**What factors are associated with waterpipe smoking cessation? A secondary data analysis**

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# ABSTRACT

**Introduction**

Waterpipe smoking is gaining popularity and becoming a major global public health concern. An understanding of factors that predict waterpipe smoking cessation is necessary for targeting tobacco control efforts.

**Methods**

This is a secondary data analysis of a randomised controlled-trial comparing the efficacy of varenicline against placebo in helping waterpipe smokers to quit. A total of 510 adult daily waterpipe smokers were recruited to the trial in 2016. Logistic regression models were applied to assess factors (i.e., demographic, environmental, behavioural, and physiological) associated with primary outcome (waterpipe smoking cessation) and secondary outcomes (waterpipe cessation alongside abstinence from cigarette and short-term and long-term waterpipe smoking cessation). Cessation was defined as 7-day point prevalence abstinence from smoking reported at 5,12, and/or 25 weeks follow ups.

**Results**

Over a period of six months, 189 (39.2%) participants abstained from waterpipe smoking for at least one week. Being male (adjusted odds ratio (aOR):2.99 (95%CI:1.47-6.08)), dual smoker (waterpipe and cigarettes) (aOR:2.98 (95%CI:1.87-4.74)), more withdrawal symptoms measured by the Mood and Physical Symptoms Scale (aOR:1.08 (95%CI:1.02-1.13)), less nicotine dependency measured by Lebanon Waterpipe Dependency Scale (aOR:0.90 (95%CI:0.85-0.96)), having history of quit attempt (aOR:2.14 (95%CI:1.16-3.96)), smoking restriction in the house (aOR:2.69 (95%CI:1.01-7.14)), and not sharing waterpipe with others (aOR:2.72 (95%CI:1.31-5.66)) predicted waterpipe smoking cessation.

**Conclusions**

In addition to nicotine dependency, social factors such as home restrictions on smoking, and not sharing waterpipe were identified as predictors of waterpipe smoking cessation. To help waterpipe smokers quit, social environment may be just as or even more important than well-known physical and psychological factors.

**Implications**

A range of factors, predominantly social factors play a significant role in facilitating or deterring waterpipe smokers from quitting smoking. Our findings suggest that interventions that focus on social as well as physical/psychological factors may encourage waterpipe smokers in achieving abstinence.

**Keywords**: waterpipe, hookah, shisha, smoking, smoking cessation

**INTRODUCTION**

Tobacco smoking is a leading cause of morbidity and mortality around the world.1 While cigarette smoking is the most common form of tobacco consumption globally, other non-cigarette forms of tobacco smoking (such as waterpipe, pipe tobacco, cigars, and bidis) are also gaining popularity in some countries. Among these, waterpipe smoking is gaining popularity, especially among young people in the Eastern Mediterranean region.2

Waterpipe (also known as hookah, shisha, narghile, argila, or hubble bubble) has been practiced for few centuries as a traditional habit especially in South Asia and the Middle East. In recent years its use has been increasing across the globe.3 Smoking prevalence surveys within European countries have shown that waterpipe smoking is becoming prevalent among youth, particularly within eastern European countries.4,5 Additionally, Global Adult Tobacco Survey (GATS, 2014) conducted in Pakistan showed that of the overall adult population, 3.0% currently use a waterpipe (3.7 million adults).6

Waterpipe smoking poses the same health risks as those associated with cigarette smoking. Risk of cancer is the most important one since waterpipe tobacco smoke includes carcinogenic ingredients, such as tobacco specific nitrosamines (TSNAs),7 and heavy metals.8 A recent meta-analysis concluded that waterpipe smokers was associated with up to 5 times higher odds of lung cancer, (Odds ratio [OR] 4.58; 95% Confidence Interval (CI), 2.61 to 8.03); strong associations between waterpipe smoking and oesophageal cancer have also been reported (OR 3.63; 95% CI, 1.39 to 9.44).9 Despite these well-documented harmful effects of waterpipe smoking, there is a common public perception that waterpipe smoking is safer compared to cigarette smoking.10,11

Smoking cessation interventions, including behavioural support12 and medications13 are strongly associated with achieving success in quitting cigarette smoking. However, for waterpipe smoking, the association between these interventions and quitting is not adequately studied. Few studies conducted among waterpipe smokers have shown little or no success in getting them to quit.14-17 One of these studies is a recently published randomised controlled-trial(RCT), which reported that the difference in repeated point abstinence between varenicline and placebo arms was not statistically significant.17 Given that the available smoking cessation interventions have not shown much benefit so far, there is a need to investigate and identify demographic, physical, psychological, and social factors that may influence quitting in waterpipe smokers. Previous studies investigated such factors primarily among cigarette smokers. These studies showed an association between smoking cessation and socio-demographic variables such as age,18,19 sex,20,21 education level,19,22 and income status,18,23 socio-environmental variables such as living with smokers,21,24,25 and smoking rules in the house;25-27 physiological and psychological variables such as comorbidity,28 and nicotine dependency;18,21-23,29 and past quit attempt history.18,30

We investigated which of the above factors were associated with smoking cessation among waterpipe smokers. We evaluated waterpipe smoking cessation, including both short-term, and long-term cessation, by making use of the dataset of a recent RCT.17 Knowing differences of the predictors between short-term and long-term cessation could help to identify factors that influence smokers to maintain abstinence from waterpipe smoking. Additionally, given that many waterpipe smokers also smoke cigarettes (dual smokers) or may compensate by smoking cigarettes during waterpipe smoking cessation, we were also interested in cessation of both waterpipe and cigarettes. This knowledge may be utilised in developing strategies to encourage smoking cessation among waterpipe smokers.

# METHOD

We conducted a secondary analysis of a dataset acquired from a recently published RCTthat compared the efficacy of varenicline against placebo in helping waterpipe smokers to quit.17 This was a two-arm, double-blind, placebo-controlled individually randomised trial conducted in four districts in Punjab, Pakistan. The ethics approvals were obtained from research ethics committees at the Pakistan Health Research Council, all participating hospitals, and the University of York. Eligible participants were given verbal and written information about the trial, and 24 hours to consider participation; those interested provided written consent. Out of the 557 screened, 510 were recruited between March and November 2016. All 510 trial participants were adult daily waterpipe smokers and were followed up for a period of 25 weeks post-randomisation. Primary outcome for the study was seven-day repeated point prevalence abstinence from all forms of tobacco.

**Variables used in the secondary analysis**

### ***Outcomes***

Our primary study outcome, waterpipe smoking cessation of any duration, was defined as abstinence from waterpipe smoking for a period of at least 7 consecutive days at any one or more of the three follow-ups at week 5, 12 or 25.

The first secondary outcome, smoking cessation of any duration made by the participants who reported 7-day point abstinence from waterpipe and cigarette smoking at any one or more of the three follow-ups. The other two secondary outcomes were based on the duration; waterpipe smoking cessation was dichotomised into long-term and short-term cessation. Long-term cessation was defined as 7-day point abstinence from smoking waterpipe reported at all three follow ups (5,12, and 25 weeks). Any other point abstinence reported at one or more follow-ups but not all three, was considered as a short-term cessation.

### ***Explanatory variables***

Multiple explanatory variables were collected at baseline representing the following categories: socio-demographic, socio-environmental, physiological and psychological, and behavioural. The socio-demographic variables were age (in years), sex (male/female), level of education (no formal education, at least primary school education), wealth index, and marital status (married, separated/divorced/widowed, single).

Wealth index was generated using principal component analysis (PCA) based on participants’ ownership of selected household items and use of selected services. These items and services were electricity, flush toilet, fixed telephone, cell telephone, television, radio, refrigerator, car, moped/scooter/motorcycle, and washing machine. For each participant, weights of all items were added up to calculate the wealth index,31 the sample was then dichotomised based on the median wealth index into two groups: half of the participants were categorised into the high wealth index group, and the other half were categorised into the low wealth index group.

The socio-environmental variables included: having children under 18 years of age (yes/no), number of people living at home (≤ 5, > 5), and smoking restriction rules. The latter were reported as the presence (partial or complete) or absence of smoking restrictions inside the house. Physiological and psychological factors included: comorbidity (yes/no), nicotine dependency assessed using the Lebanon Waterpipe Dependency Scale [LWDS-11],32 and withdrawal symptoms using the Mood and Physical Symptoms Scale [MPSS].33 In the LWDS-11 scale, there were 11 questions (items); minimum and maximum score for this scale is 0 to 33, where 33 means that participants were highly dependent on waterpipe smoking. For MPSS scale the minimum and maximum total score is 5 to 35, where 35 means that participants have strong withdrawal symptoms and 5 means that participants do not have any withdrawal symptoms.

Behavioural variables included sharing waterpipe smoking with others (yes/no), dual cigarette and water pipe smoker status (yes /no), age at starting smoking (>20 years/≤20 years), duration of smoking (>25 years/≤25 years), smoking frequency (the whole day continuously for hours, or less), and waterpipe session length (in minutes). History of waterpipe quit attempts (yes/no) were also investigated.

## **Statistical methods**

We analysed and reported the number and proportion of participants who reported waterpipe smoking cessation, including short- and long-term cessation. Additionally, the number and proportion of participants whose cessation included abstinence from cigarette smoking were reported.

The number and proportion of the categorical explanatory variables and the mean and standard deviation (SD) of the continuous explanatory variables were reported. For skewed data the median and inter-quartile range (IQR) were reported.

Multivariable binary logistic regression was used to identify explanatory variables that were associated with the study primary outcome. Similar approach was used to identify explanatory variables that were associated with the study secondary outcome, any waterpipe cessation including abstinence from cigarette. For the other secondary outcomes, short and long-term waterpipe smoking cessation, a multinomial logistic regression was used. Adjusted odd ratios (aORs) and 95% confidence interval (CI) were reported for all explanatory variables.

All reported P-values were two-sided and the significance level was set at alpha (α) = 0.05.

Study arm (intervention or control) of the primary trial was identified as potential confounder and controlled for in the study model.

To evaluate the regression models, a number of diagnostics procedures and tests were applied. The Hosmer-Lemeshow goodness of fit test was used to assess overall fit of the model. Collinearity between explanatory variables checked using Variance Inflation Factor (VIF).Box-Tidwell procedure was applied to check linearity of the continuous explanatory variables and logit of the outcome variable (quit attempt). Receiver Operating Characteristic (ROC) curve was performed in order to determine how good the final model is at discriminating between smokers who made a quit attempt and who did not.

No collinearity was noted. VIF values of all explanatory variables were less than 3.0. Additionally, no issues were observed after applying other diagnostic tests. Please refer to supplementary file 1 and supplementary file 2.

We assessed the final model for possible outliers and influential points. Any covariate pattern that was away from the other covariate patterns was dropped from the model and the multivariate analysis was repeated without them. The results of these analyses were similar to the main analysis, see supplementary file 3 and supplementary file 4 for further details.

Statistical analysis was carried out using STATA version 16.34

# RESULTS

**Participant characteristics**

Out of 510 participants recruited in the trial, 28 had missing data on the study outcome.

At baseline and by design of the original trial, most participants 429 (84.1%) were male and around half 261 (51.2%) were dual smokers (smoked both waterpipe and cigarettes). The mean age of the participants was 49.2 (SD: 15.2) years. Approximately, one-third of the participants 187 (36.7%) did not have any formal education. Over half of them 280 (54.9%) started smoking waterpipe at the age of 20 or less and just under half 248 (48.6%) had been smoking waterpipe for more than 25 years. One-quarter (128) smoked waterpipe the whole day (continuously for hours). Participants’ mean LWDS\_11 score was high 19.2 points (SD: 4.0) on a scale of maximum 33 points, see table 1 for further details.

Most participants 454 (89.2%) reported sharing waterpipe with others during smoking and 482 (94.5%) reported that they did not have any smoking restriction rules inside their homes. Just 95 (18.6%) made at least one quit attempt prior to the study.

**Outcome and explanatory variables:**

Of the 482 participants who had data for the primary outcome, 189 (39.2%) reported abstinence from waterpipe smoking for at least seven days during the six-month trial period. Of these 189 participants, 64 (13.3%) participants reported long-term cessation in comparison to 125 (25.9%) participants who reported short-term cessation. Additionally, out of the 189 participants who reported waterpipe smoking cessation, there were 91 (48.1%) participants whose waterpipe smoking cessation also included abstaining from cigarette smoking. The distribution of reported smoking cessation by follow-up time point is presented in table 2.

Multivariable models for both primary and the first secondary outcome, any waterpipe smoking cessation including abstinence from cigarette smoking are presented in table 3.

With respect to the socio-demographic variables, the odds for making waterpipe smoking cessation, either short- or long-term, was 2.99 times higher among males than females (95%CI 1.47-6.08). Participants who had rules restricting smoking in their homes were more likely to abstain from waterpipe than those without any restrictions, aOR: 2.69 (95%CI: 1.01-7.14). Participants who reported waterpipe smoking cessation, either short- or long-term, tended to have lower nicotine dependency (lower LWDS\_11 values, aOR: 0.90 (95%CI: 0.85-0.96)) but higher withdrawal symptoms (higher MPSS values) than those who did not

, aOR: 1.08 (95%CI: 1.02-1.13).

Regarding behavioural variables, the odds of waterpipe smoking cessation among dual smokers was 2.98 (95%CI: 1.87-4.74) times that of waterpipe-only smokers. Participants who reported that they were smoking waterpipe less than whole day were more likely to abstain from waterpipe smoking in comparison with the participants who reported smoking waterpipe the whole day (continuously for hours), aOR: 1.79 (95%CI: 1.02-3.16).

Additionally, participants who did not share waterpipe with others while smoking were more likely to abstain from waterpipe smoking, aOR: 2.72 (95%CI: 1.31-5.66). Participants with history of quit attempts, were more likely to quit waterpipe smoking aOR: 2.14 (95%CI: 1.16-3.96).

The predictors of waterpipe smoking cessation including abstinence from cigarette smoking included: a low score on (LWDS-11), smoking rules in the house, and history of quit attempts; see table 3 for further details. These findings are consistent with those for the primary outcome. However, some variables such as being male and dual smoker (waterpipe and cigarettes) were not associated with this secondary outcome.

Approximately one-third of males, 66 (33.5%), reporting waterpipe smoking cessation did so by switching to cigarettes, whilst among females this proportion was only one-sixth, 6 (15.4%). Additionally, a high proportion of dual smokers 193 (78.5%) reported smoking cigarettes at the follow ups, while 65 (27.5%) participants who were waterpipe-only smoker, reported smoking cigarette during the follow-ups

Findings from the multinomial logistic regression showed that being male, dual smoker (waterpipe and cigarettes), having history of previous quit attempts, higher MPSS score and lower LWDS-11 score at baseline, and having smoking rules in the house were all associated with long-term waterpipe smoking cessation while for the short-term cessation, the associated variables were being male, dual smoker (waterpipe and cigarettes), lower LWDS-11 score at baseline, and not sharing waterpipe with others while smoking. see table 4 for further details

# DISCUSSION

Our research adds several insights into the cessation related behaviour of waterpipe users in typical Pakistani and wider South Asian settings. We found that only one-third of waterpipe smokers abstained from waterpipe smoking for at least one week during the six-month trial period. The number of participants reporting waterpipe smoking cessation at each follow-up were similar throughout. Around half of the participants who abstained from waterpipe smoking also tried to stay abstinent from cigarette smoking. This was expected, as half of the participants were also cigarette smokers. Being male, dual smoker (waterpipe and cigarettes), having history of previous quit attempts, higher MPSS score and lower LWDS-11 score at baseline, not sharing waterpipe with others while smoking, and having smoking rules in the house were associated with waterpipe smoking cessation.

While the distribution and determinants of smoking cessation among cigarette smokers are well established, such information on waterpipe smokers is virtually non-existent. As far as we know, this is the first study that explored a range of factors associated with smoking cessation among waterpipe smokers. Knowing these factors is crucial to identify any similarity or difference between determinants of smoking cessation among cigarette smokers and determinants of smoking cessation among waterpipe smokers. This eventually will be helpful for future smoking cessation interventions directed towards waterpipe smokers to increase the success rates of smoking cessation.

In our study, female waterpipe smokers were less likely to abstain from smoking. This is in contrast with the literature on cigarette smokers.20-22, 28 In our sample males were more likely to switch to cigarette smoking than females during follow ups. The difficulty in switching to cigarettes among females, which comes from the social unacceptability around women smoking, is likely to be one factor that explains this finding. Based on the global adult tobacco survey 2014, the prevalence of daily cigarette smoking among females in Pakistan was 1.0% compared to 19.4% among adult male population.6 When our analysis of smoking cessation included abstinence from cigarette smoking, the association between sex and quit attempts was non-significant, which is consistent with our explanation.

Participants reporting smoking restrictions in their homes were more likely to abstain from smoking, consistent with previously published literature.25-27 The restrictions are likely to reflect structural limitations of the house, in that unlike cigarettes, waterpipes usually require a dedicated space inside the house. This would make it easier for the participants who intend to quit to stop smoking compared to the participants who live in houses where it is very easy to smoke waterpipe at their own convenience.

Despite difference in the smoking cessation between homes with or without restrictions, only 5.5% of the participants had some or full restrictions to smoke waterpipe. One reason that contributes to the paucity of restrictions is that there is a common public perception that waterpipe smoking is safer compared to cigarette smoking. Other reasons are related to the social acceptability and cultural identity of waterpipe smoking especially in the Eastern Mediterranean countries 10,11The association between smoking cessation and lower nicotine dependency is also in line with previous studies.18, 21-23, 29 The variation in the LWDS-11 scores tracked closely to smoking frequency. Psychological and physiological effects of high nicotine dependency discourage participants to stop smoking32.

Participants with higher withdrawal symptoms at baseline were also more likely to quit waterpipe smoking. MPSS scale is generally considered a stronger predictor of the success or failure of a smoking cessation. Since this scale is measured at baseline, before participants tried to stop smoking, the finding of this variable was less meaningful.33

One in two participants who were dual smokers abstained from waterpipe smoking compared to one in four participants who were waterpipe smokers only. However, dual smokers were more likely to use cigarettes as an alternative source of nicotine after quitting waterpipe. This was supported also by the secondary outcome analysis of smoking cessation including abstinence from cigarette smoking, where no evidence of a difference in smoking cessation was observed between the dual smokers and waterpipe only smokers.

Participants who did not share waterpipe smoking with others were more likely to abstain from waterpipe smoking. This relationship was not significant when smoking cessation included abstinence from cigarette smoking. This is expected as waterpipe only smokers tend to share waterpipe with others while smoking at social gatherings with family or friends. In another study, waterpipe smokers were asked about the main challenges to quitting and a desire to socialise with friends who are waterpipe smokers was reported as a key obstacle.37

Participants who had a history of making a quit attempt were more likely to abstain from waterpipe smoking, which is in line with the published literature.19,23,25,30 Smokers with history of quit attempts are more motivated to stop smoking.

The direction of the association between most of the statistically significant variables identified for the primary outcome analysis and long-term cessation were by far much obvious than that in short-term cessation. This confirms the effect of these variables on maintaining smoking cessation

## **Strengths and limitations**

To the best our knowledge, this is the first study that explored a range of factors associated with smoking cessation among waterpipe smokers. In addition, all records of smoking cessation were obtained during face-to-face interviews with the study researcher at the specified follow-up weeks and were biochemically verified by CO monitors. This minimises the possibility of missing smoking cessation due to recall bias and the possibility of temporality between outcome and explanatory variables. Our findings are robust based on the analytic approach and the diagnostic tests used to evaluate the final model.

One of the key limitations is that point abstinence at week 5, 12 and 25 was used as a measure for smoking cessation. Participants who reported not smoking even a puff during last 7 days at any of the follow-up weeks were considered as successful quitters. This method of reporting smoking cessation has a drawback. As information was collected at scheduled follow up points (i.e., 5, 12 and 25 weeks), smoking cessation that were made outside this time frame could not have been captured. While this approach would have underestimated the number of true smoking cessation events, it does not threaten the internal validity of our findings. All associations found in our study are likely to hold true if a wider range of smoking cessation would have been captured. Our study only included those daily waterpipe smokers, which possibly limits the generalisability of our findings to such groups only. As this study is a secondary analysis of a RCT where the participants enrolled in a cessation program, our findings do not necessarily extrapolate to the general population of waterpipe smokers. The final limitation was the sample size which was calculated to power the trial and not the analysis presented here; a higher number of participants would have led to an increase in the number of observations per explanatory variable, which was only 9.5 in our sample.

Knowing the variables that are associated with waterpipe smokers’ behaviour in smoking cessation could help in finding possible ways to support people attempting to quit, which is an important mediator in achieving smoking abstience.38

Waterpipe use is a social habit and may occur with or without smoking. There is potential for group interventions while at the same time, there is a need to implement stricter anti-tobacco measures, not only to prompt smoking cessation but also to discourage tobacco use and to protect non-users from second-hand smoke.

Waterpipe smokers and their family members could be educated about waterpipe smoking and its harmful effect through different procedures using public places like schools.39 There is a need to protect individuals from second-hand smoke which is also a part of the WHO’s MPOWER approach. Implementing such policies also discourages tobacco use in social settings.40

Different methods should be applied to encourage smoking household restrictions. These methods are as important as smoking restriction in the workplace in enhancing smokers to stop smoking. Encouraging application of smoking restrictions rules inside the house and putting policies that restrict waterpipe smoking at home can facilitate smokers to quit.24

To encourage smoking restrictions rules inside the house, the first step from the regulatory bodies is to tackle the common belief that waterpipe smoking is safer than cigarette smoking. This can be done using different methods including campaigning in community meetings, social occasions, local televisions, newspapers, and social media. Awareness about harmful effect of waterpipe smoking both on first and second-hand smokers may encourage people to set more strict rules regarding indoor waterpipe smoking in their homes.

Smokers who have history of smoking cessation failure may need tailored support in order to help them maintain abstinence. Yet failed smoking cessation can be still considered advantageous as their experience of trying to stop smoking can be used to enhance the success of future smoking cessation.

Waterpipe users frequently reported compensating by, or in some cases switching to cigarettes. This suggests that users may possibly need more intensive support (behavioural/pharmacological) to induce waterpipe smoking cessation that include abstinence from cigarettes

It is important to find interventions that target nicotine dependence as it is one of the major factors that prevent waterpipe smokers from stopping smoking. Further trials that utilise pharmacotherapies along with behavioural support especially among highly nicotine dependent smokers are necessary to investigate their efficacy in increasing number of smokers who maintain abstinence from smoking.41

Future studies should include non-daily smokers who smoke at least one session per week alongside daily waterpipe smokers. This will help to understand and identify factors that vary significantly between daily and occasional smokers.

In addition, further future studies should investigate factors associated with success or failure of smoking cessation in addition to those associated with making a smoking cessation This will help determine the best support that should be provided to reach the goal of making waterpipe smokers quit smoking permanently.

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# Declaration of Interests

None declared.

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