Review Article

The Effect of Water Pipe Tobacco on the Kidney: A Narrative Review

Farzaneh Futuhi[1], Malihe Abniki[2], Vahideh Shahbazi[3]

[1]Department of Adult Nephrology, School of Medicine, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Department of Anesthesiology, School of Medicine, Shohada-e-Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Department of Internal Medicine, Rasool Akram Hospital, Iran University of Medical Science, Tehran, Iran

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Abstract

Background: Water pipe tobacco is one of the methods of smoking that has a high prevalence worldwide, especially in Iran. Since tobacco can affect various body systems, in this study, we decided to review the effect of water pipe tobacco smoking on the kidneys.

Materials and Methods: In this review study, previous studies on the effect of water pipe tobacco on the kidney were reviewed. The time period studied was from 2015 to 2025. Keywords of "Smoking Water Pipe", "Smoking Water", "Water Pipe Tobacco", Tobacco, "Chronic Renal Disease", "Chronic Kidney Disease", and "Kidney" were searched in PUBMED, EMBASE, and ELSEVIER databases.

Results: Four studies were reviewed, and all were conducted on mice. According to studies, water pipe tobacco smoking causes various effects on the kidney through various mechanisms such as oxidative stress, decreased Superoxide dismutase, catalase, glutathione peroxidase activity, increased TBARS levels, lipid peroxidation, increased IL-6 and IL-1β, and DNA damage, including destruction of glomerular capillary endothelial cells, vacuolar destruction of proximal convoluted tubules, increased creatinine, blood urea nitrogen, and proteinuria.

Conclusion: Water pipe tobacco smoking may cause kidney damage, but since no study has been conducted on humans so far, it is recommended that studies be conducted on human populations.

Keywords: Kidney, Chronic kidney disease, Water pipe tobacco

***Corresponding Author:** Vahideh Shahbazi, Department of Internal Medicine, Rasool Akram Hospital, Iran University of Medical Science, Tehran, Iran; Email: Vahidehshahbazi.Dr@gmail.com

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Introduction

The use of water pipes has become a significant global public health issue, particularly among the youth. This rise in popularity is largely due to flavoured tobacco options and the misconception that water pipes are safer and less addictive than cigarettes[1-3]. However, water pipes contain various carcinogens, including polycyclic aromatic hydrocarbons and tobacco-specific nitrosamines, along with carbonyl compounds like acetaldehyde and formaldehyde. Studies show that water pipe smoke exposure offers comparable nicotine levels, resulting in significantly greater smoke exposure compared to cigarette smoke[4,5]. Tobacco use is recognised as an independent risk factor for the development of chronic kidney disease (CKD) in individuals with type 2 diabetes and the general population. CKD represents a significant public health concern, with a global prevalence estimated at 13.4%[6-9].

Establishing a causal association between water pipe usage and CKD poses considerable research challenges, primarily due to the difficulty in distinguishing the effects of water pipe inhalation from those caused by cigarette smoke or environmental toxins[10]. Consequently, there is a critical need for experimental studies focusing on the impact of water pipes on kidney health. Current data on this subject remains limited, predominantly derived from animal studies, which suggest that water pipe exposure may lead to impaired kidney function, inflammation, and oxidative stress. While some epidemiological studies indicate that air pollution, including tobacco use, may have a greater impact on vulnerable populations such as those with CKD, other research has demonstrated a potential association between water pipe use and CKD[6,7,10-12]. This review aims to consolidate existing studies regarding the relationship between water pipe use and CKD.

Methods

This review examines previous studies on the effects of water pipe smoking on kidney health, covering the period from 2015 to 2025.

We searched the PUBMED, EMBASE, and ELSEVIER databases using keywords such as "smoking water pipe," "pipe," "water pipe tobacco," "tobacco," "chronic renal disease," "chronic kidney disease," and "kidney." The inclusion criteria were studies that consisted of clinical trials, cross-sectional studies, case-control studies, cohort studies, and studies conducted between 2015 and 2025. The exclusion criteria were review studies, systematic reviews, meta-analyses, case reports, studies focusing on cigarette use, vaping, and other similar devices, as well as studies involving the use of smoked drugs and other forms of tobacco use.

Results

According to our research, a relevant study has yet to be conducted that investigates the relationship between water pipe use and CKD in humans. This gap in the literature arises from the fact that many individuals who utilise water pipes concurrently consume cigarettes or other substances, thereby complicating any potential attribution of kidney involvement solely to water pipe use. Furthermore, air pollution is known to exert an influence on kidney function, introducing additional bias in analysing the effects of water pipes on renal performance. Consequently, this study undertakes a review of earlier animal studies that have explored the impact of water pipe smoke on kidney function. During the period under review, spanning from 2015 to 2025, four studies have specifically assessed the effects of water pipe smoke on renal function.

A study by Robabeh et al. (2016) investigated the effects of water pipe smoke on kidney oxidative stress and function parameters in mice. The subjects were divided into three groups: acute exposure (one hour daily for six days), chronic exposure (one hour daily for thirty days), and a fresh air control group. Significant changes were observed in renal function parameters, including creatinine and blood urea nitrogen levels, in both exposure groups. Both acute and chronic groups exhibited a reduction in superoxide dismutase (SOD), catalase, and glutathione peroxidase (GPx), which decreased significantly only in the chronic group. Additionally, thiobarbituric acid-reactive substances (TBARS) levels in kidney homogenates increased significantly after chronic exposure. The study concluded that chronic water pipe smoke exposure adversely affects renal parameters and antioxidant markers, impairing detoxification and the elimination of toxic substances [11].

Al-Sawlaha et al. (2019) investigated the effects of water pipe smoke exposure during pregnancy on renal biomarkers in adult rats. Pregnant Wistar rats were exposed to water pipe smoke for two hours daily from gestation days 0 to 21, while a control group was exposed to fresh air. Key measurements included systolic blood pressure, renal histological parameters, and various biomarkers of renal function and oxidative stress in male and female offspring at week 20. The findings revealed that prenatal exposure to water pipe smoke significantly reduced kidney weight and glomerular area, increased blood pressure, and elevated urinary albumin levels in the offspring. Moreover, higher levels of ACE, TBARS, and angiotensin I were observed in female newborn rats, while a non-significant trend towards decreased GPx activity was noted in both genders. The study concluded that maternal exposure to water pipe smoke during

pregnancy has detrimental effects on renal function and overall health in offspring[13].

Nemar et al. (2020) investigated the effects of nasal-only exposure to water pipe smoke for one or four consecutive weeks on renal histology, inflammation, oxidative stress, DNA damage, and apoptosis. Mice were exposed to water pipe smoke for 30 minutes daily, five days per week, while control mice were exposed to air. Light and electron microscopy revealed significant damage to glomerular capillary endothelial cells and vacuolar degeneration of proximal convoluted tubules, particularly at the four-week mark. Additionally, there was a marked reduction in creatinine clearance and significant increases in proteinuria and urinary kidney injury molecule-1 (KIM-1) concentrations. The exposure also heightened renal lipid peroxidation, reactive oxygen species (ROS) levels, and oxidised glutathione. Moreover, concentrations of interleukin (IL)-6, IL-1β, and KIM-1 were elevated after water pipe smoke exposure. Comet assay results indicated DNA damage, while increased expression of cleaved caspase-3 and cytochrome C was noted in the kidneys. These findings indicate that water pipe smoke exposure leads to significant renal histopathological changes, inflammation, oxidative stress, DNA damage, and apoptosis[12].

Bigham et al. (2024) investigated the effects of water pipe smoke on a mouse model of adenine-induced CKD. Mice were fed either a normal or adenine-supplemented diet and exposed to air or water pipe smoke for 30 minutes daily, five days a week, over four weeks. The findings revealed elevated plasma levels of creatinine, urea, and indoxyl sulfate, and decreased creatinine clearance in the adenine + water pipe smoke group compared to the other groups. Additionally, higher urinary concentrations of kidney injury molecule-1 and adiponectin, along with increased activities of neutrophil gelatinase-associated lipocalin and N-acetyl-β-D-glucosaminidase, were noted in the adenine + water pipe smoke group. In kidney tissues, several markers of oxidative stress and inflammation were significantly increased. Water pipe smoke exposure was also linked to greater DNA damage, evidenced by elevated urinary 8-hydroxy-2-deoxyguanosine levels, and enhanced expression of nuclear factor-κB (NF-κB) and mitogen-activated protein kinases (ERK and p38). The results indicate that water pipe smoke exposure aggravates renal injury, oxidative stress, inflammation, DNA damage, and fibrosis in this CKD model, likely through the activation of NF-κB, ERK, and p38 pathways[14].

Discussion

To our knowledge, no extensive studies have investigated the effects of water pipe smoke on kidney function in humans, and existing animal studies are limited. Nevertheless, findings indicate that water pipe smoke exposure negatively affects kidney health in mice. Chronic exposure (four weeks or longer) has been associated with damage to glomerular capillary endothelial cells and vacuolar changes in the proximal convoluted tubules. Symptoms include increased levels of creatinine, blood urea nitrogen, proteinuria, and KIM-1, along with decreased activities of SOD, catalase, and GPx, and increased TBARS levels and renal lipid peroxidation. Furthermore, exposure leads to elevated pro-inflammatory cytokines IL-6 and IL-1β, DNA damage, and upregulated expression of cleaved caspase-3 and cytochrome C, resulting in greater renal fibrosis[11,12,14]. Additionally, a study by Al-Sawlaha et al. assessed the effects of water pipe smoke on the offspring of pregnant mice, which found increased blood pressure, urinary albumin levels, and elevated concentrations of angiotensin-converting enzyme (ACE), TBARS, and angiotensin I in female offspring[13].

Cigarette smoke represents a primary cause of preventable mortality on a global scale and is associated with an elevated risk of developing CKD[15,16]. Prolonged smoking duration correlates with an increased likelihood of CKD onset. Conversely, evidence indicates that the risk of adverse renal outcomes diminishes following extended periods of abstinence among individuals who have ceased smoking[17]. Notably, smoking serves as an independent risk factor for stages 3 to 5 CKD in women, resulting in an approximate six-fold increase in risk for current smokers, while demonstrating a reduced risk of CKD among former smokers. This association does not appear to be present in men, which may be attributable to hormonal influences[18,19]. Studies included in this review have reported that inhalation of water pipe

smoke exacerbates kidney function deterioration, inflammation, and oxidative stress[11,12]. Furthermore, exposure to water pipe smoke has been documented to adversely affect kidney function and induce oxidative stress in the offspring of rats[13].

Robabeh et al. showed that SOD, catalase, and GPx activities decreased significantly after chronic exposure to waterpipe smoke, but TBARS levels increased significantly after chronic exposure[11]. GPx is a family of selenium-containing antioxidant enzymes that catalyse the reduction of hydrogen peroxide (H_2O_2) and organic hydroperoxides to water or corresponding alcohols, using glutathione (GSH) as a cofactor. Four primary forms of selenium-dependent GPx have been identified in mammalian tissues, with GPx1 primarily localised in glial cells and exhibiting approximately ten-fold higher activity compared to neurons. In the rat brain, GPx is located in the cytosol and mitochondrial matrix, correlating with areas requiring H_2O_2 reduction during monoamine metabolism. GPx4 is distributed throughout the cell, particularly in mitochondria, where ROS and oxidizable polyunsaturated phospholipids are prevalent[20-23]. So, it seems that a reduction in GPx activity causes an increase in the concentration of tissue-damaging substances, and waterpipe smoke may make it into the human body, although no study has been done in this respect.

The effect of waterpipe smoke was also demonstrated in the studies of Robabeh et al[11]. and Al-Sawlaha et al[13]. TBARS, carbonyls, and ROS are oxidant compounds that can yield valuable insights into the oxidative status of biological systems[24]. Therefore, these studies showed that waterpipe smoke increased oxidative stress components in the kidney and may increase the risk of renal failure.

In CKD, persistent acute inflammation and weakened antioxidant systems are common and worsen with kidney damage. While inflammation and oxidative stress are essential for defending against toxins and infections, their lack of regulation can lead to adverse effects, such as increased cytokine production and elevated levels of proinflammatory mediators and oxidative stress[25].

Oxidative DNA damage results in the formation of 8-hydroxy-2'-deoxyguanosine, which can initiate a chain reaction in DNA, leading to base substitutions and strand breaks. Inadequate repair of this damage may lead to mutations, cell growth arrest, or apoptosis[26] Studies show that oxidative stress and mitochondrial dysfunction, indicated by DNA damage and cleaved caspase-3 as an apoptosis marker, are significantly elevated in mice exposed to water pipe smoke. Additionally, water pipe smoke inhalation is associated with increased plasma concentrations of TNFα and IL-1β, as well as heightened markers of oxidative stress[11-14]. These findings suggest potential harmful effects on renal health in humans; however, comprehensive studies in this area are still lacking.

Conclusion

Water pipe smoke may cause kidney damage; however, this conclusion requires caution due to the lack of human studies, as our review is based on animal research. Existing literature indicates that water pipe smoke affects the kidney through mechanisms such as oxidative stress, reduced activity of SOD, catalase, and GPx, along with increased levels of TBARS, lipid peroxidation, IL-6, IL-1β, and DNA damage, potentially contributing to CKD. It is essential to conduct controlled human studies to confirm or refute these effects.

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