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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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3 **Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-**
4 **related perceptions and responses: Results from a continuous tracking survey**
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For peer review only

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.

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4 On the 1st of December 2012, Australia became the first country to introduce mandatory plain
5 packaging for all tobacco products.¹ The new plain packs are olive green cardboard packages
6 devoid of all brand design elements, with brand name and quantity written in a standardised
7 font and location on each pack. The new packs continue to carry coloured graphic health
8 warnings covering 90% of the back of packs, with the warnings on the front of pack enlarged
9 from 30% to 75%. Manufacturers were required to produce the new packs from the 1st of
10 October 2012 and they started appearing for sale from that date; approximately 80% of
11 smokers were using plain packs by mid-November.²
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24 The plain packaging legislation aims to discourage people from taking up smoking,
25 encourage smokers to give up smoking, and discourage relapse.¹ The stated purpose of the
26 legislation is to regulate the packaging and appearance of tobacco products in order to: (a)
27 reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health
28 warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful
29 effects of smoking. As this was the first time any such legislation had been implemented, the
30 expected outcomes of the new packs were informed by a body of research consisting
31 primarily of experimental studies, summarised in recent reviews.³⁻⁶
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44 Studies in which participants were presented with mocked-up plain and branded tobacco
45 packs show that plain packaging has the potential to reduce the promotional appeal of a pack,
46 diminish positive perceptions about smokers of cigarettes from that pack, and reduce the
47 appeal of smoking in general.⁷⁻¹³ Such studies also suggest that health warnings are both
48 more noticeable and more effective when presented on plain rather than branded packs,^{14, 15}
49 with researchers suggesting that brand imagery diffuses the impact of health warnings.¹⁶
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58 These results have been corroborated in naturalistic studies in which smokers are assigned to
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3 smoke their normal cigarettes from either plain or branded packs for a period of time, with
4 plain pack smokers reporting increased negative perceptions about to their pack and smoking,
5 along with an increased impact of health warnings.^{17, 18} A limitation of these previous studies,
6 however, is the inability to differentiate the impact of plain packaging and the novelty impact
7 of a pack which is simply different to the packs that smokers are used to seeing. No studies to
8 date have been able to investigate the impact of plain tobacco packaging on tobacco pack
9 appeal and the salience and effects of health warnings in the context of mandatory plain
10 packaging, when all packs with which smokers are in contact are devoid of any branding
11 other than a name in a standard font.
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25 In the current study, we use cross-sectional survey data collected weekly for a period of seven
26 years to investigate the impact of the new packaging on adult smokers' responses to the
27 health warnings on their packs and perceptions of their packs. It was hypothesised that, after
28 the introduction of the new packs, smokers would find the health warnings more salient,
29 would have an increased response to the warnings, and would hold less favourable
30 perceptions of their packs. The continuous nature of the data allowed us to track how these
31 outcomes changed after the introduction of the new packs, investigating whether any
32 observed changes were sustained in the six months following their introduction. This
33 approach builds on our previous study evaluating the impact of the introduction of the plain
34 packaging legislation on calls to a smoking cessation helpline.¹⁹ Additionally, given that
35 responses to graphic pack warnings had been tracked since their initial introduction in 2006,
36 we were able to assess changes in these responses in the context of longer-term trends.
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55 56 **METHOD** 57 58 59 60

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.

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

24 Data on sex, age, total household income, and educational attainment (low=less than high
25 school; moderate=high school diploma or vocational college; high=tertiary), were included in
26 CITTS. Socio-economic status (SES) was indicated by a variable that combined responses to
27 household income and educational attainment.^{21, 22} High SES was defined as having a
28 household income of more than AUD\$80,000 (and any education level), or an income of
29 AUD\$40-80,000 and moderate-high education. Moderate SES was defined as either an
30 income below AUD\$40,000 and high education, or an income of AUD\$40-80,000 and
31 moderate education. Low SES was defined as either an income below AUD\$40,000 and low
32 or moderate education, or an income AUD\$40-80,000 and low education. Those with missing
33 data on one variable were classified based on the other.
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50 Average number of cigarettes smoked per day was used to indicate heaviness of smoking
51 (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day; heavy=more than
52 20 cigarettes per day). As smokers' responses to graphic health warnings and perceptions of
53 their cigarette packs might conceivably be related to their quitting experiences or propensity
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3 towards quitting, we also included previous quit attempts as a control variable (0=never tried
4 to quit; 1=tried to quit at least once).
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10 Along with demographic and smoking characteristics, respondents' pack perceptions and
11 responses to health warnings might also possibly be influenced by the timing of their
12 interview in terms of variations in anti-smoking advertising activity, changes in the costliness
13 of cigarettes, or shifting social norms.
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20 Respondents' level of exposure to anti-smoking advertising in the three months prior to their
21 interview was measured in terms of Target Audience Ratings Points (TARPs). TARPs are a
22 product of the percentage of the target audience exposed to an advertisement (reach) and the
23 average number of times a target audience member would be exposed (frequency). Hence,
24 200 TARPs might represent 100% of the target audience receiving the message an average of
25 two times over a specified period, or 50% reached four times. Exposure to advertising over a
26 3-month period was chosen based on previous research suggesting that advertising effects
27 occur within this time frame.^{22, 23} We ascertained TARPs for each of the advertisements
28 broadcast in NSW during the study period based on OZTAM Australian TV Audience
29 Measurements for adults aged 18years and older for free-to-air and cable TV ($M=1590$,
30 $SD=758$).²⁴
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47 A variable indicating cigarette costliness²⁵ at time of interview was calculated as the ratio of
48 the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette
49 brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to
50 87) to the average weekly earnings in the same quarter ($M=1.54$, $SD=0.17$).²⁶
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3 The influence of changing social norms was accounted for by statistically accounting for a
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5 time-based trend in the data.
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9 10 **Statistical analyses**

11 Two approaches to statistical analysis were used to assess the impact of the new packaging
12 on each outcome. The first approach used interrupted time series analysis, in which data
13 collected at multiple instances over time before and after an intervention is used to detect
14 whether the intervention has an effect significantly greater than the underlying secular trend.
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16 The advantages of using this approach include the ability to account for background trends,
17 control for seasonal variations, adjust for auto-correlation in the data (when each value is
18 correlated with the previous value), and to assess changes in the outcome in the context of
19 longer-term trends. We also used logistic regression analysis to compare the likelihood of
20 reporting an outcome for respondents interviewed in the months following the new packaging
21 legislation and those interviewed before the new packs, controlling for socio-demographic
22 and smoking characteristics.
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38 In the time-series analysis, the weekly data were aggregated at the monthly level (to ensure
39 sufficient sample size at each time point), providing indications of the proportion of the
40 sample reporting each outcome. We used autoregressive integrated moving average
41 (ARIMA) analysis in SAS version 9.3²⁷ to model the effects of the introduction of the new
42 packaging on the outcomes of interest, while accounting for background trends, seasonal
43 variation, the effects of television anti-tobacco advertising, and changes in cigarette
44 costliness. ARIMA modelling was chosen because the data for each of the outcomes of
45 interest were auto-correlated.
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3 ARIMA modelling comprising model investigation, estimation and diagnostic checking
4 followed the methods of Box *et al.*¹⁴ This modelling enables investigation of the size and
5 statistical significance of changes in an outcome after a specified time point, adjusting for
6 background trends and confounders. An indicator term was created to represent the week of
7 the introduction of the intervention (the ‘phasing in’ of the new packs on 1 October 2012).
8
9 The potential confounders of anti-smoking advertising activity (TARPs) and cigarette
10 costliness were included in all models. In the models predicting responses to graphic health
11 warnings, terms indicating the months of December and January were also included to
12 account for potential for seasonal variations (not included for pack perception outcomes due
13 to limited data points). Due to the large number of outcomes to be reported, we do not report
14 the effects of these covariates (available from authors on request).
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30 Next, we conducted logistic regression analysis to predict each outcome, using month of
31 interview as the indicator, focusing on the period of the introduction of the new packs
32 (August 2012 – May 2013). The months preceding and following the intervention were
33 represented by a five-level term: (a) the two months preceding the change (August-
34 September, ‘pre-plain packs (PP)’); (b) the two months of ‘phase-in’ (October-November);
35 (c) the two months ‘immediate post-PP’ (December-January); (d) ‘3-4 months post-PP’
36 (February-March); and (e) ‘5-6 months post-PP’ (April-May). Demographic and smoking
37 characteristics were included as covariates, along with recent anti-smoking advertising
38 activity. Because changes in cigarette costliness were based on quarterly data, there was a
39 high degree of multi-collinearity between costliness and time of interview (VIF=26),
40 resulting in inflated standard errors and unstable estimates of regression coefficients. We
41 therefore did not to include cigarette costliness as a covariate in these regression models. To
42 provide a point of comparison, these models were also fitted to 2011-2012 data for the same
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3 months. Logistic regression analyses were conducted using Stata v11.²⁸ Weights were applied
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5 in all analyses (using svy commands with ‘p’ weights) to adjust for a slight over-
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7 representation of females, older respondents, and regional residents compared to the NSW
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9 population.²⁹
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11 12 13 **RESULTS**

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15 Sample characteristics are shown in Table 1.
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18 19 **Responses to graphic health warnings**

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21 Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of
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23 the graphic health warning responses over time. In general, responses to the warnings had
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25 been decreasing since their introduction in 2006. Of smokers interviewed in 2006: 21%
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27 reported strong cognitive responses to the warnings, decreasing to 12% in 2011; and 20%
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29 reported strong emotional response, decreasing to 12% in 2011.
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36 The results of the interrupted time series analyses investigating the impact of the new
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38 packaging on responses to graphic health warnings are shown in Table 2. For all models, the
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40 residuals were uncorrelated and normally distributed, and all other model diagnostics
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42 indicated suitable model fit. After controlling for background trends, seasonality, anti-
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44 smoking advertising activity and cigarette costliness, there was a significant increase in the
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46 proportion of smokers having strong cognitive, emotional and avoidant responses to graphic
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48 warnings after the introduction of the new packs. The increase in the avoidant response
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50 occurred two months after the new packs were introduced, and the increase in cognitive and
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52 emotional responses occurred after three months. In the time-series analysis, the change in
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3 the proportion of smokers strongly agreeing that the warnings were the only thing they
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5 noticed on their packs after the introduction of the new packs was not significant.
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10 The results of the logistic regression analyses predicting responses to the graphic health
11 warnings are shown in Table 3. In the pre-PP period (August/September 2012), 10% of
12 smokers reported a strong cognitive response to the health warnings, this increased
13 significantly to 18% the immediate post-pp period (December/January), remaining at 19% in
14 the 5-6 months post-pp period (April/May). There were no significant differences in the
15 proportion of smokers reporting strong cognitive response over the months of the comparison
16 period. Increases were observed in the proportions of smokers reporting strong emotional
17 response (11% to 26% at 1-2 months post-pp), strong avoidant response (10% to 29% at 1-2
18 months post-pp), and salience of the warnings (12% to 34% at 1-2 months post-pp). The
19 proportions of smokers reporting these responses remained significantly higher than in the
20 pre-PP period at 3-4 months and 5-6 months post-PP. There were no significant differences in
21 any outcome between smokers interviewed pre-PP and those interviewed during the phase-in
22 period. These effects were independent of any differences between the sample on socio-
23 demographic or smoking characteristics, as well as anti-smoking advertising activity. There
24 were no significant differences in any of these outcomes over the months of the comparison
25 period.
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47 **Pack perceptions**

48 The monthly proportions of smokers strongly disagreeing with each of the pack attitude items
49 are shown in Figure 2. The results of the interrupted time series analysis show that, three
50 months following the introduction of the new packs, there was a significant increase in the
51 proportion of smokers strongly disagreeing that the look of their cigarette pack is attractive,
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3 says something good about them, influences the brand they buy, makes their brand stand out,
4 is fashionable, and matches their style (Table 2). This effect was independent of any
5 influence of long-term background trends, cigarette costliness, or anti-smoking advertising
6 activity.
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14 The results from the logistic regression analysis predicting smokers' strong negative pack
15 perceptions from month of interview are shown in Table 3. The proportion of smokers with a
16 high score on the negative pack perception index (meaning that they strongly disagreed with
17 all the statements about their packs) increased from 15% in the pre-PP period to 58% in the
18 5-6 month post-PP period. Compared to smokers interviewed in the pre-PP period, those
19 interviewed in the phase-in period, 1-2 months post-PP, 3-4 months post-PP, and 5-6 months
20 post-PP were significantly more likely to have a high score on the negative pack perception
21 index. For the comparison period, there were no significant differences in the proportion of
22 smokers in each month with strong negative perceptions. When the regression analysis was
23 run separately for each pack perception statement, the same pattern of results emerged.
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39 DISCUSSION

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41 To our knowledge, this is the first study to examine the population-level impact of the new
42 tobacco plain packs on Australian adult smokers' responses to their packs. This is an
43 important first step in evaluating the policy as these outcomes relate closely to the intended
44 purpose of the legislation. In the months following the introduction of the new packs, there
45 was an increase in the proportion of smokers reporting strong cognitive and emotional
46 responses to the warnings, avoidant behaviours related to the on-pack warnings, and salience
47 of warnings. There was also an increase in the proportion of smokers with strong negative
48 perceptions about their packs. These changes were not attributed to variations in exposure to
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3 anti-smoking advertising activity, tobacco prices, secular trends, seasonality or changes in
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5 sample composition.
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10 Consistent with the results of experimental research,^{14, 15, 17} we found that the introduction of
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12 the new packs was associated with an increase in the salience and the self-reported impact of
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14 the health warnings, such that smokers were more likely to report that the warnings are the
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16 only thing they see on their packs, that they feel they should hide or cover their pack, that the
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18 warnings encourage them to stop smoking, and that they make them worry that they
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20 shouldn't be smoking. Prominent graphic health warnings on tobacco products have been
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22 shown to increase health knowledge and perceptions of risk from smoking,^{30, 31} reduce
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24 consumption levels and increase cessation behaviour among smokers,^{31, 32} and support former
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26 smokers in remaining abstinent.³³ Importantly, the impact of graphic health warnings on
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28 smoking behaviours appears to be a function of the depth of smokers' cognitive processing of
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30 and responses to the warnings (such as those monitored in the current study),^{32, 33} suggesting
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32 that if plain packaging can intensify smokers' responses to warnings, flow-on effects on
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34 consumption and quitting are likely.
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41 Research shows that the impact of pictorial health warnings declines over time.^{31, 34} Of note is
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43 the fact that the introduction of the new packs appears to have reversed a downward trend in
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45 smokers' cognitive and emotional responses to the graphic health warnings that had been
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47 occurring since their initial introduction. On the current plain packaging, the warnings are
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49 having an equal or greater impact on adult smokers than they have since their inception. Due
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51 to the simultaneous introduction of the plain packs and changes in the size and content of the
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53 warnings themselves, the relative contribution of the warning and pack changes to this
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55 increase in smoker responses cannot be determined in this study. Nonetheless, recent
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3 evidence from eye-tracking studies suggests that plain packing itself can increase visual
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5 attention towards warning information on cigarette packs.^{35, 36}
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9 Extending experimental evidence on the influence of plain packaging on brand appeal,^{7-9, 37}
10 the current study demonstrates an impact of the new packs on adult smokers' perceptions that
11 their own packs are fashionable or attractive, that they match their style or say something
12 good about them to other smokers, or that the pack makes their brand stand out or influences
13 the brand they buy. There is a wide body of evidence from marketing literature that shows
14 how branding and packaging can modify the expected and actual subjective experience of
15 products.³⁸ Notably, changes in the way smokers perceive their pack have the potential to
16 augment smokers' subjective experience of smoking, leading to a more negative perception
17 of the taste of their cigarettes and less enjoyment in the act of smoking.⁷ Indeed, anecdotal
18 evidence suggests that Australian smokers reported their cigarettes tasted worse with the
19 introduction of plain packaging,^{39, 40} and smokers smoking from plain packs during the
20 phase-in period perceived their cigarettes to be less satisfying and lower in quality than a year
21 ago.² The likely impact of changes in the perceived experience of smoking is an avenue for
22 future studies, but research identifying enjoyment of smoking as a barrier to quitting suggests
23 that smokers who find smoking their less enjoyable might be more likely to try and quit.⁴¹
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45 The temporal pattern of changes found in this study is consistent with other early evaluations
46 of the impact of the new plain packs. The proportion of smokers reporting negative responses
47 to their packs and the warnings on them increased throughout the phase-in period,
48 corresponding to the increasing proportion of plain packs observed in public venues during
49 that period,⁴² and the number of smokers reporting to be smoking from plain packs.² The
50 earliest effects of the new packs have been detected during this phase-in period, with declines
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3 in rates of active smoking observed in outdoor dining venues in October-November,⁴² and
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5 calls to a cessation helpline peaking in November.¹⁹ From the current time-series analysis,
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7 smokers' tendency to avoid the on-pack health warnings increased significantly in December,
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9 two months after the plain packs started appearing, when plain packs became mandatory for
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11 sale. This coincides with an observed decline in rates of pack display and an increase in
12
13 concealment of packs in outdoor venues.⁴² Other changes observed in the current study
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15 (cognitive and emotional responses to graphic health warnings, and negative pack
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17 perceptions) reached significance in January, at a time when less than 5% of packs observed
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19 in outdoor venues were fully-branded.⁴² These changes occurred just after an increase in the
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21 number of smokers rating their cigarettes as being lower in quality and less satisfying than
22
23 one year ago.² All changes in pack-related responses observed in the current study were
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25 maintained at eight months after the first appearance of the new packs.
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32 The strengths of this study include the use of population-level data collected over a long time
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34 period, resulting in a large sample of adult smokers. As recommended in a recent review of
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36 the plain packaging literature,⁵ the use of a time-series approach with multiple data points
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38 before the intervention increased the power to detect any effects over and above long-term
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40 background and seasonal trends, and the inclusion of important time-related potential
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42 covariates decreased threats to the validity of the findings. The logistic regression analyses
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44 allowed us to control for any changes in sample composition in regards to demographic
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46 characteristics such as SES and smoking levels.
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52 Limitations of the study include the use of landline-only telephone numbers and a somewhat
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54 low response rate, possibly leading to some bias in sample composition. The rate of mobile-
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56 only households in Australia was recently estimated at 14%, quantifying concerns about
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3 excluding these individuals.⁴³ The response rate is similar to that of other population
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5 telephone surveys on tobacco use in Australia⁴⁴ and the overall rates of quitting are similar to
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7 other population studies of NSW smokers⁴⁵. Additionally, both of these sampling issues
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9 were consistent across the study period, limiting their influence on the observed pattern of
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11 results.
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16 In an environment of strict tobacco promotion prohibition such as Australia, cigarette
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18 packaging had become the key tool used by the tobacco industry to attract and retain
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20 customers.^{46, 47} The purpose of the plain packaging legislation was to deprive tobacco
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22 companies of an ongoing opportunity to promote their products in the community. The
23
24 introductory effects of the plain packaging legislation observed in this study are consistent
25
26 with the specific objectives of the legislation in regards to increasing the salience and impact
27
28 of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the
29
30 fact that tobacco packs are handled every time a smoker takes out a cigarette, those who
31
32 smoke more than a pack per day were potentially exposed to their new packs almost 4,000
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34 times in the first six months of the legislated changes. The findings of this study suggest that
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36 the new packs are decreasing smokers' identification with their packs and making them think
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38 more closely about the health warnings contained on them, potentially moving them closer to
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40 cessation.
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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.

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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; $n=15,745$)

	<i>N</i>	%
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

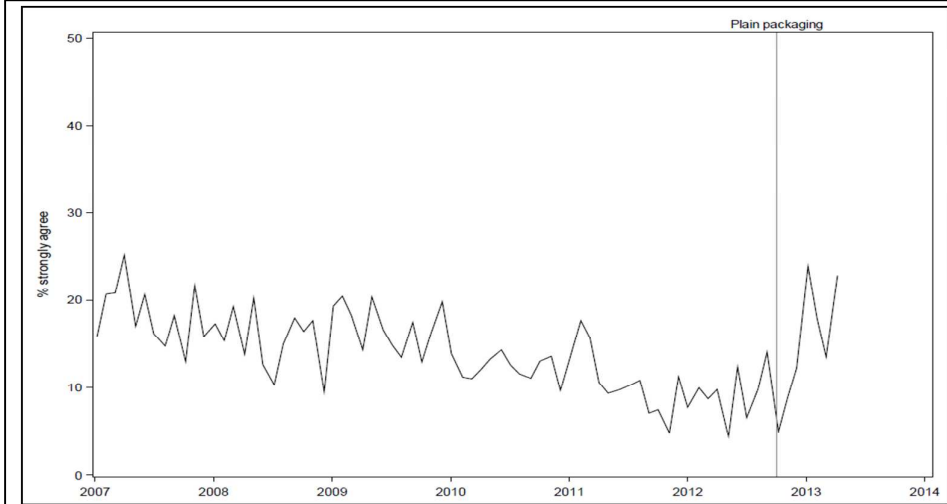
Notes. *N*s are unweighted, %s are weighted for age, sex, and location

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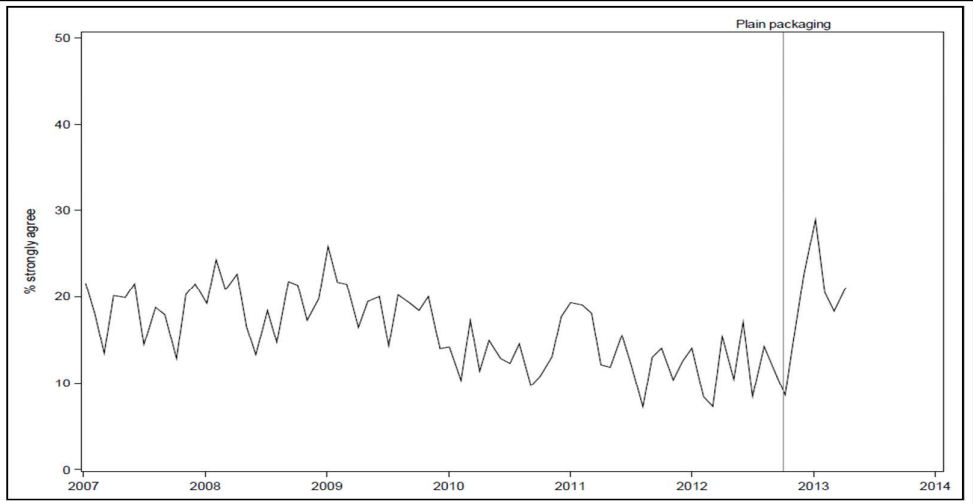
Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide 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)

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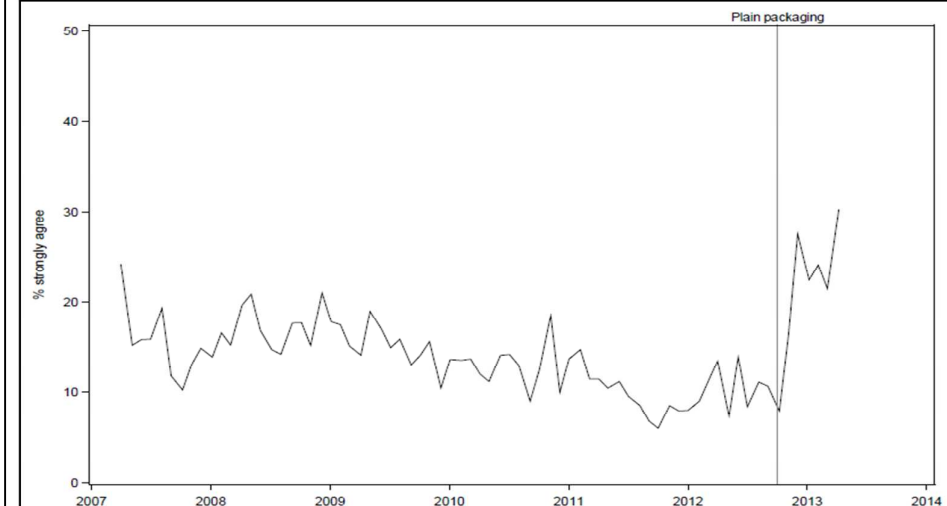
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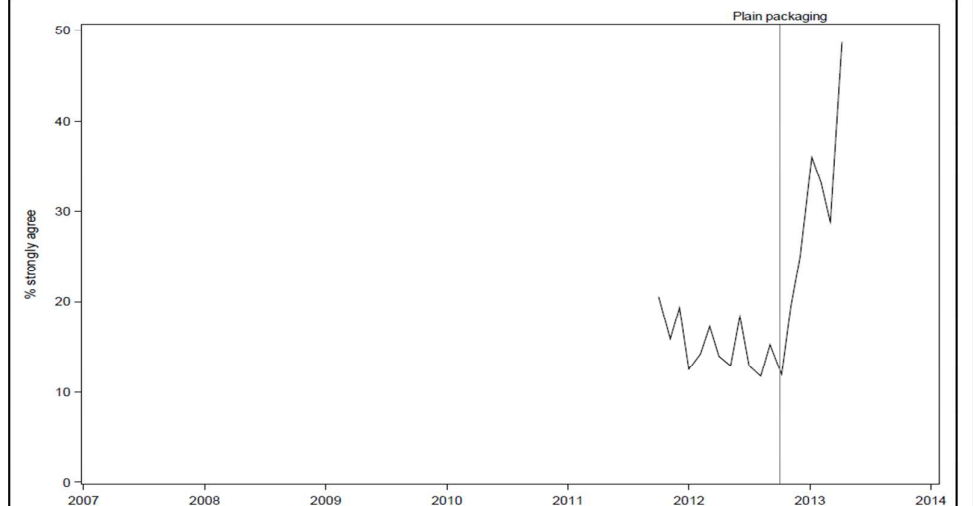
a) Cognitive response



b) Emotional response



c) Avoidant response

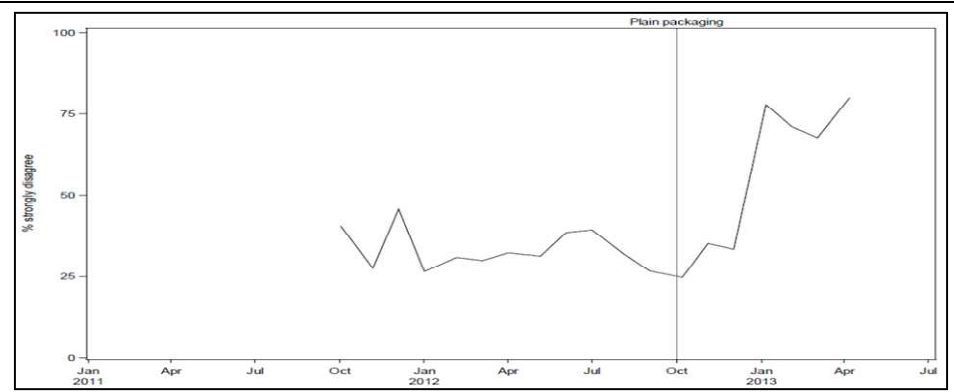
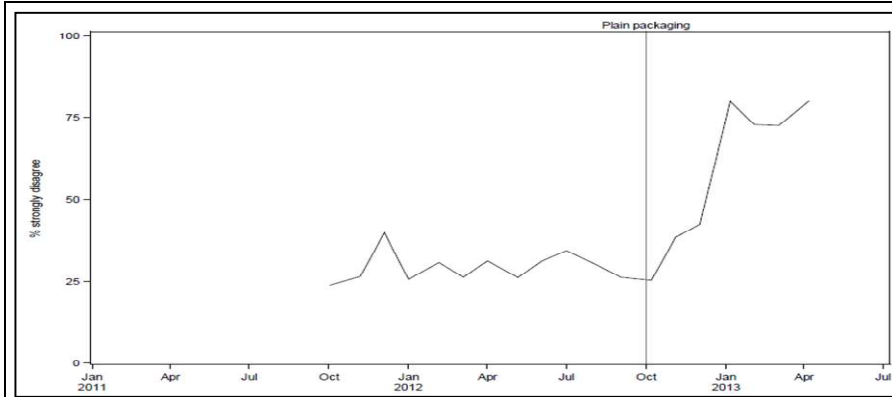


d) Warning salience

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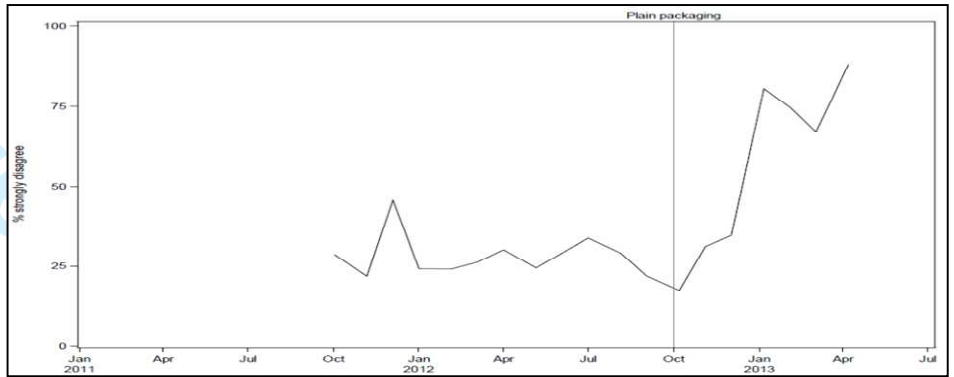
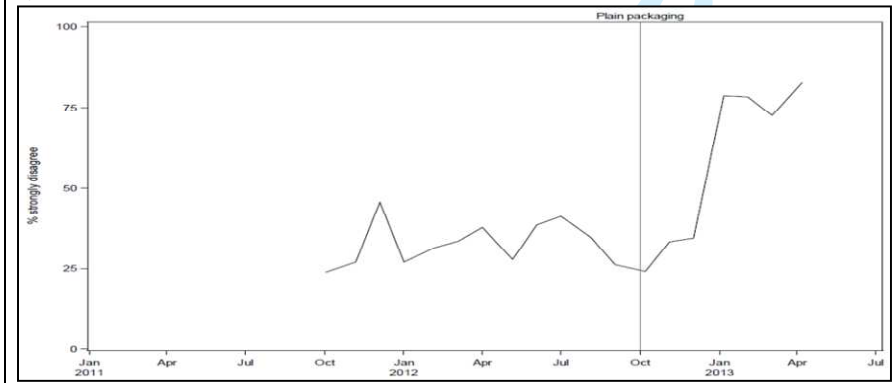
Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style

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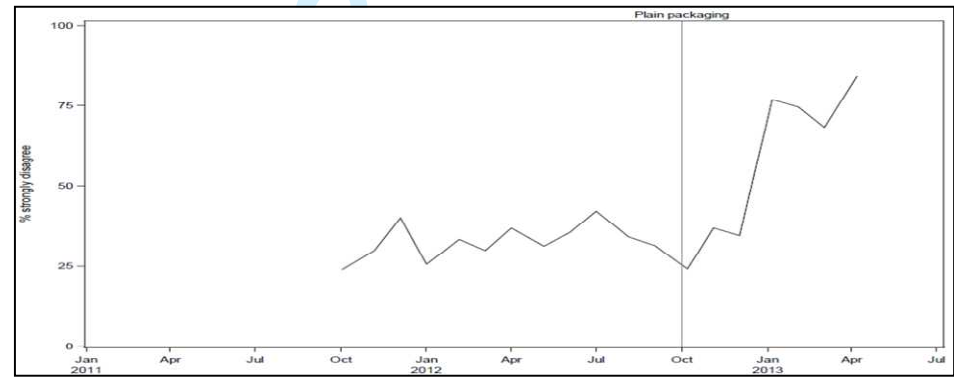
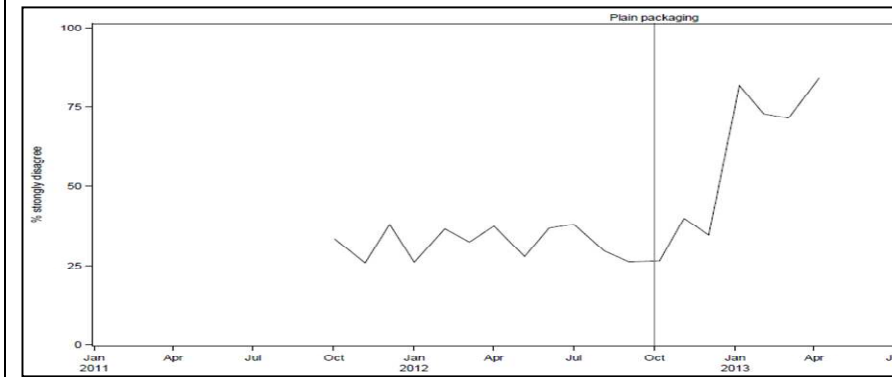
a) Attractive

b) Says something good about me



c) Influences the brand I buy

d) Make my brand stand out from others



e) 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
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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

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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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	Y
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	Y
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	Y
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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 (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	Y
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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3 **Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-**
4 **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.

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

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.

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4 On the 1st of December 2012, Australia became the first country to introduce mandatory plain
5 packaging for all tobacco products.¹ The new plain packs are olive green cardboard packages
6 devoid of all brand design elements, with brand name and number of cigarettes written in a
7 standardised font and location on each pack. The new packs continue to carry coloured
8 graphic health warnings covering 90% of the back of packs, with the warnings on the front of
9 pack enlarged from 30% to 75%. Manufacturers were required to produce the new packs
10 from the 1st of October 2012 and they started appearing for sale from that date; approximately
11 80% of smokers were using plain packs by mid-November.²
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24 The plain packaging legislation aims to discourage people from taking up smoking,
25 encourage smokers to give up smoking, and discourage relapse.¹ The stated purpose of the
26 legislation is to regulate the packaging and appearance of tobacco products in order to: (a)
27 reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health
28 warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful
29 effects of smoking. As this was the first time any such legislation had been implemented, the
30 expected outcomes of the new packs were informed by a body of research consisting
31 primarily of experimental studies, summarised in recent reviews.³⁻⁶
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44 Studies in which participants were presented with mocked-up plain and branded tobacco
45 packs show that plain packaging has the potential to reduce the promotional appeal of a pack,
46 diminish positive perceptions about smokers of cigarettes from that pack, and reduce the
47 appeal of smoking in general.⁷⁻¹³ Such studies also suggest that health warnings are both
48 more noticeable and more effective when presented on plain rather than branded packs,^{14, 15}
49 with researchers suggesting that brand imagery diffuses the impact of health warnings.¹⁶
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3 These results have been corroborated in naturalistic studies in which smokers are assigned to
4 smoke their normal cigarettes from either plain or branded packs for a period of time, with
5 plain pack smokers reporting increased negative perceptions about to their pack and smoking,
6 along with an increased impact of health warnings.^{17, 18} A limitation of these previous studies,
7 however, is the inability to differentiate the impact of plain packaging and the novelty impact
8 of a pack which is simply different to the packs that smokers are used to seeing. No studies to
9 date have been able to investigate the impact of plain tobacco packaging on tobacco pack
10 appeal and the salience and effects of health warnings in the context of mandatory plain
11 packaging, when all packs with which smokers are in contact are devoid of any branding
12 other than a name in a standard font.
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28 In the current study, we use cross-sectional survey data collected weekly for a period of seven
29 years to investigate the impact of the new packaging on adult smokers' responses to the
30 health warnings on their packs and perceptions of their packs. It was hypothesised that, after
31 the introduction of the new packs, smokers would find the health warnings more salient,
32 would have an increased response to the warnings, and would hold less favourable
33 perceptions of their packs. The continuous nature of the data allowed us to track how these
34 outcomes changed after the introduction of the new packs, investigating whether any
35 observed changes were sustained in the six months following their introduction. This
36 approach builds on our previous study evaluating the impact of the introduction of the plain
37 packaging legislation on calls to a smoking cessation helpline.¹⁹ Additionally, given that
38 responses to graphic pack warnings had been tracked since their initial introduction in 2006,
39 we were able to assess changes in these responses in the context of longer-term trends.
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56 **METHOD**

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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

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3 variable indicating strong agreement vs. not. The second was averaging the responses to these
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5 items to create a scale indicating 'Graphic Health Warning Impact', with higher scores
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7 indicating greater overall impact (Cronbach's alpha =0.70).
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11 From October 2011 smokers were asked a battery of questions relating to their perceptions of
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13 their packs: 'The look of my cigarette pack...' (i) is attractive; (ii) says something good about
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15 me to other smokers; (iii) influences the brand I buy; (iv) makes my brand stand out from
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17 other brands; (v) is fashionable; and (vi) matches my style (1=strongly disagree-5=strongly
18
19 agree). Distributions of responses to these items over the study period are shown in
20
21 Supplementary Figure 2. Responses to each item were dichotomised into strongly disagree
22
23 vs. not, and they were also reverse scored and averaged to create a scale indicating 'Negative
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25 Pack Perceptions' (Cronbach's alpha=0.87), with higher scores indicating more negative
26
27 perceptions.
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34 **Covariates**

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36 Data on sex, age, total household income, and educational attainment (low=less than high
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38 school; moderate=high school diploma or vocational college; high=tertiary), were included in
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40 CITTS. Socio-economic status (SES) was indicated by a variable that combined responses to
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42 household income and educational attainment.^{21, 22} High SES was defined as having a
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44 household income of more than AUD\$80,000 (and any education level), or an income of
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46 AUD\$40-80,000 and moderate-high education. Moderate SES was defined as either an
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48 income below AUD\$40,000 and high education, or an income of AUD\$40-80,000 and
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50 moderate education. Low SES was defined as either an income below AUD\$40,000 and low
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52 or moderate education, or an income AUD\$40-80,000 and low education. Those with missing
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54 data on one variable were classified based on the other.
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5 Frequency of smoking was used to classify smokers as ‘daily’, ‘weekly’, or ‘less frequent’
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7 smokers. Average number of cigarettes smoked per day was used to indicate heaviness of
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9 smoking (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day;
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11 heavy=more than 20 cigarettes per day). As smokers’ responses to graphic health warnings
12
13 and perceptions of their cigarette packs might conceivably be related to their quitting
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15 experiences or propensity towards quitting, we also included quit attempts in the last 12
16
17 months as a control variable (1=tried to quit at least once in the last 12 months, 0=did not).
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22 Respondents’ pack perceptions and responses to health warnings might also possibly be
23
24 influenced by the timing of their interview in terms of variations in anti-smoking advertising
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26 activity, changes in the costliness of cigarettes, or shifting social norms. Respondents’ level
27
28 of exposure to anti-smoking advertising in the three months prior to their interview was
29
30 measured in terms of Target Audience Ratings Points (TARPs). TARPs are a product of the
31
32 percentage of the target audience exposed to an advertisement (reach) and the average
33
34 number of times a target audience member would be exposed (frequency). Hence, 200
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36 TARPs might represent 100% of the target audience receiving the message an average of two
37
38 times over a specified period, or 50% reached four times. Exposure to advertising over a 3-
39
40 month period was chosen based on previous research suggesting that advertising effects occur
41
42 within this time frame.^{22, 23} We ascertained TARPs for each of the advertisements broadcast
43
44 in NSW during the study period based on OZTAM Australian TV Audience Measurements
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46 for adults aged 18years and older for free-to-air and cable TV ($M=1590$, $SD=758$).²⁴
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53 A variable indicating cigarette costliness²⁵ at time of interview was calculated as the ratio of
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55 the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette
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3 brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to
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5 87) to the average weekly earnings in the same quarter ($M=1.54$, $SD=0.17$).²⁶
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8 The influence of changing social norms was accounted for by statistically accounting for a
9
10 time-based trend in the data, described below.

11 12 13 14 **Statistical analyses**

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16 Two approaches to statistical analysis were used to assess the impact of the new packs on
17
18 each outcome. The first approach used interrupted time series analysis, in which data
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20 collected at multiple instances before and after an intervention is used to detect whether the
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22 intervention has an effect significantly greater than the underlying secular trend. The
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24 advantages of using this approach include the ability to account for background trends,
25
26 control for seasonal variations, adjust for auto-correlation in the data (when each value is
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28 correlated with the previous value), and to assess changes in the outcome in the context of
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30 longer-term trends. We also used multiple linear regression analyses to compare the scores
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32 for the two constructed scales in the months prior to and following the new packaging
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34 legislation, controlling for socio-demographic and smoking characteristics.
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38 In the time-series analysis, weekly data were aggregated at the monthly level (to ensure
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40 sufficient sample size at each time point). We assessed the impact of the introduction of the
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42 new packs on (a) the proportion of sample strongly agreeing with each of the graphic health
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44 warning statements, (b) mean Graphic Health Warning Impact score, (c) the proportion of the
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46 sample strongly disagreeing with each of the pack perception statements, and (d) mean
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48 Negative Pack Perception score. We used autoregressive integrated moving average
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50 (ARIMA) analysis in SAS version 9.3²⁷ to model the effects of the introduction of the new
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52 packaging on the outcomes of interest, while accounting for background trends, seasonal
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3 variation, the effects of television anti-tobacco advertising, and changes in cigarette
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5 costliness. ARIMA modelling was chosen because the data for each of the outcomes of
6
7 interest were auto-correlated.
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11 ARIMA modelling comprising model investigation, estimation and diagnostic checking
12 followed the methods of Box *et al.*²⁸ This modelling enables investigation of the size and
13
14 statistical significance of changes in an outcome after a specified time point, adjusting for
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16 background trends and confounders. An indicator term was created to represent the week of
17
18 the introduction of the intervention (the ‘phasing in’ of the new packs on 1 October 2012).
19
20 The potential confounders of anti-smoking advertising activity (TARPs) and cigarette
21
22 costliness were included in all models. In the models predicting responses to graphic health
23
24 warnings, terms indicating the months of December and January were also included to
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26 account for potential for seasonal variations (not included for pack perception outcomes due
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28 to limited data points). Due to the large number of outcomes to be reported, we do not report
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30 the effects of these covariates (available from authors on request).
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39 Next, we used multiple linear regression analyses to assess changes in scores on the Graphic
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41 Health Warning Impact and Negative Pack Perception scales, using month of interview as the
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43 indicator, focusing on the period of the introduction of the new packs (August 2012 – May
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45 2013).²⁹ The months preceding and following the intervention were represented by a five-
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47 level term: (a) the two months preceding the change (August-September, ‘pre-plain packs
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49 (PP)’); (b) the two months of ‘phase-in’ (October-November); (c) the two months ‘immediate
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51 post-PP’ (December-January); (d) ‘3-4 months post-PP’ (February-March); and (e) ‘5-6
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53 months post-PP’ (April-May). Demographic and smoking characteristics were included as
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55 covariates, along with recent anti-smoking advertising activity. Because changes in cigarette
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3 costliness were based on quarterly data, there was a high degree of multi-collinearity between
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5 costliness and time of interview (VIF=26), resulting in inflated standard errors and unstable
6
7 estimates of regression coefficients. We therefore included a variable indicating 'increase in
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9 cigarette costliness' in the last 12 weeks (as a percentage of costliness) as a covariate in these
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11 models. To provide a point of comparison, these models were also fitted to 2011-2012 data
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13 for the same months. An alpha level of 0.05 was used for all statistical tests. Stata v11 was
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15 used for the regression analyses.³⁰
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20 Due to a slight over-representation of females, older respondents, and regional residents
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22 (living outside of the capital city) in the CITTs sample compared to the NSW population,³¹
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24 weights were constructed using age, sex, and region of residence to make the sample more
25
26 similar to the NSW population. Weights were applied in the multiple linear regression
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28 analyses (using 'p' weights).
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34 RESULTS

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

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38 Sample characteristics are shown in Table 1.
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43 Responses to graphic health warnings

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45 Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of
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47 the graphic health warning responses over time. In general, strong agreement about the
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49 impact of the warnings had been decreasing since their introduction in 2006. Of smokers
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51 interviewed in 2006: 21% reported strong cognitive responses to the warnings, decreasing to
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53 12% in 2011; and 20% reported strong emotional response, decreasing to 12% in 2011.
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3 The results of the interrupted time series analyses investigating the impact of the new
4 packaging on responses to graphic health warnings are shown in Table 2. For all models, the
5 residuals were uncorrelated and normally distributed, and all other model diagnostics
6 indicated suitable model fit. After controlling for background trends, seasonality, anti-
7 smoking advertising activity and cigarette costliness, there was a significant increase in the
8 proportion of smokers having strong cognitive, emotional and avoidant responses to graphic
9 warnings after the introduction of the new packs. The increase in the avoidant response
10 occurred two months after the new packs were introduced (from 10% in September 2012 to
11 28% in December), and the increase in cognitive and emotional responses occurred after
12 three months (cognitive: from 13% in September 2012 to 20% in January 2013; emotional:
13 from 13% to 27%). In the time-series analysis, the change in the proportion of smokers
14 strongly agreeing that the warnings were the only thing they noticed on their packs after the
15 introduction of the new packs was not significant.
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34 The monthly average of the GHW Impact scale is shown in Figure 3. The results of the
35 interrupted time series analysis investigating the impact of the new packaging on GHW
36 Impact scores are shown in Table 2. The residuals were uncorrelated and normally
37 distributed, and all other model diagnostics indicated suitable model fit. There was a
38 significant increase in scores on the GHW Impact scale two months after the introduction of
39 the new packs, not attributable to background trends, seasonality, anti-smoking advertising
40 activity or cigarette costliness.
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52 The results of the multiple linear regression model predicting scores on the GHW Impact
53 scale are shown in Table 3. Compared to the pre-plain packaging period (August/September
54 2012), scores on the scale was significantly higher in immediate post-plain packaging period
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(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.

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3 The multiple linear regression model predicting Negative Pack Perception scores over the pp-
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5 periods showed that scores on this scale were significantly higher in each of the post-pp
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7 periods than in the pre-pp period (Table 3). For the comparison period, there were no
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9 significant differences in scores on this scale.
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11 12 13 **DISCUSSION**

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15 To our knowledge, this is the first study to examine the population-level impact of the new
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17 tobacco plain packs on Australian adult smokers' responses to their packs. This is an
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19 important first step in evaluating the policy as these outcomes relate closely to the intended
20
21 purpose of the legislation. In the months following the introduction of the new packs, there
22
23 was an increase in the proportion of smokers reporting strong cognitive and emotional
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25 responses to the warnings, avoidant behaviours related to the on-pack warnings, and salience
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27 of warnings. There was also an increase in the proportion of smokers with strong negative
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29 perceptions about their packs. These changes were not attributed to variations in exposure to
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31 anti-smoking advertising activity, tobacco prices, secular trends, seasonality or changes in
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33 sample composition.
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41 Consistent with the results of experimental research,^{14, 15, 17} we found that the introduction of
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43 the new packs was associated with an increase in the salience and the self-reported impact of
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45 the health warnings, such that smokers were more likely to report that the warnings are the
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47 only thing they see on their packs, that they feel they should hide or cover their pack, that the
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49 warnings encourage them to stop smoking, and that they make them worry that they
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51 shouldn't be smoking. Prominent graphic health warnings on tobacco products have been
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53 shown to increase health knowledge and perceptions of risk from smoking,^{32, 33} reduce
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3 consumption levels and increase cessation behaviour among smokers,^{33, 34} and support former
4 smokers in remaining abstinent.³⁵ Importantly, the impact of graphic health warnings on
5 smoking behaviours appears to be a function of the depth of smokers' cognitive processing of
6 and responses to the warnings (such as those monitored in the current study),³⁴⁻³⁶ suggesting
7 that if plain packaging can intensify smokers' responses to warnings, flow-on effects on
8 consumption and quitting are likely.

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

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

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

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30 The temporal pattern of changes found in this study is consistent with other early evaluations
31 of the impact of the new plain packs. The proportion of smokers reporting negative responses
32 to their packs and the warnings on them increased throughout the phase-in period,
33 corresponding to the increasing proportion of plain packs observed in public venues during
34 that period,⁴⁵ and the number of smokers reporting to be smoking from plain packs.² The
35 earliest effects of the new packs have been detected during this phase-in period, with declines
36 in rates of active smoking observed in outdoor dining venues in October-November,⁴⁵ and
37 calls to a cessation helpline peaking in November.¹⁹ From the current time-series analysis,
38 smokers' tendency to avoid the on-pack health warnings increased significantly in December,
39 two months after the plain packs started appearing, when plain packs became mandatory for
40 sale. This coincides with an observed decline in rates of pack display and an increase in
41 concealment of packs in outdoor venues.⁴⁵ Other changes observed in the current study
42 (cognitive and emotional responses to graphic health warnings, and negative pack
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3 perceptions) reached significance in January, at a time when less than 5% of packs observed
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5 in outdoor venues were fully-branded.⁴⁵ These changes occurred just after an increase in the
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7 number of smokers rating their cigarettes as being lower in quality and less satisfying than
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9 one year ago.² All changes in pack-related responses observed in the current study were
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11 maintained at eight months after the first appearance of the new packs, the last data point in
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13 the current series.
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17 The strengths of this study include the use of population-level data collected over a long time
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19 period, resulting in a large sample of adult smokers. As recommended in a recent review of
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21 the plain packaging literature,⁵ the use of a time-series approach with multiple data points
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23 before the intervention increased the power to detect any effects over and above long-term
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25 background and seasonal trends, and the inclusion of important time-related potential
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27 covariates decreased threats to the validity of the findings. The regression analyses allowed
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29 us to control for any changes in sample composition in regards to demographic characteristics
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31 such as SES and smoking levels. We note that the sample for this study consisted of current
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33 smokers only, and therefore any smokers who quit in the post-plain packaging period would
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35 be excluded. This might have resulted in a sample of smokers somewhat resistant to this
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37 intervention, and as such, the estimates provided in this study might be more conservative
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39 than if we had also surveyed smokers who quit during this time.
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47 Limitations of the study include the use of landline-only telephone numbers and a somewhat
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49 low response rate, possibly leading to some bias in sample composition. The rate of mobile-
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51 only households in Australia, recently estimated at 19%, increased over the years of this
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53 study.⁴⁶ Recent dual-frame surveys have shown that samples recruited via mobile-phone are
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55 more likely to include younger respondents and males than landline samples.⁴⁷ The impact of
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3 these demographic differences are likely to be reduced in the current study due to the
4 inclusion of age and gender as covariates, the use of data weighted for these variables where
5 appropriate, and the inclusion of smoking-related covariates related to these demographic
6 characteristics. The response rate of CITTs is similar to that of other population telephone
7 surveys on tobacco use in Australia,⁴⁸ and was consistent across the study period, limiting its
8 influence on the observed pattern of results.
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19 In an environment of strict tobacco promotion prohibition such as Australia, cigarette
20 packaging had become the key tool used by the tobacco industry to attract and retain
21 customers.^{49, 50} The purpose of the plain packaging legislation was to deprive tobacco
22 companies of an ongoing opportunity to promote their products in the community. The
23 introductory effects of the plain packaging legislation observed in this study are consistent
24 with the specific objectives of the legislation in regards to increasing the salience and impact
25 of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the
26 fact that tobacco packs are handled every time a smoker takes out a cigarette, those who
27 smoke more than a pack per day were potentially exposed to their new packs almost 4,000
28 times in the first six months of the legislated changes. The findings of this study suggest that
29 the new packs are decreasing smokers' identification with their packs and making them think
30 more closely about the health warnings contained on them, potentially moving them closer to
31 cessation. Future research should extend this study by considering any relationships between
32 smokers' responses to their plain packaging packs and changes in smoking behaviours,
33 investigating whether the introductory effects identified in this study were apparent in youth
34 smokers, and monitoring the impact of plain packaging on perceptions about smoking among
35 non-smoking youth and adults.
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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.

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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; $n=15,745$)

	<i>N</i>	%
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

	Month:	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.

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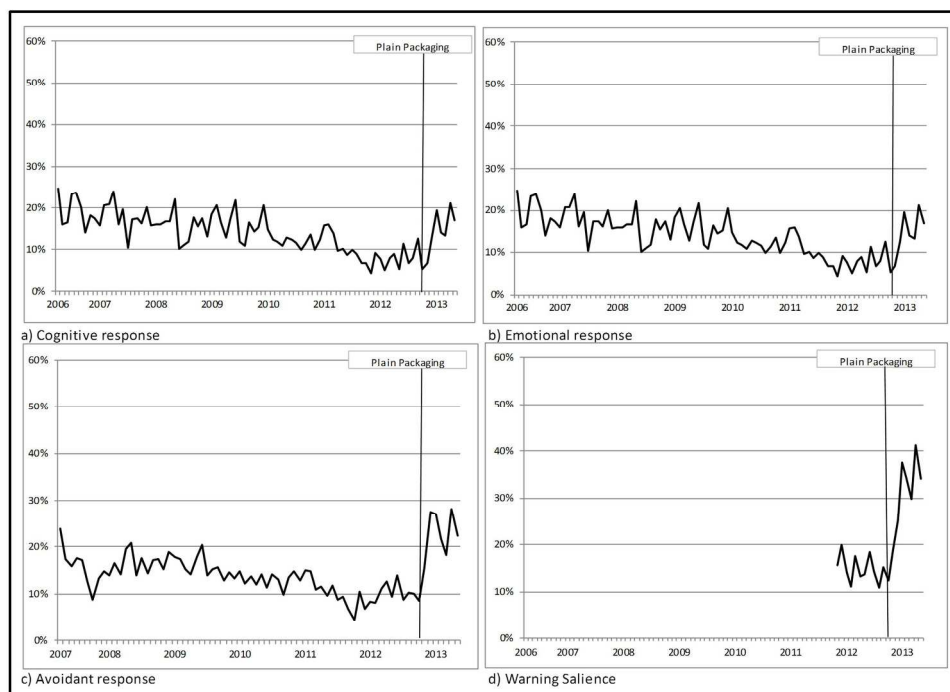


Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make me feel that I should hide 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)

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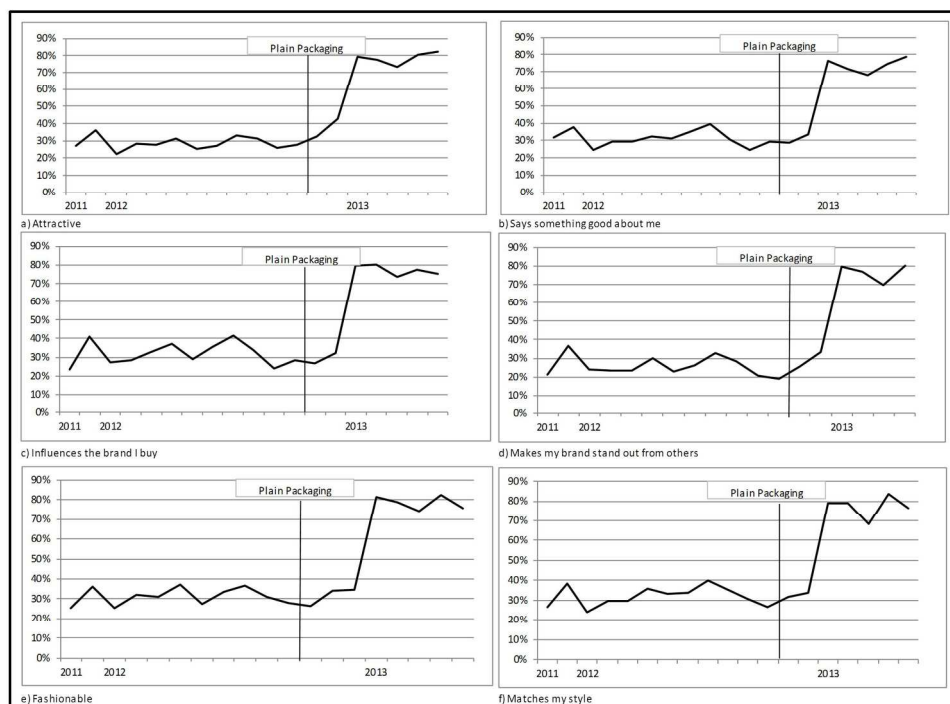


Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a) attractive; (b) says something good about me to other smokers; (c) influences the brand I buy; (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style
 254x190mm (300 x 300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

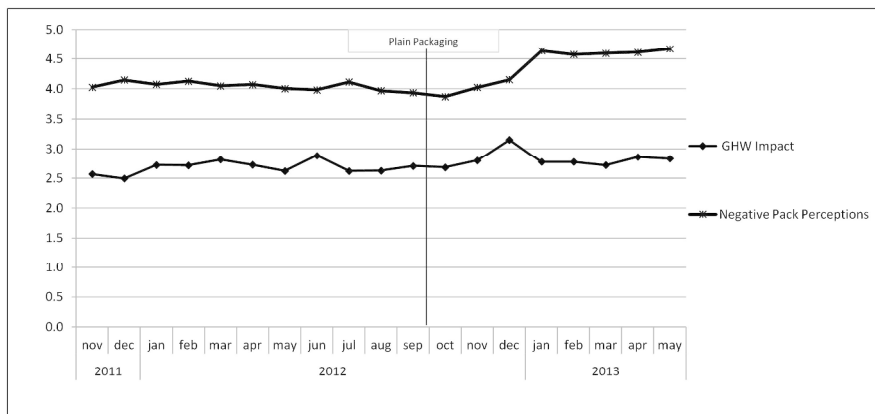
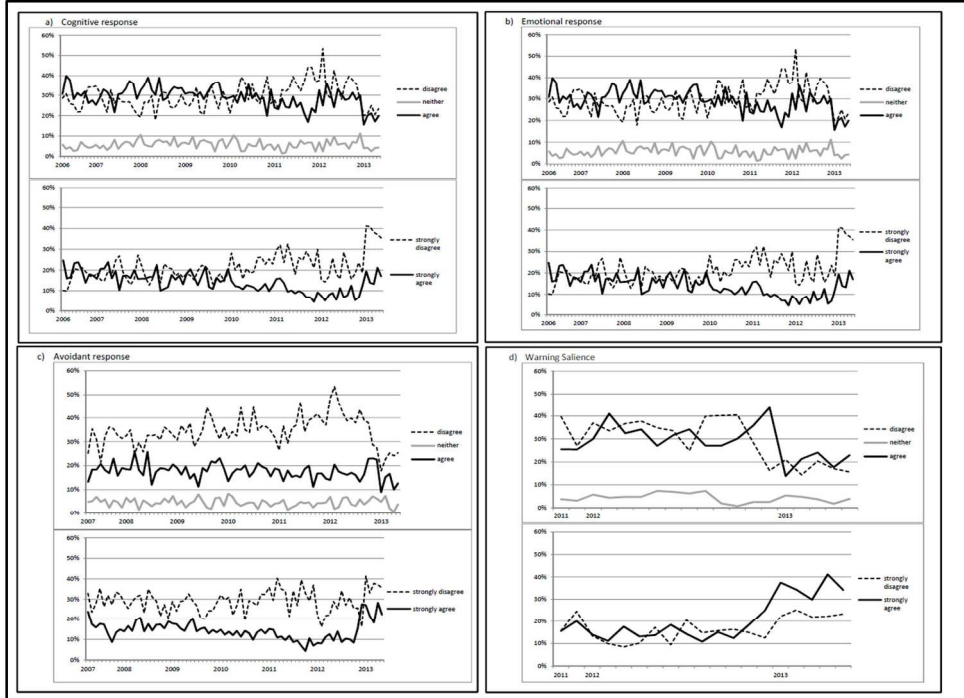


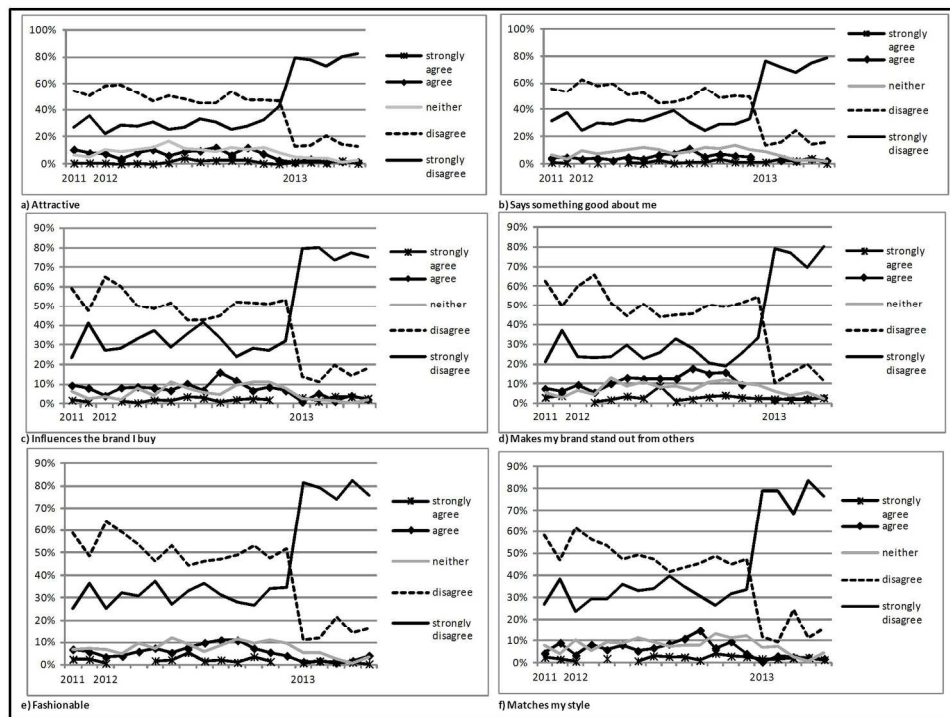
Figure 3: Monthly mean score for Graphic Health Warning Impact and Negative Pack Perception
 254x190mm (300 x 300 DPI)

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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)

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3 **Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-**
4 **related perceptions and responses: Results from a continuous tracking survey**
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9 Sally M Dunlop, Timothy Dobbins, Jane M Young, Donna Perez, David C Currow
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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.

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

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4 On the 1st of December 2012, Australia became the first country to introduce mandatory plain
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6 packaging for all tobacco products.¹ The new plain packs are olive green cardboard packages
7
8 devoid of all brand design elements, with brand name and [quantity-number of cigarettes](#)
9
10 written in a standardised font and location on each pack. The new packs continue to carry
11
12 coloured graphic health warnings covering 90% of the back of packs, with the warnings on
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14 the front of pack enlarged from 30% to 75%. Manufacturers were required to produce the
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16 new packs from the 1st of October 2012 and they started appearing for sale from that date;
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18 approximately 80% of smokers were using plain packs by mid-November.²
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24 The plain packaging legislation aims to discourage people from taking up smoking,
25
26 encourage smokers to give up smoking, and discourage relapse.¹ The stated purpose of the
27
28 legislation is to regulate the packaging and appearance of tobacco products in order to: (a)
29
30 reduce the appeal of tobacco products to consumers, (b) increase the effectiveness of health
31
32 warnings, and (c) reduce the ability of packaging to mislead consumers about the harmful
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34 effects of smoking. As this was the first time any such legislation had been implemented, the
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36 expected outcomes of the new packs were informed by a body of research consisting
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38 primarily of experimental studies, summarised in recent reviews.³⁻⁶
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44 Studies in which participants were presented with mocked-up plain and branded tobacco
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46 packs show that plain packaging has the potential to reduce the promotional appeal of a pack,
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48 diminish positive perceptions about smokers of cigarettes from that pack, and reduce the
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50 appeal of smoking in general.⁷⁻¹³ Such studies also suggest that health warnings are both
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52 more noticeable and more effective when presented on plain rather than branded packs,^{14, 15}
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54 with researchers suggesting that brand imagery diffuses the impact of health warnings.¹⁶
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57 These results have been corroborated in naturalistic studies in which smokers are assigned to
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3 smoke their normal cigarettes from either plain or branded packs for a period of time, with
4 plain pack smokers reporting increased negative perceptions about to their pack and smoking,
5 along with an increased impact of health warnings.^{17, 18} A limitation of these previous studies,
6 however, is the inability to differentiate the impact of plain packaging and the novelty impact
7 of a pack which is simply different to the packs that smokers are used to seeing. No studies to
8 date have been able to investigate the impact of plain tobacco packaging on tobacco pack
9 appeal and the salience and effects of health warnings in the context of mandatory plain
10 packaging, when all packs with which smokers are in contact are devoid of any branding
11 other than a name in a standard font.
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25 In the current study, we use cross-sectional survey data collected weekly for a period of seven
26 years to investigate the impact of the new packaging on adult smokers' responses to the
27 health warnings on their packs and perceptions of their packs. It was hypothesised that, after
28 the introduction of the new packs, smokers would find the health warnings more salient,
29 would have an increased response to the warnings, and would hold less favourable
30 perceptions of their packs. The continuous nature of the data allowed us to track how these
31 outcomes changed after the introduction of the new packs, investigating whether any
32 observed changes were sustained in the six months following their introduction. This
33 approach builds on our previous study evaluating the impact of the introduction of the plain
34 packaging legislation on calls to a smoking cessation helpline.¹⁹ Additionally, given that
35 responses to graphic pack warnings had been tracked since their initial introduction in 2006,
36 we were able to assess changes in these responses in the context of longer-term trends.
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54 **METHOD**

55 **Study Design and Participants**

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4 survey with approximately 50 interviews conducted per week throughout the year. The
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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

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3 income below AUD\$40,000 and high education, or an income of AUD\$40-80,000 and
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5 moderate education. Low SES was defined as either an income below AUD\$40,000 and low
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7 or moderate education, or an income AUD\$40-80,000 and low education. Those with missing
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9 data on one variable were classified based on the other.
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14 Frequency of smoking was used to classify smokers as 'daily', 'weekly', or 'less frequent
15 smokers. Average number of cigarettes smoked per day was used to indicate heaviness of
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17 smoking (light=less than 10 cigarettes per day; moderate=11-20 cigarettes per day;
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19 heavy=more than 20 cigarettes per day). As smokers' responses to graphic health warnings
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21 and perceptions of their cigarette packs might conceivably be related to their quitting
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23 experiences or propensity towards quitting, we also included quit attempts in the last 12
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25 months as a control variable (1=tried to quit at least once in the last 12 months, 0=did not).
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32 Along with demographic and smoking characteristics, respondents' pack perceptions and
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34 responses to health warnings might also possibly be influenced by the timing of their
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36 interview in terms of variations in anti-smoking advertising activity, changes in the costliness
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38 of cigarettes, or shifting social norms. Respondents' level of exposure to anti-smoking
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40 advertising in the three months prior to their interview was measured in terms of Target
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42 Audience Ratings Points (TARPs). TARPs are a product of the percentage of the target
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44 audience exposed to an advertisement (reach) and the average number of times a target
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46 audience member would be exposed (frequency). Hence, 200 TARPs might represent 100%
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48 of the target audience receiving the message an average of two times over a specified period,
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50 or 50% reached four times. Exposure to advertising over a 3-month period was chosen based
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52 on previous research suggesting that advertising effects occur within this time frame.^{22, 23} We
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54 ascertained TARPs for each of the advertisements broadcast in NSW during the study period
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3 based on OZTAM Australian TV Audience Measurements for adults aged 18years and older
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5 for free-to-air and cable TV ($M=1590$, $SD=758$).²⁴
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10 A variable indicating cigarette costliness²⁵ at time of interview was calculated as the ratio of
11
12 the average quarterly recommended retail pack price of the 2 top-selling Australian cigarette
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14 brands (obtained from the retail trade magazine *Australian Retail Tobacconist*, volumes 65 to
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16 87) to the average weekly earnings in the same quarter ($M=1.54$, $SD=0.17$).²⁶
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18 The influence of changing social norms was accounted for by statistically accounting for a
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20 time-based trend in the data, [described below](#).
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23 24 25 **Statistical analyses**

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27 Two approaches to statistical analysis were used to assess the impact of the new packs on
28
29 each outcome. The first approach used interrupted time series analysis, in which data
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31 collected at multiple instances before and after an intervention is used to detect whether the
32
33 intervention has an effect significantly greater than the underlying secular trend. The
34
35 advantages of using this approach include the ability to account for background trends,
36
37 control for seasonal variations, adjust for auto-correlation in the data (when each value is
38
39 correlated with the previous value), and to assess changes in the outcome in the context of
40
41 longer-term trends. We also used [multiple linear regression analyses](#) to compare the [scores](#)
42
43 [for the two constructed scales](#) in the months [prior to and](#) following the new packaging
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45 legislation, controlling for socio-demographic and smoking characteristics.
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51 In the time-series analysis, [weekly data were aggregated at the monthly level \(to ensure](#)
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53 [sufficient sample size at each time point\)](#). We assessed the impact of the introduction of the
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55 [new packs on \(a\) the proportion of sample strongly agreeing with each of the graphic health](#)
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3 [warning statements, \(b\) mean Graphic Health Warning Impact score, \(c\) the proportion of the](#)
4 [sample strongly disagreeing with each of the pack perception statements, and \(d\) mean](#)
5 [Negative Pack Perception score](#). We used autoregressive integrated moving average
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10 (ARIMA) analysis in SAS version 9.3²⁷ to model the effects of the introduction of the new
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12 packaging on the outcomes of interest, while accounting for background trends, seasonal
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14 variation, the effects of television anti-tobacco advertising, and changes in cigarette
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16 costliness. ARIMA modelling was chosen because the data for each of the outcomes of
17
18 interest were auto-correlated.
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23 ARIMA modelling comprising model investigation, estimation and diagnostic checking
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25 followed the methods of Box *et al.*²⁸ This modelling enables investigation of the size and
26
27 statistical significance of changes in an outcome after a specified time point, adjusting for
28
29 background trends and confounders. An indicator term was created to represent the week of
30
31 the introduction of the intervention (the ‘phasing in’ of the new packs on 1 October 2012).
32
33 The potential confounders of anti-smoking advertising activity (TARPs) and cigarette
34
35 costliness were included in all models. In the models predicting responses to graphic health
36
37 warnings, terms indicating the months of December and January were also included to
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39 account for potential for seasonal variations (not included for pack perception outcomes due
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41 to limited data points). Due to the large number of outcomes to be reported, we do not report
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43 the effects of these covariates (available from authors on request).
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50 Next, we [used multiple linear regression analyses to assess changes in scores on the Graphic](#)
51 [Health Warning Impact and Negative Pack Perception scales](#), using month of interview as the
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53 indicator, focusing on the period of the introduction of the new packs (August 2012 – May
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55 2013).²⁹ The months preceding and following the intervention were represented by a five-
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3 level term: (a) the two months preceding the change (August-September, 'pre-plain packs
4 (PP)'); (b) the two months of 'phase-in' (October-November); (c) the two months 'immediate
5 post-PP' (December-January); (d) '3-4 months post-PP' (February-March); and (e) '5-6
6 months post-PP' (April-May). Demographic and smoking characteristics were included as
7 covariates, along with recent anti-smoking advertising activity. Because changes in cigarette
8 costliness were based on quarterly data, there was a high degree of multi-collinearity between
9 costliness and time of interview (VIF=26), resulting in inflated standard errors and unstable
10 estimates of regression coefficients. We therefore [included a variable indicating 'increase in
11 cigarette costliness' in the last 12 weeks \(as a percentage of costliness\)](#) as a covariate in these
12 models. To provide a point of comparison, these models were also fitted to 2011-2012 data
13 for the same months. [An alpha level of 0.05 was used for all statistical tests.](#) Stata v11 [was
14 used for the regression analyses.](#)³⁰

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

37 38 39 40 41 42 43 44 45 RESULTS

46
47 [Response rate for the survey was an average of 40% in the period 2006-2013.](#)

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49 Sample characteristics are shown in Table 1.

50 51 52 53 54 Responses to graphic health warnings

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3 Figure 1 shows the monthly proportions of the smoker sample strongly agreeing with each of
4 the graphic health warning responses over time. In general, strong agreement about the
5 impact of the warnings had been decreasing since their introduction in 2006. Of smokers
6 interviewed in 2006: 21% reported strong cognitive responses to the warnings, decreasing to
7 12% in 2011; and 20% reported strong emotional response, decreasing to 12% in 2011.
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16 The results of the interrupted time series analyses investigating the impact of the new
17 packaging on responses to graphic health warnings are shown in Table 2. For all models, the
18 residuals were uncorrelated and normally distributed, and all other model diagnostics
19 indicated suitable model fit. After controlling for background trends, seasonality, anti-
20 smoking advertising activity and cigarette costliness, there was a significant increase in the
21 proportion of smokers having strong cognitive, emotional and avoidant responses to graphic
22 warnings after the introduction of the new packs. The increase in the avoidant response
23 occurred two months after the new packs were introduced ([from 10% in September 2012 to](#)
24 [28% in December](#)), and the increase in cognitive and emotional responses occurred after
25 three months ([cognitive: from 13% in September 2012 to 20% in January 2013; emotional:](#)
26 [from 13% to 27%](#)). In the time-series analysis, the change in the proportion of smokers
27 strongly agreeing that the warnings were the only thing they noticed on their packs after the
28 introduction of the new packs was not significant.
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47 [The monthly average of the GHW Impact scale is shown in Figure 3. The results of the](#)
48 [interrupted time series analysis investigating the impact of the new packaging on GHW](#)
49 [Impact scores are shown in Table 2. The residuals were uncorrelated and normally](#)
50 [distributed, and all other model diagnostics indicated suitable model fit. There was a](#)
51 [significant increase in scores on the GHW Impact scale two months after the introduction of](#)
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3 [the new packs, not attributable to background trends, seasonality, anti-smoking advertising](#)
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5 [activity or cigarette costliness.](#)
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10 The results of the [multiple linear regression model predicting scores on the GHW Impact](#)
11 [scale](#) are shown in Table 3. [Compared to the pre-plain packaging period \(August/September](#)
12 [2012\), scores on the scale was significantly higher in immediate post-plain packaging period](#)
13 [\(December/January\) and in the 5-6 month post-plain packaging period \(April/May\). These](#)
14 [effects were independent of any differences between the samples on socio-demographic or](#)
15 [smoking characteristics, anti-smoking advertising activity, or increases in cigarette costliness.](#)
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17 [There were no significant differences in scores on this scale over the months of the](#)
18 [comparison period.](#)
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30 Pack perceptions

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32 The monthly proportions of smokers strongly disagreeing with each of the pack attitude items
33 are shown in Figure 2. The results of the interrupted time series analysis (Table 2) show that,
34 three months following the introduction of the new packs, there was a significant increase in
35 the proportion of smokers strongly disagreeing that the look of their cigarette pack is
36 attractive ([from 26% in September 2012 to 80% in January 2013](#)), says something good about
37 them ([from 27% to 76%](#)), influences the brand they buy ([from 27% to 77%](#)), makes their
38 brand stand out ([from 22% to 78%](#)), is fashionable ([from 27% to 80%](#)), and matches their
39 style ([from 31% to 77%](#)). This effect was independent of any influence of long-term
40 background trends, cigarette costliness, or anti-smoking advertising activity.
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54 [The monthly average of the Negative Pack Perception scale is shown in Figure 3, and the](#)
55 [results of the interrupted time series analysis investigating the impact of the new packaging](#)
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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

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2
3 the health warnings, such that smokers were more likely to report that the warnings are the
4 only thing they see on their packs, that they feel they should hide or cover their pack, that the
5 warnings encourage them to stop smoking, and that they make them worry that they
6 shouldn't be smoking. Prominent graphic health warnings on tobacco products have been
7 shown to increase health knowledge and perceptions of risk from smoking,^{32, 33} reduce
8 consumption levels and increase cessation behaviour among smokers,^{33, 34} and support former
9 smokers in remaining abstinent.³⁵ Importantly, the impact of graphic health warnings on
10 smoking behaviours appears to be a function of the depth of smokers' cognitive processing of
11 and responses to the warnings (such as those monitored in the current study),³⁴⁻³⁶ suggesting
12 that if plain packaging can intensify smokers' responses to warnings, flow-on effects on
13 consumption and quitting are likely.

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

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

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41 The temporal pattern of changes found in this study is consistent with other early evaluations
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43 of the impact of the new plain packs. The proportion of smokers reporting negative responses
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45 to their packs and the warnings on them increased throughout the phase-in period,
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47 corresponding to the increasing proportion of plain packs observed in public venues during
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49 that period,⁴⁵ and the number of smokers reporting to be smoking from plain packs.² The
50
51 earliest effects of the new packs have been detected during this phase-in period, with declines
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53 in rates of active smoking observed in outdoor dining venues in October-November,⁴⁵ and
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55 calls to a cessation helpline peaking in November.¹⁹ From the current time-series analysis,
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3 smokers' tendency to avoid the on-pack health warnings increased significantly in December,
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5 two months after the plain packs started appearing, when plain packs became mandatory for
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7 sale. This coincides with an observed decline in rates of pack display and an increase in
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9 concealment of packs in outdoor venues.⁴⁵ Other changes observed in the current study
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11 (cognitive and emotional responses to graphic health warnings, and negative pack
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13 perceptions) reached significance in January, at a time when less than 5% of packs observed
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15 in outdoor venues were fully-branded.⁴⁵ These changes occurred just after an increase in the
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17 number of smokers rating their cigarettes as being lower in quality and less satisfying than
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19 one year ago.² All changes in pack-related responses observed in the current study were
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21 maintained at eight months after the first appearance of the new packs, [the last data point in](#)
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23 [the current series](#).
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30 The strengths of this study include the use of population-level data collected over a long time
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32 period, resulting in a large sample of adult smokers. As recommended in a recent review of
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34 the plain packaging literature,⁵ the use of a time-series approach with multiple data points
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36 before the intervention increased the power to detect any effects over and above long-term
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38 background and seasonal trends, and the inclusion of important time-related potential
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40 covariates decreased threats to the validity of the findings. The regression analyses allowed
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42 us to control for any changes in sample composition in regards to demographic characteristics
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44 such as SES and smoking levels. [We note that the sample for this study consisted of current](#)
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46 [smokers only, and therefore any smokers who quit in the post-plain packaging period would](#)
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48 [be excluded. This might have resulted in a sample of smokers somewhat resistant to this](#)
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50 [intervention, and as such, the estimates provided in this study might be more conservative](#)
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52 [than if we had also surveyed smokers who quit during this time.](#)
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3 Limitations of the study include the use of landline-only telephone numbers and a somewhat
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5 low response rate, possibly leading to some bias in sample composition. The rate of mobile-
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7 only households in Australia, recently estimated at 19%, increased over the years of this
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9 study was recently estimated at 14%, quantifying concerns about excluding these
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11 individuals.⁴⁶ Recent dual-frame surveys have shown that samples recruited via mobile-
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13 phone are more likely to include younger respondents and males than landline samples.⁴⁷ The
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15 impact of these demographic differences are likely to be reduced in the current study due to
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17 the inclusion of age and gender as covariates, the use of data weighted for these variables
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19 where appropriate, and the inclusion of smoking-related covariates related to these
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21 demographic characteristics. The response rate of CITTS is similar to that of other population
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23 telephone surveys on tobacco use in Australia,⁴⁸ and was consistent across the study period,
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27 limiting its influence on the observed pattern of results.
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32 In an environment of strict tobacco promotion prohibition such as Australia, cigarette
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34 packaging had become the key tool used by the tobacco industry to attract and retain
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36 customers.^{49, 50} The purpose of the plain packaging legislation was to deprive tobacco
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38 companies of an ongoing opportunity to promote their products in the community. The
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40 introductory effects of the plain packaging legislation observed in this study are consistent
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42 with the specific objectives of the legislation in regards to increasing the salience and impact
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44 of health warnings, and reducing the promotional appeal of tobacco packaging. Due to the
45
46 fact that tobacco packs are handled every time a smoker takes out a cigarette, those who
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48 smoke more than a pack per day were potentially exposed to their new packs almost 4,000
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50 times in the first six months of the legislated changes. The findings of this study suggest that
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52 the new packs are decreasing smokers' identification with their packs and making them think
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54 more closely about the health warnings contained on them, potentially moving them closer to
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3 cessation. [Future research should extend this study by considering any relationships between](#)
4 [smokers' responses to their plain packaging packs and changes in smoking behaviours,](#)
5 [investigating whether the introductory effects identified in this study were apparent in youth](#)
6 [smokers, and monitoring the impact of plain packaging on perceptions about smoking among](#)
7 [non-smoking youth and adults.](#)
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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.

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DATA SHARING

No additional data available.

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3 Figure 1: Monthly proportions of smokers strongly agreeing that: (a) the graphic warnings
4 encourage me to stop smoking (cognitive response); (b) with the graphic warnings, each time
5 I get a cigarette out I worry that I shouldn't be smoking (emotional response); (c) they make
6 me feel that I should hide or cover my packet from the view of others (avoidant response); (d)
7 the only thing I notice on my cigarette pack is the graphic warnings (warning salience)
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16 Figure 2: Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (a)
17 attractive; (b) says something good about me to other smokers; (c) influences the brand I buy;
18 (d) makes my brand stand out from other brands; (e) is fashionable; (f) matches my style
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26 Figure 3: Monthly mean score for Graphic Health Warning Impact and Negative Pack
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Table 1. Sample characteristics from the Cancer Institute's Tobacco Tracking Survey (CITTS) April 2006-May 2012 (smokers only; $n=15,745$)

	<i>N</i>	%
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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	Y
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —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 (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	Y
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	Y
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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 (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	Y
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.

Correction

Dunlop SM, Dobbins T, Young JM, *et al.* Impact of Australia's introduction of tobacco plain packs on adult smokers' pack-related perceptions and responses: results from a continuous tracking survey. *BMJ Open* 2014;4:e005836.

An error in coding resulted in 428 ineligible cases being included in this study. These ineligible cases were part of a concurrent pilot study of recruitment via mobile phone. The coding error was applied to the descriptive statistics and regression analyses, but not the time-series analyses. The correction of this error does not change the results or conclusions of the study, but for clarification, the following corrections are noted:

1. The sample size in the 'Participants' section of the Abstract should be 15 375.
2. In the Method section, 'Analyses for this study are limited to smokers interviewed between April 2006 and May 2013 (total n=15 745)' should read 'Analyses for this study are limited to smokers interviewed between April 2006 and May 2013 (total n=15 375)'.
3. In the Results section, 'the increase in cognitive and emotional responses occurred after 3 months (cognitive: from 13% in September 2012 to 20% in January 2013; emotional: from 13% to 27%)' should read 'the increase in cognitive and emotional responses occurred after 3 months (cognitive: from 13% in September 2012 to 21% in January 2013; emotional: from 13% to 29%)'.

Table 1 Sample characteristics from the Cancer Institute's Tobacco Tracking Survey (CITTS) April 2006 to May 2013 (smokers only; n=15 375)

	N	Per cent
Sex		
Female	8126	50
Male	7249	50
Age (years)		
18–29	2265	21
30–55	8260	48
55+	4848	31
Socioeconomic status		
Low	6443	41
Moderate	3951	27
High	4808	33
Smoking frequency		
Daily	13659	88
Weekly	917	6
Less than weekly	799	6
Smoking		
Low	5871	41
Moderate	5705	38
High	3384	22
Quit attempts in past 12 months		
None	9189	60
At least one	5975	40
Year		
2006	1600	10
2007	2289	15
2008	2094	13
2009	2135	14
2010	2146	14
2011	2157	14
2012	2126	13
2013	828	5

Ns are unweighted, per cents are weighted for age, sex and regional residence.

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% CI	p Value	M	(SD)	β	95% CI	p Value
GHW impact										
Month										
August/September	NA					2.67	(0.93)	Ref		
October/November	2.57	(0.90)	Ref			2.75	(0.97)	0.01	−0.15	0.21
December/January	2.62	(0.99)	−0.01	−0.25	0.21	0.847	2.86	(1.18)	0.09	0.05
February/March	2.77	(0.89)	0.10	−0.19	0.58	0.323	2.75	(1.17)	0.06	−0.11
April/May	2.67	(0.96)	−0.01	−0.52	0.48	0.930	2.79	(1.22)	0.03	−0.12
Negative pack perceptions										
Month										
August/September	NA					3.95	(0.76)	Ref		
October/November	4.03	(0.60)	Ref			3.96	(0.75)	0.03	−0.45	1.10
December/January	4.11	(0.64)	0.06	−0.43	1.46	0.286	4.47	(0.65)	0.25	2.52
February/March	4.08	(0.59)	0.03	−1.40	1.88	0.775	4.56	(0.63)	0.31	2.58
April/May	4.03	(0.69)	0.07	−1.61	2.80	0.598	4.67	(0.58)	0.34	3.82

Models controlled for demographics (sex, age, SES), smoking characteristics (frequency and level of smoking, 12 m quitting history), antismoking advertising activity (TARPs) and recent increases in cigarette costliness (% increase in past 12 weeks); M's and SD's are unweighted.

β , Standardised coefficient; GHW, Graphic Health Warnings; M, mean (range 1–5); NA, not applicable; SES, socioeconomic status; TARP, Target Audience Rating Points.

4. In the Results section, 'Compared with the preplain packaging period (August/September 2012), scores on the scale were significantly higher in immediate postplain packaging period (December/January) and in the 5–6 month postplain packaging period (April/May). These effects were independent of any differences between the samples on sociodemographic or smoking characteristics, antismoking advertising activity, or increases in cigarette costliness' should read 'Compared with the preplain packaging period (August/September 2012),

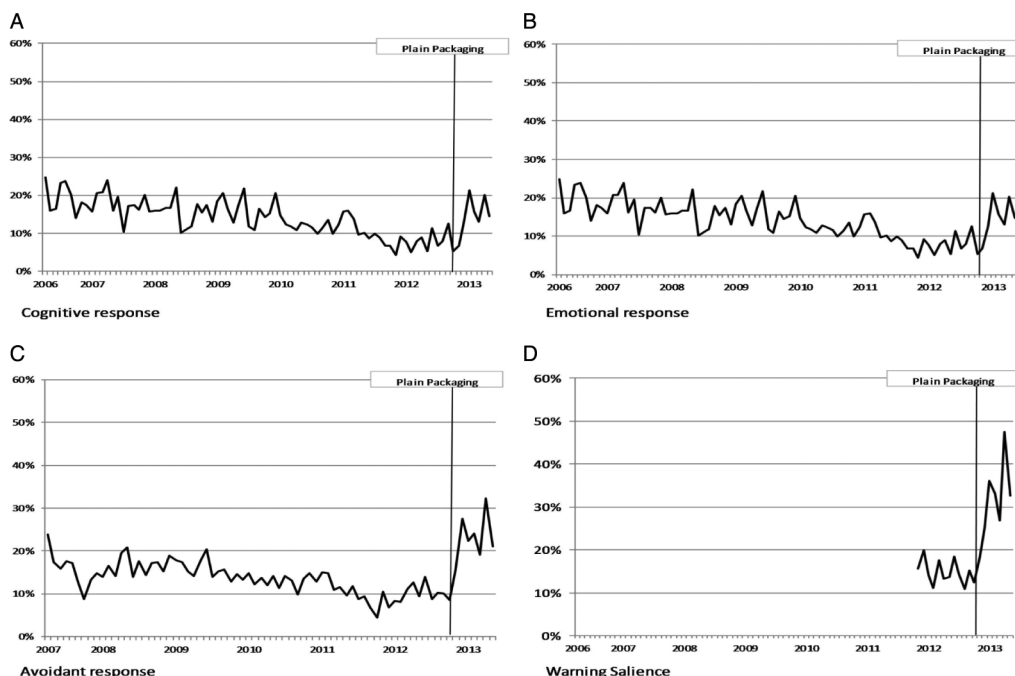


Figure 1 Monthly proportions of smokers strongly agreeing that: (A) the graphic warnings encourage me to stop smoking (cognitive response); (B) with the graphic warnings, each time I get a cigarette out I worry that I should not be smoking (emotional response); (C) they make me feel that I should hide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

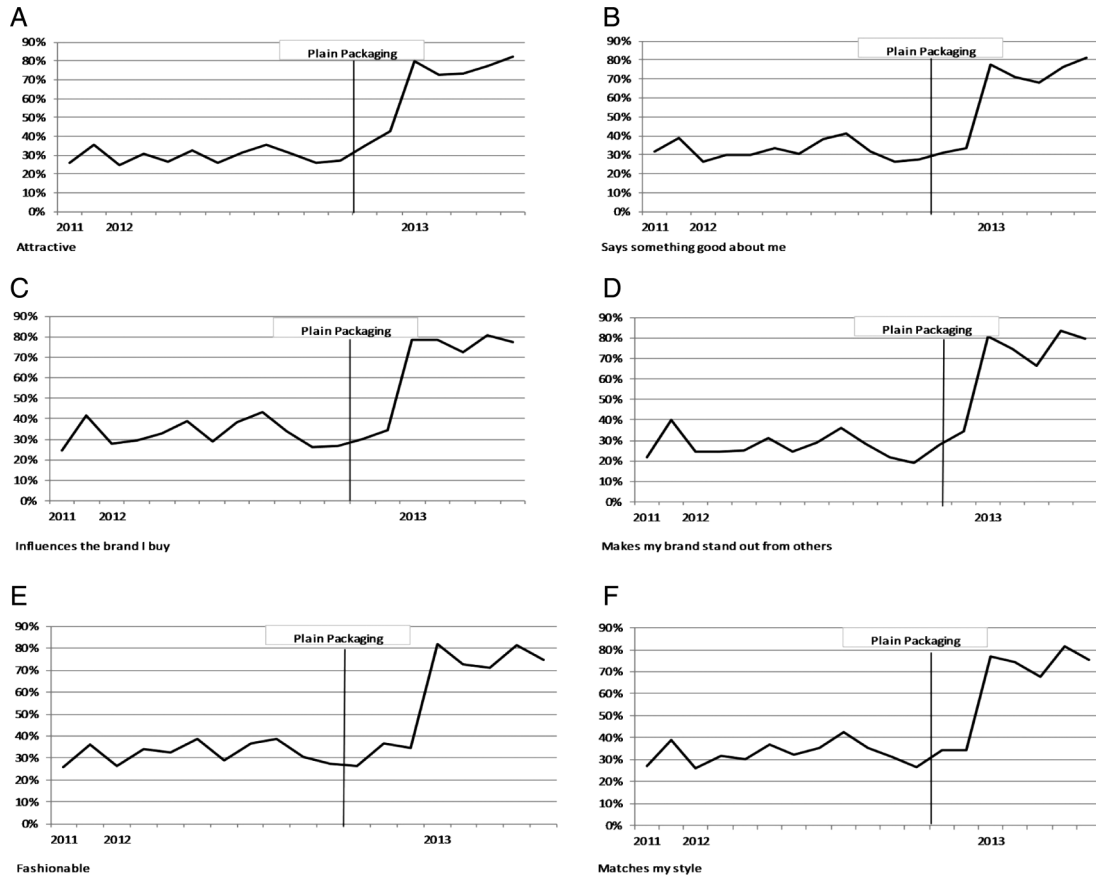
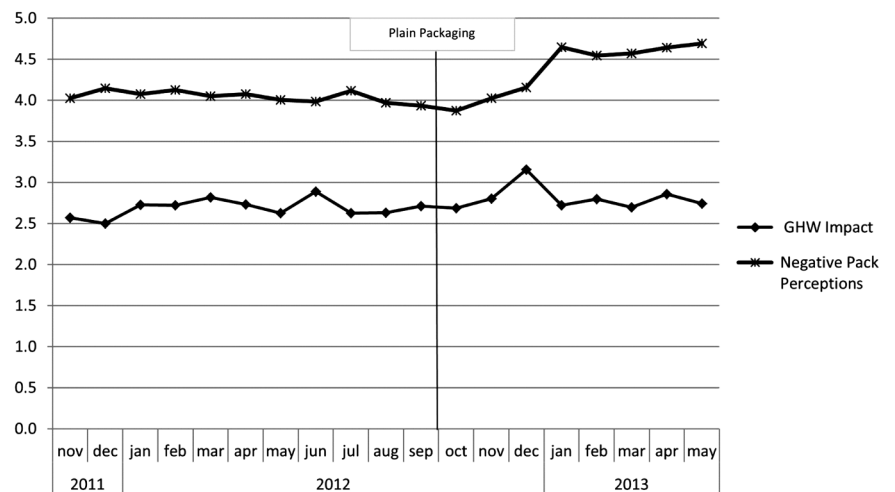


Figure 2 Monthly proportions of smokers strongly disagreeing that their cigarette pack is: (A) attractive; (B) says something good about me to other smokers; (C) influences the brand I buy; (D) makes my brand stand out from other brands; (E) is fashionable and (F) matches my style.

scores on the scale were significantly higher in immediate postplain packaging period (December/January). This effect was independent of any differences between the samples on sociodemographic or smoking characteristics, antismoking advertising activity, or increases in cigarette costliness’.

5. In the Results section, ‘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%)’ should read ‘says something good about them (from 27% to 78%), influences the brand they buy (from 27% to 79%), makes their brand stand out (from 22% to 81%), is fashionable (from 27% to 82%)’.

Figure 3 Monthly mean score for Graphic Health Warning Impact and Negative Pack Perceptions.



Corrected versions of tables 1 and 3, figures 1–3, supplementary figures 1 and 2 are below. The corrected versions of the figures result in minor changes to estimates for some data points, with no change in overall patterns of the data.



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BMJ Open 2015;5:e005836. doi:10.1136/bmjopen-2014-005836corr1