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Predictors of Nicotine Dependence among Adult Male *Midwakh* and Cigarette Smokers

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Abstract

Objectives: *Midwakh* is a popular form of smoking in the Middle East. This study aimed to assess predictors of nicotine dependence among exclusive cigarette and *midwakh* smokers in the United Arab Emirates (UAE). ***Methods:*** This cross-sectional study was conducted from September to December 2015 in Ajman, UAE. A convenience sampling strategy was used to recruit adult male smokers aged ≥18 years who exclusively smoked either cigarettes or *midwakh*. A validated self-administered questionnaire was used to collect data from the participants, with nicotine dependence assessed using the Modified Fagerström Test for Nicotine Dependence. In addition, testing was performed to determine levels of salivary cotinine and exhaled breath carbon monoxide (CO). ***Results:*** A total of 88 adult male smokers were included in the study, of which 40 (45.5%) were cigarette smokers and 48 (54.5%) smoked *midwakh*. Most participants were 26–35 years of age (48.9%), followed by 18–25 years (30.7%) and ≥35 years (20.5%). Use of *midwakh* was associated with a more than three-fold increase in the risk of moderate to high nicotine dependence in comparison with cigarette smoking. Moreover, for each unit increase in CO level, there was a 10% increase in the risk of nicotine dependency. There was also a significant association between nicotine dependence level and depth of inhalation ($P = 0.023$). ***Conclusion:*** Type of

smoking and CO levels were found to be significant predictors of nicotine dependence among adult male smokers. In particular, greater dependency was observed among *midwakh* smokers compared to those who smoked cigarettes.
Keywords: Tobacco Use; Cigarette Smoking; Addictive Behaviors; Nicotine; Risk Assessment; Carbon Monoxide; Cotinine; United Arab Emirates.

Advances in Knowledge

- To the best of the authors' knowledge, this is the first study to assess nicotine dependence in relation to *midwakh* smoking.
- The use of *midwakh* was associated with a more than threefold increase in the risk of nicotine dependence in comparison with cigarette smoking.
- Moreover, there was a significant association between depth of inhalation and nicotine dependence.

Application to Patient Care

- These findings highlight the importance of assessing other forms of tobacco consumption apart from cigarette and waterpipe smoking when eliciting smoking history from patients, particularly as *midwakh* smoking is rapidly gaining popularity in the Middle Eastern region.
- Healthcare practitioners should be aware of the high risk of nicotine dependency among *midwakh* smokers when recommending smoking cessation strategies.

Introduction

Tobacco use is responsible for the deaths of an estimated eight million people worldwide each year and is one of the main risk factors for cancer and lung and cardiovascular diseases.[1,2] Moreover, tobacco use adversely affects the heart, lungs, kidneys, bones, teeth, gums, blood vessels and reproductive and immune systems.[3] Evidence suggests that there is a 2–3-fold increase in mortality among middle-aged smokers compared to non-smokers of the same age group, leading to a lifespan reduction of approximately 10 years.[4] In 2017, the World Health Organization estimated the prevalence of current tobacco smoking among adults in the United Arab Emirates (UAE) to be 9%, rising to 15% among males alone.[5]

Despite being aware of its adverse effects, many individuals continue using tobacco as a result of the presence of and interactions between highly addictive ingredients within these products.[6] In particular, nicotine—the main psychoactive compound in tobacco—is responsible for reinforcing smoking and tobacco use behaviours, thereby serving to both establish and maintain dependency.[6,7] The Modified Fagerström Test for Nicotine Dependence (mFTND) is a tool to determine the degree of physical addiction to nicotine and is often used to help determine indications for prescribing tobacco cessation medications.[8,9] In turn, a widely used biomarker of tobacco smoke exposure is cotinine, a primary metabolite of nicotine that has a longer half-life (ranging from 9–16 hours) in comparison with nicotine (approximately two hours), thereby allowing for the assessment of tobacco exposure occurring more than eight hours beforehand.[10]

In the UAE, smoking is an important public health problem. *Midwakh* is a common form of tobacco use in this region which involves smoking a small pipe called as *midwakh* as seen in Figure 1, which is filled with a tobacco product known as *dokha*, a blend of shredded tobacco leaf and herbs.[11] A previous study identified *midwakh* to be the second most frequent form of smoking after cigarettes, accounting for 15% of all smokers in the UAE.[12] Crucially, this type of smoking appears to have high addictive potential; a study of high school students in Dubai found that 23.4% regularly smoked *midwakh* on a daily or weekly basis.[13] Recently, a published report showed no significant difference in median breath carbon monoxide (CO) and salivary cotinine levels between cigarette and *midwakh* smokers, although Mahboub *et al*. concluded that nicotine levels in *dokha* were higher in comparison with other types of tobacco products, including cigarettes, chewing tobacco, snuff tobacco and electronic cigarettes.[14,15] Few data are available regarding predictors of nicotine dependence in the UAE and the relation between *midwakh* smoking and nicotine dependence. As such, the aim of the present study was to assess predictors of nicotine dependence among cigarette and *midwakh* smokers in the UAE.

Methods

This cross-sectional survey was conducted between September and December 2015 in Ajman, UAE. The target population included adult males aged ≥18 years who were exclusive cigarette or *midwakh* smokers. Poly-smokers and those who smoked any other form of tobacco such as *beedis*, cigars, pipes, *kretecks* or e-cigarettes were excluded from the study. A convenience sampling strategy was used to recruit healthy participants from among

university students and workers at different work sites in Ajman. Details regarding the enrolment of participants in the study have been published elsewhere.[14]

A validated, pilot-tested and self-administered questionnaire was used to collect data from the participants, including sociodemographic profile, method/depth of inhalation (i.e. the volume of each "puff") and age upon first starting smoking. Nicotine dependence was assessed using the mFTND instrument.[8] The mFTND is a valid and reliable tool consisting of six questions with a total score ranging from zero to 10. In particular, one of the items seeks to determine the timing of the first cigarette of the day; this is an important predictor of dependence because the short half-life of nicotine is responsible for feelings of discomfort and craving often experienced by smokers as soon as they awaken.[8] Another item assesses number of cigarettes smoked per day, a face-valid measure of dependence and a significant predictor of smoking habits.[8]

For the purposes of the current study, the number of individual smoking sessions for *midwakh* smokers was deemed equivalent to the number of cigarettes, as cigarettes containapproximately 0.5–0.9 g of tobacco, similar to the amount used per session of *midwakh* smoking (~0.5 g).[11,14] The remaining items assess other behavioural aspects of nicotine addiction, including difficulties refraining from smoking (i.e. due to illness or in locations where such behaviours are forbidden) and the increased frequency of smoking in the morning.[8] Levels of nicotine dependence were considered to be moderate to high with mFTND scores of ≥4 and low with mFTND scores of <4.

In addition, testing was performed to assess salivary cotinine and exhaled breath CO levels. Salivary cotinine testing was conducted using rapid test strips (NicAlert™ strips, Craig Medical Distribution Inc., Vista, California, USA) based on a semi-quantitative immune-chromatographic assay method that uses monoclonal antibody-coated gold particles and a series of avidity traps.[16] Salivary samples were obtained using the funnel device and collection container provided, with participants asked to spit into the funnel until the collection container was filled at least halfway. The rapid test device was subsequently laid on a flat dry surface with the numbered levels facing up. The collection container was squeezed until approximately eight drops from the inverted saliva tube fell directly onto the white padded end of the strip. After 20–30 minutes, the test results were read by observing and scoring the level at which the color change stopped. The level on the strip and the

cotinine equivalent is as follows; level 0 is 1-10 ng/ml, level 1 is 10-30 ng/ml, level 2 is 30-100 ng/ml, level 3 is 100-200 ng/ml, level 4 is 200-500, level 5 is 500-2000 ng/ml, level 5 is 2000+ ng/ml ng/ml. Salivary cotinine levels of 2 and above (>10 ng/ml) were considered to indicate tobacco users and salivary cotinine level of 1 (1–10 ng/mL) were considered as non-users of tobacco.

Exhaled CO levels were measured using a portable CO monitor (piCO+ Smokerlyzer®, CoVita LLC, Haddonfield, New Jersey, USA) which measures breath CO levels in parts per million (ppm) based on the conversion of CO to carbon dioxide over a catalytically active electrode.[17] Monitoring was performed within eight hours of smoking, with the subjects asked to exhale completely, inhale fully and then hold their breath for 15 seconds. The participants were then requested to exhale slowly into the portable CO monitor and were encouraged to exhale fully in order to collect a sample of alveolar air. Each subject repeated this process twice, with the average of the two CO measurements used for the analysis.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), Version 24.0 (IBM Corp., Armonk, New York, USA). A t-test was performed to identify differences between mean CO and salivary cotinine levels among *midwakh* and cigarette smokers, while associations were determined using a Chi-squared test. Binary and multiple logistic regression analyses were performed in order to identify predictors of nicotine dependence based on the calculation of adjusted odds ratio (aOR) and 95% confidence interval (95% CI) values. A *P* value of <0.050 was considered statistically significant.

Ethical approval for this study was obtained from the research and ethics committees of the Gulf Medical University in Ajman and New York University in Abu Dhabi. Written informed consent was obtained from each participant prior to their enrolment in the study.

Results

A total of 88 adult males were included in the study, of which 40 (45.5%) were cigarette smokers and 48 (54.4%) were *midwakh* smokers. In terms of age distribution, 27 subjects (30.7%) were 18–25 years old**,** 43 (48.9%) were 26–35 years old and 18 (20.5%) were >35 years old. The majority were of Arab ethnicity (60.2%), employed (69.3%) and were educated to the graduate level or higher (56.8%). In terms of smoking behaviours, most

respondents had started smoking before the age of 20 years (56.8%); moreover, 42% usually inhaled deeply when smoking.

Associations between nicotine dependence and selected variables are shown in Table 1. There was a significant association between nicotine dependence and ethnicity, with moderate to high nicotine dependence significantly more frequent among Arab participants compared to those of other ethnicities (75.5% versus 48.6%; $P = 0.010$). In addition, there was a significant association between nicotine dependence and depth of inhalation, with higher levels of dependency noted among smokers accustomed to inhaling deeply compared to their counterparts (78.4% versus 54.9%; $P = 0.023$).

Table 2 compares predictors of nicotine dependence between high and low nicotine dependence groups. Mean age at smoking onset was lower for smokers with moderate to high dependence compared to those with low dependence; however, this finding was not statistically significant (18.4 ± 4.7 versus 19.7 ± 3.5 years; $P = 0.209$). However, mean CO level was significantly higher in people with moderate to high dependence compared to those with low dependence (22.0 ± 12.0 versus 14.2 ± 5.2 ppm; $P < 0.001$). In addition, mean salivary cotinine level was significantly higher in smokers with moderate to high dependence compared to those with low dependence (3.8 ± 1.8 versus 2.8 ± 1.9; $P < 0.018$).

Table 3 shows the results of the logistic regression analyses. Of the six variables included in the simple binary logistic regression analysis, ethnicity, and overall age were not significant and were therefore not included in the multiple binary logistic regression analysis. Of the remaining variables, *midwakh* use significantly increased the risk of high to moderate nicotine dependence by a factor of 3.3 compared to cigarettes (aOR: 3.3, 95% CI: 1.1–10.1; $P = 0.034$). In addition, the risk of nicotine dependence was almost twice as high among smokers who inhaled deeply compared to those who did not inhale deeply; however, this predictor was not statistically significant (aOR: 1.9, 95% CI: 0.6–5.8; $P = 0.251$). Finally, a one unit increase in CO level significantly increased the chance of nicotine dependence by 10% (aOR: 1.1, 95% CI: 1.0–1.2; $P = 0.025$).

Discussion

Nicotine dependence is an important barrier to successful cessation efforts.[18] In the current study, *midwakh* smoking was associated with a more than threefold increase in the risk of

moderate to high nicotine dependence in a cohort of exclusive *midwakh* or cigarette adult male smokers in the UAE. To the best of the authors' knowledge, this is the first study to assess nicotine dependence in relation to *midwakh* smoking. Aden *et al*. suggested that the nicotine content of *dokha* tobacco was higher than that of cigarettes, which may therefore explain the higher dependence associated with *midwakh* smoking in the present study.[19]

These findings are concerning in light of the fact that *midwakh* smoking is rapidly prevalent, particularly among young people living in the Middle Eastern region; moreover, this type of smoking is likely to continue to grow in popularity as a result of marketing efforts, with *dokha* products being advertised to potential consumers as "the future of tobacco".[12] In light of these findings, there is an urgent need for the aggressive implementation and enforcement of strict regulations on *dokha* tobacco products as well as public health education campaigns to raise awareness of the risks associated with *midwakh* smoking among potential users.

In contrast, neither overall age nor age at smoking onset were significantly associated with dependence level in the current study. Various researchers have suggested that age upon firststarting cigarette smoking is related to subsequent smoking behaviours.[20–22] In the present study, a higher proportion of participants who had initiated smoking during adolescence demonstrated moderate to high dependence compared to those who had started at 20 years of age or later; however, this finding was not statistically significant.

Ethnicity was similarly not found to be a significant predictor for nicotine dependence in the current study based on a multiple regression analysis. Evidence related to the role of ethnicity in nicotine dependence is inconsistent. Duncan *et al*. found that the effect of ethnicity on nicotine dependence was significant only when the onset of dependence occurred at <18 years of age and not when the dependence developed later in life.[23] However, Luo *et al*. concluded that dependence occurred with a lower number of cigarettes per day for African American respondents in comparison to Caucasian Americans.[24] A longitudinal study by Brook *et al*. highlighted the importance of various psychosocial and environmental factors when comparing nicotine dependence between different ethnic groups.[25]

Level of breath CO was found to be a significant predictor of nicotine dependence in the present study, with a one unit increase in CO level associated with a 10% increase in the risk of moderate to high nicotine dependence. This finding is in agreement with a study from

Tunis in which rate of expired CO was found to be a significant determinant of tobacco dependence (odds ratio: 1.059).[26] Other researchers have also noted significant correlations between exhaled breath CO level and number of cigarettes smoked over the preceding 24-hour period, as well as with amount of time since last cigarette smoked.[21]

While each unit increase in salivary cotinine level also resulted in a 10% increase in the risk of moderate to high nicotine dependence in the current study, this association was not statistically significant. Similar results have been reported by Asha *et al.* among tobacco chewers in India.[27] With regards to depth of inhalation (i.e. the volume of each "puff"), the risk of nicotine dependence in the present study was almost twice as high among smokers who inhaled deeply compared to those who did not. These data are in line with findings reported by Moolchan *et al*. indicating a relationship between puffing behaviour and the rate of nicotine metabolism and dependence.[22]

This study was limited by various factors, including the small sample size and the recruitment of solely male participants. For these reasons, the findings cannot be generalised. Further research on this topic is recommended in order to incorporate larger and more diverse samples. Nevertheless, to the best of the authors' knowledge, this is the first study to assess nicotine dependence among *midwakh* smokers in comparison to cigarette smokers. These findings provide important insight into a growing public health concern.

Conclusion

Type of smoking and CO levels were significant determinants of nicotine dependence among a cohort of adult male smokers in the UAE. In particular, *midwakh* smoking was associated with a more than three-fold increase in the risk of moderate to high nicotine dependence in comparison with cigarette smoking. Furthermore, for each unit increase in the level of breath CO, there was a 10% increase in the risk of moderate to high nicotine dependence. These findings highlight the need for public health education measures to increase awareness of the risk of nicotine dependency among *midwakh* smokers.

Conflict of Interest

The authors declare no conflicts of interest.

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Table 1: Associations between nicotine dependence and selected variables among adult male *midwakh* and cigarette smokers in Ajman, United Arab Emirates (N = 88)

Variable	**n (%)**			***P* value**
	Total	**Moderate/high dependence**	**Low dependence**	
Age in years				
18–25	27 (30.7)	19 (70.4)	8 (29.6)	0.441
26–35	43 (48.9)	25 (58.1)	18 (41.9)	
>35	18 (20.5)	13 (72.2)	5 (27.8)	
Type of smoker				0.080
Cigarette	40 (45.5)	22 (55.0)	18 (45.0)	
Midwakh	48 (54.5)	35 (72.9)	13 (27.1)	
Ethnicity				0.010
Arab	53 (60.2)	40 (75.5)	13 (24.5)	
Non-Arab	35 (39.8)	17 (48.6)	18 (51.4)	
Occupation				0.089
Student	27 (30.7)	21 (77.8)	6 (22.2)	
Employed	61 (69.3)	36 (59)	25 (41)	
Education level				0.467
Less than graduate level	38 (43.2)	23 (60.5)	15 (39.5)	
Graduate level or higher	50 (56.8)	34 (68)	16 (32)	
Age at smoking onset in years				0.467
<20	50 (56.8)	34 (68)	16 (32)	
≥20	38 (43.2)	23 (60.5)	15 (39.5)	
Depth of inhalation				0.023
Not deep	51 (58)	28 (54.9)	23 (45.1)	
Deep	37 (42)	29 (78.4)	8 (21.6)	

Table 2: Predictors of nicotine dependence according to level of dependence among adult male midwakh and cigarette smokers in Ajman, United Arab Emirates (N = 88)

Predictor	**Mean ± SD**		***P* value**
	Moderate/high dependence	**Low dependence**	
Age at smoking onset in years	18.4 ± 4.7	19.7 ± 3.5	0.209
CO level in ppm	22.0 ± 12.2	14.2 ± 5.2	0.001
Salivary cotinine level*	3.8 ± 1.8	2.8 ± 1.9	0.018
Age in years	29.0 ± 6.8	29.6 ± 5.8	0.673

SD = standard deviation; CO = carbon monoxide.
**cotinine equivalent in ng/ml is given in methodology*

Table 3: Logistic regression analysis to determine predictors of nicotine dependence among adult male *midwakh* and cigarette smokers in Ajman, United Arab Emirates (N = 88)

Predictor		**cOR (95% CI)**	***P value***	**aOR (95% CI)**	***P value***
Type of smoking	*Midwakh*	2.2 (0.9–5.4)	0.082	3.3 (1.1–10.1)	0.034
	Cigarette	1		1	
Depth of inhalation	Deep	3.0 (1.1–7.8)	0.026	1.9 (0.6–5.8)	0.251
	Not deep	1		1	
Ethnicity	Arab	3.3 (1.3–8.1)	0.011	-	-
	Non-Arab	1		-	
Age		1.4 (-3.5–2.3)	0.669	-	-
CO level		1.1 (1.1–1.2)	0.002	1.1 (1.0–1.2)	0.025
Salivary cotinine level		1.3 (1.1–1.7)	0.021	1.1 (0.8–1.6)	0.431

cOR = crude odds ratio; CI = confidence interval; aOR = adjusted odds ratio; CO = carbon monoxide. The model predicted 30.6% of the variability in nicotine dependence (R^2 = 0.306).

Figure 1: *Midwakh* pipe with *dokha* tobacco.