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Original Research Article

A Cross-Sectional Study to Assess the Correlation between Smoking and Heart Rate Variability in Urban Population of Meerut

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Abstract

Background: Smoking constitutes a significant risk factor for cardiovascular diseases, primarily through its impact on the autonomic nervous system. Heart rate variability (HRV) serves as a sensitive and non-invasive measure to assess autonomic function and smoking has been associated with adverse effects on HRV, indicating potential cardiac autonomic dysfunction.

Aims and Objectives: This study aims to assess the correlation between smoking and HRV in urban population of Meerut.

Materials and Methods: A cross-sectional study was conducted on 50 male smokers and 50 non-smokers, drawn from the urban population of Meerut, within the age range of 18-60 years, based on district census data from 2011. HRV was recorded using a Physio-Pac device. Subjects were categorized into two age groups: ≤30 years and >30 years. Data included cardiovascular parameters, time domain analysis, and frequency domain analysis. Statistical analysis was performed using Student's unpaired t-test.

Results: Urban smokers in the ≤30 year age group exhibited significantly higher LF and LF/HF ratio, alongside significantly lower HF, compared to non-smokers. Similarly, urban smokers in the >30 year age group demonstrated a significantly higher LF/HF ratio compared to non-smokers.

Conclusion: Our findings indicate a significant dominance of sympathetic activity and a notable reduction in parasympathetic activity among urban smokers. These results underscore the detrimental impact of smoking on cardiovascular health, highlighting the impairment of autonomic function associated with smoking.

Keywords: Parasympathetic, Sympathetic, Heart rate variability, Smoking, Urban.

Introduction

Smoking remains a global public health crisis, claiming the lives of over 8 million people annually worldwide. India, with approximately 12% of the world's smokers, bears a significant burden, with 1 million deaths attributed to smoking each year [1]. While smoking is commonly associated with respiratory issues and lung cancer, its impact extends to cardiovascular diseases, including coronary artery disease and peripheral vascular disease. In India, 48% of tobacco-related deaths are attributable to cardiovascular diseases [2]. According to the Global Adult Tobacco Survey (GATS-2) report for India, tobacco use persists, with nearly 11.9% of individuals in rural areas and 8.3% in urban areas engaging in smoking [3]. Smoking heightens the risk of cardiovascular events through various mechanisms. One notable mechanism is its influence on the Autonomic Nervous System (ANS). Heart Rate Variability (HRV) serves as a reliable, non-invasive, and cost-effective measure of ANS activity, reflecting beat-to-beat variations in the RR interval of successive normal beats on an electrocardiogram (ECG). Alterations in HRV signify changes in sympathovagal balance. Sympathetic activity, characterized by low-frequency components in the HRV spectrum, operates over extended periods, while parasympathetic activity, represented by high-frequency components, acts over shorter durations. The ratio between low frequency (LF) and high frequency (HF) components determines the balance between the sympathetic and parasympathetic axes. The present study was planned to elucidate the impact of smoking on HRV among the urban population of Meerut. The prevailing hypothesis states that smoking diminishes HRV, and reduced HRV is closely linked to cardiovascular morbidity and mortality. This study was initially presented as a poster at APPICON 2021-22, hosted by ESIC Medical

College, Faridabad, on April 14, 2022. Through a comparative analysis of HRV changes between smokers and non-smokers, this study seeks to contribute to the understanding of the cardiovascular implications of smoking in urban settings. By exploring the association between smoking and HRV alterations, we aim to underscore the importance of smoking cessation initiatives and preventive measures to mitigate the cardiovascular risks associated with smoking in urban populations like Meerut.

Materials & Methods

The present study was conducted in the Autonomic Function Lab of the Department of Physiology, LLRM Medical College, and Meerut (UP) in collaboration with Department of Medicine of associated SBVP Hospital, over a period of 12 months. \

Ethical approval was obtained from the Institutional Ethics Committee prior to commencing the study. A cross-sectional study was conducted involving 50 male smokers and 50 male non-smokers aged 18-60 years, selected from the urban population of Meerut District. Participants were chosen based on District census data 2011, Meerut. Exclusion criteria included unwillingness to participate, history of alcoholism, obesity, hypertension, drug use (e.g., steroids, anti-arrhythmic, antihypertensive), and presence of cardiac, respiratory, neurological, or endocrine diseases affecting HRV.

Before the procedure, participants were briefed about the examination's nature and purpose, following which written informed consent was obtained. Participants were instructed to abstain from heavy exercise, alcoholic and caffeinated beverages, and eating and drinking 2 hours prior to recording. Tests were conducted in thermo-neutral conditions between 9 am to 1 pm after acclimatization. Detailed information regarding occupation, socioeconomic status, lifestyle, exercise, dietary habits, addictions, medical status, history, and medications was obtained. Resting heart rate and blood pressure were measured, followed by a 15-minute rest period in a supine position. A short-term 5-minute ECG was recorded using a data acquisition system (Physiopac 4) at a room temperature of 26°C.

Recordings were transferred for HRV analysis using HRV analysis software version 1.1 developed by the Biosignal analysis group, University of Kubios, Finland. International guidelines for ECG standardization and interpretation were followed. Time-domain analysis included mean heart rate (bpm), root mean square of successive differences between normal heartbeats (RMSSD), mean RR interval, NN50 count, and pNN50. Frequency-domain analysis included low frequency band (LF), high frequency band (HF), and LF/HF ratio using an auto regression model.

Data were coded, entered into MS excel, and analyzed using Student's unpaired t-test for comparisons between groups. Results were expressed as Mean ± SD, and a p-value of ≤0.05 was considered significant.

Results

Both smokers and non-smokers were stratified into two age groups: ≤30 years and >30 years.

Comparison of Cardiovascular Parameters (≤30 year age):

Table 1 summarizes the comparison of cardiovascular parameters including systolic blood pressure (SBP) and diastolic blood pressure (DBP), between urban smokers and urban non-smokers in age group of ≤30 years. No significant variation was observed in SBP (p = 0.45) or DBP (p = 0.21) between the two groups.

Table 1: Comparison of Cardiovascular Parameters between Urban Smokers and Urban Non-smokers (≤ 30 years age)

Parameters	Smokers(n=29) Mean±SD	Non-Smokers(n=23) Mean±SD	p Value
SBP(mm Hg)	115.45±8.89	113.57±8.88	0.451598
DBP(mm Hg)	77.38±5.71	77.04±5.52	0.21371

Comparison of Heart Rate Variability Parameters (≤30 year age): Table 2 presents the comparison of heart rate variability (HRV) parameters between urban smokers and urban non-smokers in the age group of ≤30 years. Urban smokers exhibited a significant increase in LF (p = 0.0084) and LF/HF ratio (p = 0.0185), along with a decrease in HF (p = 0.0311) compared to urban non-smokers.

Table 2: Comparison of Heart Rate Variability (HRV) Parameters between Urban Smokers and Urban Non-smokers (≤ 30 years age)

Parameters	Smokers(n=29) Mean±SD	Non-Smokers (n=23) Mean±SD	p Value
Mean HR(bpm)	48.69±7.44	47.83±7.59	0.684153
Mean RR interval(s)	1.28±0.2	1.27±0.17	0.89087
RMSSD(ms)	43.05±26.82	45.79±38.13	0.762197
NN50(count)	24.45±15.04	23.57±9.495	0.807267

pNN50 (%)	10.11±5.77	10.94±6.64	0.630849
LF(n.u.)	79.59±11.23	70.42±12.86	0.008409 *
HF(n.u.)	11.83±7.19	16.5±7.94	0.031126 *
LF/HF ratio	9.86±6.34	6.05±4.5	0.018543 *

Comparison of Cardiovascular Parameters (>30 years age): Table 3 depicts the comparison of cardiovascular parameters, SBP and DBP, between urban smokers and urban non-smokers in the age group of >30 years. No statistically significant variation was found in SBP (p = 0.243) or DBP (p = 0.773) between smokers and non-smokers.

Table 3: Comparison of Cardiovascular Parameters between Urban Smokers and Urban Non-smokers (>30 year age)

Parameters	Smokers(n=21) Mean±SD	Non-smokers (n=27) Mean±SD	p Value
SBP(mm Hg)	124.38±10.87	120.81±9.96	0.243137
DBP(mm Hg)	79.52±5.51	79.04±5.96	0.773067

Comparison of Heart Rate Variability Parameters (>30 years age): Table 4 shows the comparison of HRV parameters between urban smokers and urban non-smokers in the age group of >30 years. LF/HF ratio was significantly higher in urban smokers compared to urban non-smokers (p = 0.0285).

Table 4: Comparison of HRV Parameters between Urban Smokers and Urban non-smokers (>30 year age)

Parameters	Smokers(n=21) Mean±SD	Non-smokers(n=27) Mean±SD	p Value
Mean HR(1/min)	46.79±8.05	46.96±8.67	0.946567
Mean RR interval(s)	1.33±0.2	1.38±0.41	0.588531
RMSSD(ms)	39.37±29.07	53.16±52.02	0.282372
NN50(count)	17.9±9.66	19.11±14.84	0.748367
pNN50 (%)	7.53±3.79	9.63±8.84	0.313643
LF(n.u.)	78.85±10.75	77.71±9.38	0.697944
HF(n.u.)	13.72±8.94	15.43±7.01	0.461791
LF/HF ratio	9.83±7.57	6.22±3.02	0.028523 *

Discussion

Our cross-sectional study aimed to investigate the association between smoking and heart rate variability (HRV) in the urban population of Meerut. Smoking is known to stimulate sympathetic activity through various mechanism including effect of nicotine on catecholamine release and sympathetic nerve activity.

The findings reveal significant alterations in HRV parameters, specifically LF, HF, and LF/HF ratio, among urban smokers compared to non-smokers, with variations observed across different age groups. LF represents sympathetic activity while HF reflects parasympathetic activity. LF/HF ratio provides insights into sympathovagal balance. Higher ratio indicates sympathetic dominance. Consistent with prior research, our study confirms that cigarette smoking is associated with adverse effects on HRV. Notably, in participants aged ≤30 years, urban smokers exhibited significantly higher LF and LF/HF ratio, indicating sympathetic dominance and reduced parasympathetic modulation among young urban smokers, indicative of autonomic imbalance and potential cardiovascular risk factors. Moreover, our study revealed a significant decrease in HF among urban smokers in the same age group. The reduced HF component, which primarily reflects parasympathetic activity, further supports the notion of impaired cardiac autonomic function among young smokers. These findings align with studies such as Andrikopoulos et al [4] and Ferdous & Ferdousi [5], which have demonstrated the acute effects of smoking on HRV, particularly in young individuals.

Moreover, our results indicate a persistent impact of smoking on HRV in older age groups (>30 years), characterized by a significantly higher LF/HF ratio. Although the differences in LF and HF between smokers and non-smokers were not statistically significant in this age group, the elevated LF/HF ratio suggests an imbalance in autonomic regulation favor ing sympathetic dominance among urban smokers.

This finding echoes the findings of Kobayashi et al. [6], who observed acute effects of smoking on HRV in occupational settings. This nuanced pattern suggests a potential age-related adaptation or resilience in parasympathetic modulation among older urban smokers, possibly due to long-term exposure to smoking or other confounding factors. Furthermore, the comparative study by Birajdar [7]

provides additional support for our findings, indicating a correlation between smoking and altered HRV parameters in heavy smokers compared to non-smokers.

Similarly, the study by Dr. Anisha et al. [8] underscores the importance of investigating HRV changes in smokers, aligning with our research objectives. The observed alterations in HRV among urban smokers underscore the potential cardiovascular consequences of smoking in the urban population of Meerut. The sympathetic dominance and reduced parasympathetic activity associated with smoking are known risk factors for cardiovascular diseases, including hypertension, coronary artery disease, and arrhythmias. Limitations of our study include its lack of emphasis on urban pollution level and individual stress level. Our findings emphasize the need for targeted smoking cessation interventions such as smoking cessation programs, awareness campaigns and implementing policies in urban settings to mitigate these adverse effects and promote cardiovascular health and also there is need to integrate HRV assessment into routine clinical practice can enhance preventive care strategies and improve cardiovascular outcomes in urban smokers.

Conclusions

This study provides valuable Correlation between smoking and Heart rate variability in urban population of Meerut. The participants were male. Notably, there was significant dominance of sympathetic activity in urban smokers and also there was significant fall in parasympathetic activity in urban smokers. Research underscores the need for more awareness, education and preventive measures against smoking in urban areas of Meerut.

In conclusion, our cross-sectional study provides compelling evidence of the detrimental impact of smoking on heart rate variability (HRV) among the urban population of Meerut. Through the assessment of HRV parameters such as LF, HF, and LF/HF ratio, we have demonstrated significant alterations indicative of autonomic imbalance and cardiovascular risk factors associated with smoking.

Our findings corroborate previous research indicating the acute and persistent effects of smoking on HRV across different age groups. Specifically, we observed sympathetic dominance and reduced parasympathetic modulation among young urban smokers, highlighting the early onset of cardiovascular risk factors in this population. Furthermore, our study suggests a potential age-related adaptation or resilience in parasympathetic modulation among older urban smokers, emphasizing the need for long-term interventions to mitigate the adverse effects of smoking. The implications of our research extend beyond academic interest, emphasizing the urgent need for targeted smoking cessation interventions in urban settings like Meerut. Implementing smoking cessation programs, raising awareness through campaigns, and enacting policies to reduce smoking prevalence are crucial steps in promoting cardiovascular health and reducing the burden of cardiovascular diseases.

Moreover, integrating HRV assessment into routine clinical practice can enhance preventive care strategies and improve cardiovascular outcomes among urban smokers. By addressing the modifiable risk factor of smoking and its impact on HRV, healthcare professionals can play a pivotal role in preventing cardiovascular morbidity and mortality in urban populations.

In conclusion, our study underscores the importance of concerted efforts from policymakers, healthcare providers, and the community to combat smoking-related cardiovascular risks in urban areas. Through collaborative action, we can strive towards a healthier urban environment and improve the cardiovascular well-being of individuals in Meerut and beyond.

Additional Information

Disclosures

Human Subjects: Consent was obtained by all participants in this study. Institutional ethics Committee, LLRM Medical College, Meerut issued approval No./SC-1/2021/7999. The Committee did not find anything objectionable/unethical vis-à-vis human subject in the proposal. The proposal is therefore awarded ethical clearance.

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