ORIGINAL RESEARCH

Unravelling the Complex Nexus: Adiposity, Blood Pressure, Cardiac Autonomic Function, and Arterial Stiffness in Young Adults - An Integrated Analysis

[1]Dr. Abhishek Sachdeva, [2]Dr. Mukesh Kumar Tiwari, [3]Dr. Mohd Shahid, [4]Dr. Amit Varshney

[1,2,3]Assistant Professor, Department of Cardiology, Moti Lal Nehru Medical College, Prayagraj, Uttar Pradesh, India
[4]Professor, Department of Emergency Medicine, Kanti Devi Medical College Hospital and Research Center, Mathura, Uttar Pradesh, India

Corresponding author
Dr Mohd Shahid
Assistant Professor, Department of Cardiology, Moti Lal Nehru Medical College, Prayagraj, Uttar Pradesh, India
Email: - *shahid.md051@gmail.com*

ABSTRACT
Background: Cardiac autonomic function and arterial stiffness are two important factors related to cardiovascular health. The autonomic nervous system (ANS) regulates involuntary bodily functions, including the cardiovascular system. It consists of two branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). These two branches work in a balanced manner to maintain optimal cardiac function.
Aim: The present study was conducted to assess relationship between adiposity, blood pressure, cardiac autonomic function and arterial stiffness in young adults.
Materials & Methods: 65 healthy subjects of both genders were included. Weight (kgs), height (meters) and BMI (Kgs/m^2) was calculated. Based on BMI, group I comprised of normal weight young healthy subjects and group II overweight/obesity subjects. Measurement of Brachial-ankle PWV (baPWV), Carotid-femoral PWV (cfPWV), Heart-brachial PWV (hbPWV), Heart-ankle PWV (haPWV), Arterial stiffness index (ASI), Aortic augmentation index (AIx) and heart rate variablility (HRV) was done.
Results: The mean BMI (Kg/m2) in group I and II was 19.1 and 27.5, PP (mm Hg) was 50.4 and 51.3, MAP (mm Hg) was 84.6 and 90.2 and HR (bpm) was 71.2 and 76.4 respectively. The difference was significant (P< 0.05). The mean baPWV (cm/s) was 987.4 and 992.3, cfPWV (cm/s) was 60.5 and 585.2, AI@75 was 5.6 and 6.2, hbPWV (cm/s) was 291.4 and 301.2, haPWV (cm/s) was 423.6 and 418.5, bASI was 21.5 and 22.6, aASI was 32.4 and 35.1 and ABI was 1.8 and 1.2 in group I and II respectively. The difference was significant (P< 0.05). In group I and group II, mean LF (nu) was 84.6 and 71.6, HF (nu) was 17.3 and 15.3 and LF/HF ratio was 5.9 and 6.2 respectively. The difference was significant (P< 0.05).
Conclusion: Sympathetic over activity can enhance the vascular tone and elevate BP. Inturn, increased BP induces stiffening of arteries that may further augment BP.
Key words: arterial stiffness, autonomic nervous system, cardiac autonomic function

Introduction

Cardiac autonomic function and arterial stiffness are two important factors related to cardiovascular health. The autonomic nervous system (ANS) regulates involuntary bodily functions, including the cardiovascular system.[1] It consists of two branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). These two branches work in a balanced manner to maintain optimal cardiac function. The sympathetic branch increases heart rate and contractility, while the parasympathetic branch slows down the heart rate and promotes relaxation.[2] The balance between these two branches is crucial for maintaining cardiovascular homeostasis. Disruptions in cardiac autonomic function, such as an imbalance between sympathetic and parasympathetic activity, can have negative effects on the heart and blood vessels. Reduced parasympathetic activity or increased sympathetic activity is associated with an increased risk of cardiovascular events and mortality.[3]

Various methods, such as heart rate variability analysis and autonomic function tests, are used to assess cardiac autonomic function. These tests measure the variations in heart rate under different physiological conditions, providing insights into the balance between sympathetic and parasympathetic influences on the heart. Arterial stiffness refers to the loss of elasticity in the arteries, which normally allow them to expand and contract with each heartbeat.

Healthy arteries are flexible and can accommodate the pulsatile blood flow, reducing the workload on the heart.[4]

With age and various pathological conditions, arteries can become stiffer due to structural changes in the arterial walls, including increased collagen deposition and decreased elastin content. Arterial stiffness can also result from the accumulation of atherosclerotic plaques, calcification, and inflammation in the arterial walls.[5] Increased arterial stiffness affects cardiovascular function in several ways. It leads to higher systolic blood pressure, reduced diastolic blood pressure, and impaired coronary perfusion. Arterial stiffness also increases the afterload on the heart, which can contribute to left ventricular hypertrophy and heart failure.[6]

The present study was conducted to assess relationship between adiposity, blood pressure, cardiac autonomic function and arterial stiffness in young adults.

Materials & Methods

The present study consisted of 65 healthy subjects of both genders. All gave their written consent to participate in the study.

Data such as name, age, gender etc. was recorded. Weight (kgs), height (meters) and BMI (Kgs/m^2) was calculated. Based on BMI, group I comprised of normal weight young healthy subjects and group II overweight/obesity subjects. BMI $\geq$ 25 was designated as obese/ overweight) and BMI 18.5-24.9 as normal weight. Blood pressure (mmHg) was measured by oscillometric method using digital blood pressure monitor in the sitting posture. Arterial stiffness was measured by oscillometric method using a non-invasive automatic device. Brachial-ankle PWV (baPWV), Carotid-femoral PWV (cfPWV), Heart-brachial PWV (hbPWV), Heart-ankle PWV (haPWV), Arterial stiffness index (ASI), Aortic augmentation index (AIx) and heart rate variablility (HRV) was measured. Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

Results

Table I Baseline characteristics

Characteristics	Group I	Group II	P value
BMI (Kg/m2)	19.1	27.5	0.04
PP (mmHg)	50.4	51.3	0.17
MAP (mmHg)	84.6	90.2	0.05
HR (bpm)	71.2	76.4	0.02

Table I shows that mean BMI (Kg/m2) in group I and II was 19.1 and 27.5, PP (mm Hg) was 50.4 and 51.3, MAP (mm Hg) was 84.6 and 90.2 and HR (bpm) was 71.2 and 76.4 respectively. The difference was significant (P< 0.05).

Table II Assessment of arterial stiffness

Arterial stiffness	Group I	Group II	P value
baPWV (cm/s)	987.4	992.3	0.52
cfPWV (cm/s)	60.5	585.2	0.19
AI@75	5.6	6.2	0.46
hbPWV (cm/s)	291.4	301.2	0.73
haPWV (cm/s)	423.6	418.5	0.78
bASI	21.5	22.6	0.93
aASI	32.4	35.1	0.81
ABI	1.8	1.2	0.94

Table II, graph I shows that mean baPWV (cm/s) was 987.4 and 992.3, cfPWV (cm/s) was 60.5 and 585.2, AI@75 was 5.6 and 6.2, hbPWV (cm/s) was 291.4 and 301.2, haPWV (cm/s) was 423.6 and 418.5, bASI was 21.5 and 22.6, aASI was 32.4 and 35.1 and ABI was 1.8 and 1.2 in group I and II respectively. The difference was significant (P< 0.05).

Graph I Assessment of arterial stiffness

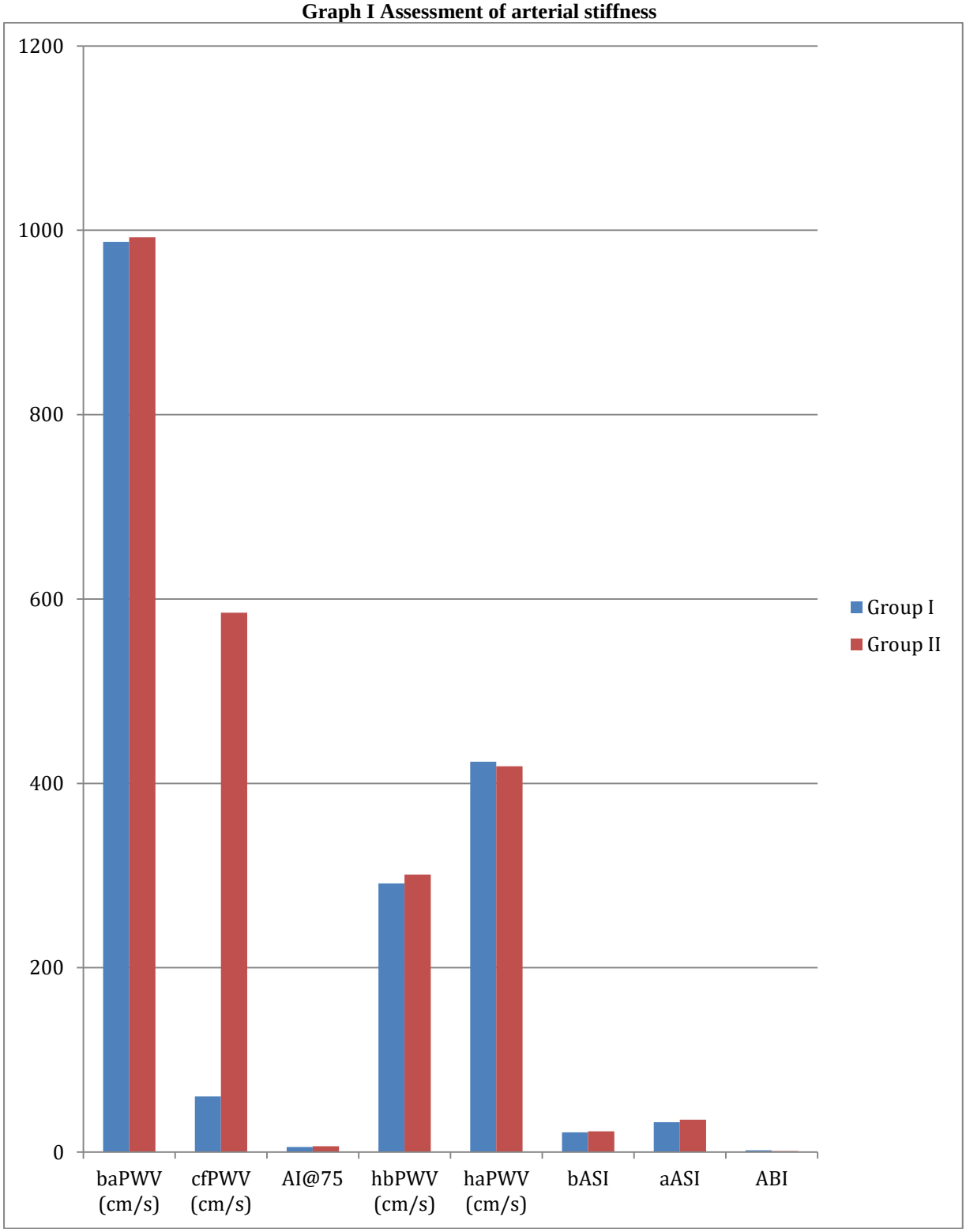
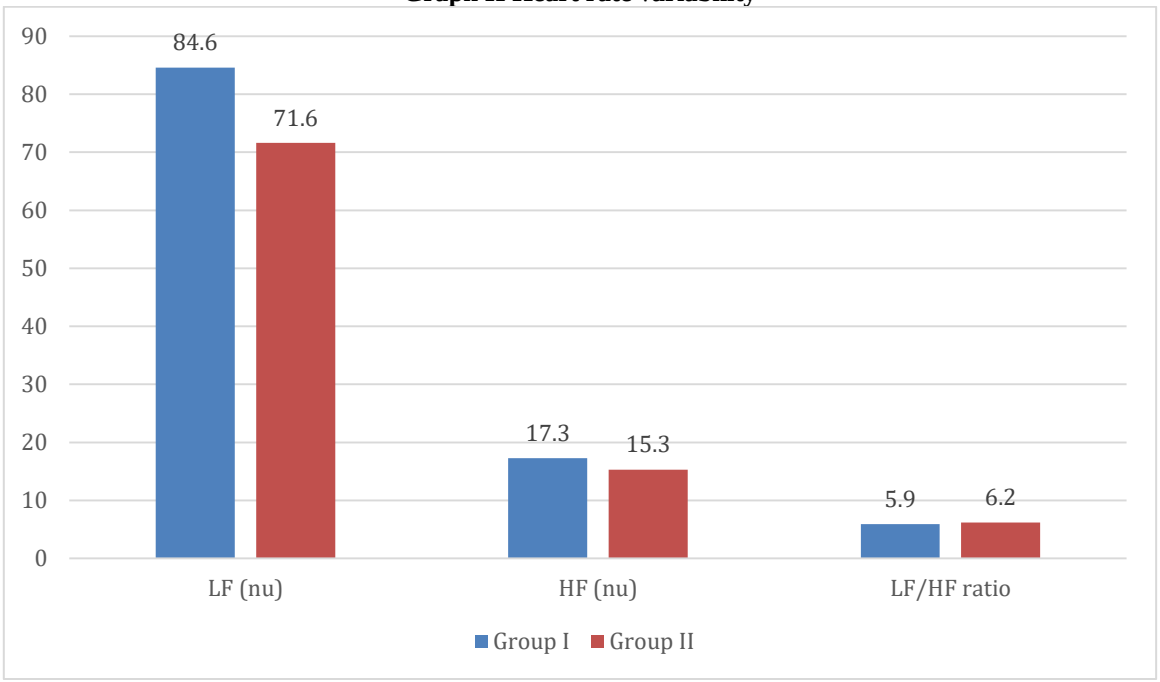


Table III Heart rate variability

Heart rate variability	Group I	Group II	P value
LF (nu)	84.6	71.6	0.02
HF (nu)	17.3	15.3	0.04
LF/HF ratio	5.9	6.2	0.05

Table III, graph II shows that in group I and group II, mean LF (nu) was 84.6 and 71.6, HF (nu) was 17.3 and 15.3 and LF/HF ratio was 5.9 and 6.2 respectively. The difference was significant (P< 0.05).

Graph II Heart rate variability



Discussion

The relationship between cardiac autonomic function and arterial stiffness is complex and interconnected. Sympathetic overactivity and reduced parasympathetic activity, characteristic of impaired autonomic function, have been associated with increased arterial stiffness.[7] Conversely, increased arterial stiffness can also affect autonomic function by altering baroreceptor sensitivity, which plays a role in regulating sympathetic and parasympathetic outflow.[8] Several techniques are used to assess arterial stiffness, including pulse wave velocity (PWV) measurements, which determine the speed at which the pressure wave travels along the arterial tree. Higher PWV values indicate increased arterial stiffness.[9] It's important to note that maintaining a healthy lifestyle, including regular exercise, a balanced diet, and managing risk factors like hypertension and diabetes, can help preserve both cardiac autonomic function and arterial elasticity, promoting overall cardiovascular health.[10]

The present study was conducted to assess relationship between adiposity, blood pressure, cardiac autonomic function and arterial stiffness in young adults.

We found that mean BMI (Kg/m2) in group I and II was 19.1 and 27.5, PP (mm Hg) was 50.4 and 51.3, MAP (mm Hg) was 84.6 and 90.2 and HR (bpm) was 71.2 and 76.4 respectively. Arakeri et al[11] determined the relationship between adiposity, cardiac ANS, arterial stiffness and blood pressure (BP). A study was conducted on 48 young healthy subjects with overweight/obesity (OW group, n=24) and normal weight (NW group, n=24) with age ranging between 18-24 years. Blood pressure, cardiac ANS and arterial health were evaluated. Heart rate variability (LF: low frequency; HF: high frequency; and LF/HF ratio) was assessed as an index of cardiac ANS function. Pulse wave velocity (brachial-ankle, carotid-femoral, heart-ankle, heart-brachial), aortic augmentation index, arterial stiffness index was measured as indices of arterial stiffness. LF and LF/HF ratio was significantly elevated while HF was lowered in obese/overweight subjects when compared to normal subjects. Though not significant but a mean increase in arterial stiffness was found in OW group when compared to NW group participants. Relationship between covariates in all the participants (n=48) is as follows: BMI was significantly correlated with MAP ($p=0.034$), HR ($p=0.048$) and LF/HF ratio ($p=0.02$). While, there was no significant correlation between (1) BMI and arterial stiffness; and (2) cardiac ANS function indices and arterial stiffness. BMI ($\beta=0.288$, $p=0.023$) and arterial stiffness ($\beta=0.516$, $p<0.001$) were the significant determinants of rising BP. MAP ($\beta=0.591$, $p<0.001$) was the significant determinant of the arterial stiffness.

We found that the mean baPWV (cm/s) was 987.4 and 992.3, cfPWV (cm/s) was 60.5 and 585.2, AI@75 was 5.6 and 6.2, hbPWV (cm/s) was 291.4 and 301.2, haPWV (cm/s) was 423.6 and 418.5, bASI was 21.5 and 22.6, aASI was 32.4 and 35.1 and ABI was 1.8 and 1.2 in group I and II respectively. In group I and group II, mean LF (nu) was 84.6 and 71.6, HF (nu) was 17.3 and 15.3 and LF/HF ratio was 5.9 and 6.2 respectively. Wildman et al[12] conducted a study on 196 participants between the age group of 20-40 years, with a follow up after two years, a linear relationship was observed between the annual weight gain and increase in aortic pulse wave velocity (PWV); and a linear decline in aortic PWV was observed corresponding to annul weight lost.

Conclusion

In conclusion, this study aimed to assess the relationship between adiposity, blood pressure, cardiac autonomic function, and arterial stiffness in young adults. The findings revealed significant associations between these variables, highlighting their complex interplay. The results showed that individuals with higher body mass index (BMI) had elevated mean arterial pressure (MAP) and heart rate (HR), indicating a potential link between adiposity and altered cardiovascular parameters. Moreover, obese/overweight subjects exhibited disturbances in cardiac autonomic function, as evidenced by increased sympathetic activity (higher LF and LF/HF ratio) and reduced parasympathetic activity (lower HF). These findings suggest that adiposity may contribute to autonomic imbalance, which can have adverse effects on cardiovascular health.

Regarding arterial stiffness, although not statistically significant, a trend towards increased stiffness was observed in the overweight/obesity group compared to the normal weight group. Arterial stiffness, as measured by various indices such as baPWV, cfPWV, AI@75, hbPWV, haPWV, bASI, aASI, and ABI, plays a crucial role in cardiovascular function. Increased arterial stiffness is associated with higher blood pressure, impaired coronary perfusion, and increased workload on the heart.

The study provides valuable insights into the relationship between adiposity, blood pressure, cardiac autonomic function, and arterial stiffness in young adults. The findings suggest that maintaining a healthy body weight and addressing adiposity-related factors could potentially improve cardiac autonomic function and arterial elasticity, promoting better cardiovascular health.

Further research is warranted to explore the underlying mechanisms and establish causality in this complex relationship. Longitudinal studies with larger sample sizes would provide more robust evidence and help guide interventions aimed at preventing or mitigating cardiovascular risks associated with adiposity and arterial stiffness in young adults.

Conflict of Interest: - None declared
Source of support: - Nil

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