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Review Article

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Effects of Khat Chewing on Blood Pressure and Heart Rate Among Students in Thamar University

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Abstract

Background: *The khat is deeply rooted in Yemeni societies and become a part of their social live. Cathinone and cathine are considered as the main components of khat and they are structurally and functionally similar to amphetamine for their effects on sympathetic nervous system. Khat effect on CVS through elevation of blood pressure, heart rate and inducing vasospasm, and there are many reports that link khat chewing to cardiovascular disorders.*

Methods: *We conducted a cross-sectional study performed among 150 students from different colleges and levels in Thamar university who used to chew khat between Oct 2019 and Fab 2020. First we offered them questionnaire for information about khat chewing habits and for risk factors of hypertension, then we measured weight and height to calculate BMI and then properly measured blood pressure and heart rate 30 minutes before and 3 hours after chewing khat session.*

Results: *We concluded that khat chewing is associated with significant increase in blood pressure and heart rate with mean difference of 11 mmHg in SBP, 8 mmHg in DBP and 11 heart rate per minute after 3 hours of chewing khat. In addition, we found that a total number of 44 of students had DBP of more than 90 mmHg compared to only 11 before chewing khat.*

Conclusion: *Khat chewing has significant rise in blood pressure and heart rate that can lead to adverse consequences on cardiovascular system and increase the incidence of hypertension, AMI, cardiomyopathy, and other cardiovascular disorders, so legal restriction for the widespread use of khat should be applied and extensive education programs about its effects on CVS and other systems should be done.*

Keywords: Khat Chewing, Systolic Bp, Diastolic Bp, Heart Rate

1. Introduction

1.1. Background

The use of khat (*Catha edulis*) is a major public health and social problem that is believed to be growing globally and it is estimated that about 20 million people worldwide are chewing khat, which previously was confined to East Africa and the Arabian Peninsula [1]. Khat leaves is chewed habitually among Yemeni people for its efficacy on the body energy [2]. Cathinone is the main effective constituent of Khat; it is structurally and functionally closely similar to amphetamine and acts as indirect sympathomimetic through releasing catecholamine from central and peripheral intraneuronal sites [3]. Although there are conflicting opinions as to whether khat, similar to amphetamines, can actually cause dependence [4]. In addition to cathinone, d-nor pseudoephedrine

has been identified as an additional psychoactive ingredient in Khat, and cathine has also been noted to have psycho stimulant properties [5].

Although Khat users frequently report increased levels of energy, alertness and self-esteem, sensations of elation, enhanced imaginative ability and a greater capacity for associating ideas, some khat chewers experience anxiety, tension, restlessness, and aggressive behavior or psychosis, and persistent consumption can lead to impairment of mental health, possibly contributing to personality disorders and psychological deterioration [1,6]. Some studies, however, indicated that hypertension is among the health consequences of Khat chewing [7,8].

A study from an urban population in Ethiopia reported an isolated increase in mean diastolic blood pressure among adults who chewed Khat regularly [8]. In some studies on students, they indicated that they had a better ability to review lessons and improved performance in exams following khat use [5,6].

1.2. Study Justification

Due to the increasing trends in khat consumption in our country and especially among university students and its association with many social and health problems, detailed study was necessary to identify how khat chewing can affect blood pressure and heart rate among students in Thamar University and to identify other risks for cardiovascular diseases.

1.3. Objectives

Our study aims to target 150 students from different colleges among Thamar University in order to find out the extent of the rise of blood pressure and heart rate after khat chewing compared to that measured before chewing khat. Also to find their chewing habits regarding duration (year), period (hours per day), and days per week of khat chewing and to assess the presence of other cardiovascular risks of chewing khat.

2. Literature Review

2.1. khat

2.1.1. Introduction

Fresh leaves of the khat (or qat) tree (*Catha edulis* Forsk.) are widely chewed in Yemen and east African countries. People chew khat for its central nervous system stimulant effects such as euphoria, energy, alertness and for social purposes [2,9].

Yemenis chew khat heavily on a daily basis. The habit of khat chewing is deeply rooted in Yemeni society and has sharply increased in recent years [10]. The pharmacological effect of khat chewing is mainly due to the cathinone present in the fresh leaves [2,9].

As cathinone, and to a lesser extent cathine, are held responsible for the effects of khat on the nervous system, the effects of the many other constituents of the khat plant are frequently overlooked, as a consequence, much research has been focused on the pharmacological effects of cathinone and cathine, and much less on the other constituents of khat [3].

In an animal study, a marked constriction of the coronary vasculature, the maximum being equivalent to that achieved with noradrenaline or the cathinone metabolite, nor pseudoephedrine [10]. The pronounced negative inotropic effect, possibly due to the impaired coronary perfusion which was demonstrated in isolated perfused hearts of guinea pigs [10,11]. In meta-analysis study which compared the difference of blood pressure between khat chewers and non-chewers, it showed that, the mean DBP of khat chewers was higher with the mean difference of 5.1 mmHg. Similarly, khat chewers had higher mean SBP, with the mean difference of 7.9 mmHg [12].

The euphoric effects of khat start after about 1 hour of chewing. Blood levels of cathinone start to rise within 1 hour and peak plasma levels are obtained 1.5 – 3.5 hours after the onset of chewing [13]. The effects of khat are obtained by chewing the tender leaves and shoots. Fresh leaves are preferred as the psychoactive properties decrease after harvesting, in particular during drying of the plant material. This is caused by the decomposition of cathinone into inactive ‘dimer’ [14]. This explains why fresh leaves are preferred and why khat is wrapped up in banana leaves to preserve freshness [15].

2.1.2. Dependence Potential

According to Kalix p (1988) , khat chewing may induce moderate but often persistent psychological dependence. Withdrawal symptoms after prolonged use are mild and may consist of lethargy, mild depression, slight trembling and recurrent bad dreams [16].

In fact, there are very few reports on khat dependence and habitual users do not show serious problems when stopping use [17,18]. Discontinuation results in improvement of sleep and appetite, and fewer constipation problems [2,6].

Although cathinone is assumed the dependence-producing constituent, khat has low abuse potential in humans and khat dependence is mild. It is associated with consuming khat on a daily basis [19]. Mild craving and tolerance to the effects of khat exist but there is no definite withdrawal syndrome. A habitual user may feel hot, lethargic and gripped with the desire to chew khat in the first two days. During sleep, nightmares are common but these stop after a few nights [2].

Recently, Al-Motarreb et al 2005 have reported an increased incidence of acute myocardial infarction (AMI) in Yemen, which was associated with khat chewing [20]. There was also a difference in the diurnal pattern of AMI presentation between khat users and non-khat users. In non-khat users the peak presentation of AMI is in the early hours, whereas in khat users it is shifted to the late afternoon and evening, which coincided with the khat chewing session [21].

2.1.3. Subjective Effects of Khat Chewing

Khat chewing induces a state of euphoria and elation with feelings

of increased alertness and arousal. This is followed by a stage of vivid discussions, loquacity and an excited mood. Thinking is characterized by a flight of ideas but without the ability to concentrate. However, at the end of a khat session the user may experience depressive mood, irritability, anorexia and difficulty to sleep [2,19]. The effect on anxiety and depression was temporary and had disappeared the next day [22].

Many Yemenite users, however, believe that khat chewing improves their sexual desire and excitement [2]. Khat chewing induced anorexia and insomnia (delayed bedtime) resulting in late wake- up next morning and low work performance the next day [23].

2.1.4. Cardiovascular Effects of Khat Chewing

The effects of cathinone and cathine on the CVS are expressed by an increment in heart rate (HR), blood pressure (BP), and vasomotor effects on the coronary vessels [24].

In one study, the administration of cathinone produced clear cut increases in BP and HR, and regular khat use was shown to cause a rise in BP and HR. These changes may parallel the levels of cathinone in the plasma [25,26].

In a pharmacokinetic study done by Toenness w et.cl(2003) reported that, diastolic and systolic blood pressures were elevated for about 3 hours after chewing khat [27].

Recently, it has been reported that khat chewing is associated with acute myocardial infarction [20,28].

Khat chewing has been found as an independent dose-related risk factor for the development of acute myocardial infarction with heavy chewers having a 39-fold increased risk [20].

An increased incidence of acute myocardial infarction presenting between 2 pm and midnight,(i.e. occurring during khat sessions), has been found [21].

Khat chewing has also been reported to be a significant risk factor for acute cerebral infarction [29]. In addition to its effects on BP, khat has also been associated with the increased incidence of acute coronary vasospasm and myocardial infarction (MI) [30]. As one of the constituents of khat, cathinone is reported to be associated with severe coronary vasoconstriction and a severe negative inotropic effect on the cardiac muscle, suggesting that coronary spasm contributes to the development of acute MI [24,31].

Khat chewers also had a higher risk of death, recurrent myocardial ischemia, cardiogenic shock, and ventricular arrhythmia [1]. Khat chewing was also found to be an independent risk factor of death, recurrent cardiac ischemia, heart failure and stroke [32].

In a study by Al-Motarreb *et al*. reported that, mild chewers were not shown to be at risk of AMI, while moderate khat chewers were shown to be at high risk (OR = 7.62) and heavy khat chewers at even higher risk (OR = 22.28) [20].

2.1.5. Toxicology, Including Adverse Reactions in Humans

Khat use affects cardiovascular, digestive, respiratory, endocrine, and genito-urinary systems. In addition, it affects the nervous system and can induce paranoid psychosis and hypomanic illness with grandiose delusions [16].

The main toxic effects include increased blood pressure, tachycardia, insomnia, anorexia, constipation, general malaise, irritability, migraine and impaired sexual potency in men [19].

• Hypnagogic Hallucinations

Hypnagogic hallucinations have been reported in chronic khat users. These consist of continuous visual and/or auditory dreamlike experiences that accompany daily life and are not related to khat sessions. Patients may consider them as normal and do not usually report these hallucinations unless specifically asked about [33].

• Impairment of Cognitive Functions

Adverse effects of khat chewing include impairment of perceptual-visual memory and decision-speed cognitive functions [34].

2.2. Hypertension

High blood pressure (BP), or hypertension, is defined by two levels by 2017 American College of Cardiology/American Heart Association (ACC/AHA) guidelines [35,36].

1. Elevated BP, with a systolic pressure (SBP) between 120 and 129 mm Hg and diastolic pressure (DBP) less than 80 mm Hg, and
2. Stage 1 hypertension, with an SBP of 130 to 139 mm Hg or a DBP of 80 to 89 mm Hg.

Hypertension is the most common primary diagnosis in the United States [37]. It affects approximately 86 million adults (≥20 years) in the United States and is a major risk factor for stroke, myocardial infarction, vascular disease, and chronic kidney disease [38].

3. Subjects and Methods

3.1. Study Population and Sampling

The study was cross-sectional study done between Oct.2019 and March 2020, that targeted 150 male students from different colleges in Thamar University who used to chew khat with age ranging between 20 to 30 years old. We have selected them randomly based on their cooperation to be volunteers in this research. The study was approved by the local ethics committee, the included students were informed about the study and asked for their participation, taking the consent of those who agreed to be included in this study.

They were targeted in their places where they used to chew khat, in order to perform the measurements with a former consent. Data were collected after physical measurement of blood pressure, heart rate, weight and height.

3.2. Methods and Materials

3.2.1. Data Collection

We met the students in their khat chewing places between 1:00 and 2:00 PM. Initially we offered them a questionnaire to fill. The consents of the candidates has been taken before collecting the data.

3.2.2. Questionnaire

A questionnaire was first introduced to students for information about age, college, and level of study. Also for information regarding their chewing khat habits, as for how long they have been chewing khat, how many days per week and how many hours per day.

Also for information about risk factors of hypertension such as if there was any previous known past or family history of hypertension, diabetes, smoking (duration, type, and quantity) , and other cardiovascular diseases.

3.2.3. Blood Pressure and Heart Rate Measurements:

We measured BP and heart rate at constant interval between 2:00 PM and 5-6 PM. We first instruct students not to drink stimulant or to do exercise at least 3 hours before measurement and we advised them to rest for at least 15 minutes before measurement.

We started the measurements 30 minutes before the start of khat chewing session and repeated the measurements after 3 hours from the beginning of khat chewing.

We measured BP while the students in setting position with their left arm supported on flat surface at the level of heart using properly calibrated mercury sphygmomanometer with suitable cuff size for arm circumference. The 1st and 4th korotkoff sounds were used to determine SBP and DBP respectively. The heart rate was calculated by palpating the radial artery for 15 seconds and multiplied by 4.

3.3. Statistical Analysis

Statistical analysis was performed using IBM SPSS version 23, and data are presented as means, standard deviations (SD) and percentages. The change between SBP, DBP, and heart rate was measured using the Paired-sample T test.

4. Results

From our study population of the 150 male students who were distributed as the following:

39.3% (n = 59) of student were 25 years old and more while 60.7% (n = 91) were less than 25 years old. 52% (n = 78) were medical students, 25.3% (n= 38) were from engineering college and 22.7% (n = 34) from other colleges. From those students 57.3% (n = 86) were studying at 4th_ 6th level and 42.7% (n = 64) are from 1st_3rd level.

Characteristics	Frequency	Percent
Age		
25 and more	59	39.3
Less than 25	91	60.7
College		
Medical college	78	52.0
Engineering	38	25.3
Others	34	22.7
Educational level		
1st – 3rd level	64	42.7
4th – 6th level	86	57.3

Table 1: Characteristics of Study Population (n = *150*)

Regarding chewing khat habits among students, we found that 64%(n = 96) have been chewing khat for more than 6 year compared to 20%(n = 30),and 16% (n = 24) who have been chewing khat for 3_ 6 years and less than 3 years respectively. Surprisingly 89.3% (n = 134) get used to chew khat for 6 to 7 days per week and 6% (n = 9) and 4.7% (n = 7) for 4 to 5 days and less than 3 days respectively. 60 % (n = 90) get used to chew khat for more than 6 hours and 30.7% (n = 46) for 3 to 6 hours and only 9.3 %(n = 14) for less than 3 hours.

Chewing habit	Frequency	Percent
Duration of chewing		
>6 years	90	60
3-6 years	46	30.7
< 3 years	14	9.3

Days of khat chewing per week		
1 – 3 days	7	4.7
3- 5 days	9	6
6-7 days	134	89.3
Hours of chewing per day		
> 6 hours	90	60.0
4-6 hours	46	30.7
1-3 hours	14	9.3

Table 2: Characteristics of Study Population n = (150)

When we assessed the risk factors for hypertension among students as shown in table 4-3 we found that 29.3% (n = 44) were smokers and 44% (n = 66) students had family history of hypertension, 32% (n = 48) students had family history of diabetes, 32.7% [49]. students had family history of cardiovascular disorders and only 2% (n = 3) students had known history of hypertension and only one student (0.7%) has history of DM.

Risk factors	N	Percent of Cases
History of hypertension	3	2%
Family history of heart disorders Family history of hypertension History of diabetes Family history of diabetes History of smoking	49	32.7%
	66	44%
	1	0.7%
	48	32%
	44	29.3%

Table 3: Students with Positive History of Cardiovascular Risk Factors

As we calculated BMI, it was SD with no significant correlation with other variable .When we measured BP and heart rate 30 minutes before and 3 hours after chewing khat as shown in table 4, we found significant change of a mean and standard deviation of 109,6 ± 11.5, 73.6 ± 11.5, and 82.3 ± 10.3 of SBP, DBP and heart rate respectively before 30 minutes of chewing khat to a mean and standard deviation of 121.2 ± 13.9, 81.7 ± 11.9, and 93.8 ± 13.8 for SBP, DBP and heart rate respectively, with mean difference of 11.6, 8.1, and 11.6 for SBP, DBP, and heart rate respectively after 3 hours of chewing khat. These changes are statistically significant with p-value of less than 0.05%.

		Mean	Std. Deviation	P value
SBP	before 30 minutes	109.65	11.545	
				.000
	after 3 hours	121.21	13.944	
DBP	before 30 minutes	73.63	11.570	
				.000
	after 3 hours	81.73	11.938	
Pulse rate	before 30 minutes	82.27	10.269	
				.000
	After 3 hours	93.86	13.892	

Table 4: Difference Between BP and Pulse Rate Measurements Before and After Chewing Khat

In addition, when we did the measurements before chewing khat, we found only one student who was hypertensive with a SBP of 200 mmHg that changed to 210 mmHg after chewing khat. Also we found that in 12 students the SBP increased to more than 140 mmHg after chewing khat with a mean and standard deviation of 147.5 ± 12.3.

On the other hand, we found that 11 students with DBP of >= 90 mmHg with mean and standard deviation of 90.91 ± 2 before chewing khat and that number increased to 44 students with mean and standard deviation of 93.07 ± 4.4 three hours after chewing khat.

Hypertension	Before	After
SBP DBP	1	12
	11	44

Table 5: Frequencies of Hypertension Before and After Chewing Khat

5. Discussion

There is an increase in khat chewers in Yemen especially among young people. In addition to the social and economic problems of khat chewing, khat consumption has many adverse consequences on many body systems, especially on the cardiovascular system. We evaluated the blood pressure and heart rate among male students from different colleges in Thamar University who used to chew khat 30 minutes before they started to chew khat and 3 to 4 hours after starting chewing khat. On this study, we found that, there is a significant increase of blood pressure and heart rate 3 hours after khat chewing, and this goes with that reported by many studies which conducted by Al-Motarreb et al., (2005), who stated that, these changes coincide with plasma level of cathinone [20]. D.Juyed et al,(2023); in their study reported that, there was a transient rise of both systolic and diastolic blood pressure and heart rate that occur during khat chewing and may extend up to 2 hours post chewing khat [7]. Bizuayehu W. Muliken (2014) in his study concluded that, regular chewing khat is associated with elevated mean diastolic blood pressure, which consistent with peripheral vasoconstrictor effect of cathinone. Regular khat chewing may have sustained effects on cardiovascular system that can contribute to elevated blood pressure at the population level [10].

In our study we found that, there are increase in systolic , diastolic and heart rate with means difference of 17mmHg in SBP , 9mmHg in DBP and 12 heart beat per minute and these go with that reported by Hassan et al,(2002) [23]. Also the results of our study go with the study done by Likawunt Samuel Asfaw (2023), who reported that, a typical khat chewing session was associated with a significant increase in the chewers BP. The mean systolic BP before khat chewing was 112 mmHg which rose to 130.5mmHg at the end of chewing session, representing a mean rise of 30.5 + - 6.0mmHg (range = 20-50mmHg).Mean diastolic BP also rose from 74.4 to 95.8mmHg after chewing khat representing a mean 20.5 = - 0.8mmHg (range approximately 10-40mmHg) [39].

Also Al-Shami et al., (2013) reported that, chewing khat for long hours can be considered as independent risk factor for hypertension [40].

In our study we found that chewing khat is a significant risk factor for hypertension and this against that reported [41,42]. who concluded in their studies that, there was insufficient evidence that khat was a risk factor for hypertension.

6. Conclusion

Our study showed that, khat chewing is associated with high BP and elevated HR., which are established risk factors for cardiovascular diseases, and can affect the CVS mainly by increasing blood pressure and heart rate.

Recommendations

Considering, the impact of this plant on the economy, the governments should design appropriate programs to educate the people about the harmful effects of khat chewing on cardiovascular system and other systems in the body, improving youth recreational services and creating adequate job opportunities to prevent people to engage in khat chewing sessions.

Health professionals should also play a role in promoting the health impacts of khat and provide psychosocial support services to quit the khat chewing habit for those who are affected chronically. Generally, clear policies should be designed and implemented to curb khat chewing in the country.

Conflicts of Interest:

The authors declare no conflicts of interest. The authors alone are responsible of the content and writing of the article,

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