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Original Article

The Effects of Tobacco Smoking Status on the Short-term Outcomes of Patient's Post-acute Myocardial Infarction: A Longitudinal Study

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Abstract

Background: Although cigarette smoking is a risk factor for cardiovascular disease (CVD), smoking cessation has considerable effects on the reduction of mortality and incidence of acute myocardial infarction (AMI). This study was done to examine the effect of tobacco smoking status and its short-term outcomes after AMI.

Materials and Methods: In this longitudinal study, 96 patients smoking tobacco products (cigarette and waterpipe) within the age range of 30-70 years who had undergone angiography following the first AMI were evaluated. The patients were evaluated at three time points in terms of tobacco smoking status, additional myocardial infarction (MI), hospitalization due to cardiac events, and some other variables. Data collection was done using a checklist and phone calls.

Results: The mean age of the patients was 52.99 ± 9.2 years. Six months following the first MI, more than 60% of the patients had ceased their tobacco smoking, but over time and at the end of the study, this value diminished, especially in waterpipe smokers. The chance of hospitalization among the men younger than 54 years who were not smokers at the baseline was 0.801. On the other hand, this chance for men below 54 years who smoked 1-10 cigarettes per day was 4.75 times higher (OR = 4.747, $P = 0.002$). In addition, men younger than 54 years who smoked waterpipe twice or more per day were hospitalized 31 times more frequently compared to the men who did not smoke waterpipe ($P = 0.001$, OR = 31.112).

Conclusion: Not smoking cigarettes or waterpipe over time would considerably reduce the chance of hospitalization due to CVD.

Keywords: Tobacco, Myocardial infarction, Short-term outcomes, Longitudinal study

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Introduction

Cigarette smoking is a known risk factor for a wide range of adverse health outcomes. Today, cigarette smoking has been established as one of the major risk factors for cardiovascular disease (CVD) and the most important cause of cardiovascular event-induced mortality (1). Tobacco smoking affects all phases of atherosclerosis including endothelial dysfunction, acute clinical accidents, development of inflammatory factors, development of bleeding disorders, increased coronary artery blood flow, and higher risk of thrombosis. It also leads to the incidence of CVD, increased rate of hospitalization, and eventually higher mortality following it (2). Meanwhile, the status of smoking is a modifiable risk factor for the patient, and cigarette smoking cessation is also modifiable. Nevertheless, the duration of cigarette smoking cessation is of great importance. Quitting tobacco products is associated with a considerable reduction in all-cause mortality in patients suffering from coronary heart disease (CHD) (3). However, only half of the cigarette smokers suffering from CHD in Europe managed to quit cigarette smoking successfully (4,5). Various case-control and cohort studies have indicated that quitting tobacco smoking following acute myocardial infarction (AMI) depending on the duration of cessation can cause up to 50% reduction in mortality rate (6). Therefore, the results of previous studies in a real clinical setting indicate that implementation of evidence-based and available methods for quitting cigarettes can apparently have a considerable impact on cigarette smoking cessation after MI (7,8).

Considering the direct relationship between the incidence of AMI and tobacco consumption and the lack of sufficient studies about the effects of cessation and continuation of tobacco smoking plus its resulting short-term consequences following the first AMI, this study was undertaken. Doing research in this area can be

an appropriate way to take the issue of tobacco cessation seriously following CVD as well as education in this regard.

Materials and Methods

The present longitudinal study was conducted to determine the status of tobacco smoking as well as short-term outcomes following the first AMI. The statistical population consisted of patients smoking tobacco (cigarette, waterpipe, or both for at least one year) within the age range of 30-70 years with the final diagnosis of the first AMI between September 2018 and May 2019. All information of these patients had been recorded in the Angiography System of Jorjani Center of Shahid Mohammadi Hospital in Bandar Abbas. Informed consent was obtained from the participants before starting the study. A total of 96 eligible patients were assigned into three groups of cessation of smoking, reduction of smoking, and continuation of smoking. They were followed up at three time points of six months, one year, and three years in terms of post-MI complications as well as the status of tobacco smoking. The primary information of patients was collected in person, while the follow-up information was collected through phone calls due to the coronavirus pandemic. The data collection was done through a researcher-made checklist, which was confirmed by a cardiologist. The items were designed in three sections. The first section was designed to collect demographic information of the patients, the second section dealt with the extent of cigarette plus waterpipe smoking individually, hypertension, diabetes, dyslipidemia, brain stroke, Heart failure (HF) following MI, age of the first MI, type of MI, and interventional measures, and the third section included items related to the status of tobacco consumption as well as post-MI complications including additional myocardial infarction (MI), rehospitalization due to cardiac events, cerebrovascular accidents (CVAs), HF, coronary artery bypass graft (CABG) surgery, percutaneous coronary intervention (PCI), and mortality three years after the initiation of the study. The collected data were interpreted and analyzed using statistical methods.

Descriptive statistics were presented as mean and standard deviation (SD) for continuous variables, and categorical variables were presented as number and percentage. For comparing the means of quantitative variables in the three groups, ANOVA was used, and for testing the relationship between two categorical variables, the chi-square test was employed. The mixed-effects logistic regression model with a random intercept was used for the analysis of longitudinal binary outcomes (hospitalization with 2 levels of yes and no). It is noteworthy that although we examined 7 outcomes (chronic heart failure [CHF], CVA, MI, hospitalization, PCI, CABG, and mortality) over 36 months, the mixed-effects logistic regression model with a random intercept was used to investigate the relationship between cigarette and waterpipe smoking and hospitalization over time since the incidence of all was low except for hospitalization. A $P<0.05$ was considered statistically significant and all analyses were performed using STATA version 14.2.

Results

In this longitudinal study, 96 tobacco smokers in the age range of 30-70 years were investigated over a three-year period following the first MI. The patients were evaluated at three-time intervals of 6, 12, and 36 months following the first MI. Of these 96 patients, 79 (82.3%) were male and 17 (17.7%) were female. Additionally, 48 patients (50%) smoked waterpipe, 62 (64.6%) used cigarette, and 14 (14.6%) consumed both at the time of the first MI. The information on the type of tobacco products smoked by each gender is shown in Figure 1. The mean age of the patients was 52.99 ± 9.2 years. The type of MI in 93 (96.9%) patients was ST-segment elevation myocardial infarction (STEMI), and in 3 (3.1%) patients, it was non-ST-segment elevation myocardial infarction (NSTEMI). Pharmacotherapy was prescribed for 12 patients, primary percutaneous coronary intervention (PPCI) for 24, PCI (including rescue PCI and pharmacoinvasive therapy) for 55, and thrombolytics for 5. The demographic characteristics of the study patients, history of underlying disease, and type of intervention taken are reported in Table 1. Six months after the first AMI, more than 60% of the patients had quit their tobacco smoking. However, over time and at the end of the study, this value diminished, particularly in waterpipe smokers, suggesting incomplete success of the patients in quitting tobacco smoking, especially waterpipe in the long run (Table 2). Post-AMI outcomes (additional MI, hospitalization due to cardiac events, CVAs, HF, mortality, additional CABG, and PCI) were examined at the baseline as well as at 6-, 12-, and 36-month periods, as reported in Table 3. No significant difference was found in terms of incidence of outcomes following AMI between the tobacco smoking

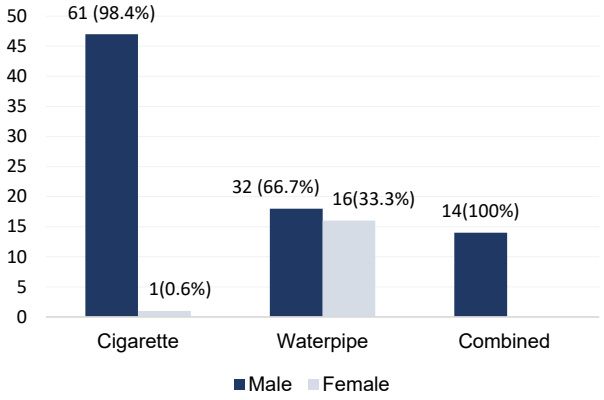

Figure 1. The Prevalence of Cigarette and Waterpipe Smoking Among Males and Females.

Table 1. Baseline Characteristics of Patients Based on the Smoking Status

Characteristics	Overall (n = 96)	Cigarette (n = 62)	Waterpipe (n = 48)	Combined (n = 14) (Waterpipe and Cigarette)	*P* value
Age	52.99 ± 9.2	51.71 ± 8.39	54.54 ± 9.98	52.64 ± 9.45	0.168
Males	79 (82.3%)	61 (98.4%)	32 (66.7%)	14 (100%)	< 0.001
Job					
Jobless	4 (4.2%)	2 (3.2%)	3 (6.3%)	1 (7.2%)	
Employee	10 (10.4%)	7 (11.3%)	6 (12.5%)	3 (21.4%)	< 0.001
Self-employed	45 (46.9%)	39 (62.9%)	13 (27.1%)	7 (50.0%)	
Retired	20 (20.8%)	13 (21.0%)	10 (20.8%)	3 (21.4%)	
Housewife	17 (17.7%)	1 (1.6%)	16 (33.3%)	0 (0.0%)	
Education					
Illiterate	25 (26.0%)	9 (14.5%)	19 (39.6%)	3 (21.4%)	
Elementary	30 (31.3%)	21 (33.9%)	14 (29.2%)	5 (35.7%)	0.029
High school	18 (18.8%)	16 (25.8%)	5 (10.4%)	3 (21.4%)	
Diploma	15 (15.6%)	12 (19.4%)	5 (10.4%)	2 (14.3%)	
Academic	8 (8.3%)	4 (6.5%)	5 (10.4%)	1 (7.2%)	
History of underlying disease					
Diabetes	21 (21.9%)	11 (17.7%)	13 (27.1%)	3 (21.4%)	0.388
Hypertension	25 (26.0%)	13 (21.0%)	16 (33.3%)	4 (28.6%)	0.237
Dyslipidemia	25 (26.0%)	17 (27.4%)	13 (27.1%)	5 (35.7%)	0.664
Type of MI					
STEMI	93 (96.9%)	60 (96.8%)	47 (97.9%)	14 (100%)	0.731
NSTEMI	3 (3.1%)	2 (3.2%)	1 (2.1%)	0 (0.0%)	
Type of intervention					
Pharmacotherapy	12 (12.5%)	10 (16.1%)	5 (10.4%)	3 (21.4%)	
PPCI	24 (25.0%)	12 (19.4%)	15 (31.3%)	3 (21.4%)	0.473
PCI	55 (57.3%)	37 (59.7%)	26 (54.2%)	8 (57.1%)	
SK	5 (5.2%)	3 (4.8%)	2 (4.2%)	0 (0.0%)	

Data are expressed as mean ± standard deviation for quantitative variables and frequency (percentage) for categorical variables. *P* values are related to the ANOVA test to compare means of quantitative variables in 3 groups and Chi-square test used for assessing the association between two categorical variables.

Table 2. Change in the Smoking Status over 3 Years

	No Change	Increase	Reduce	Stop
Cigarette (n = 62); Number of missing data in the first and third year were 5 and 4, respectively.				
Month 6	7 (11.3%)	1 (1.6%)	16 (25.8%)	38 (61.3%)
Month 12	15 (24.2%)	9 (14.5%)	1 (1.6%)	32 (51.6%)
Month 36	12 (19.4%)	16 (25.8%)	4 (6.5%)	26 (41.9%)
Waterpipe (n = 48); Number of missing data in the first and third year were 4 and 1, respectively.				
Month 6	3 (6.3%)	1 (2.1%)	8 (16.7%)	36(75.0%)
Month 12	39 (81.3%)	3 (6.3%)	1 (2.1%)	1 (2.1%)
Month 36	40 (83.3%)	5 (10.4%)	0 (0.0%)	2 (4.2%)

Each stage was compared to the previous stage.

status and its type.

It is noteworthy that although we examined 7 outcomes (CHF, CVA, MI, hospitalization, PCI, CABG, and mortality) over 36 months, the mixed-effects logistic regression model with a random intercept was used to investigate the relationship between cigarette and waterpipe smoking and hospitalization over time since the incidence of all was low except for hospitalization.

Based on the results of mixed-effects logistic regression model in Table 4, the mean intercept, that is, the log odds (logarithm of odds of hospitalization), was 0.801 for males under the age of 54 years who did not use cigarette at the beginning of the study. The odds of hospitalization for males under the age of 54 years who used 1 to 10 cigarettes a day was 4.75 times higher compared to their counterparts who did not consume cigarette at the beginning of the

Table 3. Cardiovascular Outcomes in Patients After the First MI

Characteristics	Overall (n=96)	Cigarette (n=62)	Waterpipe (n=48)	Combined (n=14) (Waterpipe and Cigarette)	*P* Value[a]
Baseline					
HF	1 (1.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.398
CVA	1 (1.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.398
Month 6					
HF	5 (5.2%)	3 (4.8%)	3 (6.3%)	1 (7.1)	0.879
CVA	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	NS
MI	2 (2.1%)	2 (3.2%)	1 (2.1%)	1 (7.1)	0.296
Hospitalization	22 (22.9%)	15 (24.2%)	12 (25.0%)	5 (35.7)	0.483
PCI	10 (10.4%)	6 (9.7%)	7 (14.6%)	3 (21.4)	0.248
CABG	4 (4.2%)	3 (4.8%)	1 (2.1%)	0 (0.0%)	0.542
Mortality	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	NS
Month 12					
HF	6 (6.3%)	3 (4.8%)	3 (6.3%)	0 (0.0%)	0.513
CVA	1 (1.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.406
MI	3 (3.1%)	1 (1.6%)	3 (6.3%)	1 (7.1%)	0.213
Hospitalization	20 (20.8%)	14 (22.6%)	9 (18.8%)	3 (21.4%)	0.811
PCI	10 (10.4%)	6 (9.7%)	7 (14.6%)	3 (21.4%)	0.254
CABG	5 (5.2%)	4 (6.5%)	1 (2.1%)	0 (0.0%)	0.341
Mortality	1 (1.0%%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.398
Month 36					
CVA	1 (1.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.461
MI	3 (3.1%)	1 (1.6%)	2 (4.2%)	0 (0.0%)	0.580
Hospitalization	10 (10.4%)	6 (9.7%)	6 (12.5%)	2 (14.3%)	0.603
PCI	6 (6.3%)	4 (6.5%)	3 (6.3%)	1 (7.1%)	0.897
CABG	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	NS
Mortality	1 (1.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	0.461

HF: heart failure, CVA: cerebrovascular accidents, MI: myocardial infarction, PCI: percutaneous coronary intervention, CABG: coronary artery bypass surgery.
[a] Chi-square test; NS: no statistics are computed because some variables are constant.

Table 4. Random Intercept Logistic Regression for Longitudinal Binary Outcomes of Hospitalization (Yes/No) to Assess the Relationship between Cigarette Consumption and Hospitalization

Characteristics	Coefficient	Odds Ratio	Standard Error[b]	*P* Value	95% Confidence Interval for Odds Ratio
Intercept	0.801	2.228	0.935	0.056	0.978-5.074
Gender (reference: men)					
Women	0.477	1.611	0.876	0.381	0.555-4.677
Age (reference: <54)					
Age≥54	0.619	1.857	0.754	0.127	0.838-4.117
Cigarette (reference: no cigarettes)					
1-10	1.557	4.747	2.394	0.002	1.766-12.756
≥11	1.710	5.528	3.190	0.003	1.784-17.132
Time	-1.792	0.166	0.038	<0.001	0.106-0.260
Intercept var[a]	1.381		0.773	-	0.461-4.139

[a] It indicates variance for random individual effects; [b] Standard error for odds ratio.

study (OR=4.747, *P*=0.002). Additionally, the odds of hospitalization for males under the age of 54 years who used 11 or more cigarettes a day was 5.53 times higher compared to their counterparts who did not consume cigarette at the beginning of the study (OR=5.528, *P*=0.003). The odds of hospitalization for males under the age of 54 years who did not use cigarette reduced to 0.834 over time (OR=0.166, *P*<0.001).

Based on Table 5, men under the age of 54 who used two or more waterpipes a day were about 31 times more likely

Table 5. Random Intercept Logistic Regression for Longitudinal Binary Outcomes of Hospitalization (Yes/No) to Assess the Relationship between Waterpipe Consumption and Hospitalization

Characteristics	Coefficient	Odds Ratio	Standard Error[b]	*P* Value	95% Confidence Interval for Odds Ratio
Intercept	1.329	3.780	1.379	<0.001	1.849-7.729
Gender (reference: men)					
Women	-1.144	0.319	0.195	0.062	0.096-1.060
Age (reference: <54)					
Age≥54	0.405	1.498	0.575	0.291	0.707-3.178
Waterpipe (reference: no waterpipe)					
0.1-1	1.016	2.762	1.531	0.067	0.932-8.188
≥2	3.437	31.116	31.538	0.001	4.268-226.846[c]
Time	-1.670	0.188	0.041	<0.001	0.122-0.289
Intercept var[a]	1.136		0.685	-	0.349-3.702

[a] It indicates variance for random individual effects; [b] Standard error for odds ratio; [c] The reason for the wide confidence interval for waterpipe is that the number of waterpipe use in this group has varied between 0 and 10 times a day, 0.1 in this group indicates that a person uses a waterpipe every 10 days, 0.5 indicates that a person uses a waterpipe every two days, and ... up to 10 indicates that a person uses a waterpipe 10 times a day.

to be hospitalized than men who did not use waterpipe at the beginning of the study (OR = 31.112, $P = 0.001$). The odds of hospitalization for males under the age of 54 years who did not use waterpipe reduced to 0.812 over time (OR = 0.188, $P < 0.001$).

Discussion

CVD is growing in developing countries, with men showing a higher prevalence compared to women. Considering the patients of this study, a lower proportion of women suffered from AMI, which is in line with previous studies (5,8-10). One reason behind this difference could be the effects of estrogen in women, which was observed in other studies as well (11). The results of this study revealed a higher prevalence of waterpipe smoking compared to cigarette smoking among women, which could be due to less social stigma compared to cigarette as well as the entertainment aspect of waterpipe among women.

Serious life-threatening events such as AMI provide a strong stimulus for tobacco smoking cessation. Several studies have concluded that 50% of patients quit tobacco smoking following MI (12). In this study, 64.6%, 50%, and 14.6% of the patients smoked cigarette, waterpipe, and both, respectively. At 6 months of follow-up, among cigarette smokers, 61.3% had ceased their consumption, which was 75% among waterpipe smokers. However, this value diminished over time. At three years, 41.9% of cigarette and 4.2% of waterpipe smoking patients had managed to persist in their tobacco smoking cessation. A study by the European Heart Association in 24 European countries also indicated that only half of the patients with coronary artery disease could quit cigarette smoking (5).

The data of this research showed that the odds ratio of hospitalization was 0.801 for men younger than 54 years who had not smoked cigarette at the baseline of the study, it was 4.75 times greater for men younger than 54 years who smoked 1-10 cigarettes per day, and it was 5.53 times larger for men younger than 54 years who smoked 11 or more cigarettes per day, compared to their peers who did not smoke at the baseline. The odds ratio of hospitalization for men younger than 54 years who had not smoked decreased to 0.834 over time. Men younger than 54 years who smoked waterpipe twice or more per day were 31 times more likely to be hospitalized compared to the men who did not smoke waterpipe at the baseline of the study. On the other hand, the odds ratio of hospitalization for men younger than 54 years who did not smoke waterpipe had diminished to 0.812 over time.

With regard to rehospitalization following MI and its association with cigarette, various studies have shown the effect of cigarette smoking cessation on the reduction of CVD complications (MI, brain stroke, HF, and mortality), while the rehospitalization factor has remained understudied in this regard (13-20). Meanwhile, rehospitalization for acute coronary syndromes (ACS) as well as coronary revascularization following AMI is common. Accordingly, numerous studies have dealt with predictors of rehospitalization for ACS. In the study by Arnold, factors such as age, gender (female), PCI at the hospital, and previous CABG were mentioned as the most important predictors of rehospitalization for ACS (21). In line with the present study, Shah showed the effect of cigarette smoking cessation on the reduction of rehospitalization of patients with AMI. According to that study, 30% reduction was seen in the rehospitalization of patients who had quit smoking cigarettes (22). In a cohort study in Canada, after adjustment for various factors, it was stated that long-time cigarette smoking was associated with increased duration of hospitalization due to CVD (23). On the other hand, in the study conducted by Jørgensen et al, tobacco use did not have any significant effect on hospital stay (24).

Considering the complications of CHF, CVA, MI, hospitalization, PCI, CABG, and mortality and their

relationship with smoking, no significant relationship was observed in the present study. The results of the present study were in line with some large-scale and reliable studies (25-30); however, in some cases, the results of the studies were contrary to the present study (6,26,31-33). This difference can be attributed to several reasons. The first one is the use of different study populations and the second is the definition of reducers. In the present study and the one by Gerber (33), "reducers" were the patients who, when comparing two consecutive time points, reduced their reported number of smoked cigarette and waterpipe but did not reach zero. In contrast, in the studies conducted by Godtfredsen et al (30) and Tverdal and Bjartveit (29), reducers were defined as those who had reduced smoking tobacco by at least 50%. The third explanation regarding the different results is that the reduction in the extent of tobacco smoking may be associated with poor health status, and real benefits of life expectancy due to decreasing the extent of tobacco smoking may be overshadowed by the higher risk of susceptibility to other factors.

Limitations

In the present study, we faced some limitations. They included the lack of cooperation of some patients in phone calls, incompleteness of older files, and reliance on self-reports on the status of tobacco smoking by patients.

Conclusion

As seen, the results indicated the effects of tobacco on the rehospitalization of patients following the first AMI. Smoking tobacco (cigarette and waterpipe) was associated with increased rehospitalization rate (due to cardiac events) of patients following the first AMI. Therefore, quitting tobacco smoking can reduce the rehospitalization of patients due to cardiovascular events. Considering the small number of study patients, it is recommended that cohort studies should be designed and conducted with a longer duration and a larger sample size to interpret the relationship between cessation versus continuation of tobacco smoking, especially waterpipe, and the first MI as well as its following complications.

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Conflict of Interest Disclosures

The authors declare no conflict of interest.

Disclaimer

The views expressed here are those of the authors and do not necessarily reflect the views of the Ministry of Health and Medical Education.

Ethical Statement

This study was approved by the Ethics Committee of Hormozgan University of Medical Sciences (IR.HUMS.REC.1398.025).

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Informed Consent

An informed consent form was taken from all the participants.

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