

# A Short-Term Follow-Up Study on the Effect of Khat Chewing on Blood Pressure and Heart Rate among Healthy Adults in Taiz, Yemen, Chewing Associated Factors and SDS-Khat

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## Abstract

**Background:** This study aims to investigate the short-term effect of khat on the diastolic and systolic blood pressure (DBP, SBP) and heart rate (HR) of Yemeni adults. Factors associated with Khat and dependency were also investigated, that the khat chewing is a growing public habit among Yemeni people.

**Methods:** A cross sectional-study was conducted between April and September 2021 in Taiz, Yemen. 100 healthy adult were selected using a random sampling method. A well-structured questionnaire was designed to collect the data. The DBP, SBP and HR were measured using an electronic apparatus (visocor OM50). The Severity of Dependency Scale (SDS-Kat) was used to evaluate the psychological dependence. SPSS (version 21) program was used for data analysis.

**Results:** The DBP and SBP were significantly elevated after either 05. H or 1 h of khat chewing in comparison to DBP and SBP at zero time (DBP: 77.90±9, 79.86±10 versus 73.82±7; SBP: 115.36±12, 119.11±15, versus 110.46±11;  $P = 0.00$  for each), as well the HR was significantly elevated after either 05. H or 1 h of khat chewing in comparison to HR at zero time (80.27±12, 81.29±12 versus 78.33±11;  $P = 0.04$  and  $0.00$  respectively). The effect of khat chewing on the DBP and SBP sound to be age-dependent; since the chewers with 40-49 years old were more affected than others ages but the HR exhibited no change after chewing among the chewers with different ages. It looks there is a synergistic effect between khat chewing and abnormal body mass index (BMI) on the elevation of blood pressure in particular DBP. The blood pressures of the single chewers are more affected by khat chewing more than married ones (DBP: 83.67±11 versus 76.19±8; SBP: 126.71±15 versus 111.80±11,  $P = 0.00$  for each) but The HR exhibited no significantly difference between single and married chewers. The results showed that no significantly difference in the DBP, SBP and HR between chewers with different education levels. The SDS-Khat score was 5.28±3.24. 58% of the khat chewers were more likely dependent, while 42.2% were less likely dependent and the males were more likely dependent than females (5.91±2.92 versus 3.72±3.51;  $P = 0.005$ ). The chewers awareness for the psychological effect of khat were not related to the dependence except their awareness for khat-causing nightmare (OR = 2.92; CI 95%: 1.27– 6.69,  $P = 0.013$ ).

**Conclusion:** the elevation of DBP and SBP is affected by khat chewing; to a less extent, HR is affected. Another finding is the synergistic effect of abnormal BMI and khat chewing on the elevation of blood pressure in particular DBP. In addition, the gender-based dependence is reported according to SDS-Khat, since the males were more likely khat-dependent than females.

## 1. Introduction

Khat (*Catha edulis*) is an evergreen plant that is widely chewing in Yemen and east Africa [1]. There are more than 20 different compounds were identified in the leaves and twigs of khat, but the amphetamine cathinone is believed to be the most pharmacologically active compound exerting its activity on the nervous system [2-4].

The khat chewing is a traditionally habit in all socioeconomic Yemeni groups with a higher prevalence in males than in females [2,5]. Although, khat is an addictive due to its negative consequences according to WHO, it has many look-like positive purposes such as facilitating individual's communication, strengthen the social relationships improving self-confidence, performance and work capacity [6,7].

There are many equivocal reports about the effect of khat chewing on human mood and health, blood pressure is one of the central issues that have been investigated. Recently, cross-sectional study reported that khat chewing was associated factor with hypertension among Ethiopian adults [8] another study reported the elevation of systolic and diastolic blood pressures for about three hours after khat chewing [9]. In a case control study, the increasing of diastolic pressure in khat chewers more than non-chewer was recorded [6,10]. In an animal study, the blood pressure of rats was increased as a result of acute and subchronic administration of khat [11,12] and this increasing is significant at higher dose of administered khat [12] as well this increasing was reported in human khat chewers and was corresponding to the time duration of khat chewing [13]. The prolonged chewing Khat could lead to increased diastolic blood pressure [6]. The mechanism of khat-based elevation in the blood pressure is may due the vasoconstriction activity [1,14].

Although the khat-associated issues including hypertension have been reported in many literatures, but, to our knowledge, there is no follow-up investigation of khat chewing on the blood pressure and heart rate among yemeni people in particular healthy adults, so

this study was conducted to investigate the short-term effect of khat chewing on the diastolic and systolic blood pressure (DBP, SBP) and heart rate (HR) among healthy yemeni adults. The khat chewing's associated factors and dependency scale were also investigated.

## 2. Methods

**2.1. Study Design and Sampling.** This is a cross sectional-study conducted from April to September 2021 in Taiz, Yemen. One hundred healthy adult aged between 19 to 60 years were selected using a random sampling method.

All chewers were voluntary participated in this study after meeting certain criteria.

**2.2. Inclusion and Exclusion Criteria.** These criteria include; that the volunteer should be free of any disease, avoiding eating a meal that could effect on the BP or HR, smoking, drinking any beverage such as coffee, ginger or tea within two hours before khat chewing (zero time). eer who didn't meet volunt The one of these criteria was excluded.

**2.3. Data Collection.** A well-structured questionnaire was designed, according to the literatures, and then distributed to collect the data by pre-trinee medical students under supervision of a leader researcher. The systolic and diastolic blood pressure (systolic SBP and diastolic DBP in mmHg), heart rate (HR) and other physical measurements were taken. Blood pressure and heart rate were taken from the left arm of the participant had been taken a rest for five minutes using an electronic apparatus (visocor OM50) in order to get accurate readings and improve the data collection process. The SBP, DBP and HR were measured three times; at zero time before khat chewing, then after 30 minutes and after one hour finally. The Severity of Dependency Scale (SDS-Kat) was used to evaluate the psychological dependence to khat chewing. The SDS-Kat and the questions related to the awareness of chewers about the psychological effect of khat were translated to Arabic language prior presentation to the study participants.

**2.4. Data Analysis.** SPSS (version 21) software program has been used for data entry

and analysis. Descriptive statistics were performed for to know the characteristics of the study participants. Paired-Samples T Tests was conducted to compare the variables (such as: HR, DBP and SBP) before and after the khat chewing among the same subjects. Independent-Samples T Tests were conducted to compare the variables (such as: HR, DBP and SBP) between the male and female groups. One-Way ANOVA Tests were done to

### 3. Results

#### 3.1. Sociodemographic and Khat Chewing Characteristics

The adults who met previously mentioned criteria were interviewed, of all study participants; 71 (71%) are male, aged  $28 \pm 8$  (19-45) year and 29 (29%) are female  $33 \pm 10$  (21-60) year, in fact this result is in agreement with many other studies; since males had higher tendency to chew khat than females [15-19]. According to the marital status they are almost equal, since 49 (49%) were single and 51 (51%) were married (Table 1). Their education level is distributed as 35 participants was college students and 24, 20, 8, 6, 6, 1 were secondary school, bachelor degree,

the variables (such as: HR, DBP and SBP) in the more than two-levels character (such as, Education levels and BMI Ranking), if any differences between the character levels; Post Hoc Test (LSD) was employed. The Odds Ratios (ORs) was calculated to determine the factors associated with khat chewing. Histogram graph was drawn for SDS scores distribution among khat chewers.

diploma, master, PhD holders respectively, in addition 1 participant could read and write and 2 participants were illiterates (Figure 1). Most of the participants (75%) chewed khat daily spending about 1700 YER per day. The mean of the chewing session was  $5 \pm 1.7$  hours while sleeping hours was  $7 \pm 1.4$  per a day. The main reasons for khat chewing were increasing energy (21%), improving the concentration to study or work (21%), enjoying with the partner or friends (16%) and modifying the mood (14%) (Figure 2). 29% of the khat showers were favored to drink water and 23% favored to drink soft drinks (Figure 3).

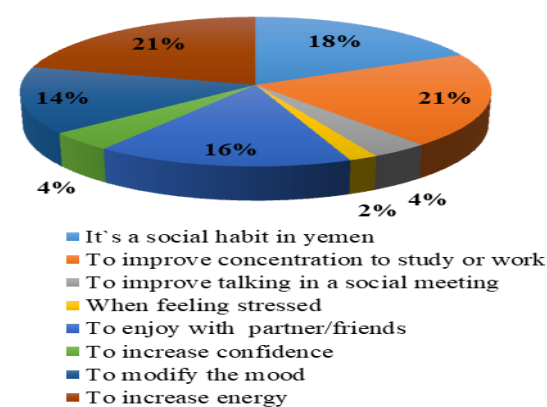
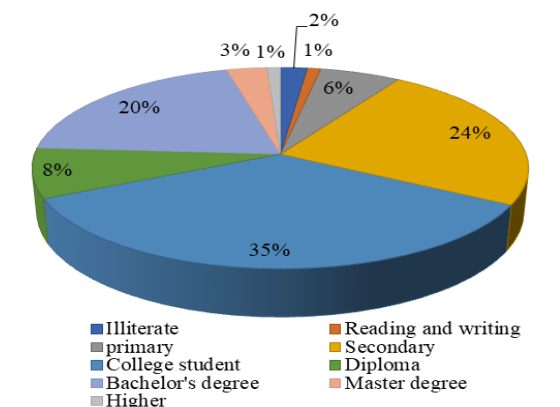


Figure 1. Education Level of the Participants Figure 2. Reasons of Chewing Khat

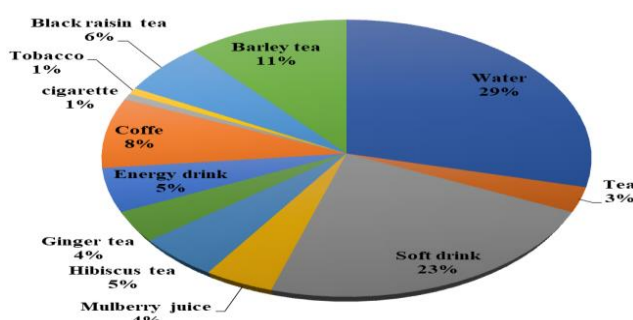


Figure 3. What often taken with the Chewing Khat

### 3.2. Effect of Khat chewing on the DBP, SBP and HR

The DBP, SBP and HR of the khat chewers were measured before chewing at zero time, then after half an hour of khat chewing and last after one hour of khat chewing. **Table 1** shows there is significantly differences in the mean of DBP after half an hour and 1 hour of khat chewing in comparison to the mean of DBP at zero time ( $p$  value: 0.00 for each), as well there is a significantly difference between the mean of DBP after half an hour of khat chewing and DBP after 1 hour ( $p$  value = 0.0.01). **Table 1** also shows there is significantly differences in the mean of SBP

after half an hour and 1 hour of khat chewing in comparison to the mean of SBP at zero time ( $p$  value: 0.00 for each), as well there is a significantly difference between the mean of SBP after half an hour of khat chewing and SBP after 1 hour ( $p$  value = 0.0.01). The mean of HR after half an hour and after one hour of the khat chewing were significantly different to the mean of HR at zero time ( $p$  value: 0.04 and 0.00 respectively), but no significantly difference between the mean of HR after half an hour of khat chewing and HR after one hour ( $p$  value = 0.19), however, they are significantly correlated (0.80,  $P$  value 0.00)

**Table 1.** The Effect of Khat Chewing on DBP, SBP and HR of the Participants (N = 100)

Variable	Measurement Time								
	Before chewing, Zero Time	After 0.5 h of chewing	$p$ Value	Before chewing, Zero Time	After 1 h of chewing	$p$ Value	After 0.5 h of chewing	After 1 h of chewing	$p$ Value
	Mean $\pm$ SD			Mean $\pm$ SD			Mean $\pm$ SD		
DBP	73.82 $\pm$ 7	77.90 $\pm$ 9	0.00*	73.82 $\pm$ 7	79.86 $\pm$ 10	0.00*	77.90 $\pm$ 9	79.86 $\pm$ 10	0.01*
SBP	110.46 $\pm$ 11	115.36 $\pm$ 12	0.00*	110.46 $\pm$ 11	119.11 $\pm$ 15	0.00*	115.36 $\pm$ 12	119.11 $\pm$ 15	0.01*
HR	78.33 $\pm$ 11	80.27 $\pm$ 12	0.04*	78.33 $\pm$ 11	81.29 $\pm$ 12	0.00*	80.27 $\pm$ 12	81.29 $\pm$ 12	0.19

### 3.3. Relationship between Sociodemographic Factors and DBP, SBP of Participants

The effect of khat chewing on the DBP sounds to be age-dependent; since the chewers with 40-49 years old were more affected than chewers with 19-29 years old after half an hour of chewing khat (83 $\pm$ 8, 76 $\pm$ 7;  $P$  value = 0.005), in addition, after one hour of khat chewing, they were more affected than chewers with 19-29 and 30-39 years old (87 $\pm$ 12 versus 76 $\pm$ 8 and 85 $\pm$ 11 respectively;  $P$  value = 0.00). the SBP changes were significantly appeared after one hour of chewing, that chewers with 40-49 years old were more affected than chewers with 19-29 and 30-39 years old (133 $\pm$ 15 versus 113 $\pm$ 12 and 125 $\pm$ 13 respectively;  $P$  value = 0.00, **Table 2**).

Although, the DBP mean value after chewing was significantly different with the DBP mean

value before chewing, the effect of khat chewing on the DBP according to the gender isn't clear, since there is a significant difference between male and female before chewing. On the other hand, The SBP mean values were significantly different between male and female before chewing, but no difference after chewing. It may refer to the khat effect that led to cancellation of the difference of SBD mean values before chewing (**Table 2**).

The effect of khat chewing on the DBP according to the BMI isn't straightforward; before chewing, there was significantly difference between underweight group in comparison to both overweight and obese groups (70 $\pm$ 9 versus 76 $\pm$ 8 and 76 $\pm$ 8 respectively;  $P$  value  $\leq$  0.03). The DBP mean values were significantly different between underweight group and all other groups after half hour of chewing ( $P$  value  $\leq$  0.007). Moreover there were significant differences in

the DBP mean values between each group versus all other groups except obese group versus overweight group ( $P$  value  $\leq 0.05$ ). The SBP changes were significantly appeared after one hour of chewing, that SBP of the obese group was significantly different to the SBP of all other groups ( $P$  value  $\leq 0.001$ ). It looks there is a synergistic effect between khat chewing and BMI on the blood pressure in particular DBP (**Table 2**).

According to the marital status, The changes in the DBP and SBP mean values between

single and married chewers were significantly appeared only after one hour of chewing (DBP =  $83.67 \pm 11$  versus  $76.19 \pm 8$ ,  $P$  value 0.00; SBP =  $126.71 \pm 15$  versus  $111.80 \pm 11$ ,  $P$  value 0.00 respectively). That means the blood pressures of the single chewers are more affected by khat chewing more than married ones. It's clear that no difference on the SBP between chewers with different education levels, although there was slightly differences on their DBP after chewing ( $P$  value = 0.03, **Table 2**).

**Table 2.** Relationship between Sociodemographic Factors and DBP, SBP of the Study Participants

Variables	Sample N	Diastolic Pressure						Systolic Pressure					
		Before chewing, Zero Time		After 0.5 h of chewing		After 1 h of chewing		Before chewing, Zero Time		After 0.5 h of chewing		After 1 h of chewing	
		Mean ±SD	p Value	Mean ±SD	p Value	Mean ±SD	p Value	Mean ±SD	p Value	Mean ±SD	p Value	Mean ±SD	p Value
<b>Age</b>													
19-29	59	73±6	0.48	76±7	0.02 <sup>*a</sup>	76±8	0.00 <sup>*b</sup>	111±11	0.01 <sup>*c</sup>	114±12	0.20	113±12	0.00 <sup>*b</sup>
30-39	23	74±9		78±12		85±11		106±10		114±12		125±13	
40-49	16	76±7		83±8		87±12		111±13		120±11		133±15	
≥ 50	2	78±4		70±7		72±2		134±9		127±7		119±15	
<b>Gender</b>													
Male	71	74.88±6	0.02 <sup>*</sup>	79.50±8	0.00 <sup>*</sup>	82.01±11	0.00 <sup>*</sup>	108.78±11	0.02 <sup>*</sup>	114.45±11	0.25	119.23±16	0.89
Female	29	71.20±9		73.96±10		74.58±7		114.55±12		117.58±14		118.79±12	
<b>BMI</b>													
Underweight	11	70±9	0.07 <sup>*d</sup>	70±9	0.00 <sup>*e</sup>	71±8	0.00 <sup>*f</sup>	110±15	0.55	116±18	0.17	113±8	0.00 <sup>*g</sup>
Normal	49	73±6		77±7		78±9		111±11		113±10		116±15	
Overweight	28	76±8		80±8		84±10		108±11		117±11		120±14	
Obese	12	76±8		83±12		88±11		113±12		122±15		133±12	
<b>Material Status</b>													
Single	49	74.30±8	0.50	79.28±10	0.13	83.67±11	0.00 <sup>*</sup>	109.04±12	0.23	115.53±13	0.89	126.71±15	0.00 <sup>*</sup>
Married	51	73.35±6		76.56±8		76.19±8		111.82±11		115.19±11		111.80±11	
<b>Education Level</b>													
Illiterate	2	73.5±5	0.446	70±14	0.033 <sup>*</sup>	74±7	0.037 <sup>*</sup>	123.5±13	0.245	118.5±25	0.605	126.5±9	0.364
Reading and Writing	1	82±0		87±0		80±0		110±0		120±0		130±0	
Primary School	6	75±7		80.66±9		77.66±8		117±13		120±9		122.16±20	
Secondary School	24	74.29±5		76.20±7		78.70±8		108.75±11		113.41±10		114.45±16	
College Students	35	72.65±7		77.05±10		76.57±10		112.8±11		117.08±14		117.11±12	
Diploma	8	74.5±13		78.75±5		82.12±9		110±15		109.75±8		117.25±11	
Bachelor	20	75.5±7		82.15±7		87.35±11		105.75±9		116.1±16		125.1±5	
Master	3	70±10		75±16		81±20		110±16		114±20		125.66±32	
Higher	1	61±0		55±0		76±0		104±0		97±0		132±0	

\* Significant value.

**LSD Test:** <sup>a</sup> the P value (0.005) between (19-29) group and (40-49) group; <sup>b</sup> the P value (0.000) between (19-20) group versus (30-39) and (40-49) groups; <sup>c</sup> the P value (≤0.007) between (≥ 50) group and all other groups; <sup>d</sup> the P value (≤0.03) between underweight versus both overweight and obese groups; <sup>e</sup> the P value (≤0.007) between underweight group and all other groups; <sup>f</sup> the P value (≤0.05) between each group versus all other groups except obese versus overweight group; <sup>g</sup> the P value (≤0.001) between obese group and all other groups

### 3.4. Relationship between Sociodemographic Factors and HR of the Participants

The effect of khat chewing on the HR sounds to be age-independent; since the HR exhibited no change after chewing among the chewers with different ages (Table 3). Although The HR after half an hour and after one hour of the khat chewing was significantly different to the HR at zero time (*p* value: 0.04 and 0.00 respectively, Table 1).

Although, the HR mean values after half hour of chewing were significantly different between male and female (77.11±11; 88±12; *P* value = 0.00) as well the HR mean values after an hour of chewing were significantly different between male and female (78.45±11; 88.24±13; *P* value = 0.00), the effect of khat chewing on the HR according to the gender isn't clear, since there is a significant difference between male and

female before chewing, but the HR mean values were increased after chewing in comparison to the HR mean value before chewing.

Table 3 shows that were significant differences in the HR between chewers with different BMI after half hour (*P* value = 0.02) and after one hour (*P* value = 0.01) of khat chewing. The Post-Hoc analysis clarified that refer to the difference between underweight group and all other groups after half hour (*P* value ≤ 0.04) and one hour (*P* value (≤ 0.026) of khat chewing. According to the marital status, The HR exhibited no significantly difference between single and married chewers, however; there were increasing in the HR of both single and married after chewing in comparison to the HR before chewing. It's clear that no difference on the HR between chewers with different education levels (Table 3).

Table 3. Relationship between Sociodemographic Factors and HR of Participants (N = 100)

Variable	Sample N	Heart Rate					
		Before chewing, Zero Time		After 0.5 h of chewing		After 1 h of chewing	
		Mean±SD	PValue	Mean±SD	PValue	Mean±SD	P Value
<b>Age</b>							
19-29	59	79±12	0.38	81±13	0.30	82±13	0.51
30-39	23	75±8		77±8		78±8	
40-49	16	80±14		81±13		83±14	
≥ 50	2	83±4		91±7		84±8	
<b>Gender</b>							
Male	71	75.87±10	0.00 *	77.11±11	0.00 *	78.45±11	0.00 *
Female	29	84.34±12		88±12		88.24±13	
<b>BMI</b>							
Underweight	11	84±10	0.08	89±15	0.02 * <sup>a</sup>	92±15	0.01* <sup>b</sup>
Normal	49	77±11		81±13		81±13	
Overweight	28	76±11		76±7		78±9	
Obese	12	83±12		79±12		81±11	
<b>Material Status</b>							
Single	49	77.61±11	0.54	79.73±12	0.67	81.26±12	0.98
Married	51	79.01±12		80.78±13		81.31±13	
<b>Education Level</b>							
Illiterate	2	77±17	0.06	82±18	0.07	80.5±15	0.144
Reading and Writing	1	77±0		77±0		72±0	
Primary School	6	78.33±10		82.33±11		86.33±12	
Secondary School	24	73.95±11		76.70±10		78.62±16	
College Students	35	82.65±11		84.65±14		84.37±13	
Diploma	8	78.12±9		82.5±10		83.75±11	
Bachelor	20	74.35±9		74±8		75.4±6	
Master	3	90.33±19		88±21		89.33±25	
Higher	1	81±0		84±0		92±0	

\* Significant value.

**LSD test:** <sup>a</sup> the P value ( $\leq 0.04$ ) <sup>b</sup> the P value ( $\leq 0.026$ ) between underweight group and all other groups

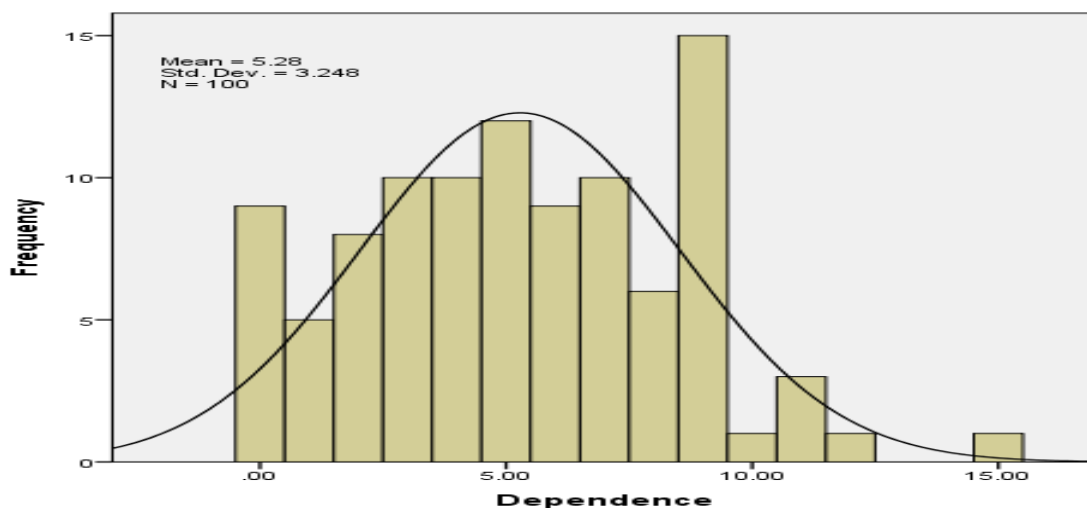
### 3.5. SDS-Khat among Study Participants

The mean score of SDS-Khat and the frequency of each score were calculated (**Table 4**); since the mean score was  $5.28 \pm 3.24$  (**Figure 4**). Considering  $\geq 5$  as a dependence cutoff point, 58 (58%) of khat chewers were more likely dependent, while 42 (42.2%) were less likely dependent. The most frequency of the chewers (15%) scored nine (9), followed by (12%) scored five (5), then ten percent (10%) for both scores three (3) and four (4) scores. The zero and six scores were both recorded as 9%, the two and eight scores were recorded 8% and 6% respectively while the remainder thirteen and

fourteen scores weren't recorded among study participants (**Table 4**). According to gender, the males were more likely khat-dependent than females ( $5.91 \pm 2.92$  versus  $3.72 \pm 3.51$ ;  $P = 0.005$ ). All of the features presented in the **table 5** couldn't consider as risk factors associated with khat chewing as well as the chewers awareness for the psychological effect of khat chewing were not related to the dependence except their awareness for khat causing nightmare (OR = 2.92; CI 95%: 1.27– 6.69,  $P = 0.013$ ; **Table 6**). All the questions presented in the table 6 were taken from the literature [2].

**Table 4.** The severity of dependence scale SDS- Khat among study participants

SDS- Khat Score	Frequency (N =100)	SDS- Khat Score	Frequency (N =100)
0	9	8	6
1	5	9	15
2	8	10	1
3	10	11	3
4	10	12	1
5	12	13	0
6	9	14	0
7	10	15	1



**Figure 4.** Frequency distribution of SDS scores among the khat chewers.

**Table 5.** Relationship between khat dependence and chewing features.

Item	More likely dependent (≥ 5 scores) N	Less likely dependent (<5 scores) N	p value	OR (CI)
<b>Khat chewing session hours</b>				
≥ 6	32	18	0.31	1.641 (0.737-3.655)
<6	26	24		
<b>Chewing Frequency per week</b>				
4-7 Times	46	37	0.291	0.518 (0.167-1.603)
Less than 3 Times	12	5		
<b>Years of khat chewing</b>				
≥10 years	23	20	0.540	0.72 (0.324-1.612)
<10 years	35	22		
<b>Smoking</b>				
Yes	29	20	0.842	1.10 (0.497-2.435)
No	29	22		

**Table 6.** Relationship between khat dependence and awareness for the psychological effect of khat

Item	Awareness				p value	OR (CI)
	Dependent		Nondependent			
	Yes	No	Yes	No		
Do you know that khat can cause addiction?	49	9	32	10	0.314	1.701 (0.623-4.647)
Do you know that World Health Organization put khat as type of narcotics?	26	32	24	18	0.311	0.609 (0.274-1.357)
Do you know that khat can cause rapid beating of the heart?	28	30	22	20	0.84	0.848 (0.383-1.879)
Do you know that khat increase blood pressure?	37	21	22	20	0.305	1.602 (0.714-3.595)
Do you know that khat decrease appetite?	47	11	32	10	0.623	1.335 (0.508-3.512)
Do you know that khat cause constipation?	43	15	26	16	0.273	1.764 (0.749-4.154)
Do you know that long term use of khat can cause mental diseases?	17	41	11	31	0.823	1.169 (0.480-2.847)
Do you know that long term use of khat can cause cardiovascular diseases?	17	41	12	30	1	1.037 (0.432-2.490)
Do you know that long term use of khat can cause hepatitis?	15	43	12	30	0.821	0.872 (0.358-2.125)
Do you know that khat can cause headache?	32	26	20	22	0.544	1.354 (0.610-3.003)
Do you know that khat can cause aggressions?	25	33	13	29	0.297	1.690 (0.733-3.897)
Do you know that khat can cause hallucinations?	31	27	16	26	0.157	1.866 (0.831-4.189)
Do you know that khat can cause insomnia?	47	11	30	12	0.337	1.709 (0.669-4.365)
Do you know that khat can cause nightmares?	41	17	19	23	0.013*	2.920 (1.273-6.695)

Do you know that khat can cause depressive disorder?	23	35	22	20	0.228	0.597 (0.268-1.332)
Do you know that khat can cause slight trembling?	14	44	13	29	0.498	0.710 (0.292-1.726)

\*Significant *p* value; Fisher exact test was used.

#### 4. Discussion

Our study indicated to the elevation in the DBP, SBP and HR after half an hour and after one hour of khat chewing in comparison to the DBP at zero time before chewing khat and the elevation of DBP and SBP after one hour of chewing was higher than elevation after half an hour of chewing. This findings were in a good agreement with many various-designed studies; since chewing khat was be found an associated factor with hypertension [8,20] and prolonged exposure to Khat led to the DBP increasing [6], in a pharmacokinetic study reported the elevation of DBP and SBP after three hours of chewing [21]]. In a case control study reported the elevation of Systolic blood pressure in both groups; chronic consumers and naive subjects but this elevation was more in the in naive subjects [22]. Another case control study; The DBP was found to be higher than non-chewers [6]. The elevation of BP was corresponded to the chewing time duration [13] (Toennes et al., 2003). In animal studies on rats; the dose-dependent elevation of BP due to acute administration of khat was reported [11]. This elevation may refer to the sympathomimetic activity of cathinone, the major component in khat, on the cardiovascular system [23]. Nencini et al., reported that the chronic khat chewers developed a tolerance against the sympathomimetic effects of the khat, that the changes in the HR and BP of the subjects unaccustomed to khat chewing were more occurred than in chronic khat chewers [22]. The effect of khat chewing on the DBP sounds to be age-dependent; since the old chewers (40-49 y) were more affected than younger chewers (19-29 y) after either half an hour or one hour of chewing khat. To a less extent, the SBP change was significantly appeared after one hour of chewing in the chewers (40-49 y). The literatures reported that the subjects (25-35 y) were the most among khat chewers [24] [25].

A further novel finding is that the effect of khat chewing on the DBP according to the BMI isn't straightforward; It looks there is a synergistic effect between khat chewing and BMI on the blood pressure in particular DBP. It is unlikely that a higher prevalence of normal BMI among Khat chewers than among non-khat chewers. [26], in the same line, the Khat chewing was found to be a risk factor for increasing body weight [26-28]. The relationship between khat chewing and BMI isn't easy to explained that could led to paradoxical conclusions [29].

According to the education level, our study showed that the chewing khat exhibited no difference on the SBP among chewers with different education levels, although there was a slightly difference on their DBP after chewing. The finding is directly in line with previous finding since an association between khat chewing and educational level was reported among an Ethiopian people [30], as well no education was a significant risk factor for chewing khat in Yemeni pregnancy women [31]. However, the more recent study demonstrated that the khat chewing was not significantly associated with education level in the Yemeni women [25].

The Severity of Dependence Scale (SDS) was employed on UK-residence Yemeni khat chewers to assess the psychological dependence [32]. This SDS is a useful scale to predict the burden of physical or psychological symptoms [33]. The implementation of SDS-Khat on our study participants showed that 58 (58%) of them were more likely dependent, while 42 (42.2%) were less likely dependent; considering  $\geq 5$  as a dependence cutoff point. According to gender, the males were more likely khat-dependent, while females were less likely dependent. In the same line, a cross-sectional study on Saudi male khat chewers showed that Half (52.2%) of khat chewers showed psychological dependency by using SDS [33]. Physical and

psychological dependence of khat were contested in literatures and the WHO stated that “There is inconsistent data regarding the dependence potential of khat” [34]. Our study indicate that the khat related features, presented in table 5, including prolonged chewing were not associated risk factors. However, El-Setouhy et al reported that chewers who had longer khat sessions ( $\geq 6$  hours) were more likely dependent [33], as well prolonged Khat chewing could lead to psycho-neurological disturbances such as neurosis. Furthermore, the more frequent chewing, more than 2 days per week, was associated with psychological khat dependence [32]. Finally, its noteworthy to mention to the limitations of our study; as the others cross-sectional study design, the association of khat chewing with the elevation in the BP and HR was confirmed but the causality couldn't, our participants chewed different types of khat and the amount of khat was not easy to be adjusted; thus the activity of Khat varies accordingly.

### Conclusions

The rapidly elevations of DBP, SBP and HR, in a less degree, due to khat chewing have been confirmed. This study also demonstrated that the abnormal BMI could exert a synergistic effect with khat chewing on the elevation of blood pressure in particular DBP. According to SDS-Khat, the gender-based dependence among Yemeni adults is reported.

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