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Effects of simple active referrals of different intensities on smoking abstinence and smoking cessation services attendance: a cluster randomised clinical trial

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Abstract

Background and aims

Proactive brief cessation advice by a lay counsellor combined with a referral to a smoking cessation service (active referral) is effective in increasing service use and quitting in community smokers. We compared the effect of two modified approaches to referrals on the cessation outcomes in community smokers.

Design

Three-arm cluster-randomised trial.

Setting

General community in Hong Kong.

Participants

Daily cigarette smokers (n=1163; 77.7% male).

Interventions

Participants were randomised to receive onsite active referral (OSR, n=395), where lay counsellors helped participants make appointments with a smoking cessation service of their choice plus tailored reminders; mobile text messaging referral (TMR, n=385), where participants were encouraged to use a smoking cessation service via text messages; or brief cessation advice only (Control, n=383).

Measurements

The primary outcome was a self-reported 7-day point-prevalence abstinence at 6 months post-treatment initiation. Secondary outcomes included 7-day point-prevalence abstinence at 3 and 18 months, biochemically validated abstinence, smoking reduction and the use of cessation services at 3, 6 and 18 months.

Findings

Using the intention-to-treat analysis, the OSR (17.7%) and TMR (17.1%) groups had significantly higher self-reported abstinence than the Control (12.0%) group at 6 months (odds ratio [OR] for OSR vs. Control=1.58, 95% confidence interval [CI]=1.06-2.36; OR for TMR vs. Control=1.52, 95% CI=1.01-2.28; both $P<0.05$). The corresponding validated abstinence rates at 6 months were 7.6%, 7.8% and 3.9% (OR for TMR vs. Control=2.02, 95% CI=1.07-3.81; OR for TMR vs. Control=2.07, 95% CI=1.10-3.92; both $P<0.05$). Self-reported and validated abstinence were similar at 18 months. OSR groups had higher rates of smoking cessation service use than the Control group at all follow-ups (all $P<0.001$). The smoking reduction rates were similar in continuing smokers.

Conclusions

Simple active referrals (in person or via text messaging) to smoking cessation services increased abstinence rates among smokers in Hong Kong compared with general brief cessation advice. Onsite active referral increased the use of smoking cessation services compared with general brief cessation advice.

Introduction

The low engagement of smokers in evidence-based treatment for tobacco dependence has substantial public health implications. Only a third (31.2% in 2015) of the smokers in the US tried to quit by using counselling and medication [1], and fewer than 5% of smokers attend a stop smoking service in the UK every year [2]. In Hong Kong, where the daily smoking prevalence was lower (10.0% in 2017), only of 2.4% smokers have ever used a smoking cessation service [3], which are free with proven effectiveness [4-6]. Promoting the use of smoking cessation services is a promising means to increase quitting.

Novel approaches to connect smokers to smoking cessation services have been increasingly studied [7-10]. The Ask-Advice-Connect trial in the US has found that sending smokers' contacts to quitline through the electronic health record system is effective in increasing treatment enrolment by 13 times [8]. The Start2quit trial in the UK has found that personalised risk information and an invitation to a taster session of smoking cessation services are effective in increasing service use and abstinence [10]. Our community-based trial (n=1226) found that lay counsellor-delivered referrals to smoking cessation services are effective in increasing service use and abstinence at 6 months (17.2% vs. 11.5%, *P*=0.03) in proactively recruited smokers [11]. In this trial, the contacts of the smokers who agreed to be referred were sent to their selected smoking cessation service providers. Subsequently, the service providers proactively called the participants for telephone counselling or scheduling appointments for the participant to visit a smoking cessation clinic. This approach of active referral, herein referred to as call-back referral (CBR), had a time lag of about 2 weeks between the selection of a service provider and them proactively calling the participants. However, about 70.9% of participants who agreed to be referred defaulted the appointment or missed the proactive call from the service providers, suggesting room for improvement [11]. Therefore, we developed two modified CBR approaches. The first approach, which was more intensive and personalised, aimed to reduce the time lag by helping smokers make an appointment with a smoking cessation service onsite during recruitment, followed by instant messaging reminders (onsite referral). The second, less intensive approach, used text messaging for promoting the use of smoking cessation services after initial contact with the participants at baseline (text-messaging referral).

The present trial tested the short-term (6 months) and long-term (18 months) effect of onsite referral and text-messaging referral on smoking abstinence and smoking cessation service attendance in community smokers.

Methods

Study overview

This is a three-arm, parallel, cluster randomised controlled trial wherein participants were randomised to receive an onsite referral (OSR), text messaging referral (TMR), or general cessation advice (Control). The trial was nested within a "Quit to Win" Contest for smoking cessation conducted in all 18 districts in Hong Kong [11-15]. The study protocol has been published elsewhere [16] and has been approved by the Institutional Review Board (IRB) of

the University of Hong Kong/Hospital Authority Hong Kong West Cluster (UW16-320). The trial has been registered with ClinicalsTrials.gov, number NCT03565796.

Procedures

From 19 June to 30 September 2016, participants were individually recruited from 68 community sites (e.g., housing estates, shopping malls, public transport hubs) throughout Hong Kong. Randomisation was done at the community site level; all participants within the same site received the same intervention. Similar to our previous trials [11, 13-15], we were assisted by trained smoke-free ambassadors, namely, undergraduate students and volunteers from nongovernmental organizations, to recruit participants and deliver baseline interventions. All ambassadors attended a one-day workshop and were tested on their knowledge, attitude and practice before participant recruitment. The trained ambassadors proactively approached smokers individually at a smoking hotspot in the vicinity of the recruitment sites using a 'foot-in-the-door' approach [16], wherein smokers were first asked about their smoking behaviours. The smokers were then invited to perform exhaled carbon monoxide (CO) tests and encouraged to join the study to quit or reduce their smoking. Participants were Hong Kong residents aged 18 years or older who had been smoking at least one cigarette daily over the past 3 months, validated by an exhaled CO level of ≥4 part per million; able to communicate in Cantonese; willing to quit or reduce smoking; and owned a mobile phone for follow-up. Those who were currently receiving other smoking cessation treatments or had a communication barrier, either physical or cognitive, were excluded. All eligible smokers who were willing to participate in the trial provided written consent and completed a baseline questionnaire before receiving their assigned treatment. Telephone follow-ups were conducted at 1, 2, 3, 6 and 18 months after baseline to assess the treatment outcomes. Participants who reported to have quit for at least 7 days at 3, 6, and 18 months were invited to participate in a face-to-face validation to confirm abstinence conducted by a trained research assistant (Appendix S1). Participants received a small cash incentive (HK$500≈US$64) for passing each validation test, which was found to have no effect on abstinence in our previous trial [17]. The last follow-up of the participants was completed on 30 June 2018.

Randomisation and masking

Participants were individually recruited and cluster-randomised (1:1:1) to the OSR group, TMR group or Control group based on the community sites (n=68). Although participants received the intervention at the individual level, cluster-randomisation was used to avoid potential intervention contamination between groups. The randomisation scheme was computer-generated by a researcher who was not involved in participant recruitment. The assignments were made in variable block sizes of either 3, 6 or 9 to ensure a similar number of participants in each group. The allocation was concealed from the ambassadors until the beginning of each recruitment session. Masking of the ambassadors and the participants was not possible due to the nature of the intervention; although, outcome assessors and statistical analysts were masked from the coding of the treatment groups' status.

Interventions

OSR group

The advice participants in the OSR group received was guided by the AWARD model (Ask, Warn, Advise, Refer and Do-it-again, Appendix S2), brief cessation advice modified from the 5As (Ask, Advise, Assess, Assist, and Arrange) for use in community settings [11-14]. Apart from asking about their smoking behaviour (Ask) and advising to quit or reduce smoking (Advise), the ambassadors also warned the participants about the harm of smoking using a health warning leaflet. The ambassadors then introduced the local smoking cessation services to the participants using a pocket-size referral card and offered onsite referral to their choice of a smoking cessation service (Refer). Smoking cessation treatments included individual psychological counselling (via telephone or face-to-face), group therapy, nicotine replacement therapy, smoking cessation medications, and acupuncture (Appendix S3) [4-6]. For participants who were willing to be referred, the ambassadors immediately made telephone calls to the service provider of their choice, made appointments with them, and relayed the details of the appointment (date, time and location of the clinic) to the participants. A reminder was sent to the participants 1 to 3 days before the scheduled appointment through WhatsApp, a mobile instant messaging app. Participants in the OSR group also received a message on WhatsApp daily until one month after baseline (Do-it-again). For smokers who did not use WhatsApp, they were contacted via short messaging service (SMS). The messages were tailored according to whether the participant had made an appointment with and attended a smoking cessation service. The messages, covered the harms of smoking and benefits of quitting, encouragements to quit and the use of smoking cessation services, and reminders to attend their appointment; these were aimed to increase the participants' motivation to use the services. During telephone follow-ups at 1, 2 and 3 months, participants who refused to be referred at baseline were also advised to use a smoking cessation service and offered referral to one.

TMR group

At the baseline, participants in the TMR group also received brief cessation advice guided by the AWARD model and were each given a health warning leaflet and a referral card. They were introduced (using the referral card) and motivated to use the smoking cessation services onsite. Although the participants were encouraged to use a smoking cessation service, the ambassadors did not refer them to any. Sixteen fixed scheduled and generic text messages (3 per week in the first month, then once a week in the second month) were sent to the participants through SMS. The messages mostly focused on encouraging the participants to use and make appointments with a smoking cessation service. Participants were also advised to use a smoking cessation service during telephone follow-up, although no referral was offered.

Control group

Participants in the Control group were asked about their smoking status and advised to quit or reduce smoking at baseline without information about the harms of smoking and smoking cessation services. That is, they received very brief general advice.

All participants received a 12-page self-help smoking cessation booklet at baseline. The summary of the intervention components of the 3 groups is available in the online supplementary material (Table S1).

Similar to our previous trials [11, 13-15], all ambassadors were instructed to follow a standardized recruitment script to ensure the accurate delivery of baseline interventions and print-based materials. At each recruitment session, a research assistant provided the necessary supervision and assistance to the ambassadors.

Measures

Baseline measures

The baseline questionnaire measured the participants' smoking and quitting behaviour, cigarette dependence (assessed by the heaviness of smoking index [18]), intention to quit, perception of quitting (importance, difficulty and confidence), and sociodemographic characteristics.

Outcome measures

The primary outcome was the self-reported 7-day point-prevalence abstinence (PPA) at 6 months after treatment initiation (3 months after the end of treatment), following established guidelines on outcome assessment in population-based smoking cessation studies [19]. Secondary outcomes included the 7-day PPA at 3 months (end of treatment) and at 18 months; bio-verified abstinence at 3, 6 and 18 months confirmed by the exhaled CO(<4 part per million) and salivary cotinine (<10 μg/L) tests [20, 21]; smoking reduction, defined by at least a 50% reduction in daily cigarette consumption compared with that at baseline; and cumulative use of the smoking cessation service, defined as having attended at least one treatment session delivered by a smoking cessation service provider.

Given the budget available when the study was conceived, we planned to follow the participants for 6 months after randomisation. In April 2018, with additional funding offered by the funding body, we added an 18-month follow-up for all participants to examine the long-term effect of the interventions. This change was approved by the IRB.

Data analyses

Sample size calculation

We calculated the required sample size based on the results from our previous trial on CBR [11], and assumed a self-reported 7-day PPA of 9.5% in the Control group and 17% in the TMR group at 6 months in the intention-to-treat population. Our analyses focused on the pairwise comparisons between the OSR and Control groups and between the TMR and Control groups; we expected that the more intensive OSR group would have a slightly higher quit rate than the TMR group. With a power of 80% and an allocation ratio of 1:1, 320 participants in each arm were required to detect a between-group difference at a two-sided 5% level of significance. To account for the potential clustering effect, we calculated the design effect (=1.255) by assuming an inter-cluster correlation coefficient of 0.015 for the

primary outcome [13] and an average cluster size of 18. Therefore, 1205 participants were required in the total sample.

Main analyses

The primary analyses were done using the intention-to-treat method. Participants with missing outcomes were assumed to have an unchanged smoking status and behaviour from the baseline, under an assumption of missing not at random. The analysis of variance method was used to calculate the intra-cluster correlation coefficients for each outcome, owing to a potential clustering effect. We used logistic regressions to compare the primary and secondary outcomes among the study groups because the clustering effect was found to be negligible (<0.001 for the primary outcome; Table S2). To account for potential imbalances in baseline characteristics, we also conducted multivariable logistic regression and adjusted baseline covariates that are known to predict smoking cessation. These include age, sex, marital status, nicotine dependency, quit attempt, reduction attempt, and intention to quit [22, 23]. Generalized estimating equation (GEE) models with a logit link and an exchangeable correlation structure were also used to examine the intervention effect, accounting for the potential clustering effect of recruitment sessions. Under the assumption of missing at random, we used multiple imputations by chained equation models to impute missing outcomes for testing sensitivity to missing data (Appendix S4). Inferences were drawn from 50 imputed datasets.

We also calculated the operation cost for each intervention; this consisted of expenses on manpower and materials needed for training, recruitment, and intervention delivery. A 2-sided P<0.050 was considered statistically significant for all tests. All statistical analyses were conducted using Stata/MP version 15.1.

Results

Participants

Of the 1344 smokers screened for eligibility, 1163 participants were eligible and consented to participate. The participants were cluster-randomised to the OSR group (n=395; 22 clusters), TMR group (n=385; 23 clusters), or Control group (n=383; 23 clusters). The mean age of the participants was 41.4 years (SD=16.7); 77.7% were male. The 3 groups showed similar baseline characteristics, except that the OSR group tended to have more participants with an intention to quit in 7 days than the TMR and Control groups (Table 1).

Smoking cessation outcomes

Overall follow-up rate was 72.9% at 6 months, which was similar in all 3 groups. Using an intention-to-treat analysis, the self-reported 7-day PPA was significantly higher in the OSR group than in the Control group at 3 months (14.4% vs. 8.6%, P=0.011) and 6 months post-treatment initiation (17.7% vs. 12.0%, P=0.025) (Table 2). Similarly, the self-reported PPA was higher in the TMR group than in the Control group at 3 months (13.0% vs. 8.6%, P=0.053) and 6 months (17.1% vs. 12.0%, P=0.045). The findings remained similar in the multivariable analyses, although the OR for TMR vs. OSR became insignificant.

The validated abstinence rates were also higher in the OSR and TMR groups than in the Control group at 6 months (7.6% and 7.8% vs. 3.9%; both P<0.050). The point estimates were similar after adjusting for baseline covariates. Self-reported and validated abstinence were similar among the 3 study groups at 18 months. The smoking reduction rates in participants who reported smoking in the past 7 days were similar among the 3 groups at all follow-up time points. The results were consistent in the GEE (Table S2) and multiple imputation models (Table S3).

Use of smoking cessation service

The use of smoking cessation services was significantly higher in the OSR group than in the Control groups at all follow-up timepoints (all P<0.001). There were no significant differences in the use of smoking cessation services between the TMR and Control groups. Pharmacotherapy (nicotine replacement therapy or smoking cessation medication) was the most common treatment received by the participants in the OSR group (63/106, 59.4%, Table 3). Individual psychological counselling (telephone or face-to-face) was most used by the TMR (17/31, 54.8%) and Control groups (13/27, 48.1%). Nearly two-thirds of the OSR participants (65.1%) who accepted referral failed to attend the smoking cessation services; 76.6% reported "busy schedule" as the primary reason. Bivariate analyses showed that the failure to attend the appointment was associated with a younger age, being single, having no child, and having no past quit attempt (Table S4).

Cost analyses

The total operating cost associated with training ambassadors (US $417), recruiting participants (US $25115), and following-up via telephone (US $221) was US $25753 (Tables 4). The average cost per participant assigned to each intervention was similar in the OSR (US $22.1), TMR (US $22.6) and Control (US $21.7) groups. The cost per participant with the self-reported PPA at 6 months was similar for the OSR (US $124.8) and TMR (US $131.9) groups, which were both about 30% lower than that of the Control group (US $180.7).

Discussion

This trial found that the two modified approaches of active referral—onsite referral and text-messaging referral—were more effective than providing general brief advice alone in increasing short-term (≤6 months post-treatment initiation) abstinence in a cohort of proactively recruited smokers in the community. The increase of about 60% in the self-reported PPA was moderate. The observed stronger effect on biochemically validated abstinence (about 90% increase) further corroborates the positive findings. The OSR yielded a 3-fold increase in the actual usage rate of smoking cessation services within 6 months compared to the Control group. The costs per self-reported abstinence at 6 months were comparable between the OSR and TMR groups and lower than the Control group.

This study has several strengths. We used a proactive, foot-in-the-door approach to recruit many smokers who would otherwise be unlikely to engage in smoking cessation; this includes smokers who were not willing to quit in the short-term (50.5%) and those without any previous quit attempt (62.9%). This also allowed us to recruit a more representative cohort of smokers, compared to if passive recruitment was used, to extend the applicability of

our findings to smokers in real-life situations. Another strength is the execution of an 18-month follow-up to assess the long-term intervention effect using biochemical validation of abstinence status; this is rarely done in large, population-based smoking cessation trials. All analyses were on an intention-to-treat basis to account for selective attrition.

We were able to assess the primary outcome in 72.9% of the participants, which was satisfactory given the difficulty in preventing attrition in community-based trials where the retention rate is typically about 65% [9, 24]. Although non-response (selection) bias could not be excluded, our sensitivity analyses using multiply imputed data yielded similar results. Another strength of our trial was the inclusion of biochemically validated abstinence as an outcome. This is often considered unnecessary in population-based trials of smoking cessation interventions with minimal contact between the investigators and participants [25]. The participation rate in the validation was about 51.1%, which was acceptable and comparable to our previous studies [11, 15] and trials conducted in similar settings elsewhere [10]. The participation rates were similar across the 3 study groups, and the relative effect sizes of self-reported and bio-verified abstinence outcomes were homogenous.

Our trial had some limitations. First, our trial did not include a group in which participants only received offers of a referral to a smoking cessation service onsite and without mobile messaging; this precluded the estimation of the individual effect of each component in the OSR and TMR groups. Factorial trials in which participants were randomised to receive onsite referral or mobile messaging or both or neither are needed. Nevertheless, the intervention model was developed to be readily implementable in the real-world setting. Second, the trial was not powered to compare the intervention effect between the OSR and TMR groups. The true effect of the OSR vs. TMR should be tested in future fully-powered trials. Third, despite randomisation, the OSR group tended to have more participants who were willing to quit in in 7 days than the other 2 groups at baseline, which is a known predictor of smoking cessation [22, 23]. Nevertheless, our sensitivity analyses adjusted baseline covariates and converged on similar results. Finally, the trial was conducted in Hong Kong, where smoking cessation services are mostly free. The costs of smoking cessation service providers were not included in the operating cost and our findings may not be applicable to places where free smoking cessation services are not available.

A significantly higher cumulative rate of the use of a smoking cessation service was observed in the OSR group than in the less intensive TMR group and the Control group. This, coupled with our observation that the use of a smoking cessation service is associated with increased abstinence at 6 months [15], suggested that the higher 6-month abstinence rate was attributable to the greater use of smoking cessation services in the OSR group than in the Control group. However, the TMR group had a higher abstinence rate than the Control group, despite a similar rate in the use of smoking cessation services. A possible explanation may be related to the use of text messages in the TMR groups, which has been found to have a moderate effect on 6-month abstinence in other randomised trials [26]. The text messages used in the TMR group might have contributed to the increased abstinence by pathways other

than promoting the use of a smoking cessation service, such as increased perceived psychosocial support [27].

The abstinence rate was only slightly, non-significantly higher in the OSR group, in which mobile messaging was also used, than in the TMR group. While speculative, it is possible that mobile messaging as an adjunct to an established treatment for tobacco dependence may confer minimal additional benefits, as observed in a recent pilot trial of varenicline plus text messaging versus varenicline alone [28] and a fully-powered trial of NRT plus text messaging versus NRT alone [29]. While TMR seems to be more cost-effective than OSR because of the low-intensity design, the intervention costs of the 2 groups were similar. The average costs per participant for recruitment and intervention delivery were low (US$21.6), suggesting a high applicability of our brief intervention models in places with limited healthcare resources [30].

Caution is needed in interpreting the results from the post-hoc 18-month follow-up as only half of the participants were successfully interviewed. The cumulative rates of the use of a smoking cessation service remained higher in the OSR group than in the TMR and Control groups, but no significant differences in both self-reported and validated abstinence were evident among the 3 groups. In the absence of evidence on the effect of treatment beyond 12 months from the initiation of smoking cessation services in Hong Kong, the inconsistent results call for studies to evaluate the long-term smoking cessation outcomes of the service providers. Nevertheless, the fact that a brief intervention model (with or without referral) led by lay counsellors could achieve a long-term (18-month) self-reported (16.2%) and validated abstinence rate (4.9%) in an unselected cohort of community smokers is remarkable. As we were only able to contact half of the participants at 18 months and used intention-to-treat analyses, this gave conservative treatment estimates; the true abstinence rate is likely to be greater in the original cohort.

Further studies are warranted to explore different strategies to boost attendance in smoking cessation services. Most smoking cessation clinics in Hong Kong provide service during office hours on weekdays. Since most participants reported “busy schedule” as the primary reason for failure to attend a scheduled appointment with service providers, changing or extending the opening hours to the evening and weekends maybe a solution. This also points to the need to develop effective smoking cessation interventions that can transcend geographical boundaries and time restrictions, such as mobile phone-based or “mHealth” support for smoking cessation [15, 26] to increase the reach and accessibility of tobacco dependence treatment.

Conclusions

Onsite active referral and mobile text-messaging referral increased the smoking abstinence rate at 6 months compared to simple, low cost, and proactive advice. Simple active referrals of different intensities showed similar smoking abstinence rates.

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Figure 1. Study flow chart

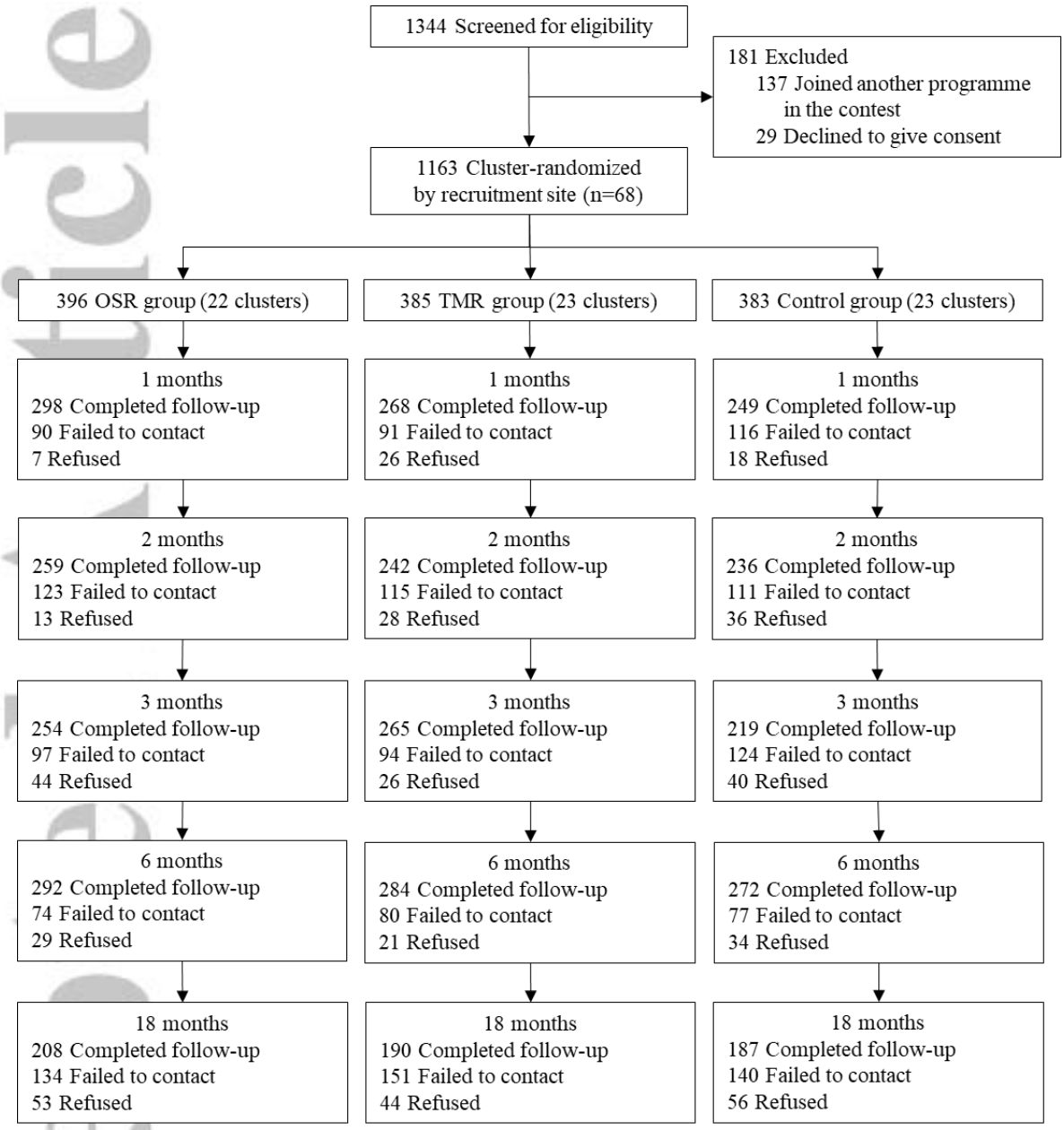

Table 1. Characteristics of the study participants (N=1163)

Characteristics, n (%)[†]	OSR (N=395)	TMR (N=385)	Control (N=383)
Age (years), mean ± SD	40.9 ± 16.3	41.0 ± 16.7	42.3 ± 17.1
Sex			
Male	311 (78.7)	301 (78.2)	291 (76.2)
Female	84 (21.3)	84 (21.8)	91 (23.8)
Marital status			
Single	157 (42.7)	162 (44.8)	137 (40.2)
Married/ Cohabited	199 (54.1)	185 (51.1)	185 (54.3)
Divorced/separated/ Widowed	12 (3.3)	15 (4.1)	19 (5.6)
Have a child (vs. no child)	159 (46.5)	160 (48.3)	136 (44.7)
Employment status			
Employed	264 (74.2)	231 (68.6)	208 (65.8)
Unemployed	52 (14.6)	62 (18.4)	61 (19.3)
Retired	40 (11.2)	44 (13.1)	47 (14.9)
Education level			
Elementary or below	30 (8.5)	42 (13.1)	48 (15.4)
Secondary	245 (69.0)	203 (63.2)	189 (60.6)
Tertiary	80 (22.5)	76 (23.7)	75 (24.0)
Monthly household income (US$1=HK$7.8)			
Less than 10,000	50 (14.4)	53 (17.2)	58 (19.3)
10,000-29,999	237 (68.3)	206 66.7)	184 (61.1)
30,000 or more	60 (17.3)	50 (16.1)	59 (19.6)
Daily cigarettes consumption (sticks)			
1-10	199 (50.4)	211 (55.0)	176 (46.2)
11-20	156 (39.5)	135 (35.2)	163 (42.8)
> 20	40 (10.1)	38 (9.9)	42 (11.0)
Nicotine dependency (HSI)			
Light (≤ 2)	197 (51.2)	208 (54.6)	175 (46.8)
Moderate (3-4)	160 (41.6)	153 (40.2)	169 (45.2)
Heavy (5-6)	28 (7.3)	20 (5.3)	30 (8.0)
Past quit attempt			
Within past month	10 (2.6)	12 (3.2)	13 (3.5)
Within past 6 months	11 (2.8)	24 (6.4)	17 (4.5)
Within past year	22 (5.7)	25 (6.6)	18 (4.8)
More than 1 year ago	81 (20.9)	82 (21.7)	94 (25.1)
Never	263 (68.0)	235 (62.2)	233 (62.1)
Intention to quit			
Within 7 days	136 (35.1)	91 (23.9)	74 (19.8)
Within 30 days	63 (16.2)	51 (13.4)	59 (15.8)
Within 60 days	36 (9.3)	25 (6.6)	31 (8.3)
Undetermined	153 (39.4)	214 (56.2)	210 (56.2)
Perception of quitting, mean ± SD[‡]			
Importance	6.6 ± 2.2	6.7 ± 2.1	6.4 ± 2.3
Difficulty	7.0 ± 2.3	7.1 ± 2.3	6.9 ± 2.4
Confidence	5.7 ± 2.2	5.7 ± 2.2	5.6 ± 2.1

OSR: onsite referral; TMR: text-messaging referral; SD: standard deviation; HSI: Heaviness of Smoking Index.

[†] Sample size varied because of missing responses in some variables.

[‡] Score: 0-10, higher scores indicating stronger perceptions.

Table 2. Smoking cessation and service use outcomes (N=1163)[†]

	OSR (N=395)	TMR (N=385)	Control (N=383)	OR (95% CI)		Adjusted OR (95% CI)[†]	
				OSR vs. Control	TMR vs. Control	OSR vs. Control	TMR vs. Control
Self-reported 7-day PPA							
1-month	47 (11.9)	49 (12.7)	26 (6.8)	1.85 (1.12-3.06)*	2.00 (1.22-3.30)**	1.75 (1.00-3.06)*	1.98 (1.15-3.42)*
2-month	67 (17.0)	47 (12.2)	42 (11.0)	1.66 (1.10-2.51)*	1.13 (0.73-1.76)	1.62 (1.02-2.56)*	1.06 (0.65-1.73)
3-month	57 (14.4)	50 (13.0)	33 (8.6)	1.79 (1.14-2.82)*	1.58 (0.99-2.52)	1.54 (0.96-2.49)	1.32 (0.81-2.15)
6-month[‡]	70 (17.7)	66 (17.1)	46 (12.0)	1.58 (1.06-2.36)*	1.52 (1.01-2.28)*	1.56 (1.00-2.42)*	1.40 (0.90-2.19)
18-month	72 (18.2)	56 (14.6)	60 (15.7)	1.20 (0.82-1.75)	0.92 (0.62-1.36)	1.25 (0.82-1.89)	0.86 (0.56-1.34)
Validated abstinence							
3-month	27 (6.8)	23 (6.0)	18 (4.7)	1.49 (0.81-2.75)	1.29 (0.68-2.43)	1.35 (0.71-2.58)	1.19 (0.61-2.32)
6-month	30 (7.6)	30 (7.8)	15 (3.9)	2.02 (1.07-3.81)*	2.07 (1.10-3.92)*	1.83 (0.95-3.53)	1.82 (0.94-3.52)
18-month	16 (4.1)	18 (4.7)	23 (6.0)	0.66 (0.34-1.27)	0.77 (0.41-1.45)	0.69 (0.35-1.40)	0.75 (0.37-1.50)
Smoking reduction[§]							
1-month	84 (21.3)	65 (16.9)	72 (18.8)	1.17 (0.82-1.66)	0.88 (0.61-1.27)	1.04 (0.71-1.53)	0.87 (0.58-1.29)
2-month	75 (19.0)	62 (16.1)	64 (16.7)	1.17 (0.81-1.69)	0.96 (0.65-1.40)	1.18 (0.78-1.78)	1.10 (0.72-1.67)
3-month	74 (18.7)	65 (16.9)	62 (16.2)	1.19 (0.82-1.73)	1.05 (0.72-1.54)	1.21 (0.79-1.85)	1.29 (0.85-1.97)
6-month	80 (20.3)	62 (16.1)	74 (19.3)	1.06 (0.75-1.51)	0.80 (0.55-1.16)	0.90 (0.60-1.33)	0.84 (0.56-1.26)
18-month	56 (14.2)	40 (10.4)	40 (10.4)	1.42 (0.92-2.18)	0.99 (0.63-1.58)	1.75 (1.05-2.91)*	1.33 (0.79-2.26)
Use of smoking cessation services (cumulative)							
1-month	49 (12.4)	7 (1.8)	11 (2.9)	4.79 (2.45-9.36)***	0.63 (0.24-1.63)	5.97 (2.72-13.1)***	0.77 (0.27-2.17)
2-month	78 (19.5)	19 (4.9)	13 (3.4)	7.00 (3.82-12.84)***	1.48 (0.72-3.04)	10.29 (4.97-21.32)***	1.65 (0.71-3.83)
3-month	102 (25.8)	26 (6.8)	24 (6.3)	5.21 (3.25-8.34)***	1.08 (0.61-1.92)	7.24 (4.14-12.64)***	1.23 (0.64-2.37)
6-month	106 (26.8)	31 (8.1)	27 (7.1)	4.84 (3.08-7.59)***	1.15 (0.68-1.97)	6.99 (4.09-11.94)***	1.31 (0.71-2.43)
18-month	111 (28.1)	34 (8.8)	34 (8.9)	4.01 (2.65-6.07)***	0.99 (0.60-1.64)	5.90 (3.60-9.66)***	1.15 (0.65-2.03)

OR: odds ratio; CI: confidence interval; OSR: onsite referral; TMR: text-messaging referral; PPA: point prevalence of abstinence.

[†] The primary outcome was abstinence at 6 months after treatment initiation.

[‡] Adjusting for the baseline covariates including age, sex, marital status, nicotine dependency, quit attempt, reduction attempt and intention to quit.

[§] Quitting not included as reduction.

*P<0.05; **P<0.01; ***P<0.001.

Table 3. Smoking cessation services use (N=1163)

	OSR (N=395)	TMR (N=385)	Control (N=383)
Agreed to be referred to a smoking cessation service (at baseline) †			
Attendance rate within 6 months	106 (34.9)	--	--
No-show‡	198 (65.1)	--	--
Services or medications used (among service users)	N=106	N=31	N=27
1. Nicotine replacement therapy (gum/patch/inhaler)	42 (39.6)	6 (19.4)	5 (18.5)
2. Prescribed cessation medication (e.g. Varenicline)	36 (34.0)	4 (12.9)	7 (25.9)
3. Telephone counselling	29 (27.4)	10 (32.3)	8 (29.6)
4. Face-to-face counselling	29 (27.4)	10 (32.3)	6 (22.2)
5. Acupuncture	21 (19.8)	4 (12.9)	2 (7.4)
6. Group counselling	3 (2.8)	2 (6.5)	1 (3.7)
Reasons for not using smoking cessation service §	N=209	N=302	N=288
1. Busy schedule	160 (76.6)	221 (73.2)	216 (75.0)
2. Time mismatch	49 (23.4)	71 (23.5)	59 (20.5)
3. Not interested	38 (18.1)	126 (41.7)	83 (28.9)
4. Perceived it as not useful	33 (15.8)	107 (35.4)	120 (41.7)
5. Inconvenient location	6 (2.9)	10 (3.3)	13 (4.5)

OSR: onsite referral; TMR: text-messaging referral.

† Records of baseline referral were only available for OSR participants.

‡ Participants with missing data were counted as failure to use the smoking cessation services.

§ Sample size varied because of missing responses.

Table 4. Operation cost for the intervention	Cost (US$)		
	OSR group (n=395)	TMR group (n=385)	Control group (n=383)
1. Training			
• Manpower 1: A research nurse for delivering knowledge of smoking cessation and counselling skills (1 hour)	7	7	7
• Manpower 2: A chair professor for delivering knowledge in tobacco control (0.5 hour)	16	16	16
• Manpower 3: A post-doctoral fellow for project introduction (0.5 hour)	4	4	4
• Material: lecture notes (88 participants x US$3.8)	112	112	112
Sub-total	**139**	**139**	**139**
2. Recruitment and intervention delivery			
• Manpower 1: trained student ambassadors in each recruitment session (2 in a pair to provide intervention in each session, 22 sessions x 6 persons x 7 hours x US$8.1 x 1.05 for Mandatory Provident Fund)	7859	7859	7859
• Manpower 2: transferring smokers' information to smoking cessation services providers (22 sessions for x 0.5 hour x US$17.1 incl. Mandatory Provident Fund)	188		
• Materials 1:			
o Active referral information card (US$0.13 each)	51	50	
o Health warning leaflet (US$0.13 each)	51	50	
o Self-help booklet (US$0.44 each)	174	169	169
• Materials 2:			
o Smokerlyzer mouth-piece (US$0.38 each)	150	146	146
o Smoking cessation services booking (3min of each calling x US$0.01 x 304 persons)	9		
o Text messaging (16 SMS per subject x US$0.03)		185	
Sub-total	**8482**	**8459**	**8174**
3. Telephone booster at 1-month and 2-month follow-ups			
• Manpower: (no. of subjects x 1 minute of each booster x 2 boosters x US$8.1 x 1.05 for Mandatory Provident Fund / 60)	112	109	
Sub-total	**112**	**109**	
Total (1+2+3)	**8733**	**8707**	**8313**

OSR: onsite referral; TMR: text-messaging referral.