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Are quitting-related cognitions and behaviours predicted by proximal responses to plain packaging with larger health warnings? Findings from a national cohort study with Australian adult smokers

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ABSTRACT

Background Implementation of tobacco plain packaging (PP) with larger graphic health warnings (GHWs) in Australia had positive effects on responses reflecting the specific objectives of the PP policy and on follow-up quitting-related cognitions and behaviours. The aim of this study was to examine predictive relationships between these proximal and distal outcomes.

Methods A nationally representative sample of Australian adult cigarette smokers completed a baseline survey and a 1-month follow-up survey within the first year of policy implementation (n(weighted)=3125). Logistic regression analyses tested whether baseline measures of cigarette appeal, GHW effectiveness, perceived harm and concern/enjoyment predicted each of seven follow-up measures of quitting-related cognitions and behaviours, adjusting for baseline levels of the outcome and covariates.

Results In multivariable models, we found consistent evidence that several baseline measures of GHW effectiveness positively and significantly predicted the likelihood that smokers at follow-up reported thinking about quitting at least daily, intending to quit, having a firm date to quit, stubbing out cigarettes prematurely, stopping oneself from smoking and having attempted to quit. Two of the quitting-related outcomes were also predicted by feeling more smoking-related concern than enjoyment. A smaller number of the appeal variables were prospectively associated with quitting-related outcomes, while believing that brands do not differ in harmfulness did not positively predict any outcomes.

Conclusions These findings provide an initial insight into the pathways through which PP with larger GHWs may lead to changes in smoking behaviour. Future research should examine whether the effects are conditional on individual demographic and smoking characteristics.

INTRODUCTION

Drab dark brown plain packaging (PP) for tobacco products was first introduced in Australia from 1 October 2012 and fully implemented from 1 December 2012.^{1 2} At the same time, new and larger graphic health warnings (GHWs), covering 75% of the front of cigarette packs (up from 30% previously) and maintaining a coverage of 90% of the back, were also introduced onto packs.^{2 3} The specific objectives of the PP legislation were to: (A) reduce the appeal of tobacco products; (B) increase the effectiveness of the GHWs and (C) reduce the

ability of packaging to mislead consumers about the harmful effects of smoking. More broadly though, and as part of a comprehensive tobacco control programme, the PP legislation aimed to reduce smoking rates by discouraging people from taking up smoking, encouraging smokers to quit and discouraging relapse. In a complementary way, the Information Standard that prescribed the new GHWs^{2 3} aimed to increase consumer knowledge of the health effects resulting from tobacco use, ensure the continuing effectiveness of health warnings on the retail packaging of tobacco products, and by ensuring their effectiveness, encourage cessation and discourage initiation and relapse.³

Using data collected in continuous cross-sectional surveys conducted between April 2012 and November 2013 with a nationally representative sample of over 7000 Australian adult cigarette smokers (the National Plain Packaging Tracking Survey), Wakefield *et al*⁴ (this volume) demonstrated that the three specific objectives of the PP policy were largely achieved within the first year of implementation. Cigarette and cigarette packaging appeal reduced after implementation of the packaging changes. Smokers were more likely to report disliking the look of their pack, that their pack had lower appeal compared to a year ago, their cigarettes were of lower quality, less satisfying, and of lower value compared to a year ago, and that cigarette brands do not differ in prestige.⁴ Postimplementation, smokers were also more likely to notice the GHW first when they looked at their pack, to claim the GHWs had made them feel motivated to quit, and to report that they had tried to avoid the GHWs by deliberately concealing their pack and requesting a pack with a different health warning. Demonstrating the credibility of the GHWs, the proportion of smokers who did not believe that the dangers of smoking had been exaggerated remained stable at around two-thirds. Finally, there was some evidence that the packaging changes reduced the ability of tobacco packaging to mislead consumers. The proportion of smokers who believed brands do not differ in harm increased from before to after implementation. However, there was no change over time in the perception that cigarette brands differ in strength or that one's own cigarettes were more harmful compared to a year ago.⁴

Supplementing this evidence, Durkin *et al*⁵ (this volume) found increases in quitting-related cognitions and behaviours among adult cigarette smokers following implementation of PP with



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larger GHWs. The National Plain Packaging Tracking Survey was extended to a cohort study by recontacting smokers 1 month later, which allowed for comparisons in the rate of 1-month change in quitting-related outcomes for cohorts surveyed during the preimplementation, transition and postimplementation periods. Most notably, compared with smokers surveyed before the packaging changes, those who completed their follow-up survey after full implementation were more likely to report that in the past month they had concealed their pack, stubbed out cigarettes prematurely and attempted to quit.⁵

Although no research has yet specifically examined predictive relationships between proximal responses to the Australian packaging changes and subsequent quitting-related outcomes, it is reasonable to expect that these measures will be prospectively related. Cigarette packaging—as one of many forms of cigarette marketing—is known to play an important role in driving the initiation, continuation and cessation of smoking behaviour,^{6–11} and exposure to GHWs has been shown to increase quitting cognitions and attempts¹² and even to reduce smoking prevalence.¹³ In the light of evidence that PP with larger GHWs had the desired effect on both the specific objectives of the PP legislation⁴ and also on a number of more distal outcomes,⁵ the aim of the current study was to investigate associations between these proximal and distal measures of effectiveness of the packaging changes. Specifically, we examined whether each of the variables that Wakefield *et al*⁴ used to measure the effectiveness of PP with larger GHWs and that were found to change in the expected direction following implementation prospectively predicted each of the quitting-related cognitions and behaviours examined by Durkin *et al*⁵ (thoughts about quitting, intentions to quit, pack concealment, stubbing out, stopping oneself from smoking and attempting to quit). Evidence of prospective relationships between these proximal and distal measures would shed light on the *mechanisms* through which PP with larger GHWs may contribute to quitting cognitions and behaviours.

METHODS

Study design and procedure

Using dual frame random digit dialling telephone surveys (response rate 57%), we conducted a prospective cohort study in which respondents completed a follow-up interview approximately 1 month after baseline (median time to follow-up=29 days, range=18–64 days; mean retention rate per month=83%, range=78%–87%). The study procedure is described in more detail elsewhere.^{4 5 14}

Sample

For the purposes of this study, the sample was restricted to current smokers of factory-made or roll-your-own cigarettes (currently smoked daily or weekly, or smoked monthly or less-than-monthly but self-identified as a smoker rather than as an ex-smoker) who completed their baseline and follow-up surveys during the first year of implementation of the packaging changes; that is, after 1 December 2012 and before 30 November 2013 (prior to implementation of the 12.5% tax increase for tobacco products that occurred in Australia on 1 December 2013). We further limited the sample to those who had valid data on all covariates (>98% of cases). In total, within this period, 4240 (weighted; n(unweighted)=4229) cigarette smokers completed their baseline survey and 3125 (weighted; n(unweighted)=3081) of these also completed the follow-up survey.

We used two analytical samples. First, cigarette smokers at baseline who continued to be cigarette smokers at follow-up ('continuing cigarette smokers'; n(weighted)=2948; n

(unweighted)=2907) were used in models predicting all outcomes except for quit attempts. Second, cigarette smokers at baseline who completed the follow-up survey ('baseline cigarette smokers'; n(weighted)=3125; n(unweighted)=3081) were used in models predicting the likelihood that smokers had attempted to quit in the month between the baseline and follow-up surveys.

Outcome measures

Quitting-related cognitions

As described by Durkin *et al*,^{5 14} in the baseline and follow-up interviews we measured the occurrence of *thoughts about quitting in the past week* (thought about quitting once or several times a day vs thought about quitting only once every few days, once or not at all). *Intentions to quit* were measured by asking respondents whether they intended to quit in the next month (yes vs no or do not know/cannot say), and by further asking those who intended to quit if they had set a *firm date to quit* in the next month (yes vs no or do not know/cannot say (including those who did not intend to quit)).

Pack concealment and microindicators of concern

At baseline and follow-up, we asked respondents to report how frequently in the past month they had *concealed or covered their cigarette packs, stubbed out a cigarette* because they thought about the harms of smoking, and had *stopped themselves from smoking* when they had an urge to smoke. Response options for all three measures were dichotomised to allow us to compare those who had engaged in the behaviour several or many times in the past month with those who had performed the behaviour never or just once or twice.^{5 14}

Quit attempts

At baseline, respondents were asked whether they had ever attempted to quit smoking and, if so, how long it had been since their last quit attempt. At follow-up, those who had been current smokers at baseline were asked if they were still smoking and, if so, whether they had made any attempts to quit smoking over the past month. Our measure of *attempts to quit* between baseline and follow-up included all baseline smokers who had made a quit attempt, including those who were still smoking and those who were quit at follow-up (ie, had made a successful quit attempt). Given the evidence that the recency of previous quit attempts is an important predictor of subsequent quit attempts,¹⁵ we controlled for smokers' recent quitting history using a five-category measure: never tried to quit; tried to quit more than 12 months ago; tried to quit between 6 and 12 months ago; tried to quit between 2 and 6 months ago or tried to quit within the past month.

Predictor variables

Appeal variables

As predictor variables, we used six appeal-related variables that changed from preimplementation to postimplementation in a direction consistent with the aims of the PP legislation.⁴ At baseline, respondents: (1) indicated whether they liked the look of their current cigarette pack (somewhat or strongly disagreed that they liked their pack vs all other responses); rated their current cigarettes as being higher, lower or about the same compared to a year ago in terms of (2) appeal of the packaging, (3) quality, (4) satisfaction and (5) value for money (lower compared to a year ago vs all others); and (6) reported whether they believed there are differences between brands in prestige (no vs yes/do not know).¹⁴

Health warning effectiveness variables

Five GHW effectiveness variables changed in a direction consistent with the aims of the PP legislation.⁴ At baseline, respondents indicated: (1) whether they usually noticed the GHW first when looking at a pack of cigarettes (vs noticing other aspects of the pack first, such as branding); (2) whether they agreed or disagreed that the dangers of smoking have been exaggerated (somewhat/strongly disagree vs neutral and agree responses); (3) whether the health warnings made them feel more motivated to quit (much more motivated vs all others); and whether they had tried to avoid the GHWs in the past month by (4) covering up or concealing their pack or putting their cigarettes in another container (several or many times vs other responses) or (5) requesting a pack with a different health warning on it (yes vs no).¹⁴

Perceived harm variables

The one harm perception variable that changed in a direction consistent with the aims of PP⁴ was also included. Smokers were asked whether they believed that some cigarette brands are more harmful than others (no vs yes/do not know).¹⁴

Balance between enjoyment and concern

Deciding to give up smoking can be conceptualised as a struggle between factors that enhance the enjoyment of smoking and factors that increase concern about the impact of smoking.¹⁶ Although reducing enjoyment and increasing concern were not the primary objectives of the PP legislation, it is likely that these two constructs would be influenced by cigarette appeal, GHW effectiveness and perceived harm, and in combination, they have been found to predict quitting-related outcomes.¹⁷ We created a baseline measure of the balance between enjoyment and concern from items measuring how often respondents had thought about how much they enjoy smoking in the past month: 1=never; 2=once or twice; 3=several times or 4=many times, and how concerned they were that smoking may affect or has already affected their own personal health: 1=not at all; 2=a little concerned; 3=somewhat concerned; 4=very concerned and 5=extremely concerned. We then standardised these two variables using z-scores and subtracted the standardised 'concern' score from the standardised 'enjoyment' score. After inspecting a histogram of resulting scores to identify natural cut points, we constructed a categorical variable with three levels: more enjoyment (<1 SD below the mean); balanced between enjoyment and concern; and more concern (>1 SD above the mean).

Covariates

At baseline, respondents reported their sex, age and highest level of education. Socioeconomic status was measured using the Australian Bureau of Statistics' Index of Socio-Economic Disadvantage, using the 2011 census data of the postcode area in which respondents resided.¹⁸ Respondents also reported the number of cigarettes smoked per day and the time to first cigarette, which were combined into the Heaviness of Smoking Index.¹⁹

We sourced records from ACNielsen of monthly Target Audience Rating Points (TARPs) for adults aged 18 and above for all antismoking campaigns aired on television over the survey period. TARPs represent potential exposure to advertising. Consistent with previous research which has shown that effects of antismoking advertising occur within 3-month periods,^{20 21} we used a cumulative sum of the previous 3 months' TARPs, based on the date of follow-up. Cigarette costliness in the month of follow-up interview was calculated as

the ratio of the average recommended retail price (RRP) of the top 10 brands (weighted by market share) to the average weekly earnings in the respondents' state of residence.²² We controlled for percentage change in costliness over the past 3 months, in those survey months in which RRP's increased due to excise/customs duty indexation¹⁴: percentage change in costliness in February 2013, $M=3.29$, $SE=0.05$; August 2013, $M=0.42$, $SE=0.08$.

Statistical analysis

The baseline sample was weighted using a design weight and a poststratification weight, accounting for telephony status (landline or mobile), gender, age by education, and state of residence.^{4 14} The follow-up sample was weighted using a longitudinal weight, derived from an adjustment to the baseline weighting variable, which accounted for each participant's probability of being retained in the follow-up sample.^{5 14}

We conducted a series of initial logistic regression models to examine the association between each predictor and each outcome (ie, one model per predictor/outcome). When more than one significant predictor (at $p<0.05$) of an outcome was identified, we then conducted a multivariable model that included all predictors associated with the outcome at $p<0.05$, so as to identify the strongest independent predictors. We conducted initial and multivariable models that were unadjusted (presented in appendix A of the online supplementary material) and adjusted for the covariates described above as well as the date of the follow-up survey and the number of days between surveys (results from adjusted models are presented here in tables and text). Unadjusted and adjusted models both controlled for the baseline level of the outcome variable.

We conducted two sets of sensitivity testing. First, to examine the possibility that associations between the predictors and the outcomes were influenced by the anticipation of the 12.5% tax increase on 1 December 2013 rather than the packaging changes, we repeated all adjusted analyses excluding respondents who were followed up in November 2013 ($n(\text{weighted})=297$ baseline cigarette smokers and 284 continuing cigarette smokers). Second, previous research has indicated that interest in quitting tends to be lower in the last 3 weeks of December and higher in the first 2 weeks of January.²³ As none of the respondents in this study were followed up in December, we repeated all adjusted analyses including an indicator variable to capture the January seasonality effect.

All analyses were conducted in Stata V12.1,²⁴ adjusting for the effects of sample weighting on parameter estimates and SEs. In addition, an unconditional approach was used to limit the sample as appropriate for each set of analyses, ensuring correct estimation of the SEs. Cases that had missing data on outcome variables, the baseline versions of these variables and predictor variables (typically <5% combined) were deleted listwise from each model.

RESULTS

Table 1 presents sample characteristics, and descriptive statistics for the predictor variables and outcome variables.

Predicting quitting-related cognitions

Among continuing cigarette smokers at follow-up, 36.5% reported that they had thought about quitting at least daily in the past week. Table 2 shows that, in the initial models, cigarette smokers who at baseline disliked the look of their pack were significantly more likely to report thinking about quitting at least daily at follow-up, compared with those who did not dislike the

Table 1 Sample characteristics, predictor variables at baseline, and outcome variables at follow-up for continuing and baseline cigarette smokers at follow-up

	Continuing cigarette smokers at follow-up* (N=2948)	Baseline cigarette smokers at follow-up† (N=3125)
<i>Sample characteristics at baseline and covariates</i>		
	%	%
Sex		
Males	54.7	55.1
Females	45.3	44.9
Age (years)		
18–29	27.3	28.1
30–49	46.7	46.4
50–69	25.9	25.6
Highest level of education		
Less than high school	33.4	32.9
Completed high school/some tertiary	54.4	54.3
Tertiary or above	12.2	12.8
Socioeconomic status		
Low	41.4	41.0
Mid	41.6	42.0
High	17.0	17.0
	Mean (SE)	Mean (SE)
Heaviness of smoking index (0–6)	2.23 (0.04)	2.17 (0.04)
Days between baseline and follow-up survey	30.08 (0.10)	30.11 (0.10)
Antismoking advertising in past 3 months	1447 (17.2)	1446 (16.8)
<i>Predictor variables at baseline</i>		
	%	%
Appeal variables		
Dislikes pack	79.9	79.5
Lower pack appeal	48.9	48.7
Lower quality	26.3	26.1
Lower satisfaction	20.6	20.5
Lower value for money	55.1	55.0
Believes brands <i>do not</i> differ in prestige	48.2	48.0
Health warning effectiveness variables		
Notices GHW first when looking at pack	65.9	66.1
<i>Does not</i> believe dangers of smoking are exaggerated	62.1	62.9
Attributes much more motivation to quit to GHWs	12.4	13.3
Concealed or covered pack in past month	23.0	23.0
Requested different GHW in past month	8.9	9.1
Perceived harm variables		
Believes brands <i>do not</i> differ in harmfulness	67.8	67.3
Balance between enjoyment and concern		
More enjoyment	16.4	21.0
Balance	58.5	55.2
More concern	23.0	21.7
<i>Outcome variables at follow-up</i>		
Quitting-related cognitions		
Daily thoughts about quitting in past week	36.5	–
Intend to quit in next month	36.5	–
Firm date to quit in next month	6.7	–
Pack concealment and microindicators of concern		
Concealed or covered pack several or many times in past month	19.5	–
Stubbed out several or many times in past month	26.7	–
Stopped oneself from smoking several or many times in past month	37.8	–
Quitting behaviours		
Attempted to quit in past month	–	23.6

All data are weighted using longitudinal weights. Owing to rounding and missing data on outcome variables (including do not know, not applicable and refused responses), percentages may not sum to 100. Descriptive data for the covariate capturing percentage change in cigarette costliness are presented in text.

*Sample used in analyses predicting daily thoughts about quitting, intentions to quit in next month, firm date to quit in next month, pack concealment, stubbing out and stopping oneself from smoking.

†Sample used in analyses predicting attempts to quit in past month.

GHW, graphic health warning.

look of their pack. Similarly, smokers who at baseline reported less satisfaction from their cigarettes compared to a year ago were more likely to report daily thoughts about quitting. Quitting thoughts were also significantly and positively predicted by noticing GHWs first, disagreeing that the dangers of smoking have been exaggerated, attributing motivation to quit to the GHWs and pack concealment. Quitting thoughts were unrelated to believing brands *do not* differ in harm, but were positively predicted by feeling more concern than enjoyment. Entering all of these significant predictors into a multivariable model changed the pattern of results only slightly: the predictive effects of noticing GHWs first and feeling more concern than enjoyment were no longer statistically significant (table 2).

Among continuing cigarette smokers at follow-up, 36.5% intended to quit within the next month. No appeal variables predicted intentions, but in the initial models, smokers were significantly more likely to intend to quit if at baseline they reported noticing GHWs first, disagreeing that the dangers of smoking have been exaggerated and attributing motivation to quit to the GHWs. Intentions were also significantly and positively predicted by feeling more concern than enjoyment. In the multivariable model, the predictive effect of all variables except noticing GHWs first remained statistically significant (table 2).

Smokers who intended to quit were further asked if they had set a firm date to quit, and 6.7% of all continuing smokers reported that they had. Having a firm date to quit was significantly and positively predicted in the initial models by GHW noticeability, disagreeing that the dangers of smoking have been exaggerated and attributing motivation to quit to the GHWs. The pattern and significance of findings remained in the multivariable model (table 2).

Predicting pack concealment and microindicators of concern

Among continuing cigarette smokers at follow-up, 19.5% reported that they had concealed or covered up their cigarette pack several or many times in the past month. None of the predictor variables were significantly associated with pack concealment in the initial models, so no multivariable model was conducted (table 3).

Just over one-quarter (26.7%) of continuing smokers reported that they had stubbed out a cigarette at least several times in the past month. In the initial models, stubbing out was significantly and positively predicted by lower satisfaction compared to a year ago; by GHW noticeability, attributing motivation to quit, pack concealment and requesting a different GHW; and by feeling more concern than enjoyment. The multivariable model showed a similar pattern of results (table 3).

More than two-thirds (37.8%) of continuing cigarette smokers reported that they had stopped themselves from having a cigarette at least several times in the past month. In the initial models, stopping smoking was significantly and positively predicted by lower satisfaction compared to a year ago, disagreeing that the dangers of smoking have been exaggerated, attributing motivation to quit to GHWs and feeling more concern than enjoyment. In the multivariable model, the predictive effects of attributing motivation to quit to GHWs and feeling more concern than enjoyment were no longer statistically significant (table 3).

Predicting quit attempts

Overall, 23.6% of baseline cigarette smokers had made an attempt to quit in the month between their baseline and follow-up survey (including those who had relapsed to smoking *and* those who were still quit at follow-up). In the initial models, quit attempts were significantly predicted by one appeal variable: unexpectedly, smokers who believed that brands *do*

not differ in prestige were significantly *less likely* to have attempted to quit, although this effect did not remain statistically significant in the multivariable model. In contrast, smokers were more than twice as likely to have attempted if they attributed motivation to quit to GHWs, and if they had requested a pack with a different GHW, and both of these effects remained significant in the multivariable model. Finally, quit attempts were also predicted by the perceived harm variable. Unexpectedly, smokers who believed that brands *do not* differ in harmfulness were *less likely* to have attempted to quit at follow-up, although again this effect did not remain statistically significant in the multivariable model (table 4).

Sensitivity testing

Appendix A in the online supplementary material presents results for initial and multivariable models that were unadjusted for covariates, and shows that there was very little difference in the overall pattern of findings. Online supplementary appendices B and C show that the two sets of sensitivity testing also did not change the overall pattern of results.

DISCUSSION

We found consistent evidence in the multivariable models that indicators of GHW effectiveness were prospectively related to 1-month changes in several of the quitting-related outcomes. In particular, smokers were more likely to have engaged in four of the seven quitting cognitions and behaviours if they did not believe that the dangers of smoking are exaggerated (an indicator of GHW credibility), and they were significantly more likely to have engaged in five of the seven outcomes if they attributed motivation to quit to GHWs. Consistent with evidence of the role that GHWs play in promoting smoking cessation^{12 13 25 26} and experimental research demonstrating that GHWs are more effective when they appear on plain packs,^{27–31} these findings suggest that the short-term increases in quitting-related intentions and behaviours observed in Australia following implementation of PP with larger GHWs⁵ are most likely explained by smokers' responses to the new and larger GHWs.

In the multivariable models, we also found that smokers who experienced more concern than enjoyment from their smoking were significantly more likely to have an intention to quit, and to report stubbing out. In contrast, the belief that brands *do not* differ in harmfulness was not significantly associated with any of the outcomes, and only some of the appeal variables were prospectively related to quitting-related cognitions and behaviours: smokers who at baseline disliked the look of their cigarette pack were more likely to report daily thoughts about quitting, and those who reported lower satisfaction were more likely to report daily thoughts about quitting, stubbing out and stopping oneself from smoking.

Providing further evidence that GHW effectiveness may be the primary driver of the observed increases in quitting cognitions and behaviours among adult smokers, the initial models revealed an additional four significant effects of appeal, perceived harm and enjoyment/concern variables that did not remain statistically significant once entered into the multivariable model with the GHW effectiveness variables. Besides this small number of effects though, the pattern of results (including the magnitude of effects) was largely the same across the initial and multivariable models—particularly for the GHW effectiveness variables—indicating that the various predictors explain unique variance in the outcomes. In particular, results from the multivariable models predicting quitting thoughts and the two microindicators of concern suggest that the effect of lower

Table 2 Associations between appeal, health warning effectiveness, perceived harm and enjoyment/concern variables measured at baseline, and quitting-related cognitions measured at 1-month follow-up among continuing cigarette smokers

	Daily thoughts about quitting in past week		Intend to quit in next month		Firm date to quit in next month	
	Initial models (N=2565 to 2915)	Multivariable model (N=2571)	Initial models (N=2584 to 2995)	Multivariable model (N=2831)	Initial models (N=2584 to 2995)	Multivariable model (N=2883)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Appeal variables						
Dislikes pack	1.59** (1.17 to 2.16)	1.38* (1.00 to 1.89)	1.16 (0.85 to 1.57)	–	1.01 (0.62 to 1.63)	–
Lower pack appeal	1.01 (0.81 to 1.26)	–	1.00 (0.80 to 1.25)	–	1.19 (0.82 to 1.73)	–
Lower quality	1.26 (1.00 to 1.59)	–	1.00 (0.78 to 1.27)	–	0.96 (0.65 to 1.41)	–
Lower satisfaction	1.46** (1.13 to 1.88)	1.49** (1.14 to 1.95)	1.19 (0.92 to 1.53)	–	1.33 (0.90 to 1.97)	–
Lower value for money	1.12 (0.91 to 1.38)	–	1.01 (0.81 to 1.24)	–	1.06 (0.76 to 1.48)	–
Believes brands <i>do not</i> differ in prestige	0.90 (0.72 to 1.11)	–	1.08 (0.87 to 1.33)	–	0.93 (0.65 to 1.32)	–
Health warning effectiveness variables						
Notices GHW first when looking at pack	1.37** (1.10 to 1.72)	1.07 (0.84 to 1.35)	1.32* (1.06 to 1.64)	1.20 (0.95 to 1.50)	1.82** (1.23 to 2.71)	1.60* (1.06 to 2.40)
<i>Does not</i> believe dangers of smoking are exaggerated	1.72*** (1.38 to 2.14)	1.69*** (1.33 to 2.15)	1.48*** (1.19 to 1.84)	1.39** (1.11 to 1.75)	1.64* (1.12 to 2.40)	1.50* (1.02 to 2.23)
Attributes much more motivation to quit to GHWs	2.72*** (1.90 to 3.90)	2.52*** (1.71 to 3.73)	1.71*** (1.24 to 2.36)	1.48* (1.06 to 2.07)	2.00** (1.29 to 3.11)	1.81** (1.17 to 2.78)
Concealed or covered pack in past month	1.61*** (1.28 to 2.03)	1.46** (1.14 to 1.88)	1.03 (0.82 to 1.30)	–	0.91 (0.61 to 1.36)	–
Requested different GHW in past month	1.00 (0.68 to 1.48)	–	1.26 (0.86 to 1.85)	–	0.95 (0.53 to 1.68)	–
Perceived harm variables						
Believes brands <i>do not</i> differ in harmfulness	0.83 (0.66 to 1.04)	–	0.86 (0.68 to 1.08)	–	0.89 (0.61 to 1.29)	–
Balance between enjoyment and concern						
More enjoyment	1.00	1.00	1.00	1.00	1.00	–
Balance	1.19 (0.88 to 1.60)	1.02 (0.74 to 1.39)	1.34 (0.98 to 1.82)	1.21 (0.89 to 1.65)	0.93 (0.57 to 1.52)	–
More concern	1.59** (1.13 to 2.24)	1.25 (0.87 to 1.81)	2.29*** (1.61 to 3.25)	1.96*** (1.37 to 2.82)	1.30 (0.76 to 2.23)	–

Bolded results are statistically significant at $p < 0.05$. The weighted N per initial model varies due to missing data on outcome variables and predictor variables. The weighted N for each multivariable model includes only those cases with valid data on the outcome variable and all of the predictor variables included in the model. All models adjust for the outcome variable measured at baseline and for: date of the follow-up survey; number of days between baseline and follow-up survey; cumulative Target Audience Rating Points (antismoking television advertising) in the 3 months prior to the follow-up survey; change in cigarette costliness (based on month of the follow-up survey); sex; age; education; socioeconomic status and Heaviness of Smoking Index (measured at baseline). – Predictor variable not included in multivariable model due to non-significant (at $p < 0.05$) association with outcome variable in initial model.

*** $p \leq 0.001$, ** $p < 0.01$, * $p < 0.05$.

GHW, graphic health warning.

Table 3 Associations between appeal, health warning effectiveness, perceived harm and enjoyment/concern variables measured at baseline, and pack concealment and microindicators of concern measured at 1-month follow-up among continuing cigarette smokers

	Concealed or covered pack several or many times in past month		Stubbed out several or many times in past month		Stopped oneself from smoking several or many times in past month	
	Initial models (N=2568 to 2899)	Initial models (N=2566 to 2919)	Multivariable model (N=2559)	Initial models (N=2567 to 2913)	Multivariable model (N=2770)	
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	
Appeal variables						
Dislikes pack	1.05 (0.69 to 1.61)	1.40 (1.00 to 1.95)	–	1.13 (0.85 to 1.50)	–	
Lower pack appeal	1.25 (0.94 to 1.66)	1.11 (0.88 to 1.40)	–	1.17 (0.95 to 1.44)	–	
Lower quality	1.07 (0.80 to 1.41)	1.12 (0.88 to 1.43)	–	1.07 (0.86 to 1.33)	–	
Lower satisfaction	1.07 (0.78 to 1.45)	1.36* (1.05 to 1.77)	1.41* (1.07 to 1.84)	1.36* (1.07 to 1.72)	1.38** (1.09 to 1.76)	
Lower value for money	0.94 (0.71 to 1.23)	0.94 (0.76 to 1.18)	–	1.10 (0.90 to 1.35)	–	
Believes brands <i>do not</i> differ in prestige	0.93 (0.71 to 1.21)	1.08 (0.86 to 1.35)	–	0.99 (0.82 to 1.21)	–	
Health warning effectiveness variables						
Notices GHW first when looking at pack	0.95 (0.72 to 1.26)	1.51*** (1.19 to 1.91)	1.46** (1.13 to 1.88)	1.09 (0.89 to 1.33)	–	
<i>Does not</i> believe dangers of smoking are exaggerated	0.91 (0.70 to 1.18)	1.14 (0.91 to 1.42)	–	1.31** (1.07 to 1.60)	1.35** (1.09 to 1.67)	
Attributes much more motivation to quit to GHWs	1.26 (0.84 to 1.89)	1.93*** (1.38 to 2.71)	1.75** (1.23 to 2.48)	1.39* (1.02 to 1.90)	1.32 (0.95 to 1.83)	
Concealed or covered pack in past month	–	1.37** (1.08 to 1.74)	1.32* (1.03 to 1.69)	1.21 (0.97 to 1.50)	–	
Requested different GHW in past month	1.46 (0.93 to 2.28)	1.57* (1.07 to 2.30)	1.49 (0.99 to 2.22)	1.27 (0.89 to 1.82)	–	
Perceived harm variables						
Believes brands <i>do not</i> differ in harmfulness	0.96 (0.72 to 1.27)	0.86 (0.68 to 1.10)	–	0.98 (0.79 to 1.22)	–	
Balance between enjoyment and concern						
More enjoyment	1.00	1.00	1.00	1.00	1.00	
Balance	1.01 (0.70 to 1.46)	1.18 (0.86 to 1.62)	1.15 (0.82 to 1.62)	1.18 (0.90 to 1.56)	1.14 (0.85 to 1.52)	
More concern	0.91 (0.60 to 1.38)	1.79*** (1.27 to 2.52)	1.62* (1.12 to 2.34)	1.43* (1.04 to 1.96)	1.31 (0.94 to 1.82)	

Bolded results are statistically significant at $p < 0.05$. The weighted N per initial model varies due to missing data on outcome variables and predictor variables. The weighted N for each multivariable model includes only those cases with valid data on the outcome variable and all of the predictor variables included in the model. All models adjust for the outcome variable measured at baseline and for: date of the follow-up survey; number of days between baseline and follow-up survey; cumulative Target Audience Rating Points (antismoking television advertising) in the 3 months prior to the follow-up survey; change in cigarette costliness (based on month of the follow-up survey); sex; age; education; socioeconomic status and Heaviness of Smoking Index (measured at baseline). – Predictor variable not included in multivariable model due to non-significant (at $p < 0.05$) association with outcome variable in initial model.

*** $p \leq 0.001$, ** $p < 0.01$, * $p < 0.05$.

GHW, graphic health warning.

perceived satisfaction after the packaging changes contributed to these quitting-related cognitions and behaviours independently of responses that were more closely tied to the new GHWs.

Although caution must be exercised when interpreting findings that were not part of a systematic pattern of effects and were not significant in the multivariable models, we do note that two of the findings in the initial models were in an unexpected direction and are difficult to explain (negative associations between believing that brands *do not* differ in prestige/harmfulness and quit attempts). It may be that these appeal and perceived harm variables operate in different ways for different smokers, influenced by factors such as the brand and variant they smoke (eg, cigarettes from premium, mainstream or value brand segments) and their history with that brand. It is also possible that the impact of these beliefs may be moderated by responses to the GHWs. Furthermore, it is possible that the predictive effects observed in this study are different for different demographic subgroups, particularly given that Wakefield *et al*⁴ found greater change on the appeal variables for younger than older adult smokers. Further research is required to investigate

the possibility that the predictive effects observed in this study may be conditional on demographic and smoker characteristics.

It is possible that the variables measured in this study are related to each other in more complex ways.³² For example, one recent study identified a series of mediational pathways through which health warnings lead to quit attempts,¹² while another used structural equation models to explore associations between aspects of cigarette and cigarette packaging appeal, and cigarette consumption and quit attempts.³³ In addition, longitudinal studies have established that quitting-related cognitions and microindicators of concern predict attempts to quit.^{17 34–37} Studies that more thoroughly investigate the pathways through which PP and GHW policies lead to changes in smoking behaviours are critical.

A particular strength of this study is the use of a cohort design, with a good retention rate and a nationally representative sample. In these analyses, respondents acted as their own control, allowing us to minimise the influence of unobserved individual differences and any time-invariant response biases. While these analyses provide some confidence that the proposed causal order between variables is the correct one, further

Table 4 Associations between appeal, health warning effectiveness, perceived harm and enjoyment/concern variables measured at baseline, and quit attempts measured at 1-month follow-up among baseline cigarette smokers

	Initial models (N=2726 to 3116) OR (95% CI)	Multivariable model (N=2964) OR (95% CI)
Appeal variables		
Dislikes pack	0.89 (0.66 to 1.20)	–
Lower pack appeal	1.04 (0.83 to 1.30)	–
Lower quality	1.22 (0.96 to 1.56)	–
Lower satisfaction	1.12 (0.87 to 1.45)	–
Lower value for money	1.03 (0.83 to 1.29)	–
Believes brands <i>do not</i> differ in prestige	0.79* (0.64 to 0.98)	0.88 (0.70 to 1.10)
Health warning effectiveness variables		
Notices GHW first when looking at pack	1.05 (0.83 to 1.33)	–
<i>Does not</i> believe dangers of smoking are exaggerated	0.98 (0.78 to 1.23)	–
Attributes much more motivation to quit to GHWs	2.31*** (1.73 to 3.09)	2.15*** (1.59 to 2.91)
Concealed pack in past month	1.20 (0.94 to 1.52)	–
Requested different GHW in past month	2.04*** (1.43 to 2.89)	1.88*** (1.30 to 2.71)
Perceived harm variables		
Believes brands <i>do not</i> differ in harmfulness	0.78* (0.62 to 0.99)	0.86 (0.68 to 1.09)
Balance between enjoyment and concern		
More enjoyment	1.00	–
Balance	0.98 (0.72 to 1.34)	–
More concern	1.40 (0.99 to 1.99)	–

Bolded results are statistically significant at $p < 0.05$. The weighted N per initial model varies due to missing data on the outcome variable and predictor variables. The weighted N for the multivariable model includes only those cases with valid data on the outcome variable and all of the predictor variables included in the model. All models adjust for recency of the last quit attempt made at baseline and for: date of the follow-up survey; number of days between baseline and follow-up survey; cumulative Target Audience Rating Points (antismoking television advertising) in the 3 months prior to the follow-up survey; change in cigarette costliness (based on month of the follow-up survey); sex; age; education; socioeconomic status and Heaviness of Smoking Index (measured at baseline). –Predictor variable not included in multivariable model due to non-significant (at $p < 0.05$) association with outcome variable in initial model.

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

GHW, graphic health warning.

mediation analyses and controlled experimental studies are required to establish if the appeal, GHW effectiveness, perceived harm and enjoyment/concern variables are causally responsible for the observed changes in quitting-related outcomes.⁵ Nonetheless, the policy relevance of these findings is reinforced by the fact that we controlled for other factors known to predict quitting (antismoking television advertising and changes in cigarette costliness) and also found that the effects were robust to adjustments for seasonality effects and any anticipatory effects related to the December 2013 tax increase. The short duration of the 1-month follow-up period meant that we were unable to fairly assess rates of sustained quitting and engagement in other behaviours that smokers may use to circumvent heightened feelings of risk, including switching products or reducing daily cigarette consumption. These low incidence outcomes would be better assessed in longer term cohort studies.

Overall, the current findings strengthen the evidence base for PP with larger GHWs by demonstrating that quitting-related cognitions and behaviours are prospectively predicted by the more proximal beliefs and perceptions widely used as outcome measures in the experimental and naturalistic studies that helped make the case for PP.^{10 11 38} Our findings suggest that, among adults, increased GHW effectiveness is likely to be particularly influential in driving quitting behaviour. As such, these results contrast with study findings of adolescents, where implementation of the new packaging was found to lead adolescents to have fewer favourable and more unfavourable perceptions of cigarette packs,³⁹ with little evidence that the new GHWs had an effect.⁴⁰ However, our understanding of the role that the appeal of cigarettes and cigarette packaging plays in influencing adult smoking behaviour may be improved by further examining

interactive relationships between the appeal, GHW effectiveness and perceived harm variables, and by testing whether these effects are conditional on smoker characteristics.

What this paper adds

- ▶ This is the first study to examine whether the proximal measures of plain packaging with larger and refreshed graphic health warning effectiveness—measures of appeal, graphic health warning effectiveness and perceived harm—predict subsequent changes in quitting-related cognitions and behaviours.
- ▶ Using a prospective cohort study with a nationally representative sample of Australian adult cigarette smokers surveyed within the first year of plain packaging, we found increased graphic health warning effectiveness to be particularly influential in driving adult quitting cognitions and behaviour, some influence for select appeal variables and no contribution from accurate harm perceptions.
- ▶ These findings provide initial insight into the mechanisms through which plain packaging with larger and refreshed graphic health warnings is likely to bring about changes in smoking behaviours.

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Contributors MW designed the study. KC and MZ managed the data collection and cleaned the data files. EB and SD analysed the data and interpreted the results. EB drafted the manuscript with contributions from all authors. All authors approved the final manuscript.

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