Journal of Medical Sciences

ISSN 1682-4474

science alert

ANSInet
an open access publisher
http://ansinet.com

Research Paper

J. Med. Sci., 17 (2): 95-101
April-June, 2017
DOI: 10.3923/jms.2017.95.101

Doppler Assessment of the Effect of Chewing Qat on Hemodynamics of the Common Carotid Arteries

[1]Mohamed Ibrahim, [2]Bushra Hussein A. Malik and [3]Moawia Gameraddin

Chewing qat has been established to cause cardiovascular and various health problems. The study aims to explore the effects of chewing qat on hemodynamics of the common carotid arteries (CCAs). This is clinically important for quantifying the cerebral perfusion which is a key factor of cerebrovascular diseases. This was a descriptive quantitative study. A total of 200 of healthy non-qat volunteers were investigated with gray scale and Doppler sonography for assessment of common carotid arteries (CCAs) using a 7-10 MHz linear transducers according to a standard carotid sonography protocol. The CCAs hemodynamics, diameters and intima media thickness were assessed. The heart rate and blood pressure were taken on the left arm and measured at 3-5 min interval. The blood flow in CCAs was assessed using the Doppler parameters, peak systolic velocity, end-diastolic velocity, pulsatility index and resistive index. The Doppler parameters were measured before and after chewing qat. SPSS and paired sample t-test was used to analyze the results. A p-value<0.05 was considered to be significant. chewing qat had significantly raised the heart rate and blood pressure (p-value = 0.00 and 0.001, respectively). The blood resistivity and pulsatility of the common carotid arteries were significantly decreased after chewing qat. The peak systolic velocity and maximum end-diastolic velocity were significantly increased after chewing qat (p-values = 0.001 and 0.00, respectively). The diameters and intima media thickness of each CCA were not affected with qat chewing. Chewing qat has significant impact on the hemodynamics of the common carotid arteries, probably as a consequence of vasoconstrictor effect of qat on the blood vessels. This may affect the cerebral perfusion. Further studies are needed on possible morbidity of carotid arteries lesions associated with regular qat chewing.

Key words: Doppler, blood pressure, hemodynamics, resistivity, pulsatility, carotid arteries

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued four times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

Moawia Gameraddin
Department of Diagnostic Radiology,
Faculty of Medical Applied Science,
Taibah University, KSA P.O. Box: 344

Tel: 00966534821130

[1]Faculty of Medicine, University of Hargeisa, Hargeisa Somaliland
[2]Department of Diagnostic Radiology, Faculty of Medical Applied Science, University of Hail, KSA
[3]Department of Diagnostic Radiology, Faculty of Medical Applied Science, Taibah University, KSA

ANSInet
Asian Network for Scientific Information

INTRODUCTION

Qator Khat (Catha edulis) is an herbal product consisting of the leaves and shoots of the shrub Catha edulis. It is cultivated as a bush or small tree in East Africa and the Arabian Peninsula, harvested and then chewed to obtain a stimulant effect[1]. In Somalia chewing qat is deeply integrated into the social and cultural norms of the community. It has been widely chewed for its stimulant action by the population in these regions for many years. The buds and leaves contain amphetamine-like psycho active substances, which produce euphoria and stimulation[2]. The khat users from Africa and Arabia, who migrated to different countries have disseminated several health problems to these T countries around the globe[3,4]. A recent report accounted that currently 20 million people worldwide regularly used khat[4]. Cathinone is a psychostimulant, which structurally and functionally closely similar to amphetamine. It was reported that it has adverse effects and causes neurological, cardiac and psychiatric manifestations[5].

It has been reported that the effects of qat is attributed to cathinone and cathine which are responsible for most of the effects of khat[2]. However, various adverse effects have been reported on consumption of qat by humans, Kassim and Croucher[6]. Qat has impact on heart and blood vessels. A study performed by Sallam *et al*.[7], concluded that cathine/cathinone increases blood pressure and heart rate. It was found that chewing was associated with increased diastolic blood pressure (DBP)[8]. Furthermore, khat chewing has significant effect on coronary blood vessels. Al-Shami and Al-Motarreb reported that khat as an independent risk factor for coronary artery disease[9]. However, it is theorized that qat increases cerebral blood flow velocity and reduces vasomotor reactivity but no study proved[10].

Ultrasound and Doppler methods are ideally suited for bedside examinations, Doppler and duplex techniques have been used to estimate cerebral blood flow in healthy adults by measuring flow volumes of the common carotid arteries[11]. RI and PI are Commonly used parameters for characterizing the Doppler wave form. They are related to the vascular resistance. The investigators, therefore, used both indexes as well as flow velocity to investigate the effects of qat chewing on hemodynamics of common carotid arteries.

However, to our knowledge, found no reports or studies demonstrating the effect of qat on hemodynamics of CCAs. Therefore, the aim of this study was to determine the immediate effects of qat chewing on the hemodynamics of the common carotid arteries such as flow velocity and waveform parameters. However, according to knowledge, few studies demonstrate the effect of qat chewing on characteristics of blood flow in CCAs.

MATERIALS AND METHODS

This was a descriptive cross-sectional study. A total of 200 healthy volunteers of non-qat chewers recruited in a cohort study (190 males, 10 females, mean age was 37.1 years). The study was conducted from 11 July, 2016-1st of August, 2017. The participants have no medical history or physical signs of cerebrovascular or cardiovascular disease. They were scanned for assessing the CCAs. All subjects were asked to avoid from chewing qat or smoking cigarettes for at least 8 h prior participating in the study. Then they were instructed to chew the qat. Oral informed consent was obtained from each participant before the procedure. The participants were scanned at Kaah Community Hospital in Hargeisa Somaliland.

Each participant rested in the supine position for at least 15 min on a comfortable bed in the test room to stabilize heart rate. Color duplex sonography of the entire CCAs was performed using a 7-10 MHz linear array transducer of a sonography system (DCN3, Mindray China). All participants were examined in the supine position with the head hyperextended and turned away from the side being scanned. In the color Doppler imaging, the velocity range of the color scale was set slightly higher than the Nyquist limit to easily detect flow disturbances. Pulsed Doppler measurement was done using a sample volume that covers the entire luminal width. Flow velocities were recorded when the signal was stable for at least 5 sec. Exact angle correction of the Doppler frequencies was performed by adjusting the angle of Doppler beam and the course of the vessel (along with the walls of the vessel as well as along the color Doppler stream). All duplex measurements were documented using a hard disk of the ultrasound machine and computer. The following angle-corrected flow velocities were measured in each CCA: (1) Peak systolic velocity, (2) Maximum end diastolic velocity, (3) Diameter of the CCA and (4) Intima media thickness of the CCA. The resistivity index (RI) and pulsatility index (PI) was calculated by the machine. After completion of the baseline recordings, all participants were asked to chew a qat and then the same measurements were repeated, on average 2 h after chewing qat. Heart rate and blood pressure were measured at baseline and after chewing the qat. Three consecutive measurements were taken on the left arm at 3-5 min interval. Average of the second and third measurements was used to determine the mean systolic BP and mean diastolic BP and heart rate (HR) of study participants as recommended in the WHO STEPS method[12,13].

Statistical analysis: All statistical analysis was performed with SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). Data are presented in tables and figures. Quantitative variables were expressed as mean±standard deviation. Data were assessed for normality using the Kolmogorov-Smirnov test (p-value>0.05) and normal Q-Q plots. The paired sample t test is used to compare continuous variables before and after qat chewing. A p-value<0.05 was considered as statistically significant.

Table1: Estimation of systolic BP, diastolic BP and heart rate before and after chewing qat

Variables	Mean±SD	p-value
Systolic BP before chewing qat	112.27±10.90 mmHg	0.001
Systolic BP after chewing	115.60±8.015 mmHg	
Diastolic BP before chewing qat	63.44±7.49 mmHg	0.0001
Diastolic BP after chewing qat	86.40±21.917 mmHg	
Heart rate before chewing qat	75.7±8.4 bpm	0.00
Heart rate after chewing qat	83.9±10.6 bpm	

Table 2: Doppler evaluation of CCAs hemodynamics before and after chewing qat

Doppler parameters	Mean±SD (cm sec^{-1})	p-value
PSV before chewing qat	84.5±11.3	0.001
PSV after chewing qat	90.2±9	
EDV before chewing qat	16.2±2.7	0.00
EDV after chewing qat	18.2±3.5	

Table 3: Comparison of resistivity index and pulsatility index of left and right CCAs before and after chewing qat

Parameters	Right CCA Mean±SD	Significance (p-value)	Left CCA Mean±SD	Significance (p-value)
RI before chewing qat	0.80±0.0378	0.23	0.83±0.0299	0.0001
RI after chewing qat	0.79±0.0393		0.77±0.0505	
PI before chewing qat	2.650±0.9411	0.003	2.992 ±0.5685	0.001
PI after chewing qat	2.384±0.4221		2.274±0.374	

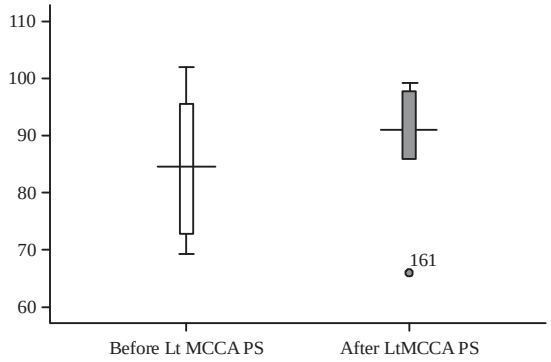

Fig. 1: Comparison of PSV of the left CCA before and after chewing qat
Lt MCCA PS: left mid-common carotid artery peak systolic values are Mean±SD

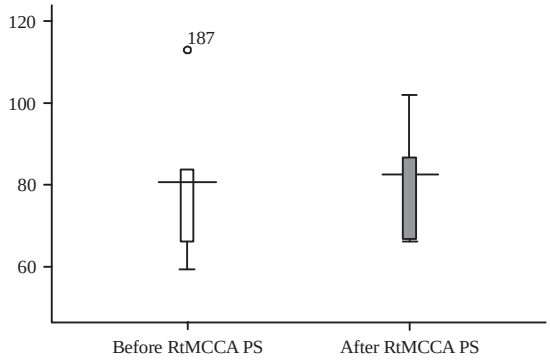

Fig. 2: Comparison of the PSV of the right CCA before and after chewing qat
Rt MCCA PS: Right mid-common carotid artery peak systolic values are Mean±SD

RESULTS

Of the 200 healthy volunteers scanned by Doppler sonography, 190 (95%) were males and 10 (5%), were females. The age of volunteers was ranged between 17-55 years with a mean of 37.13 years. In this study, the mean systolic blood pressure before and after chewing the qat was 112.3 and 115.6 mmHg with a standard deviation (SD) of 10.9 and 8.015 mmHg, respectively. The mean difference is 3.34 mmHg with a 95% CI of 1.316-5.354. Paired t-test was used to find whether the mean difference is statistically significant or not. The result showed that systolic blood pressure (BP) and diastolic BP were significantly increased after chewing qat (p-value = 0.001 and 0.0001, respectively) as shown in Table 1. On the other hand, the mean heart rate before and after chewing qat was provided in Table 1. The mean difference was 8.2 with a p-value = 0.000 which indicates the heart rate was significantly increased after chewing qat (Table 1).

It was observed PSV has significantly increased after qat chewing, the same as did EDV (Table 2). This elevation in PSV and EDV was more noticeable in the left CCA than in the right CCA. The comparison of PSV and EDV of the right and left CCAs before and after chewing qat were also shown in Fig. 1 and 2. RI and PI of the left and right CCAs were calculated automatically by the ultrasound Doppler machine. There was no significant in blood resistivity of the right CCA before and after qat chewing (0.80±0.0378, 0.79±0.393, p-value = 0.23). However, there was significant decrease in blood resistivity of the left CCA. It was observed that the pulsatility index was significantly decreased in both left and right CCAs (p-values = 0.003 and 0.001, respectively) as shown in Table 3. Therefore, qat chewing has significant impact on resistivity, pulsatility and velocity of blood flow in the CCAs.

The comparison of RI and PI of in left CCA before and after chewing was further demonstrated in Fig. 3 and 4. These comparisons revealed significant elevation of resistivity index and pulsatility index in the left CCA due to the impact of chewing qat. The Doppler measurements of PSV, EDV and RI in the left CCA was depicted in Doppler sonograms shown by Fig. 5 and 6. The measurement was performed before and after chewing qat. They showed significant changes in velocity and resistivity of blood flow in the left CCA.

Regarding the results of sonographic measurements, there was no change in the diameters after qat chewing as depicted in Table 4. The measurement of IMT revealed no change in thickness before and after chewing qat (Table 4).

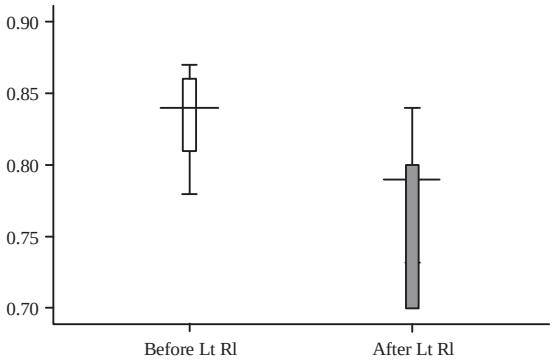

Fig. 3: Comparison of RI before and after chewing qat
Lt RI: left Resistive Index values are Mean±SD

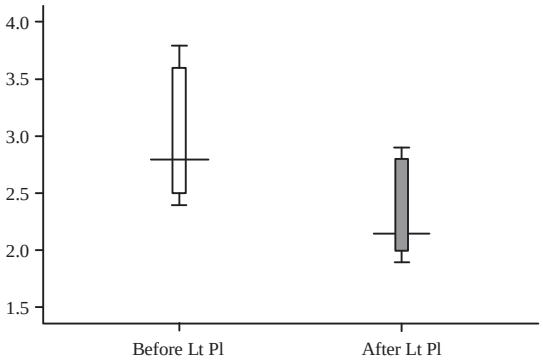

Fig. 4: Comparison of PI before and after chewing qat
Lt PI: left Pulsatility Index values are Mean±SD

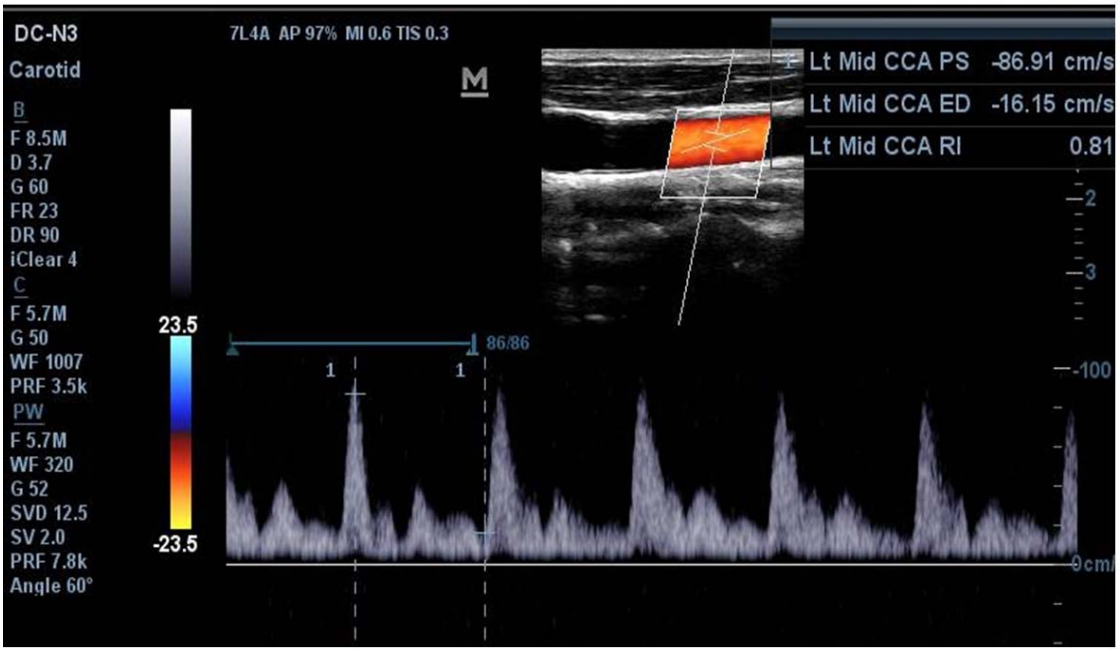

Fig. 5: Doppler assessment of hemodynamics of the left common carotid artery before chewing qat

Table 4: Assessment of IMT and diameters of CCAs before and after qat-chewing

Parameters	Right CCA (mm)	Left CCA (mm)
IMT common carotid arteries (before chewing)	5.44±0.12	6.06±0.04
IMT common carotid arteries (after chewing)	5.62±0.12	6.06±0.04
Diameter common carotid arteries (before chewing)	6.57±0.05	6.06±0.04
Diameter common carotid arteries (after chewing)	6.59±0.05	6.06±0.04

Values are indicated as Mean±SD

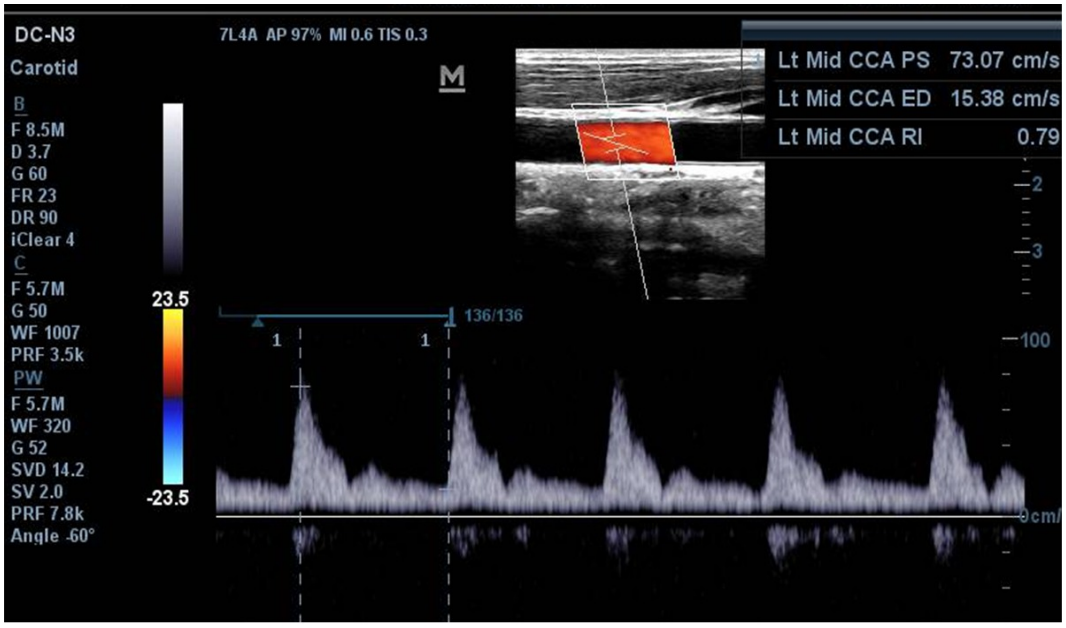

Fig. 6: Doppler assessment of hemodynamics of the left common carotid artery after chewing qat for the same subject

DISCUSSION

The findings of the present study revealed that CCAs, PSV, EDV, RI and PI were significantly changed in qat chewers while the diameter and IMT remain unchanged.

The effect of qat on the cardiovascular system had been established in several studies as discussed below. A significant increase in blood pressure and heart rate was observed. This is attributed to qat intake which causes cardiovascular problems such as hypertension, tachycardia, myocarditis, cerebral hemorrhage and consequently death. Regular qat chewing is associated with elevated mean diastolic blood pressure as result of the peripheral vasoconstrictor effect of Cathinone[8]. Cathinone increases blood pressure. The vasoconstrictor effects of cathinone and arterial hypertension produced by qat chewing. Balint *et al*., reported that regular chewing of qat caused a rise in arterial blood pressure and heart rate which were attributed to the levels of cathinone in the plasma[14]. However, the same effect might occur in the cerebral vasculature which is mainly supplied by the carotid arteries. In this study, there was significant higher blood pressure and heart rate among the qat chewers ($p = 0.00$). These findings were in consistency with Birhane *et al*.[15], Hussein *et al*.[16]. Al Suwaidi *et al*.[17], Al'Absi and Grabowski [18] and Al-Hashem[19], who reported khat chewing has significant impact on heart and blood pressure. However, hypertension and a significant progressive rise in blood pressure among qat chewers reported in a study performed by Al-Habori[20] and Getahun *et al*.[8].

In the present study, it was observed the heart rate has significantly increased after chewing qat. The mechanism of elevated blood pressure observed before and after the qat chewing is attributed to the effect of cathinone. It causes vasoconstriction of coronary arteries[21]. These results consistent supported the fact that qat has had pathophysiological mechanisms effect on the cardiovascular system. However, in this study, no direct effect on the diameter of CCAs and IMT was found.

The evaluation of carotid blood flow is important to predict associated cerebrovascular diseases such as stroke. In a recent study, qat was proved to cause occlusion of cerebral artery[22]. This supported the fact that ischemic stroke and intracranial hemorrhage developed after qat chewing. In a case report, a 28 years old male qat chewer patient developed cerebrovascular accident after chewing qat, with the suggestion of an increased thrombogenicity as a key factor[23]. Qat chewing has also been reported to increase the incidence of acute cerebral infarction[24]. Therefore, evaluation of CCAs hemodynamics is clinically relevant to predict cerebrovascular damage in an early stage to avoid severe complications. In the current study, it was observed that the CCA's PSV and EDV were significantly increased after chewing qat ($p = 0.001$ and 0.00). The increase in PSV and EDV was more noticeable in left than in the right CCA. It was observed that the blood resistive and pulsatility indexes were significantly decreased in the left CCA. These findings supported significant changes in resistivity, pulsatility and velocity of blood flow in CCAs. The changes reflect the impact of qat chewing in hemodynamics of CCAs which may affect the cerebral blood flow. Since extracranial arterial disorders is one of the principal cause of ischemic stroke, changes in carotid blood

flow is assumed to be one of the etiology. Sanjay reported two cases of strokes associated with khat consumption[25]. Thus the association of khat with ischemic stroke supported the finding of this study that significant fluctuation in carotid flow may contribute to ischemic stroke. Additionally, the pharmacologic effects of chewing qat affects hemodynamics of carotid arteries which attributed to vasoconstriction of the vessels[26]. Thus, possible direct vasoconstriction of the vasa vasorum or impairment of flow because of the increase of blood pressure with chewing qat may lead to ischemia of the carotid artery wall which increased the resistance of the vessel[26,27]. Overall, changed Doppler waveforms and velocity characteristics of the CCAs may provide a useful index of the early vascular damage that predisposes qat chewers to develop significant vascular diseases.

CONCLUSION

Chewing qat has significantly changed the CCAs hemodynamics, probably as a consequence of enhanced vasoconstrictor effects of cathinone. However, the changes in CCA's PSV, EDV, RI and PI events attributed to the chewing qat provide useful data of extracranial blood flow and predict early vascular damage that predisposes qat chewers. In conclusion, at chewing has significant impact on resistivity, pulsatility and velocity of blood flow in the CCAs.

SIGNIFICANCE STATEMENTS

The current study assessed the influence of chewing qat on blood flow of carotid arteries which was rarely demonstrated in literature. The hemodynamics of CCAs was significantly changed in qat chewers. This is clinically useful to predict and prevent diseases associated with cerebrovascular perfusion.

REFERENCES

1. Sheikh, K.A., M. El-Setouhy, U. Yagoub, R. Alsanosy and Z. Ahmed, 2014. Khat chewing and health related quality of life: Cross-sectional study in Jazan region, Kingdom of Saudi Arabia. Health Quality Life Outcomes, Vol. 12. 10.1186/1477-7525-12-44
2. Wabe, N.T., 2011. Chemistry, pharmacology and toxicology of khat (Catha Edulis Forsk): A review. Addiction Health, 3: 137-149.
3. Osman, F.A. and M. Soderback, 2011. Perceptions of the use of khat among Somali immigrants living in Swedish society. Scandinavian J. Soc. Med., 39: 212-219.
4. Corkery, J.M., F. Schifano, A. Oyefeso, A.H. Ghodse, T. Tonia, V. Naidoo and J. Button, 2011. Bundle of fun' or 'bunch of problems'? Case series of khat-related deaths in the UK. Drugs: Educ. Prevent. Policy, 18: 408-425.
5. Prosser, J.M. and L.S. Nelson, 2012. The toxicology of bath salts: A review of synthetic cathinones. J. Med. Toxicol., 8: 33-42.
6. Kassim, S. and R. Croucher, 2006. Khat chewing amongst UK resident male Yemeni adults: An exploratory study. Int. Dental J., 56: 97-101.
7. Sallam, M.A., K.A. Sheikh, R. Baxendale, M.N. Azam and M. El-Setouhy, 2016. The physiological and perceptual effects of plant extracts (Catha Edulis Forsk) during sustained exercise. Substance Abuse Treat. Prevent. Policy, Vol. 11. 10.1186/s13011-016-0063-4.
8. Getahun, W., T. Gedif and F. Tesfaye, 2010. Regular Khat (*Catha edulis*) chewing is associated with elevated diastolic blood pressure among adults in Butajira, Ethiopia: A comparative study. BMC Public Health, Vol. 10. 10.1186/1471-2458-10-390.
9. Al-Shami, M. and A. Al-Motarreb, 2013. Association of khat chewing with significant coronary artery disease in patients presenting with heart failure. J. Saudi Heart Assoc., 25: 149-150.
10. Hassan, N.A.G.M., A.A. Gunaid, A.A. Abdo-Rabbo, Z.Y. Abdel-Kader, M.A. Al-Mansoob, A.Y. Awad and I.M. Murray-Lyon, 2000. The effect of qat chewing on blood pressure and heart rate in healthy volunteers. Trop. Doct., 30: 107-108.
11. Oates, C.P., A.R. Naylor, T. Hartshorne, S.M. Charles and T. Fail *et al*., 2009. Joint recommendations for reporting carotid ultrasound investigations in the United Kingdom. Eur. J. Vascular Endovascular Surg., 37: 251-261.
12. WHO., 2003. STEPS Q by Q guide for chronic diseases risk factor surveillance-instrument V2.0. World Health Organization, Rome.
13. WHO., 2003. WHO STEPS surveillance. World Health Organization (WHO), Part 3: Training and Practical Guides, Section 2: Interviewers Guide.
14. Balint, E.E., G. Falkay and G.A. Balint, 2009. Khat- A controversial plant. Wiener klinische Wochenschrift 121: 604-614.
15. Birhane, B.W. and M.W. Birhane, 2014. The effect of Khat (*Catha edulis*) chewing on blood pressure among male adult Chewers, Bahir Dar, Northwest Ethiopia. Science, 2: 461-468.
16. Hussein, S. Gumaih, B.H. Al-Khateeb and W.A. Hadi, 2017. The effect of khat chewing on blood pressure and the correlation between body mass index and blood pressure among Yemeni people in Sana's city. Al-Razi Univ. J. Med. Sci., 1: 1-11.
17. Al Suwaidi, J., W.M. Ali and S.L. Aleryani, 2013. Cardiovascular complications of Khat. Clin. Chim. Acta, 419: 11-14.
18. Al'Absi, M. and J. Grabowski, 2012. Concurrent use of tobacco and khat: Added burden on chronic disease epidemic. Addiction, 107: 451-452.

19. Al-Hashem, F.H. and A.S. Shatoor, 2012. Acute oral administration of Khat (*Catha edulis*) aqueous extract elevates blood pressure and prolongs QT and QTC intervals in Wistar albino rats. Saudi Med. J., 33: 1065-1072.
20. Al-Habori, M., 2005. The potential adverse effects of habitual use of *Catha edulis* (khat). Expert Opin. Drug Safety, 4: 1145-1154.
21. Baker, K.E., A.A. Herbert and K.J. Broadley, 2007. Vasoconstriction of porcine left anterior descending coronary artery by ecstasy and cathinone is not an indirect sympathomimetic effect. Vascular Pharmacol., 47: 10-17.
22. Alsharafi, W.A., F.F. Bi, Y.Q. Hu, H.M. Mujlli and B. Xiao, 2015. Effect of Khat on apoptosis and related gene Smac/DIABLO expression in the cerebral cortex of rats following transient focal ischemia. Environ. Toxicol. Pharmacol., 39: 424-432.
23. De Ridder, S., F. Eerens and L. Hofstra, 2007. Khat rings twice: Khat-induced thrombosis in two vascular territories. Netherlands Heart J., 15: 268-269.
24. Ali, W.M., M. Zubaid, A. Al-Motarreb, R. Singh and S.Z. Al-Shereiqi *et al*., 2010. Association of khat chewing with increased risk of stroke and death in patients presenting with acute coronary syndrome. Mayo Clin. Proc., 85: 974-980.
25. Kulkarni, S.V., Y.A.A. Mughani, E.H.A. Onbol and P. Kempegowda, 2012. Khat and stroke. Ann. Indian Acad. Neurol., 15: 139-140.
26. Al-Motarreb, A., K. Baker and K.J. Broadley, 2002. Khat: Pharmacological and medical aspects and its social use in Yemen. Photother. Res., 16: 403-413.
27. Vanwalleghem, I.E., P.W. Vanwalleghem and J.L. De Bleecker, 2006. Khat chewing can cause stroke. Cerebrovascular Dis., 22: 198-200.