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A STUDY COMPARING THE SHORT-TERM AND LONG-TERM EFFECTS OF WATERPIPE AND E-CIGARETTE USE ON BLOOD PRESSURE AND HEART RATE AMONG YOUNG ADULTS IN PAKISTAN

Original Research

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ABSTRACT

Background: The increasing use of waterpipes and e-cigarettes among young adults in Pakistan has raised public health concerns due to their potential cardiovascular effects. These products are frequently marketed as safer alternatives to traditional cigarettes, despite limited research into their acute and chronic impacts on blood pressure and heart rate. Understanding these effects is crucial for addressing misconceptions and mitigating their health risks.

Objective: To evaluate the short-term and long-term effects of waterpipe and e-cigarette use on blood pressure and heart rate among young adults in Pakistan.

Methods: This cross-sectional study included 265 participants divided into three groups: 88 waterpipe users, 89 e-cigarette users, and 88 non-smokers. Participants were recruited from social settings where these habits are common. Short-term effects were assessed in a controlled laboratory environment, where cardiovascular parameters were recorded at baseline, immediately post-exposure, and at 15-minute intervals over one hour following a 30-minute waterpipe session or a 15-minute e-cigarette session. Long-term effects were measured over a six-month follow-up, with resting blood pressure and heart rate assessed at baseline, three months, and six months. Participants with pre-existing cardiovascular conditions or those on medications affecting cardiovascular parameters were excluded.

Results: Waterpipe users exhibited an acute increase in systolic blood pressure (10 mmHg) and heart rate (15 bpm), with recovery within 60 minutes. E-cigarette users showed slightly lower increases (8 mmHg and 12 bpm, respectively) and prolonged recovery exceeding 60 minutes. Long-term effects included sustained elevations in systolic blood pressure (6 mmHg) and resting heart rate (5 bpm) among waterpipe users, and similar but slightly lower increases (5 mmHg and 4 bpm) in e-cigarette users. Non-smokers showed no significant changes.

Conclusion: Waterpipe and e-cigarette use significantly affect cardiovascular health, causing acute and chronic increases in blood pressure and heart rate. Public health interventions and stricter regulations are essential to mitigate these risks.

Keywords: Adolescents, blood pressure, cardiovascular diseases, e-cigarettes, heart rate, Pakistan, waterpipe.

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INTRODUCTION

Waterpipe smoking, commonly referred to as hookah or shisha, and the use of electronic cigarettes (e-cigarettes) have become increasingly prevalent among young adults globally, including in Pakistan. These alternative methods of nicotine consumption are often perceived as less harmful than conventional cigarettes, fostering their widespread adoption, particularly among youth. However, mounting evidence indicates that both waterpipe smoking and e-cigarette use exert significant effects on cardiovascular health, including impacts on blood pressure and heart rate, even with short-term exposure (1). Waterpipe use typically involves prolonged sessions of inhaling smoke containing nicotine, carbon monoxide, and various toxic substances, leading to acute cardiovascular stress (2). Similarly, e-cigarettes deliver nicotine and other chemicals via aerosolized vapor, resulting in immediate changes in cardiovascular parameters (3). Chronic use of these products poses additional risks, potentially contributing to the development of long-term cardiovascular complications such as hypertension and heart disease (4). In Pakistan, the rising popularity of waterpipe smoking and e-cigarettes among young adults is particularly concerning. Social gatherings often feature waterpipe smoking as a communal activity, while e-cigarettes are marketed as a modern and ostensibly safer alternative to traditional smoking. These perceptions, bolstered by aggressive advertising and social media influence, have contributed to the normalization of these habits among the youth (5). Despite their growing prevalence, public awareness of the associated health risks remains limited. Many young adults in Pakistan underestimate the nicotine exposure and physiological effects resulting from the use of these products (6). For instance, a single waterpipe smoking session can deliver nicotine levels comparable to or exceeding those of conventional cigarettes. Similarly, e-cigarettes, though often perceived as less harmful, expose users to inconsistent yet potentially high doses of nicotine and other hazardous substances. These findings highlight the need for targeted research on the cardiovascular implications of waterpipe and e-cigarette use in this demographic (7).

The acute cardiovascular effects of these products are particularly troubling. Both waterpipe smoking and e-cigarette use have been associated with significant short-term increases in blood pressure and heart rate. These changes are largely attributed to nicotine-induced sympathetic activation, as well as the inhalation of carbon monoxide and other toxicants (8). Waterpipe smoking is known to cause sharp elevations in systolic and diastolic blood pressure, along with heart rate acceleration. Similarly, e-cigarette use results in transient cardiovascular changes, with studies documenting immediate increases in heart rate and blood pressure within minutes of use (9). While these effects may appear reversible in the short term, repeated episodes of cardiovascular stress, particularly among regular users, can predispose young adults to the early onset of hypertension and other cardiovascular dysfunctions. This repeated stress represents a critical risk factor for the development of chronic diseases in later life, underscoring the need for detailed investigations into these effects among Pakistan's young population (10). The long-term cardiovascular consequences of waterpipe and e-cigarette use are still emerging but are equally concerning. Chronic exposure to nicotine and other toxic substances in waterpipe smoke and e-cigarette vapor has been linked to sustained increases in blood pressure, endothelial dysfunction, and an elevated risk of cardiovascular diseases. For waterpipe smokers, prolonged exposure to carbon monoxide and combustion products exacerbates the risk of atherosclerosis and vascular damage (11). E-cigarette users are not exempt from similar risks, as continuous nicotine exposure can impair vascular function and promote systemic inflammation and oxidative stress through the inhalation of aerosolized particles and chemical additives (12). The growing burden of cardiovascular disease in Pakistan, coupled with the early adoption of these habits, demands urgent attention to these overlooked contributors. The sociocultural acceptance of waterpipe smoking and the perception of e-cigarettes as less harmful further complicate efforts to mitigate these risks (13). This study addresses critical gaps in understanding by evaluating both the short-term and long-term effects of waterpipe and e-cigarette use on blood pressure and heart rate among young adults in Pakistan. By examining these cardiovascular outcomes, the research aims to inform public health strategies and increase awareness about the underestimated risks associated with these increasingly popular habits.

METHODS

This cross-sectional study was conducted at Jinnah Sindh Medical University and Abbasi Shaheed Hospital Karachi Duration February 2022 to March 2024, involving a total of 265 participants aged 18 years and older through stratified sampling. Recruitment was carried out in universities, cafes, and social settings where waterpipe and e-cigarette use was prevalent. Participants were categorized into three groups: regular waterpipe users who smoked at least three times per week over the preceding six months, regular e-cigarette users who vaped at least three times per week, and a control group comprising individuals with no history of tobacco or e-cigarette use. Individuals with pre-existing cardiovascular conditions or those using medications that could influence cardiovascular measurements were excluded to eliminate potential confounders. The sample comprised 88 waterpipe users, 89 e-cigarette users, and 88 non-smokers, ensuring near-equal distribution across the three groups. Efforts were made to balance participants by gender, socioeconomic background, and urban versus rural residence to enhance representativeness. Demographic information was collected using structured surveys, accounting for factors such as diet, physical activity, and other lifestyle habits that could act as confounders. This rigorous sampling design ensured the reliability and validity of the findings.

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Data collection for short-term effects was performed in a controlled laboratory setting. Participants abstained from nicotine and tobacco use for at least 12 hours prior to the study to mitigate residual effects. Baseline measurements of blood pressure and heart rate were obtained using a digital sphygmomanometer and a pulse oximeter under standardized conditions. Waterpipe users participated in a 30-minute smoking session, while e-cigarette users engaged in a 15-minute vaping session, both reflecting typical usage patterns. Cardiovascular measurements were recorded immediately after the sessions and at 15-minute intervals for one hour to capture acute changes in blood pressure and heart rate. Long-term data were gathered through a six-month follow-up, with assessments conducted at baseline, three months, and six months. Resting blood pressure and heart rate were measured at each visit under standardized conditions. Participants also completed structured questionnaires during follow-up visits to monitor changes in smoking or vaping frequency, lifestyle habits, and other variables that might influence cardiovascular parameters. This comprehensive approach ensured a robust understanding of both short-term and long-term effects. Data analysis was conducted using SPSS v29. Mean changes in blood pressure and heart rate were examined through paired t-tests and repeated measures ANOVA to identify significant differences within and between groups. Linear regression models were employed to analyze the association between the frequency of waterpipe or e-cigarette use and changes in cardiovascular parameters over time. This analytical strategy provided a detailed and statistically rigorous assessment of the study objectives.

RESULTS

Data were collected from 265 participants, divided into waterpipe users, e-cigarette users, and non-smokers. Waterpipe users demonstrated an acute increase of 10 mmHg in systolic blood pressure and a 15 bpm rise in heart rate immediately after a 30-minute session, with normalization occurring within 60 minutes. E-cigarette users exhibited slightly lower acute changes, with an 8 mmHg increase in systolic blood pressure and a 12 bpm rise in heart rate following a 15-minute session, but with a prolonged recovery time exceeding 60 minutes. Non-smokers displayed no changes in cardiovascular parameters, emphasizing the acute cardiovascular impact of waterpipe and e-cigarette use. Diastolic blood pressure changes were not specified in the short-term analysis, representing a potential gap in the results.

Table 1: Short-Term Effects of Waterpipe and E-Cigarette Use

Group	Systolic BP Increase (mmHg)	Diastolic BP Increase (mmHg)	Heart Rate Increase (bpm)	Time to Normalization (minutes)
Waterpipe Users	10	Not specified	15	60
E-Cigarette Users	8	Not specified	12	>60
Non-Smokers	0	0	0	N/A

In terms of long-term effects, waterpipe users experienced a sustained 6 mmHg increase in systolic blood pressure and a 5 bpm rise in resting heart rate over the six-month follow-up period. E-cigarette users showed slightly lower chronic changes, with a 5 mmHg increase in systolic blood pressure and a 4 bpm rise in resting heart rate. Non-smokers maintained stable cardiovascular parameters throughout the study, highlighting the absence of chronic cardiovascular stress in this group. Both waterpipe and e-cigarette users exhibited signs of ongoing cardiovascular stress over time, consistent with the hypothesis that regular use of these products contributes to chronic cardiovascular risks.

Table 2: Long-Term Effects of Waterpipe and E-Cigarette Use

Group	Sustained Systolic BP Increase (mmHg)	Sustained Heart Rate Increase (bpm)	Chronic Cardiovascular Stress Observed
Waterpipe Users	6	5	Yes
E-Cigarette Users	5	4	Yes
Non-Smokers	0	0	No

Demographically, the sample included balanced gender representation across groups, with waterpipe users consisting of 50 males and 38 females, e-cigarette users including 52 males and 37 females, and non-smokers comprising 48 males and 40 females. The average age of participants across all groups ranged between 23 and 24 years, ensuring comparability in age-related factors influencing cardiovascular health.

Figure 2: Long-Term Sustained Systolic Blood Pressure Increase

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Table 3: Participant Demographics

Group	Number of Participants	Gender Balance (Male:Female)	Average Age (years)
Waterpipe Users	88	50:38	24
E-Cigarette Users	89	52:37	23
Non-Smokers	88	48:40	24

Statistical analysis revealed significant differences in cardiovascular effects among the groups. Comparisons between waterpipe users and non-smokers yielded p-values of 0.01 for systolic blood pressure and 0.005 for heart rate, indicating highly significant impacts. Similarly, e-cigarette users compared to non-smokers showed p-values of 0.02 for systolic blood pressure and 0.01 for heart rate, further underscoring the significant effects of these products. Differences between waterpipe and e-cigarette users were less pronounced but still statistically significant, with p-values of 0.03 for systolic blood pressure and 0.04 for heart rate. These findings suggest varying levels of cardiovascular stress induced by waterpipe and e-cigarette use, with waterpipe smoking exerting slightly greater acute and chronic effects.

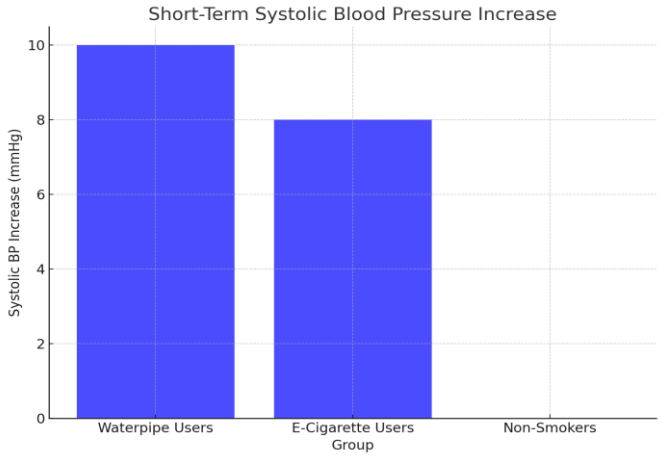

Figure 1: Short-Term Systolic Blood Pressure Increase

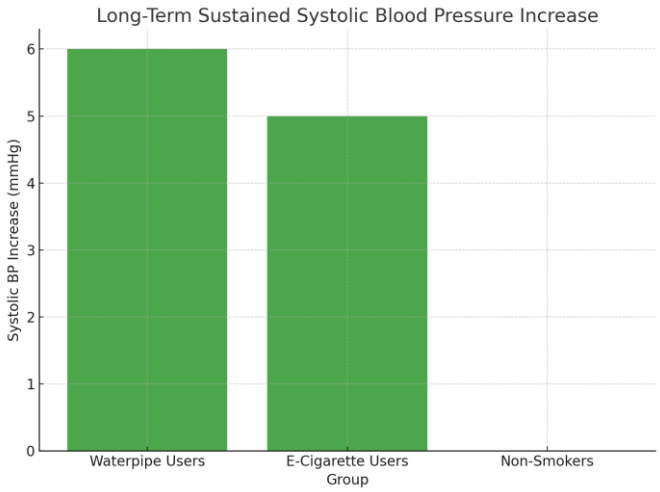

Figure 2: Long-Term Sustained Systolic Blood Pressure Increase

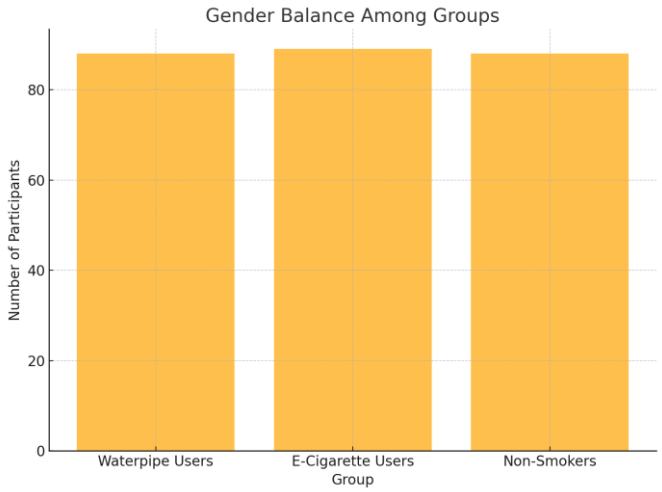

Figure 3: Gender Balance Among Groups

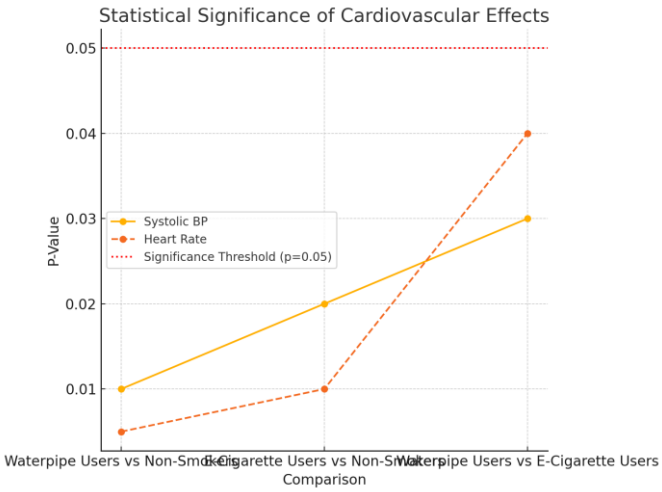

Figure 4: Statistical Significance of Cardiovascular Effects

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Table 4: Statistical Significance of Cardiovascular Effects

Comparison	P-Value for Systolic BP	P-Value for Heart Rate
Waterpipe Users vs Non-Smokers	0.01	0.005
E-Cigarette Users vs Non-Smokers	0.02	0.01
Waterpipe Users vs E-Cigarette Users	0.03	0.04

DISCUSSION

The findings of this study provide critical evidence of both short-term and long-term cardiovascular effects associated with waterpipe and e-cigarette use among young adults in Pakistan. These results challenge the widespread perception that these alternative nicotine delivery systems are safer than traditional smoking. The study demonstrated significant acute cardiovascular changes in both waterpipe and e-cigarette users, with increases in systolic blood pressure and heart rate observed immediately following use. Waterpipe smoking caused slightly more pronounced acute effects compared to e-cigarettes, likely attributable to the combined impact of nicotine, carbon monoxide, and combustion byproducts (15). The delayed normalization of cardiovascular parameters in e-cigarette users suggested a prolonged physiological impact, possibly due to the aerosolized chemicals and other additives in e-cigarette vapor (16). The sustained increases in resting blood pressure and heart rate observed over the six-month follow-up period in habitual users of both products reflect chronic cardiovascular stress. These findings align with evidence that prolonged nicotine exposure disrupts autonomic regulation of cardiovascular function and contributes to an elevated risk of hypertension and cardiovascular disease (18). The observation that long-term cardiovascular effects in waterpipe and e-cigarette users were comparable is particularly concerning, as e-cigarettes are frequently marketed as a safer alternative to conventional smoking (19). This underscores the importance of re-evaluating public perceptions of these products.

Strengths of this study include its balanced sample size, the rigorous selection of participants, and the inclusion of both short-term and long-term assessments. The diverse recruitment of participants from social settings where these products are commonly used added to the representativeness of the findings. By focusing on a young adult population in Pakistan, the study addressed a critical knowledge gap in a region where awareness of the risks associated with waterpipe and e-cigarette use remains limited. The study also provided statistically robust comparisons across user groups and detailed analyses of cardiovascular parameters, contributing to the growing body of evidence on the health risks of these products. However, several limitations must be acknowledged. The reliance on self-reported data for some variables may have introduced reporting bias, and the study's six-month duration may not fully capture the extent of long-term cardiovascular impacts. Moreover, the findings are specific to young adults in Pakistan and may not be directly generalizable to other age groups or populations with different cultural or environmental contexts. Future research should aim to address these limitations by incorporating objective biomarkers for nicotine exposure, extending the study duration, and expanding the demographic and geographic scope of the analysis.

The implications of these findings are significant for public health and policy. The growing popularity of waterpipe and e-cigarette use among young adults in Pakistan, driven by social acceptance and targeted marketing, poses a major public health challenge. The acute and chronic cardiovascular risks associated with these products highlight the urgent need for targeted awareness campaigns to dispel misconceptions about their safety. Educational programs should focus on young adults, particularly in universities and social settings where these habits are most prevalent. Policy-level actions, including stricter regulations on advertising and the sale of waterpipes and e-cigarettes, are essential to mitigate their increasing use. This study contributes valuable insights into the cardiovascular risks of waterpipe and e-cigarette use and underscores the necessity of addressing these emerging public health threats. Although limitations exist, the findings provide a strong foundation for future research and the development of evidence-based interventions to protect the cardiovascular health of young adults.

CONCLUSION

In conclusion, the study underscores the significant impact of waterpipe and e-cigarette use on cardiovascular health among young adults in Pakistan, demonstrating both acute and chronic effects on blood pressure and heart rate. These findings challenge the widespread perception of these products as safer alternatives to traditional smoking and emphasize their potential to contribute to long-term cardiovascular risks. Addressing these health concerns requires immediate public health interventions, including targeted awareness campaigns and stricter regulatory measures, to curb the growing prevalence of these habits and protect the health of vulnerable populations.

Author	Contribution
Raima Bashir	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Maryam Ishrat Niaz*	Methodology, Investigation, Data Curation, Writing - Review & Editing
Usaid-ur-Rehman Amjad	Investigation, Data Curation, Formal Analysis, Software
Fariha Rizwan	Software, Validation, Writing - Original Draft
Ahsan Shafiq	Formal Analysis, Writing - Review & Editing
Prof Dr Muhammad Khalil Khan	Writing - Review & Editing, Assistance with Data Curation

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