are in contact are devoid of any branding other than a name in a standard font.

In the current study, we use cross-sectional survey data collected weekly for a period of seven years to investigate the impact of the new packaging on adult smokers' responses to the health warnings on their packs and perceptions of their packs. It was hypothesised that, after the introduction of the new packs, smokers would find the health warnings more salient, would have an increased response to the warnings, and would hold less favourable perceptions of their packs. The continuous nature of the data allowed us to track how these outcomes changed after the introduction of the new packs, investigating whether any observed changes were sustained in the six months following their introduction. This approach builds on our previous study evaluating the impact of the introduction of the plain packaging legislation on calls to a smoking cessation helpline.[19] Additionally, given that responses to graphic pack warnings had been tracked since their initial introduction in 2006, we were able to assess changes in these responses in the context of longer-term trends.

## METHOD

### Study Design and Participants

The Cancer Institute's Tobacco Tracking Survey (CITTS) is a serial cross-sectional telephone survey with approximately 50 interviews conducted per week throughout the year. The CITTS monitors smoking-related cognitions and behaviours among adult smokers and recent quitters (quit in last 12 months) in New South Wales (NSW), Australia's most populous state. Households are recruited using random digit dialling (landline telephone numbers only) and a random selection procedure is used to recruit participants within households (selecting the *n*th oldest eligible adult). Analyses for this study are limited to smokers interviewed between April 2006 and May 2013 (total $n$ = 15,745), with an average response rate of 40% (American Association for Public Opinion Research Response Rate #4).[20] The CITTS is approved by the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). The study was funded by the Cancer Institute NSW.

**Outcome Measures**

Following the introduction of the original graphic health warnings on tobacco packs in March 2006, questions were included in CITTS relating to smokers' responses to the warnings. These questions assessed cognitive response to the warnings ('the graphic warnings encourage me to stop smoking') and emotional response ('with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking'). From April 2007, warning avoidance was also assessed ('they make me feel that I should hide or cover my packet from the view of others'). From October 2011, the salience of the warnings was also assessed ('the only thing I notice on my cigarette pack is the graphic warnings'). All answers were given on a 5-point Likert scale (1=strongly disagree- 5=strongly agree). The distributions of responses to these items over the study period are shown in Supplementary Figure 1. Responses to these items were used in two ways. The first was collapsing responses for each item into a binary variable indicating strong agreement vs. not. The second was averaging the responses to these

items to create a scale indicating 'Graphic Health Warning Impact', with higher scores indicating greater overall impact (Cronbach's alpha =0.70). ~~Due to distributions of the data, responses were collapsed into a binary variable indicating strong agreement vs. other.~~

From October 2011 smokers were asked a battery of questions relating to their perceptions of their packs: 'The look of my cigarette pack…' (i) is attractive; (ii) says something good about me to other smokers; (iii) influences the brand I buy; (iv) makes my brand stand out from other brands; (v) is fashionable; and (vi) matches my style (1=strongly disagree-5=strongly agree). Distributions of responses to these items over the study period are shown in Supplementary Figure 2. Responses to each item were dichotomised into strongly disagree vs. not, and they were also reverse scored and averaged to create a scale indicating 'Negative Pack Perceptions' (Cronbach's alpha=0.87), with higher scores indicating more negative perceptions.~~Responses were dichotomized into strongly disagree vs. other. Changes in each of these individual items in relation to the introduction of the new tobacco packs were explored, and for the purpose of analysis, we also constructed a variable indicating strong negative pack perceptions (strong disagreement with all of the statements vs. not).~~

**Covariates**

Data on sex, age, total household income, and educational attainment (low=less than high school; moderate=high school diploma or vocational college; high=tertiary), were included in CITTS. Socio-economic status (SES) was indicated by a variable that combined responses to household income and educational attainment.[21, 22] High SES was defined as having a household income of more than AUD$80,000 (and any education level), or an income of AUD$40-80,000 and moderate-high education. Moderate SES was defined as either an

income below AUD$40,000 and high education, or an income of AUD$40-80,000 and moderate education. Low SES was defined as either an income below AUD$40,000 and low or moderate education, or an income AUD$40-80,000 and low education. Those with missing data on one variable were classified based on the other.

Frequency of smoking was used to classify smokers as 'daily', 'weekly', or 'less frequent' smokers. Average number of cigarettes smoked per day was used to indicate heaviness of smoking (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day; heavy=more than 20 cigarettes per day). As smokers' responses to graphic health warnings and perceptions of their cigarette packs might conceivably be related to their quitting experiences or propensity towards quitting, we also included quit attempts in the last 12 months as a control variable (1=tried to quit at least once in the last 12 months, 0=did not).

~~Along with demographic and smoking characteristics, r~~Respondents' pack perceptions and responses to health warnings might also possibly be influenced by the timing of their interview in terms of variations in anti-smoking advertising activity, changes in the costliness of cigarettes, or shifting social norms. Respondents' level of exposure to anti-smoking advertising in the three months prior to their interview was measured in terms of Target Audience Ratings Points (TARPs). TARPs are a product of the percentage of the target audience exposed to an advertisement (reach) and the average number of times a target audience member would be exposed (frequency). Hence, 200 TARPs might represent 100% of the target audience receiving the message an average of two times over a specified period, or 50% reached four times. Exposure to advertising over a 3-month period was chosen based on previous research suggesting that advertising effects occur within this time frame.[22, 23] We ascertained TARPs for each of the advertisements broadcast in NSW during the study period

based on OZTAM Australian TV Audience Measurements for adults aged 18years and older for free-to-air and cable TV (*M*=1590, *SD*=758).[24]

A variable indicating cigarette costliness[25] at time of interview was calculated as the ratio of the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to 87) to the average weekly earnings in the same quarter (*M*=1.54, *SD*=0.17).[26]

The influence of changing social norms was accounted for by statistically accounting for a time-based trend in the data, described below.

**Statistical analyses**

Two approaches to statistical analysis were used to assess the impact of the new packs on each outcome. The first approach used interrupted time series analysis, in which data collected at multiple instances before and after an intervention is used to detect whether the intervention has an effect significantly greater than the underlying secular trend. The advantages of using this approach include the ability to account for background trends, control for seasonal variations, adjust for auto-correlation in the data (when each value is correlated with the previous value), and to assess changes in the outcome in the context of longer-term trends. We also used multiple linear regression analyses to compare the scores for the two constructed scales in the months prior to and following the new packaging legislation, controlling for socio-demographic and smoking characteristics.

In the time-series analysis, weekly data were aggregated at the monthly level (to ensure sufficient sample size at each time point). We assessed the impact of the introduction of the new packs on (a) the proportion of sample strongly agreeing with each of the graphic health

warning statements, (b) mean Graphic Health Warning Impact score, (c) the proportion of the sample strongly disagreeing with each of the pack perception statements, and (d) mean Negative Pack Perception score. We used autoregressive integrated moving average (ARIMA) analysis in SAS version 9.3[27] to model the effects of the introduction of the new packaging on the outcomes of interest, while accounting for background trends, seasonal variation, the effects of television anti-tobacco advertising, and changes in cigarette costliness. ARIMA modelling was chosen because the data for each of the outcomes of interest were auto-correlated.

ARIMA modelling comprising model investigation, estimation and diagnostic checking followed the methods of Box *et al*.[28] This modelling enables investigation of the size and statistical significance of changes in an outcome after a specified time point, adjusting for background trends and confounders. An indicator term was created to represent the week of the introduction of the intervention (the 'phasing in' of the new packs on 1 October 2012). The potential confounders of anti-smoking advertising activity (TARPs) and cigarette costliness were included in all models. In the models predicting responses to graphic health warnings, terms indicating the months of December and January were also included to account for potential for seasonal variations (not included for pack perception outcomes due to limited data points). Due to the large number of outcomes to be reported, we do not report the effects of these covariates (available from authors on request).

Next, we used multiple linear regression analyses to assess changes in scores on the Graphic Health Warning Impact and Negative Pack Perception scales, using month of interview as the indicator, focusing on the period of the introduction of the new packs (August 2012 – May 2013).[29] The months preceding and following the intervention were represented by a five-

level term: (a) the two months preceding the change (August-September, 'pre-plain packs (PP)'); (b) the two months of 'phase-in' (October-November); (c) the two months 'immediate post-PP' (December-January); (d) '3-4 months post-PP' (February-March); and (e) '5-6 months post-PP' (April-May). Demographic and smoking characteristics were included as covariates, along with recent anti-smoking advertising activity. Because changes in cigarette costliness were based on quarterly data, there was a high degree of multi-collinearity between costliness and time of interview (VIF=26), resulting in inflated standard errors and unstable estimates of regression coefficients. We therefore included a variable indicating 'increase in cigarette costliness' in the last 12 weeks (as a percentage of costliness) as a covariate in these models. To provide a point of comparison, these models were also fitted to 2011-2012 data for the same months. An alpha level of 0.05 was used for all statistical tests. Stata v11 was used for the regression analyses.[30]

Due to a slight over-representation of females, older respondents, and regional residents (living outside of the capital city) in the CITTS sample compared to the NSW population,[31] weights were constructed using age, sex, and region of residence to make the sample more similar to the NSW population. Weights were applied in the multiple linear regression analyses (using 'p' weights).

## RESULTS

Response rate for the survey was an average of 40% in the period 2006-2013.

Sample characteristics are shown in Table 1.

### Responses to graphic health warnings

Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of the graphic health warning responses over time. In general, strong agreement about the impact of the warnings had been decreasing since their introduction in 2006. Of smokers interviewed in 2006: 21% reported strong cognitive responses to the warnings, decreasing to 12% in 2011; and 20% reported strong emotional response, decreasing to 12% in 2011.

The results of the interrupted time series analyses investigating the impact of the new packaging on responses to graphic health warnings are shown in Table 2. For all models, the residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. After controlling for background trends, seasonality, anti-smoking advertising activity and cigarette costliness, there was a significant increase in the proportion of smokers having strong cognitive, emotional and avoidant responses to graphic warnings after the introduction of the new packs. The increase in the avoidant response occurred two months after the new packs were introduced (from 10% in September 2012 to 28% in December), and the increase in cognitive and emotional responses occurred after three months (cognitive: from 13% in September 2012 to 20% in January 2013; emotional: from 13% to 27%). In the time-series analysis, the change in the proportion of smokers strongly agreeing that the warnings were the only thing they noticed on their packs after the introduction of the new packs was not significant.

The monthly average of the GHW Impact scale is shown in Figure 3. The results of the interrupted time series analysis investigating the impact of the new packaging on GHW Impact scores are shown in Table 2. The residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. There was a significant increase in scores on the GHW Impact scale two months after the introduction of

the new packs, not attributable to background trends, seasonality, anti-smoking advertising activity or cigarette costliness.

The results of the multiple linear regression model predicting scores on the GHW Impact scale are shown in Table 3. Compared to the pre-plain packaging period (August/September 2012), scores on the scale was significantly higher in immediate post-plain packaging period (December/January) and in the 5-6 month post-plain packaging period (April/May). These effects were independent of any differences between the samples on socio-demographic or smoking characteristics, anti-smoking advertising activity, or increases in cigarette costliness. There were no significant differences in scores on this scale over the months of the comparison period.

**Pack perceptions**

The monthly proportions of smokers strongly disagreeing with each of the pack attitude items are shown in Figure 2. The results of the interrupted time series analysis (Table 2) show that, three months following the introduction of the new packs, there was a significant increase in the proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive (from 26% in September 2012 to 80% in January 2013), says something good about them (from 27% to 76%), influences the brand they buy (from 27% to 77%), makes their brand stand out (from 22% to 78%), is fashionable (from 27% to 80%), and matches their style (from 31% to 77%). This effect was independent of any influence of long-term background trends, cigarette costliness, or anti-smoking advertising activity.

The monthly average of the Negative Pack Perception scale is shown in Figure 3, and the results of the interrupted time series analysis investigating the impact of the new packaging

on these scores are shown in Table 2. The residuals were uncorrelated and normally distributed, and all other model diagnostics indicated suitable model fit. There was a significant increase in scores on the Negative Pack Perception scale three months after the introduction of the new packs, not attributable to background trends, seasonality, anti-smoking advertising activity or cigarette costliness.

The multiple linear regression model predicting Negative Pack Perception scores over the pp-periods showed that scores on this scale were significantly higher in each of the post-pp periods than in the pre-pp period (Table 3). For the comparison period, there were no significant differences in scores on this scale.

## DISCUSSION

To our knowledge, this is the first study to examine the population-level impact of the new tobacco plain packs on Australian adult smokers' responses to their packs. This is an important first step in evaluating the policy as these outcomes relate closely to the intended purpose of the legislation. In the months following the introduction of the new packs, there was an increase in the proportion of smokers reporting strong cognitive and emotional responses to the warnings, avoidant behaviours related to the on-pack warnings, and salience of warnings. There was also an increase in the proportion of smokers with strong negative perceptions about their packs. These changes were not attributed to variations in exposure to anti-smoking advertising activity, tobacco prices, secular trends, seasonality or changes in sample composition.

Consistent with the results of experimental research,[14, 15, 17] we found that the introduction of the new packs was associated with an increase in the salience and the self-reported impact of

the health warnings, such that smokers were more likely to report that the warnings are the only thing they see on their packs, that they feel they should hide or cover their pack, that the warnings encourage them to stop smoking, and that they make them worry that they shouldn't be smoking. Prominent graphic health warnings on tobacco products have been shown to increase health knowledge and perceptions of risk from smoking,[32, 33] reduce consumption levels and increase cessation behaviour among smokers,[33, 34] and support former smokers in remaining abstinent.[35] Importantly, the impact of graphic health warnings on smoking behaviours appears to be a function of the depth of smokers' cognitive processing of and responses to the warnings (such as those monitored in the current study),[34-36] suggesting that if plain packaging can intensify smokers' responses to warnings, flow-on effects on consumption and quitting are likely.

Research shows that the impact of pictorial health warnings declines over time.[33 37] Of note is the fact that the introduction of the new packs appears to have reversed a downward trend in smokers' cognitive, emotional, and avoidant responses to the graphic health warnings that had been occurring since their initial introduction. On the current plain packaging, the warnings are having an equal or greater impact on adult smokers than they have since their inception. Due to the simultaneous introduction of the plain packs and changes in the size and content of the warnings themselves, the relative contribution of the warning and pack changes to this increase in smoker responses cannot be determined in this study. Nonetheless, recent evidence from eye-tracking studies suggests that plain packing itself can increase visual attention towards warning information on cigarette packs.[38, 39] Future research should assess whether the downward trend in responses to health warnings resumes following the introductory period of plain packaging.

Extending experimental evidence on the influence of plain packaging on brand appeal,[7-9, 40] the current study demonstrates an impact of the new packs on adult smokers' perceptions that their own packs are fashionable or attractive, that they match their style or say something good about them to other smokers, or that the pack makes their brand stand out or influences the brand they buy. There is a wide body of evidence from marketing literature that shows how branding and packaging can modify the expected and actual subjective experience of products.[41] Notably, changes in the way smokers perceive their pack have the potential to augment smokers' subjective experience of smoking, leading to a more negative perception of the taste of their cigarettes and less enjoyment in the act of smoking.[7] Indeed, anecdotal evidence suggests that Australian smokers reported their cigarettes tasted worse with the introduction of plain packaging,[42, 43] and smokers smoking from plain packs during the phase-in period perceived their cigarettes to be less satisfying and lower in quality than a year ago.[2] The likely impact of changes in the perceived experience of smoking is an important avenue for future studies, but research identifying enjoyment of smoking as a barrier to quitting suggests that smokers who find smoking their less enjoyable might be more likely to try and quit.[44]

The temporal pattern of changes found in this study is consistent with other early evaluations of the impact of the new plain packs. The proportion of smokers reporting negative responses to their packs and the warnings on them increased throughout the phase-in period, corresponding to the increasing proportion of plain packs observed in public venues during that period,[45] and the number of smokers reporting to be smoking from plain packs.[2] The earliest effects of the new packs have been detected during this phase-in period, with declines in rates of active smoking observed in outdoor dining venues in October-November,[45] and calls to a cessation helpline peaking in November.[19] From the current time-series analysis,

smokers' tendency to avoid the on-pack health warnings increased significantly in December, two months after the plain packs started appearing, when plain packs became mandatory for sale. This coincides with an observed decline in rates of pack display and an increase in concealment of packs in outdoor venues.[45] Other changes observed in the current study (cognitive and emotional responses to graphic health warnings, and negative pack perceptions) reached significance in January, at a time when less than 5% of packs observed in outdoor venues were fully-branded.[45] These changes occurred just after an increase in the number of smokers rating their cigarettes as being lower in quality and less satisfying than one year ago.[2] All changes in pack-related responses observed in the current study were maintained at eight months after the first appearance of the new packs, the last data point in the current series.

The strengths of this study include the use of population-level data collected over a long time period, resulting in a large sample of adult smokers. As recommended in a recent review of the plain packaging literature,[5] the use of a time-series approach with multiple data points before the intervention increased the power to detect any effects over and above long-term background and seasonal trends, and the inclusion of important time-related potential covariates decreased threats to the validity of the findings. The regression analyses allowed us to control for any changes in sample composition in regards to demographic characteristics such as SES and smoking levels. We note that the sample for this study consisted of current smokers only, and therefore any smokers who quit in the post-plain packaging period would be excluded. This might have resulted in a sample of smokers somewhat resistant to this intervention, and as such, the estimates provided in this study might be more conservative than if we had also surveyed smokers who quit during this time.

Limitations of the study include the use of landline-only telephone numbers and a somewhat low response rate, possibly leading to some bias in sample composition. The rate of mobile-only households in Australia, recently estimated at 19%, increased over the years of this study~~was recently estimated at 14%, quantifying concerns about excluding these individuals~~.[46] Recent dual-frame surveys have shown that samples recruited via mobile-phone are more likely to include younger respondents and males than landline samples.[47] The impact of these demographic differences are likely to be reduced in the current study due to the inclusion of age and gender as covariates, the use of data weighted for these variables where appropriate, and the inclusion of smoking-related covariates related to these demographic characteristics. The response rate of CITTS is similar to that of other population telephone surveys on tobacco use in Australia,[48] and was consistent across the study period, limiting its influence on the observed pattern of results.

In an environment of strict tobacco promotion prohibition such as Australia, cigarette packaging had become the key tool used by the tobacco industry to attract and retain customers.[49, 50] The purpose of the plain packaging legislation was to deprive tobacco companies of an ongoing opportunity to promote their products in the community. The introductory effects of the plain packaging legislation observed in this study are consistent with the specific objectives of the legislation in regards to increasing the salience and impact of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the fact that tobacco packs are handled every time a smoker takes out a cigarette, those who smoke more than a pack per day were potentially exposed to their new packs almost 4,000 times in the first six months of the legislated changes. The findings of this study suggest that the new packs are decreasing smokers' identification with their packs and making them think more closely about the health warnings contained on them, potentially moving them closer to

cessation. Future research should extend this study by considering any relationships between smokers' responses to their plain packaging packs and changes in smoking behaviours, investigating whether the introductory effects identified in this study were apparent in youth smokers, and monitoring the impact of plain packaging on perceptions about smoking among non-smoking youth and adults.

## COPYRIGHT



## COMPETING INTERESTS

SD, TD, JY, DP, DC have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare (1) no support from any third party organisation for the submitted work; (2) no financial relationships with any company that might have an interest in the submitted work in the previous three years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) all authors have no non-financial interests that may be relevant to the submitted work.

## CONTRIBUTORSHIP STATEMENT

SD, DP and JY conceived the study. DP and SD acquired the data. SD searched the literature and extracted the data.TD and SD did the analyses. All authors interpreted the data. SD drafted the manuscript. TD, JY, DP and DC contributed to the initial revision of the manuscript. SD, TD, JY, DP and DC contributed to the critical revision of the manuscript before publication. SD is the guarantor. All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

## TRANSPERANCY

SD affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

## ETHICS APPROVAL

The CITTS has ethics approval from the NSW Population Health Services Research Ethics Committee (HREC/10/CIPHS/13). All respondents gave informed consent before taking part in the study.

## FUNDING

This study was internally funded by the Cancer Institute NSW.

## DATA SHARING

No additional data available.

Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide or cover my packet from the view of others (avoidant response); (d) the only thing I notice on my cigarette pack is the graphic warnings (warning salience)

Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style

Figure 3: Monthly mean score for Graphic Health Warning Impact and Negative Pack Perception

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Table 1. Sample characteristics from the Cancer Institute's Tobacco Tracking Survey (CITTS) April 2006-May 2012 (smokers only; *n*=15,745)

| | *N* | % |
|---|---|---|
| **Sex**: | | |
| Female | 8298 | 50 |
| Male | 7503 | 50 |
| **Age**: | | |
| 18-29 yrs | 2405 | 21 |
| 30-55 yrs | 8470 | 48 |
| 55+ yrs | 4924 | 31 |
| **Socio-Economic Status** | | |
| Low | 6577 | 41 |
| Mod | 4071 | 27 |
| High | 4974 | 33 |
| **Smoking Frequency** | | |
| Daily | 14025 | 88 |
| Weekly | 950 | 6 |
| Less than weekly | 826 | 6 |
| **Smoking** | | |
| Low | 5827 | 41 |
| Mod | 5837 | 38 |
| High | 3473 | 22 |
| **Quit Attempts in Past 12m** | | |
| None | 9443 | 60 |
| At least one | 6145 | 40 |
| **Year:** | | |
| 2006 | 1600 | 10 |
| 2007 | 2289 | 15 |
| 2008 | 2094 | 13 |
| 2009 | 2135 | 14 |
| 2010 | 2146 | 14 |
| 2011 | 2157 | 14 |
| 2012 | 2126 | 13 |
| 2013 | 1254 | 8 |

Notes. *N*s are unweighted, %s are weighted for age, sex, and regional residence

Table 2. Results of interrupted time series analyses investigating the impact of new tobacco packaging on smokers' responses to graphic health warnings and pack attitudes

| | | **Increase in % strongly agree (95% CI)** | **P** |
|---|---|---|---|
| **Responses to graphic health warnings** | Cognitive [a] | 9.8 (3.0, 16.5) | 0.005 |
| | Emotional [a] | 8.6 (1.7, 15.4) | 0.010 |
| | Avoidant [b] | 9.8 (4.2, 15.3) | <0.001 |
| | Warning Salience [c] | 2.5 (-10.1, 15.1) | 0.700 |
| | GHW Impact [c] | 0.38 (0.05, 0.70) [d] | 0.02 |
| | | **Increase in % strongly disagree (95% CI)** | |
| **Pack perceptions** | Attractive [c] | 57.5 (38.0, 77.1) | <0.001 |
| | Says something good about me [c] | 54.5 (36.9, 72.1) | <0.001 |
| | Influences the brand I buy [c] | 40.6 (23.2, 58.0) | <0.001 |
| | Makes my brand stand out [c] | 55.6 (35.0, 76.2) | <0.001 |
| | Is fashionable [c] | 44.7 (28.1, 61.2) | <0.001 |
| | Matches my style [c] | 48.1 (32.2, 64.0) | <0.001 |
| | Negative Pack Perceptions [c] | 0.21 (0.02, 0.40) [d] | 0.03 |

Notes. All models adjusted for TARPs, cigarette costliness, and seasonal variations (where possible); full results available from authors on request; all effects occurred at 3-months lag, except for 'avoidant' responses to the graphic health warnings and GHW Impact (2-month lag); [a] Data available April 2006 – May 2013; [b] Data available April 2007 – May 2013; [c] Data available October 2011 – May 2013; [d] Increase in Mean score

Table 3. Results from linear regression models predicting Graphic Health Warning Impact and Negative Pack Perceptions from month of interview in the plain packaging and comparison periods

| | | Comparison period (2011-2012) | | | | | Plain packaging period (2012-2013) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | (SD) | β | 95% C.I. | p | M | (SD) | β | 95% C.I. | p |
| **GHW Impact** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 2.67 | (0.93) | Ref | | |
| | Oct/Nov | 2.57 | (0.90) | Ref | | | 2.75 | (0.97) | 0.00 | -0.16 0.18 | 0.932 |
| | Dec/Jan | 2.62 | (0.99) | -0.01 | -0.25 0.21 | 0.847 | 2.88 | (1.16) | 0.09 | 0.07 0.46 | 0.008 |
| | Feb/March | 2.77 | (0.89) | 0.10 | -0.19 0.58 | 0.323 | 2.75 | (1.15) | 0.07 | -0.04 0.39 | 0.110 |
| | April/May | 2.67 | (0.96) | -0.01 | -0.52 0.48 | 0.930 | 2.85 | (1.21) | 0.06 | 0.01 0.34 | 0.043 |
| **Negative Pack Perceptions** | **Month:** | | | | | | | | | | |
| | Aug/Sept | n/a | | | | | 3.95 | (0.76) | Ref | | |
| | Oct/Nov | 4.03 | (0.60) | Ref | | | 3.96 | (0.75) | 0.02 | -0.47 1.06 | 0.449 |
| | Dec/Jan | 4.11 | (0.64) | 0.06 | -0.43 1.46 | 0.286 | 4.50 | (0.63) | 0.27 | 2.74 4.18 | <0.001 |
| | Feb/March | 4.08 | (0.59) | 0.03 | -1.40 1.88 | 0.775 | 4.58 | (0.61) | 0.37 | 3.14 4.75 | <0.001 |
| | April/May | 4.03 | (0.69) | 0.07 | -1.61 2.80 | 0.598 | 4.64 | (0.63) | 0.40 | 3.87 5.21 | <0.001 |

Notes. GHW=Graphic Health Warnings; M=Mean (range 1-5); SD=Standard Deviation; β=standardised coefficient; C.I.=95% Confidence Interval; models controlled for demographics (sex, age, SES), smoking characteristics (frequency and level of smoking, 12m quitting history), anti-smoking advertising activity (TARPs), and recent increases in cigarette costliness (% increase in past 12 weeks); M's and SD's are unweighted.

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | Y/N |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Y |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Y |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Y |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Y |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Y |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Y |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Y |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case | |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Y |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Y |
| Bias | 9 | Describe any efforts to address potential sources of bias | Y |
| Study size | 10 | Explain how the study size was arrived at | Y |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Y |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Y |
| | | (*b*) Describe any methods used to examine subgroups and interactions | Y |
| | | (*c*) Explain how missing data were addressed | Y |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed<br>*Case-control study*—If applicable, explain how matching of cases and controls was addressed<br>*Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Y |
| | | (*e*) Describe any sensitivity analyses | |

Continued on next page

| | | | |
|---|---|---|---|
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Y |
| | | (b) Give reasons for non-participation at each stage | |
| | | (c) Consider use of a flow diagram | |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Y |
| | | (b) Indicate number of participants with missing data for each variable of interest | |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | Y |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Y |
| | | (*b*) Report category boundaries when continuous variables were categorized | |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Y |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Y |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Y |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Y |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Y |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.