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CLINICAL & BASIC RESEARCH

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 the predictors of nicotine dependence among cigarette or *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 implemented 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, the levels of salivary cotinine and exhaled breath carbon monoxide (CO) were measured. ***Results:*** Of the 88 adult male smokers included in the study, 40 (45.5%) were cigarette smokers and 48 (54.5%) smoked *midwakh*. The majority of participants were 26–35 years of age (48.9%), followed by 18–25 years (30.7%) and >35 years (20.5%). *Midwakh* use was associated with more than a three-fold increase in the risk of moderate-to-high nicotine dependence compared to 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 level were found to be significant predictors of nicotine dependence among adult male smokers. In particular, greater dependency was observed among *midwakh* smokers than cigarette smokers.

Keywords: Tobacco Use; Cigarette Smoking; Addictive Behaviours; Nicotine; Risk Assessment; Carbon Monoxide; Cotinine; United Arab Emirates.

Advances in Knowledge

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

Application in Patient Care

- *The findings of this study highlight the importance of assessing forms of tobacco consumption other than cigarette and waterpipe smoking when eliciting a patient's smoking history, particularly because midwakh smoking is rapidly gaining popularity in the Middle East.*
- *Healthcare practitioners should be aware of the high risk of nicotine dependency among midwakh smokers when recommending smoking cessation strategies.*

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 two- to three-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 current prevalence of 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 due to 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, thus establishing and maintaining dependency.[6,7] The Modified Fagerström Test for Nicotine Dependence (mFTND) is a tool for determining an individual's degree of physical addiction to nicotine as well as indicators 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 (9–16 hours) than nicotine (approximately two hours), 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 smoking in

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this region; it involves a small pipe called *midwakh* which is filled with *dokha*, a blend of shredded tobacco leaves and herbs [Figure 1].[11] A previous study identified *midwakh* to be the second most frequent form of smoking after cigarettes, accounting for 15% of all tobacco smokers in the UAE.[12] Notably, 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] Furthermore, a recently published report showed no significant differences in the median breath carbon monoxide (CO) and salivary cotinine levels between cigarette and *midwakh* smokers, although Mahboub *et al*. concluded that the nicotine level in *dokha* is higher than in other types of tobacco products, including cigarettes, chewing tobacco, snuff tobacco and electronic cigarettes.[14,15] Limited data is available regarding the predictors of nicotine dependence in the UAE and the relationship between *midwakh* smoking and nicotine dependence. Therefore, this study aimed to assess the predictors of nicotine dependence among cigarette and *midwakh* smokers in the UAE.

Methods

This cross-sectional survey study was conducted between September and December 2015 in Ajman, UAE, and included adult males aged ≥18 years who exclusively smoked either cigarettes or *midwakh*. 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 their sociodemographic profile, method/depth of inhalation (i.e. the volume of each 'puff') and age when they first started smoking. Nicotine dependence was assessed using the mFTND instrument.[8] The mFTND is a valid and reliable tool that consists of six questions and a total score ranging from zero to 10. In particular, one of the items seeks to determine the timing of a smoker's first cigarette of the day; this is an important predictor of dependence because the short half-life of nicotine is responsible for the discomfort and craving often experienced by smokers as soon as they awaken.[8] Another item assesses the number of cigarettes smoked per day, a face-valid measure of dependence and a significant predictor of smoking habits.[8] The remaining items assess other behavioural aspects of nicotine addiction including the difficulty to refrain from smoking when required (i.e. due to illness or in locations where such behaviours are forbidden) and increased frequency of smoking in the morning.[8] Levels of nicotine dependence were considered to be moderate-to-high when mFTND scores were ≥4 and low when mFTND scores were <4.

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 contain approximately 0.5–0.9 g of tobacco, similar to the amount used per session of *midwakh* smoking (~0.5 g).[11,14]

In addition, salivary cotinine and exhaled breath CO levels were assessed. Salivary cotinine testing was conducted using rapid test strips (NicAlert™ strips, Craig Medical Distribution Inc., California, USA) based on a semi-quantitative immunochromatographic assay 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 level at which the colour change stopped was observed and scored to obtain the test results. The levels on the strip and the cotinine equivalent were as follows: level 0 was 1–10 ng/mL, level 1 was 10–30 ng/mL, level 2 was 30–100 ng/mL, level 3 was 100–200 ng/mL, level 4 was 200–500 mg/mL, level 5 was 500–2000 ng/mL and level 6 was 2000 + ng/mL. Salivary cotinine levels 2 and above (>30 ng/mL) were considered to indicate tobacco users; a salivary cotinine level of 0 (1–10 ng/mL) was considered to indicate non-users of tobacco.

Exhaled CO levels were measured using a portable CO monitor (piCO+ Smokerlyzer®, CoVita LLC, New Jersey, USA) that 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 and fully into the portable CO monitor so that samples of alveolar air could be collected; each subject repeated this process twice. The average of the two CO measurements were 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 the 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 to identify predictors of nicotine dependence based on the calculation of adjusted odds ratio (aOR) and 95% confidence interval (CI) values. A *P* value <0.050 was considered statistically significant.

Written informed consent was obtained from each participant prior to their enrolment in the study. 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 (NYUADPHRC-PILOT2014-RSHAIKH35000).

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 participants (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%), were employed (69.3%) and had attained an education level of graduate or higher (56.8%). In terms of smoking behaviours, most participants had started smoking before the age of 20 years (56.8%); moreover, 42% usually inhaled deeply when smoking.

A significant association was found between nicotine dependence and ethnicity, with moderate-to-high nicotine dependence being significantly more frequent among Arab participants than those of other ethnicities (75.5% versus 48.6%; *P* = 0.010). In addition,

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				0.441
18–25	27 (30.7)	19 (70.4)	8 (29.6)	
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 the Methods.*

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		0.082		0.034
Midwakh	2.2 (0.9–5.4)		3.3 (1.1–10.1)	
Cigarette	1		1	
Depth of inhalation		0.026		0.251
Deep	3.0 (1.1–7.8)		1.9 (0.6–5.8)	
Not deep	1		1	
Ethnicity		0.011		-
Arab	3.3 (1.3–8.1)		-	
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).*

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 1].

Mean age at smoking onset was lower for smokers with moderate-to-high dependence than those with low dependence; however, this finding was not statistically significant (18.4 ± 4.7 versus 19.7 ± 3.5 years; *P* = 0.209). In contrast, mean CO level was significantly higher in people with moderate-to-high dependence than those with low dependence (22.0 ± 12.2 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 2].

Figure 1: Photograph of a *midwakh* pipe with *dokha* tobacco.

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 moderate-to-high 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 risk of nicotine dependence by 10% (aOR = 1.1, 95% CI: 1.0–1.2; *P* = 0.025) [Table 3].

Discussion

Nicotine dependence is a significant barrier to successful smoking cessation.[18] In the current study, *midwakh* smoking was associated with more than a three-fold increase in the risk of moderate-to-high nicotine dependence in a cohort of adult males who exclusively smoke either *midwakh* or cigarettes 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*. stated that the nicotine content of *dokha* tobacco is higher than that of cigarettes;[19] this may explain the higher dependence associated with *midwakh* smoking in the present study.

These findings are concerning as *midwakh* smoking is rapidly increasing, particularly among young people living in the Middle Eastern region; moreover, this type of smoking is likely 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 found to be significantly associated with dependence level in the current study. Various researchers have suggested that the age at which an individual starts smoking cigarettes is related to their subsequent smoking behaviours.[20–22] In the current study, a higher proportion of participants who had started smoking during adolescence demonstrated a moderate-to-high dependence compared to those who had started at 20 years of age or later; however, this finding was not statistically significant.

Similarly, ethnicity was not found to be a significant predictor of nicotine dependence in the current study's multiple regression analysis. Evidence related to the role of ethnicity in nicotine dependence is inconsistent in the literature as well. 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 nicotine dependence occurred with a lower number of cigarettes per day among African American respondents compared to Caucasian Americans.[24] Furthermore, a longitudinal study by Brook *et al*. highlighted the importance of various psychosocial and environmental factors when comparing the nicotine dependence of 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 Tunisia, in which the rate of expired CO was found to be a significant determinant of tobacco dependence (OR = 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 the amount of time since the last cigarette was smoked.[21]

While each unit increase in salivary cotinine level 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 and Dhanya 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 findings are in line with the results 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 recruitment of solely male participants; due to this, the findings cannot be generalised. Further research in this area is recommended 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 compared to cigarette smokers. These findings provide important insights into a growing public health concern.

Conclusion

The 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 a three-fold increase in the risk of moderate-to-high nicotine dependence compared to 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 that can 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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AUTHORS' CONTRIBUTION

RBS conceptualised the idea of the study. SAS, RBS and MW designed the study. JS and JM collected and

analysed the data. SAS drafted the manuscript. RBS and MW revised the manuscript. All authors approved the final version of the manuscript.

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