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Physiology

AN OBSERVATIONAL STUDY TO EVALUATE THE RELATIONSHIP OF VISCERAL ADIPOSITY INDEX WITH PULSE WAVE VELOCITY IN GENERAL POPULATION OF JODHPUR CITY

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ABSTRACT **Background:** Association between obesity and CVD is attributed to vascular dysfunction linking the two pathological states.The aim of the study was to analyse the relationship of obesity with arterial stiffness in general population of Jodhpur city. **Materials and Methods:** Cross sectional study including 150 adults aged 25-65 years (50.85±11.06).Anthropometric parameters like weight, height, WC and BMI were measured.Biochemical tests were performed to obtain VAI values by calculations.Arterial stiffness was measured by pulse wave velocity using Periscope based on oscillometric technique. **Results:** Left brachial pulse wave velocity (p value 0.018) and CF PWV(p value 0.050), significantly associated with log VAI in Pearson correlation analysis. Significant p value on comparison of pwvs in log VAI quartiles was observed for Lt Ba PWV by ANOVA test. The study results conclude positive association between VAI and pulse wave velocity.

KEYWORDS : adipocytes,Visceral adiposity index ,Pulse wave velocity, arterial stiffness

INTRODUCTION-

The prevalence of overweight and obesity has reached epidemic levels,(1) increasing the risk of metabolic syndrome, atherosclerosis, and type 2 diabetes.(2) All of these are crucial contributors to cardiovascular morbidity and mortality. Obesity is described as an excess of body fat linked to increased risk of high blood pressure(3)which is the the main predictor of arterial stiffness development and vascular injury . Central arterial stiffness is widely acknowledged as a significant effect of ageing that causes harmful vascular phenotypes.(4) Decreased compliance of the central vasculature alters arterial pressure and flow dynamics and impacts cardiacperformance and coronary perfusion.(5)

Age advancement observes multiple degenerative changes in the walls of large elastic arteries thus contributing to increased stiffening over time(6).The European Society of Hypertension (ESH)/European Society of Cardiology (ESC), declared the measurement of aortic PWV, as the gold standard method for assessing and management of arterial hypertension and arterial stiffness.(7)The pulse wave travels through the artery system, and its speed is inversely proportional to the arterial wall's distensibility: the higher the velocity, the lower the vascular distensibility.(8)The use of PWV to assess the vascular phenotype allows for the quantification of subclinical vascular disease even before the onset of systemic hypertension.(9).

Obesity chiefly marks the hypertrophy and hyperplasia of adipocytes, adipose tissue inflammation and irregular adipokine secretion,(10).Adipokines dysregulation,via various mechanisms like vascular inflammation,endothelial dysfunction, and vascular remodeling induces rise in stiffness of vasculature.(11)Visceral adiposity is the fat deposited around internal organ sites. Excess adipose tissue, in particular abdominal and visceral adipose tissue (VAT), has been closely linked to the development of the metabolic syndrome. Because visceral fat has been proven to secrete particular cytokines and substances that are implicated in atherogenesis and autonomic imbalance, abdominal adiposity is thought to be more detrimental.(12) The Visceral Adiposity Index (VAI) is an empirical mathematical model, gender-specific, based on simple anthropometric (BMI and WC) and functional parameters (triglycerides (TG) and HDL cholesterol (HDL)), used to estimate visceral adiposity and is validated by abdominal MRI.(13,14)Arterial compliance decreases with increase in adiposity(15)independent of BP level, ethnicity, and age(16). The previous study literature expliciting the association between Visceral Adiposity Index and arterial stiffness in healthy individuals is very meager and conflicting.So, the present study aims to analyse the correlation between these two variables .

MATERIALS AND METHODS- research work was commenced after the approval of the synopsis by the ethical committee,SNMC.

Study Design: cross sectional observational study,

Study Location: Department of Physiology, Dr. S.N.Medical College, Jodhpur, Rajasthan.

Study Duration: from July 2021 to July 2022.

Sample size: 150 subjects

Sample size calculation: The sample size was calculated using the below formula for correlation coefficient

$N = ([Z_\alpha + Z_\beta]/C)^2 + 3$

Where

N= Sample size.

Z_α= the standard deviation for α

Z_β = the standard deviation for β

$C = 0.5^* \ln([1+r]/[1-r])$

r = expected correlation coefficient.

α=0.05 Z_α=1.959964

β=0.05 Z_β=1.644854

Expected r=0.3 C=0.30952

Sample size= 138.64 = 139

Hence a total of 150 subjects, 75 males and 75 females were selected and studied.

Subjects & selection method: random selection of subjects from general population.

Inclusion criteria: Individuals aging between 25 to 65 years, of either gender who are native residents of Jodhpur city.

Exclusion criteria:

1. Smokers
2. History of Cardio vascular disease and Renal disease
3. Any Chronic illness like Malignancy, Tuberculosis, Interstilial Lung Disease, Arthritis , Psychiatric disorders.
4. Any Acute infection like Covid -19 , Influenza, Typhoid.
5. Any medical condition influencing degree of obesity such as Thyroid disease, Cushing syndrome etc.
6. Subjects on Weight reduction medications and steroids,

Procedure methodology- Only those subjects were enrolled for the study who gave informed consent to participate in the study. Name, Age, Gender and Socio-economic data was collected in a Performa, followed by anthropometric measurements, physical examination and medical history review. All participants enrolled in the study were as per inclusion/exclusion criteria.

In the present study, anthropometric measurements (Weight, Height ,Waist circumference,17 Body Mass Index) (18)lipid profile tests(total cholesterol (TC), triglycerides (TG), and high density lipoprotein (HDL by Robonik automatic biochemical auto-analyzer (19) were performed.

Visceral Adiposity Index- In the present study, skewness of data is observed for Visceral adiposity index so log transformation of presented values was done and log transformed variable was used for analysis of data. Visceral adiposity index calculated using sex specific equations.

$$\text{Females: VAI} = \left(\frac{\text{WC}}{36.58 + (1.89 \times \text{BMI})}\right) \times \left(\frac{\text{TG}}{0.81}\right) \times \left(\frac{1.52}{\text{HDL}}\right),$$

$$\text{Males: VAI} = \left(\frac{\text{WC}}{39.68 + (1.88 \times \text{BMI})}\right) \times \left(\frac{\text{TG}}{1.03}\right) \times \left(\frac{1.31}{\text{HDL}}\right),$$

Arterial Stiffness was assessed by PERISCOPE [RMS India], a Computer based pulse waveform analysis system that uses simultaneous Noninvasive Blood Pressure measurements and waveform from four limbs and ECG waveforms to calculate Pulse Wave Velocity (20) We collected right and left brachial ankle (ba PWV) and carotid femoral (cf PWV) pulse wave velocity and their reference value for age, from report generated by this device.

Statistical analysis-Data were expressed as mean ± SD. Statistic calculations were done using Analysis ToolPak Add-in in Microsoft Office excel® 2007 and IBM ® SPSS ® Statistics Subscription. Data were compared in 4 log VAI groups and in 2 groups by median splitting the pvw values by ANNOVA test. Correlation analyses were performed between each and every variable by Pearson correlation analysis

OBSERVATIONS AND RESULTS

Table 1 shows results of Pearson Corealation analysis done to associate the Visceral Adiposity Index with arterial stiffness.

Table 1 - Relationship between log VAI and Pulse wave velocity (Pearson correlation) (N 150)

Variables	r value	p value	Significance
Right BaPWV(cm/sec)	0.067	0.419	NS
Left BaPWV (cm/sec)	0.193	0.018	S
C-F PWV (cm/sec)	0.153	0.050	S

*NS = Not Significant, S = Significant ($p < 0.05$) HS = Highly Significant ($p < 0.01$)

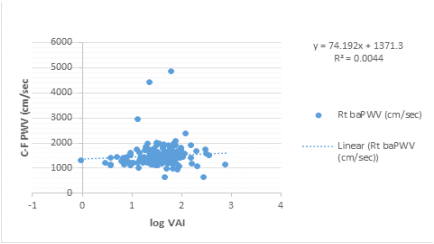
Left brachial pulse wave velocity (p value 0.018) and CF PWV, significantly associated with log VAI indicate positive corelations between arterial stiffness parameters and obesity.

Table shows comparison of various pulse wave velocity values in log VAI quartiles.

TABLE 2- Arterial stiffness indices (pulse wave velocity) in log VAI quartiles.

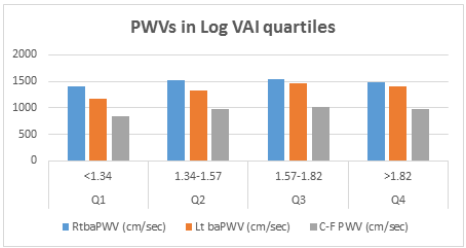
Log VAI	Q1 <1.34	Q2 1.34-1.57	Q3 1.57-1.82	Q4 >1.82	Sig
N 150	37	38	38	37	
Variables	Mean± SD	Mean± SD	Mean± SD	Mean± SD	p value
RtbaPWV (cm/sec)	1406.55±336.06	1521.14±545.03	1541.56±609.90	1474.19±345.16	0.62
Lt baPWV (cm/sec)	1163.73±281.25	1334.70±353.62	1469.85±387.50	1398.45±449.71	0.0042
C-F PWV (cm/sec)	850.00±164.05	970.49±272.14	1024.09±358.36	972.54±294.21	0.057

Chart 1 – Pearson correlation between log VAI and C-F PWV (cm/sec)



Linear increase in pulse wave velocity is observed with increase in log VAI.

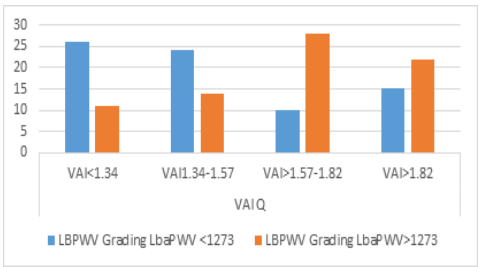
Observed data show all arterial stiffness parameters consistentently increase with log VAI.Statically Significant p value on comparison of variables was observed for Lt Ba PWV by ANOVA test.



Left brachial ankle pulse wave velocity is divided into two groups as per median value and distribution of subjects in all 4 quartiles is tabulated below

Table-3- Distribution of subjects in VAI quartile groups with Median splitting of Lt –ba PVW

Lt - baPVW	Total subjects	Q1 VAI <1.34	Q2 VAI 1.34-1.57	Q3 VAI 1.57-1.82	Q4 VAI >1.82
Lt baPVW<1273	75	26	24	10	15
Lt bapvw>1273	75	11	14	28	22
Total	150	37	38	38	37



When the subjects are distributed as per median LT –baPWV and VAI quartiles, we observe that subjects with greater PVW values are more in number in higher VAI quartiles,thus indicating their co existence together.

DISCUSSION.

Adiposity of either type whether central (visceral) or generalized (subcutaneous) more or less may contribute in arterial stiffness. The release of inflammatory cytokines also known as adipocytokines, may stimulate the pro-inflammatory state, which further progresses to obesity-induced low-grade inflammation.(21).These adipocytokines also increase the production of reactive species in the brain, through activation of NADPH oxidase,(22) increase the oxidative stress in rostral ventro-lateral medulla, which determines the basal sympathetic activity.(23)Increased basal sympathetic activity reflects as increased blood pressure, raised resting heart rateand vascular smooth muscle

cell (VSMC) tone, with resultant increased arterial stiffness(24,25,)

The increased secretion of prothrombin activator inhibitor-1 from fat cells may play a role in the pro coagulant state along with changes in endothelial function may be responsible for increase vascular stiffness and hypertension. (2).

Moreover, increased body fatness results in elevated circulating leptin concentrations, which are linked to increased arterial stiffness(7)

Similar results were observed by Kim –Sutton Tyrell (2001), B. Strasser M. Arvandi (2015) (26) Hirokazu Morigami1, Tomoaki Morioka1 (2016) (27),Bin Wu , Jingshan Huang (2018), (28)Hee Seon Choi (2019) ,Da-Hye Son (2021). (29)

Our results did not match with study done by A. Ishida 2017(30) In univariate analyses, VFA and WC showed a weak positive correlation; followed by weak negative association in multivariate analyses after adjustment for sex, age, systolic pressure, and heart rate. Visceral fat obesity was not systolic pressure-independently associated with increased aortic stiffness.

CONCLUSION-

VAI index calculated using BMI, WC, HDL AND TG shows positive associations with pulse wave velocities.Subjects with high arterial stiffness values also presented with high log VAI values thus proving their co existence together. In VAI quartiles , pulse wave velocities gradually increased with increased values of VAI explaining that obesity and vascular dysfunction exhibit a cause effect relationship greatly affecting cardiovascular morbidity and mortality.

REFERENCES

1. World Health Organization. Obesity – Preventing and Managing the Global Epidemic: Report of a WHO Consultation on Obesity. Geneva: WHO, 1998
2. Hubert HB, Feinleib M, McNamara PM, Castelli WP: Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the Framingham Heart Study.Circulation 1983; 67: 968–977
3. Haffner S, Taegtmeyer H: Epidemic obesity and the metabolicsyndrome. Circulation 2003;108: 1541–1545
4. Rocchini AP Obesity and blood pressure regulation. In: Bray GA, Bouchard C, James WP, eds. Handbook of obesity: etiology and pathophysiology2004. 2nd Ed. New York: Marcel Dekker; 873– 897.
5. Safar M. Obesity, Arterial Stiffness, and Cardiovascular Risk. Journal of the American Society of Nephrology. 2006;17(4_suppl_2):S109-S111.
6. Bianchini E., Giannarelli C. Bruno RM, Armenia S., Landini L (2013). Functional and structural Alterations of large arteries:methodological issues. In Curr Pharm Des 2013; Vol. 19, 2390-2400
7. Sutton-Tyrrell K, Newman A, Simonsick E, Havlik R, Pahor M, Lakatta E et al. Aortic Stiffness Is Associated With Visceral Adiposity in Older Adults Enrolled in the Study of Health, Aging, and Body Composition. Hypertension. 2001;38(3):429-433.
8 Bramwell J, Hill A. VELOCITY OF TRANSMISSION OF THE PULSE-WAVE. The Lancet. 1922;199(5149):891-892.
9. Castellon X,Bogdanova V. Screening for subclinical atherosclerosis by noninvasive methods in asymptomatic patients with risk factors. Clin Interv Aging.2013; 8: 573-580
10. You T, Yang R, Lyles MF, Gong D, Nicklas BJ. Abdominal adipose tissue cytokine gene expression: relationship to obesity and metabolic risk factors. Am J PhysiolEndocrinolMetab. 2005; 288: E741–E747
11. Zieman S,Melenovsky V, et al. Mechanisms, Pathophysiology, and Therapy of Arterial Stiffness. Arteriosclerosis, Thrombosis, and Vascular Biology. 2005;25(5):932-943.
12. Despress JP. Abdominal obesity: The most prevalent cause ofthe metabolic syndrome and related cardiometabolic risk. EurHeart J 2006;8:B4-12
13. Amato MC, Giordano C, Galia M, Criscimanna A, Vitabile S, Midiri M, et al. Visceral adiposity index: A reliable indicator of visceral fat function associated with cardiometabolic risk. Diabetes Care. 2010;33(4):920–2
14. Amato, Marco Calogero, and Carla Giordano. "Visceral Adiposity Index: An Indicator of Adipose Tissue Dysfunction." International Journal of Endocrinology, vol. 2014, 2014, doi:10.1155/2014/730827.
15. Tounian P, Aggoun Y, Dubern B, Varille V, Guy-Grand B, Sidi D, Girardet JP, Bonnet D: Presence of increased stiffness of the common carotid artery and endothelial dysfunction in severelyobese children: A prospective study. Lancet 358: 1400–1404, 2001
16. Klabunde R.Cardiovascular Physiology Concepts.2nd ed.Philadelphia: Lippincott Williams & Wilkins; 2012: 41-59
17. Neovius M, Linne Y, Rossner S. BMI, waist-circumference and waist-hip-ratio as diagnostic tests for fatness in adolescents. Int J Obes (Lond). 2005;29(2):163-9. Epub 2004/12/01. doi:10.1038/sj.ijo.0802867. PubMed PMID: 15570312.
18. Deurenberg P, Westsrate JA, Seidell JC. Body mass index as a measure of body fatness; age and sex specific prediction formulas. Br J Nutr. 1991; (65): p-105-114.
19. Allain,CC Poon, LS Chan,CSG, Richmond Wand Fu PC, Clin Chem 1974;20:470-75
20. Yamashina A, Tomiyama H, Takeda K, Tsuda H, Arai T, Hirose K, Koji Y, hori S, Yamamoto Y: Validity, reproducibility, and clinical significance of noninvasive brachial ankle pulse wave velocity measurement. Hypertension Research 2002, 25:359-364.].
21. Hegazi RA, Sutton-Tyrrell K, Evans RW, Kuller LH, BelleS, Yamamoto M, Edmundowicz D, Kelley DE: Relationship of adiposity to subclinical atherosclerosis in obese patients with type 2 diabetes. Obes Res. 2003; 11: 1597–1605
22. Hirooka Y: Oxidative stress in the cardiovascular center has pivotal role in the sympathetic activation in hypertension. Hpertens Res 2011, 34:407-412.
23. Jules H, Ronald MM. Measuring Activity of the Autonomic Nervous System in Humans. Obesity Research 2003; 11: 2–4.
24 Quadri R, Maule S, Flecchia D, et al Autonomic nervous system activity in obese subjects before and after caloric restriction. FunctNeurol. 1990 Jul-Sep;5(3):273-6.
25. Gillum RF. The epidemiology of resting heart rate in a national sample of men and women: Associations with hypertension, coronary heart disease, blood pressure, and other cardiovascular risk factors. Am Heart J. 1988;116:163–174.
26. B. Strasser M, Arvandi et al Nutrition, Metabolism & Cardiovascular Diseases (2015) 25, 495e502 Abdominal obesity is associated with arterial stiffness in middle-aged adults
27. Hirokazu Morigami1, Tomoaki Morioka1, Yuko Yamazaki1, Satoshi Imamura1, Ryutaro Numaguchi1Visceral Adiposity is Preferentially Associated with Vascular Stiffness Rather than Thickness in Men with Type 2 DiabetesJ Atheroscler Thromb, 2016; 23: 1067-107
28. Choi et al Association between new anthropometric parameters and arterial stiffness based on brachial-ankle pulse wave velocity Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2019:12 1727–
29. Da-Hye Son, Hyun-Su Ha 2021 Association of the new visceral adiposity index with coronary artery calcification and arterial stiffness in Korean populationNutrition, Metabolism & Cardiovascular Diseases (2021) 31, 1774-1781
30. Ishida, A.1; Kinjo, K.2; Ohya, Y.1 [PP.28.01] ASSOCIATION OF VISCERAL FAT OBESITY WITH SYSTOLIC PRESSURE AND ARTERIAL STIFFNESS, Journal of Hypertension: September 2017 - Volume 35 - Issue - p e317 doi: 10.1097/01.hjh.0000523939.58998.2a