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Nicotine replacement therapy to aid gradual cessation in smokers with no intention to quit: Association between reduction quantity and later abstinence

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ABSTRACT

Objective. We examined how quantity and trajectory of smoking reduction influence later abstinence in smokers without intention to quit and being prescribed free nicotine replacement therapy (NRT).

Method. We conducted an *a posteriori* analysis from a data archive of adult smokers in a randomized controlled trial of smoking reduction using counseling and free NRT ($n = 928$). Reduction was analyzed as the absolute and percentage decrease in self-reported daily cigarette consumption at three follow-ups (1 week, 1 and 3 months) compared with the baseline. Logistic regression model and multiple imputation were used to examine the association between early reduction and abstinence at 6 months.

Results. Reducing 10% of cigarette consumption at the three follow-ups was associated with 16% (95% CI 5–28%), 23% (95%CI 11–36%) and 27% (95% CI 13–42%) increase in abstinence, respectively. Greater reduction predicted abstinence when the percentage reduction was more than one-third (above 31.4%). Progressive increase in the percentage reduction predicted more abstinence (OR = 1.90, 95%CI 1.01–3.58).

Conclusions. Greater percentage reduction by at least one-third and progressive reduction predicted abstinence in those who reduced smoking. Such new evidence can guide the improvement of clinical service for tobacco dependency treatment and support further studies on smoking reduction and cessation.

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Introduction

Smoking kills 6 million people each year in the world (World Health Organization, 2011). Tobacco control interventions have successfully reduced the global smoking prevalence in the past decade, but the decline has slowed down recently (Ng et al., 2014). To help smokers to quit, smoking reduction is an alternative harm reduction strategy to reduce first with the assistance of nicotine replacement therapy (NRT) and behavioral counseling before abstinence.(National Institute for Health and Clinical Excellence, 2013).

The review by Lindson-Hawley et al. (2012) summarized a few mechanisms for smoking reduction and abstinence: from the view of psychopathology, reduction in nicotine dose reduces drug dependence and withdrawal symptoms (Mooney et al., 2011); from the view of cognitive psychology, smoking reduction may increase self-efficacy and the likelihood to quit (Lindson-Hawley et al., 2012). While traditional cessation strategies (e.g., motivational interviewing, stage-matched intervention) might not help some smokers to achieve cessation, reduction is appealing because making progression towards the goal of complete cessation reflects visible behavioral change (Carpenter et al., 2004). Experimental studies have found that smoking reduction intervention combining medication and counseling is effective for smokers without intention to quit (Asfar et al., 2011; Batra et al., 2005; Bolliger et al., 2000; Carpenter et al., 2004; Chan et al., 2011; Rennard et al., 2006; Shiffman et al., 2009; Wennike et al., 2003), but it is not clear whether the increase in quitting is due to NRT availability, reduction itself, or both (Asfar et al., 2011).

Although a few studies have found the dose–response effect between reduction quantity and later abstinence (Broms et al., 2008; Falba et al., 2004; Farkas, 1999; Hughes et al., 2004), these studies arbitrarily categorized reduction quantity and assumed a few thresholds of reduction for cessation. Other associations such as curvilinear association have not been examined.

The association between reduction quantity at one time point and abstinence has been supported by a few prospective studies (Farkas, 1999; McDermott et al., 2008; Meyer et al., 2003), but no studies has examined the effect of continued reduction over a period of time. In reality, smokers may either reduce cigarette consumption progressively

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before a quit attempt, or maintain a certain level of the percentage reduction. Progressively reducing smoking might help smoker perceive that complete abstinence is achievable without abruptly changing their current behavior (Lindson-Hawley et al., 2012).

The present *a posteriori* analysis, based on data from our previously published RCT, which helped smokers without quitting intention to use NRT for smoking reduction (Chan et al., 2011), aimed to examine the association between the quantity of smoking reduction at the follow-ups and abstinence at the final follow-up. Our two research questions were as follows: (1) What was the association between the quantity of smoking reduction (measured in absolute and percentage reduction) and the likelihood of later abstinence? (2) Did progressive increase in the smoking reduction during the study period predict later abstinence?

Materials and methods

Data

The archived data of 928 smokers recruited to the RCT and received smoking reduction intervention during October 2004 to April 2007 were analyzed (Chan et al., 2011). The RCT aimed to examine the effectiveness of smoking reduction counseling plus free NRT in the smokers not willing to quit. All subjects were daily Chinese smokers who reported no intention to quit in the near future but were interested in reducing smoking within the next 7 days. They were recruited through announcements in the local media and contacting previous cohorts of smokers who failed to quit in Hong Kong. They were randomly allocated to two intervention groups and one control group by opening a serially labeled, opaque and sealed envelope with a card inside. All subjects provided written consent. The study was approved by the Institutional Review Board of the Hong Kong West Cluster of Hong Kong Hospital Authority (Ref. UW 03-103 T/103).

Intervention

Both intervention group A1 ($n = 479$) and A2 ($n = 449$) received a 15-min face-to-face counseling on smoking reduction by trained smoking cessation counselors and free NRT for eight weeks in total (Supplementary material 1). The counseling for groups A1 and A2 emphasized that the goal of smoking reduction was abstinence. Trained counselors advised the participants the importance of smoking reduction, how reduction is useful and effective when quitting is difficult, and how to develop a tailored smoking reduction schedule. The counselors in the trial advised the participants to increase reduction at 1-week and 1-month follow-up, but the participants had the autonomy to alter their reduction amount. In addition, group A1 also received 3-min counseling of adherence to NRT, which followed the guidelines on adherence interventions by the World Health Organization (World Health Organization, 2003) (Supplementary material 2 and 3). The control group only received a 10-min brief advice on the health hazards of smoking and the importance of smoking cessation at baseline only. All the participants of the 3 groups were given a 12-page self-help quitting pamphlet, "Tips for Quit Smoking," produced by Hong Kong Council on Smoking and Health. The present analysis included the subjects in groups A1 and A2 as they were followed up at 1 week, 1 month, 3 months and 6 months.

Outcome measurements

All subjects were asked if they smoked in the past 7 days at all follow-ups for the primary outcome of the point prevalence of abstinence. For those who reported smoking in the past 7 days at the 1-week follow-up, they were then asked the mean daily cigarette consumption in the past week. Participants who reported smoking at 1-, 3- and 6-month follow-up were asked about their mean daily cigarette consumption in the past month. Participants were classified as reducers at a particular follow-up if the number of self-reported daily cigarette consumption was less than baseline. At the 1-week and 1-month face-to-face follow-up, exhaled carbon monoxide (CO) and urinary cotinine level were collected. Self-reported quitters who reported no smoking in the past 7 days at the 6-month follow-up were invited for the biochemical verification. Validated quitters were identified if their exhaled CO was less than 9 parts per million and urinary cotinine concentration was less than 115 ng/ml.

Covariates

Demographic information, including gender, age, household income and whether living with children at home, was enquired. Self-perceived importance, difficulty and confidence to reduce were assessed with the following questions on a rating scale from 0 to 100: (1) How important is it for you to reduce smoking? (2) How much difficulty do you think you will have in reducing smoking? (3) How much confidence do you have that you will be able to reduce smoking by at least 50% of your current level? Smoking-related information included whether having previous quit attempt in lifetime, years of daily smoking, daily cigarette consumption (<15 versus ≥ 15) and 6-item Fagerstrom Test for Nicotine Dependence (Heatherton et al., 1991). We assessed the adherence to NRT at the 1-week, 1-month and 3-month follow-up by enquiring if they had ever consumed or consumed all the NRT prescribed at the previous follow-up. Treatment condition (group A1 versus group A2) was also included as an adjustment factor.

Data analysis

The percentage reduction was calculated by dividing the difference of daily cigarette consumption between baseline and a particular follow-up by the number of cigarettes consumed at baseline. Descriptive statistics about the reduction quantity by different smoking status and reduction at all follow-ups are shown in Table 2. Multiple logistic regression models were used to examine the predictive power of absolute and percentage reduction on the 6-month abstinence in the participants who had not quit at those follow-ups. Each model examined the reduction quantity at one particular follow-up, in absolute or in percentage reduction, to predict the 6-month abstinence. All the models were adjusted for treatment condition (group A1 versus group A2), baseline demographic, smoking characteristics and adherence to NRT. To test the curvilinear association between reduction and cessation, quadratic transformation of the absolute and percentage reduction was included in the models. Wald test of the regression coefficient for the quadratic term was conducted. If the coefficient was significant, a scatterplot and a fitted quadratic line were used to demonstrate the curvilinear association.

The second set of regression model estimated the predictive power of increasing reduction from 1-week to 3-month follow-up on the 6-month abstinence in four separate regression models, where the predictors included (1) smokers with increased reduction from 1 week to 1 month, (2) smokers with increased reduction from 1 month to 3 months, (3) smokers with increased reduction from 1 week to 3 months and (4) smokers with increased reduction throughout the three follow-ups. The reference group in these regression models included participants who reported no increase in smoking reduction.

To provide more robust estimate with missing values of cigarette consumption due to loss to follow-up, Markov Chain Monte Carlo (MCMC) was used to implement multiple imputation procedure for the missing values (Rubin, 2004; Schafer, 1997). The imputation generated 20 data sets with imputed missing data with the factors relating to cigarette consumption in 1-week, 1-, 3- and 6-month follow-up. All the data analysis were conducted with SAS version 9.2.

Table 1
Baseline characteristics of the participants in the intervention groups (all participants, groups A1 and A2).

		All ($n = 928$)	Group A1 ($n = 479$)	Group A2 ($n = 449$)
Sex, n(%)	Male	748 (80.6)	373 (77.9)	375 (83.5)
	Female	180(19.4)	106 (22.1)	74 (16.5)
Age, mean ± SD, years		41.9 ± 10.3	41.5 ± 10.3	42.4 ± 10.3
Marital status, n(%)	Married/cohabiting	658(70.9)	323 (67.4)	335 (74.8)
	Others	270(29.1)	156 (32.6)	113 (25.2)
Education level, n(%)	Primary or below	101(10.9)	53 (11.1)	48 (10.7)
	Secondary	608(65.5)	331 (69.1)	329 (73.4)
	Tertiary or above	218(23.5)	95 (19.8)	71 (15.8)
Age started smoking, mean ± SD, years		17.8 ± 4.7	18.0 ± 4.6	17.5 ± 4.8
Years of regular smoking, mean ± SD		24.1 ± 10.4	23.5 ± 10.8	24.8 ± 9.9
Daily cigarette consumption, mean ± SD		19.9 ± 9.8	19.8 ± 9.4	20.1 ± 10.1
Fagerstrom Nicotine Dependence Score, mean ± SD		5.2 ± 2.3	5.3 ± 2.3	5.2 ± 2.4
Lifetime quit attempt before trial, n(%)	None	204(22.0)	104 (21.8)	100 (22.4)
	1 attempt	266(28.7)	144 (30.1)	122 (27.4)
	2 to 5 attempts	370(39.9)	178 (37.2)	192 (43.0)
	6 to 10 attempts	32(3.4)	21 (4.4)	11 (2.5)
	more than 10 attempts	52(5.6)	31 (6.5)	21 (4.7)
Used nicotine replacement therapy before trial, n(%)		359(38.7)	193 (40.3)	166 (37.1)
Importance in reducting smoking, mean ± SD		82.7 ± 17.2	82.8 ± 17.3	82.5 ± 17.2
Difficulty in reducing smoking, mean ± SD		69.4 ± 22.2	69.0 ± 22.7	69.8 ± 21.7
Confidence in reducing smoking, mean ± SD		64.1 ± 20.3	64.9 ± 20.1	63.3 ± 20.5
Choice of NRT in the study, n(%)	Patch (15 mg)	578(62.3)	306 (64.0)	272 (60.6)
	Gum (2 mg)	257(27.7)	133 (27.8)	124 (27.6)
	Gum(4 mg)	89(9.6)	39 (8.2)	50 (11.1)
	Refused to use NRT when offered	3 (0.4)	0 (0.0)	3 (0.6)

Results

No significant difference in the socio-demographic and smoking characteristics between groups A1 and A2 at the baseline was found. The proportions of using NRT patch and gum for the intervention were 61.2% and 38.7%, respectively (Table 1). Over 60% of the participants had reduced smoking in each follow-up (Table 2). The quit rate increased progressively from 2.3% at 1 week to 16.9% at 6 months. Any use of NRT since baseline when asked at the 1-week, 1-month and 3-month follow-up was 85.2%, 75.8% and 82.4%, respectively. The self-reported complete adherence of NRT at all the follow-up was over 50%. It was associated with higher percentage reduction at all the follow-ups, but was not associated with abstinence (Supplementary material 4). The regression models were adjusted for complete NRT adherence, socio-demographic and smoking characteristics at baseline. Exhaled CO values decreased as the participants reduced more cigarettes.

From the regression analysis, there was about 3–5% increase in the odds of abstinence per 1 cigarette reduced at 1-week, 1-month or 3-month follow-up compared to baseline (Table 3). Reducing 10% of cigarette consumption at the three follow-ups was associated with 16% (95% CI 5–28%), 23% (95%CI 11–36%) and 27% (95% CI 13–42%) increase of the odds of abstinence at 6-month follow-up, respectively (Table 3). The dose–response effect was significant for reductions at all follow-up, except 1-week absolute reduction. Percentage reduction and later follow-up had better goodness of fit than absolute reduction and early follow-up (Fig. 1).

Curvilinear association between reduction and abstinence was assessed by adding a quadratic term of reduction quantity in each regression model. Small magnitudes of all quadratic terms were observed (Beta < 0.001). Only the quadratic term of 1-month absolute (Beta $= -0.00387$, $p = 0.02$), and 3-month percentage reduction (Beta $= 0.00063$, $p < 0.01$) was significant (Table 3). The scatter plot of predicted probability against reduction showed the linear relationship for the absolute and percentage reduction at 1 week, percentage reduction at 1 month and absolute reduction at 3 months and the curvilinear association for the absolute reduction at 1 month and percentage reduction at 3 months. In the regression model with the quadratic term of 3-month percentage reduction, the inflection point for the fitted curve was 31.4%, indicating the positive association between percent reduction and abstinence when the percent reduction was higher than 31.4%.

Participants who increased the reduction at 1 month (compared with 1-week reduction) and 3 months (compared with reduction at 1 week and 1 month) had an insignificantly higher quit rate than those who maintained or decreased the percentage reduction (Table 4). Progressive increase in reduction from the 1-week to 3-month follow-up significantly increased the odds of abstinence (OR = 1.90, 95%CI = 1.01–3.58).

Discussion

The present study showed the overall dose–response relationship between reduction and abstinence in smokers who had no intention to quit and received free NRT, which was consistent with previous cohort studies which targeted all smokers (Falba et al., 2004; Farkas, 1999; Hughes et al., 1999, 2004). Greater and progressive reduction may be associated with higher motivation to quit, which was suggested as a moderator between reduction and cessation (Cheong et al., 2007). However, the goodness of fit in the linear models was relatively poor when early reduction and absolute reduction in cigarettes were considered. The dose–response effect of percentage reduction was more stable than absolute reduction, and the latter was consistent with another study that the absolute reduction of cigarettes was not associated with quit rate (Farkas, 1999). Smokers with large absolute reduction might have large cigarette consumption at baseline, which would confound the dose–response relationship between absolute reduction and abstinence. The percentage reduction at 3-month and abstinence at 6-month had a curvilinear relationship, such that greater reduction predicted abstinence when the percentage reduction was more than one-third. The predicted probability of abstinence was very low (below 0.1) when the percent reduction was below 31.4%, which suggested that too small a reduction does not help reduce the nicotine dependence (Lindson-Hawley et al., 2012; Mooney et al., 2011). Also, smokers who received intensive intervention but reduced only a little might have a lower motivation to continue the quitting process and thus a lower likelihood to quit successfully.

The present study provided preliminary evidence that smokers who increased their percentage reduction progressively were more likely to quit eventually than those who did not reduce or did not increase their

Table 2
Smoking and quitting status of participants at follow-ups ($n = 928$).

	1 week		1 month		3 months		6 months	
	n	%	*n*	%	*n*	%	*n*	%
Smoking status (compared to baseline)								
No reduction	31	3.3	34	3.7	76	8.2	113	12.2
Reduced smoking	748	64.8	658	70.9	615	66.3	561	60.5
Quitted smoking	26	2.3	44	4.7	105	11.3	157	16.9
Missing/lost to follow-up	123	10.7	192	20.7	132	14.2	97	10.5
Mean number of daily cigarettes (SD) (All smokers)	11.8 (7.0)		10.1 (6.9)		10.2 (7.4)		11.6 (7.8)	
Mean number of daily cigarettes (Reducers only)	11.6 (6.8)		9.7 (6.5)		9.0 (6.1)		10.1 (6.4)	
Mean % cigarette reduction compared with baseline (SD) (Reducers only)	42.3 (18.5)		52.0 (20.1)		55.7 (22.2)		49.0 (22.4)	
Cigarette reduction								
1–24.9%	127	17.0	61	9.3	55	8.9	69	11.4
25–49.9%	342	45.7	219	33.3	147	23.9	204	33.7
50–74.9%	235	31.4	281	42.7	271	44.1	241	39.8
75–99.9%	44	5.9	97	14.7	142	23.1	91	15.0
Used any prescribed NRT*	791	85.2	703	75.8	765	82.4	NA	NA
Used all prescribed NRT**	542	58.4	483	52.1	498	53.7	NA	NA
Mean exhaled carbon monoxide (parts per million) (SD)								
No reduction	13.6 (8.1)		12.3 (8.0)		NA	NA	NA	NA
Reduced smoking 1–24.9%	16.9 (9.5)		14.6 (9.2)		NA	NA	NA	NA
Reduced smoking 25–49.9%	14.4 (7.7)$^{+}$		13.3 (7.5)		NA	NA	NA	NA
Reduced smoking 50–74.9%	11.0 (7.9)$^{++}$		10.8 (8.0)$^{++}$		NA	NA	NA	NA
Reduced smoking 74.9–99.9%	8.3 (7.2)$^{++}$		4.5 (4.5)$^{+++}$		NA	NA	NA	NA
Quitted smoking	2.1 (1.3)$^{+++}$		1.9 (1.4)$^{+++}$		NA	NA	NA	NA
Mean urine cotinine (ng/ml) (SD)								
No reduction	5.5 (0.8)		5.0 (1.7)		NA	NA	NA	NA
Reduced smoking 1–24.9%	5.6 (0.5)		5.4 (1.0)		NA	NA	NA	NA
Reduced smoking 25–49.9%	5.6 (0.7)		5.5 (1.0)		NA	NA	NA	NA
Reduced smoking 50–74.9%	5.4 (0.9)		5.3 (0.9)		NA	NA	NA	NA
Reduced smoking 75–99.9%	4.9 (1.1)$^{++}$		5.1 (1.0)		NA	NA	NA	NA
Quitted smoking	3.8 (2.0)$^{+++}$		3.6 (1.2)$^{+++}$		NA	NA	NA	NA

***Independent t-test showed that the readings of exhaled carbon monoxide and urinary cotinine were significantly different from the group of "reduced smoking 1–24.9%" ($^{+}p < 0.05$; $^{++}p < 0.01$; $^{+++}p < 0.001$).

* 1-week follow-up: any use of prescribed NRT in the past 7 days; 1-month follow-up: any use of prescribed NRT in the past month; 3-month follow-up: any use of prescribed NRT in the past 3 months.

** 1-week follow-up: Used all NRT in the past 7 days; 1-month follow-up: Used all NRT in the past month; 3-month follow-up: Used all NRT in the past 3 months.

reduction. It is consistent with the psychopathological view that progressive increase in the reduction quantity may increase self-efficacy and thereby their motivation to quit eventually (Lindson-Hawley et al., 2012). Only the smokers who could maintain and increase reduction at all follow-ups showed more abstinence significantly because they showed a higher persistency in reducing smoking towards the cessation goal. In the reference groups of the regression models in Table 4, some smokers might have quit abruptly without going through the reduction process, which might reduce the influence of reduction.

Given the current evidence, NRT-aided smoking reduction is an effective quitting strategy in smokers with no intention to quit. They should be given structured assistance to reduce by at least one-third and increase the reduction throughout the pre-quit period. More importantly, before recommending any strategies to the smokers, counselors should understand the smokers' motivation to quit and perceived difficulty to reduce. If the strategy of smoking reduction is applicable, counselors should design scheduled targets of reduction and discuss how to adhere to the schedule with the smoker.

The present study was the first to examine the association between smoking reduction and cessation in a large sample of Chinese smokers who had no intention to quit. Instead of arbitrary categorization of reduction quantity, we regressed on both absolute and percentage reduction as continuous variables to predict the outcomes. Both linear and curvilinear associations were examined. However, there were a few limitations. The current analysis relied on self-reported cigarette consumption of the participants at each follow-up, which might be subject to recall bias. The level of exhaled carbon monoxide of the participants was measured at 1-week and 1-month follow-up, but it might be affected by the temporal proximity to recent smoking and could not validate reduction. Hence, we used the self-reported number of cigarettes smoked as the unit of analysis. At the final follow-up, because biochemical validation of abstinence was voluntary, only 84 of the 181 quitters (46.4%) participated. A major limitation of the present study was that validated abstinence was not the primary outcome. Second, the present study did not address the rate of smoking reduction. Smokers who could quickly reduce cigarette consumption might be more capable to handle withdrawal symptoms and had a higher likelihood to quit. Lastly, the study design did not provide sufficient evidence for the casual relationship of greater reduction and abstinence. An RCT allocating smokers to a large or a small reduction intervention is more appropriate to test the difference.

Conclusion

This *a posteriori* analysis of RCT data found that greater reduction in smoking predicted more abstinence in smokers who had no intention to quit and had used NRT. Progressively increasing the percentage reduction during the pre-quit period was predictive of more abstinence. Such new evidence can guide the improvement of clinical service for

Table 3
Odds ratios and regression coefficients of abstinence at 6 months by smoking reduction quantity (excluding participants lost to follow-up and quitters at follow-ups).

Follow-up time	Predictor	Adjusted OR of abstinence (95%CI)	Regression coefficient	*p*-value
1-week ($n = 748$)	Per 1 cigarette reduced	1.03 (1.00, 1.07)		0.09
	Per 10% cigarette reduced	1.16 (1.05, 1.28)		<0.01
	Quadratic term of cigarette reduction		−0.00156	0.25
	Quadratic term of percentage reduction		0.00012	0.49
1-month ($n = 658$)	Per 1 cigarette reduced	1.05 (1.01, 1.08)		0.01
	Per 10% cigarette reduced	1.23 (1.11, 1.36)		<0.01
	Quadratic term of cigarette reduction		−0.00387	0.02
	Quadratic term of percentage reduction		0.00001	0.60
3-month ($n = 615$)	Per 1 cigarette reduced	1.03 (1.00, 1.74)		0.03
	Per 10% cigarette reduced	1.27 (1.13, 1.42)		<0.01
	Quadratic term of cigarette reduction		−0.00239	0.10
	Quadratic term of percentage reduction		0.00063	<0.01

Adjusted variables: gender, age, household income group, previous quit attempt, self-perceived importance, difficulty and confidence to reduce smoking, Fagerstrom Test for Nicotine Dependence, living with children at home, years of daily smoking, daily cigarette consumption ≥15, adherence to NRT during the follow-up period.

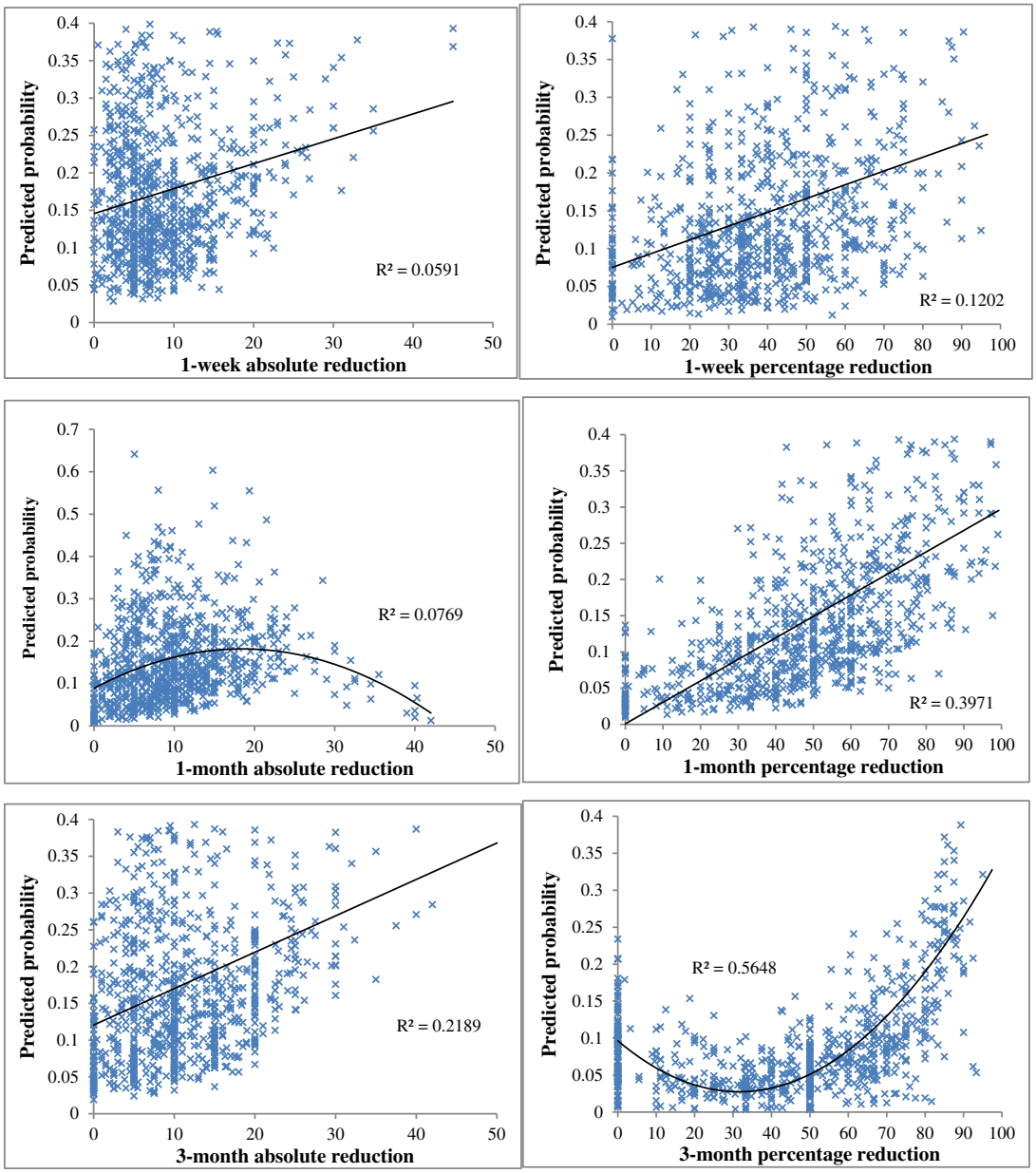

Fig. 1. Scatterplot of the predicted probability of 6-month abstinence against reduction of cigarette consumption at 1-week, 1-month and 3-month follow-up.

Table 4
Quit rate at 6-month follow-up by increasing percentage reduction (excluding participants lost to follow-up and quitters at follow-ups).

Increased reduction in daily cigarette consumption, follow-up time		Quit rate at 6-month	Adj. OR (95% CI)	*p*-value
1-month > 1-week ($n = 639$)	Yes	68/416 (16.3%)	1.31 (0.80, 2.14)	0.28
	No*	29/223 (13.0%)		
3-month > 1-month ($n = 555$)	Yes	27/257 (10.5%)	1.57 (0.89, 2.77)	0.12
	No*	22/298 (7.4%)		
3-month > 1-week ($n = 607$)	Yes	39/369 (10.6%)	1.58 (0.88, 2.82)	0.12
	No*	19/238 (8.0%)		
3-month > 1-month > 1-week ($n = 517$)	Yes	20/154 (13.0%)	1.90 (1.01, 3.58)	0.04
	No*	26/363 (7.2%)		

Adjusted variables: gender, age, household income group, previous quit attempt, self-perceived importance, difficulty and confidence to reduce smoking, Fagerstrom Test for Nicotine Dependence, living with children at home, years of daily smoking, daily cigarette consumption ≥ 15, and adherence to NRT during the follow-up period.

* The reference group included those reducers who did not increase percentage reduction, or had the same percentage reduction as previous.

tobacco dependency treatment and support further studies on smoking reduction and cessation.

Clinical trial registration number: ISRCTN05172176 (http://www.controlled-trials.com).

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Conflict of interest

This work was supported by the Health and Health Services research Fund, Hong Kong SAR, grant no. 01030611. Nicotine patches/gum provided free of charge to the subjects were provided free from Pfizer, later named as McNeil AB. The research funding body and Pfizer were not involved in the design and conduct of the study, in the collection, management, analysis or interpretation of the data, or in the preparation, review or approval of the manuscript. Moreover, we do not have any connection with any researchers of the tobacco, alcohol, pharmaceutical or gaming industries or

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References

Asfar, T., Ebbert, J.O., Klesges, R.C., Relyea, G.E., 2011. Do smoking reduction interventions promote cessation in smokers not ready to quit? Addict. Behav. 36, 764–768.
Batra, A., Klingler, K., Landfeldt, B., Friederich, H.M., Westin, A., Danielsson, T., 2005. Smoking reduction treatment with 4-mg nicotine gum: a double-blind, randomized, placebo-controlled study. Clin. Pharmacol. Ther. 78, 689–696.
Bolliger, C.T., Zellweger, J.-P., Danielsson, T., et al., 2000. Smoking reduction with oral nicotine inhalers: double blind, randomised clinical trial of efficacy and safety. BMJ 321, 329–333.
Broms, U., Korhonen, T., Kaprio, J., 2008. Smoking reduction predicts cessation: longitudinal evidence from the Finnish Adult Twin Cohort. Nicotine Tob. Res. 10, 423–427.
Carpenter, M.J., Hughes, J.R., Solomon, L.J., Callas, P.W., 2004. Both smoking reduction with nicotine replacement therapy and motivational advice increase future cessation among smokers unmotivated to quit. J. Consult. Clin. Psychol. 72, 371–381.
Chan, S.S.C., Leung, D.Y.P., Abdullah, A.S.M., Wong, V.T., Hedley, A.J., Lam, T.-H., 2011. A randomized controlled trial of a smoking reduction plus nicotine replacement therapy intervention for smokers not willing to quit smoking. Addiction 106, 1155–1163.
Cheong, Y., Yong, H.-H., Borland, R., 2007. Does how you quit affect success? A comparison between abrupt and gradual methods using data from the International Tobacco Control Policy Evaluation Study. Nicotine Tob. Res. 9, 801–810.
Falba, T., Jofre-Bonet, M., Busch, S., Duchovny, N., Sindelar, J., 2004. Reduction of quantity smoked predicts future cessation among older smokers. Addiction 99, 93–102.
Farkas, A.J., 1999. When does cigarette fading increase the likelihood of future cessation? Ann. Behav. Med. 21, 71–76.
Heatherton, T.F., Kozlowski, L.T., Frecker, R.C., Fagerstrom, K.-O., 1991. The Fagerstrom Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. Br. J. Addict. 86, 1119–1127.
Hughes, J.R., Cummings, K.M., Hyland, A., 1999. Ability of smokers to reduce their smoking and its association with future smoking cessation. Addiction 94, 109–114.
Hughes, J.R., Lindgren, P.G., Connett, J.E., Nides, M.A., 2004. Smoking reduction in the Lung Health Study. Nicotine Tob. Res. 6, 275–280.
Lindson-Hawley, N., Aveyard, P., Hughes, J.R., 2012. Reduction versus abrupt cessation in smokers who want to quit. Cochrane Database Syst. Rev. 2012, 11.
McDermott, L., Dobson, A., Owen, N., 2008. Smoking reduction and cessation among young adult women: a 7-year prospective analysis. Nicotine Tob. Res. 10, 1457–1466.
Meyer, C., Rumpf, H.-J., Schumann, A., Hapke, U., John, U., 2003. Intentionally reduced smoking among untreated general population smokers: prevalence, stability, prediction of smoking behaviour change and differences between subjects choosing either reduction or abstinence. Addiction 98, 1101–1110.
Mooney, M.E., Johnson, E.O., Breslau, N., Bierut, L.J., Hatsukami, D.K., 2011. Cigarette smoking reduction and changes in nicotine dependence. Nicotine Tob. Res. 13, 426–430.
National Institute for Health and Clinical Excellence, 2013. Tobacco: harm-reduction approaches to smoking. Public Health Guidance 45. National Institute for Health and Clinical Excellence, Manchester, The UK.
Ng, M., Freeman, M.K., Fleming, T.D., et al., 2014. SMoking prevalence and cigarette consumption in 187 countries, 1980–2012. JAMA 311, 183–192.
Rennard, S.I., Glover, E.D., Leischow, S., et al., 2006. Efficacy of the nicotine inhaler in smoking reduction: a double-blind, randomized trial. Nicotine Tob. Res. 8, 555–564.
Rubin, D.B., 2004. Multiple Imputation for Nonresponse in Surveys. John Wiley & Sons, New York.
Schafer, J., 1997. Analysis of Incomplete Multivariate Data. Chapman and Hall, New York.
Shiffman, S., Ferguson, S.G., Strahs, K.R., 2009. Quitting by gradual smoking reduction using nicotine Gum: a randomized controlled trial. Am. J. Prev. Med. 36, 96–104 (e1).
Wennike, P., Danielsson, T., Landfeldt, B., Westin, Å., Tønnesen, P., 2003. Smoking reduction promotes smoking cessation: results from a double blind, randomized, placebo-controlled trial of nicotine gum with 2-year follow-up. Addiction 98, 1395–1402.
World Health Organization, 2003. Adherence to Long-Term Therapies: Evidence for Action. World Health Organization, Geneva.
World Health Organization, 2011. WHO Report on the Global Tobacco Epidemic, 2011. World Health Organization, 2008, Geneva.