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Original Article

Effect of body mass change on arterial wall elasticity in young adults

Deben Laishram*, Glad Mohesh.M.I.**

**Professor & Head, Department of Physiology, Shri Sathya Sai Medical College &RI.*
***Assistant Professor,Department of Physiology,Shri Sathya Sai Medical College &RI.*

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ABSTRACT

Obesity classification based on height and weight alone will be not sufficient enough as this doesnot gives the real fat content of the body. Body fat gives a clear picture of the person's proximity towards cardiovascular diseases. Arterial wall elasticity is lost due to fat deposition in the walls of these arteries which can be detected by doing a plethysmographic pulse wave analysis. Materials and methods: Forty eight age matched individuals are screened for their BMI, blood pressure and pulse wave properties.Data collected were later grouped into four based on their BMI for comparison.One way Annova was done for the analysis. Results: Changes in values of the parameters were found to be significantly decreased or increased depending upon the BMI. Conclusion: As BMI increases the impact of obesity is noted in the arterial walls which develop stiffness which can be easily diagnosed through Pulse plethysmographic analysis. Early screening and treatment or lifestyle modification will do good to the obese subjects well before they land up with some CVS disease.

1. Introduction

Body mass index (BMI) is a measure of excess weight related to height rather than of excess adiposity. Any person who maintains a constant BMI may show a progressive increase in the ratio of fat to lean body mass [1].Calculating body mass index is the easiest way to evaluate overweight and obesity. Quetelet index is the quotient of body mass in kilograms divided by square of height in meters (Kg/m^2).The normal BMI range according to WHO is 18.5-24.9 Kg/m2.BMI values of less than 18.5 Kg/m^2 are classified as underweight, 25-29.9 Kg/m^2 as overweight, 30-34.9 Kg/m^2as obese and values 35Kg/m^2 or higher as morbid obesity[2]. Obesity is an important risk factor for cardiovascular disease which is associated with increased stiffening of the arteries, enhancing reflection of the pulsewaveforms[3]. Body fat content showed a higher correlation with age than it did with BMI and vascular stiffness is a significant risk factor in cardiovascular disease. Higher BMI is frequently accompanied by hypertension, associated with endothelial dysfunction and low grade inflammation in otherwise healthy subjects[6]. Arterial stiffness and wave reflection are also influenced to some extent by vascular tone which in turn, is under the control of endothelium derived nitric oxide[7]. Wildman et al demonstrated that, increased BMI correlated with aortic pulse wave velocity (PWV) in both young and older adults. However, surprisingly, their association was stronger in younger subjects and much weaker in older individuals with larger BMI. Previous studies concerning the association of fatness with vascular stiffness used surrogate anthropometric measure, such as BMI which may be misleading in the estimation of body fat content. It is known that BMI does not predict body fat amount and was developed as a measure of weight and not as an index of obesity[8].There are several possible mechanisms to explain the association between arterial stiffness, wave reflection

2. Materials and method

This study was conducted at Shri Sathya Sai Medical College and Research Institute, Ammapettai, Kancheepuram. Institutional Ethical Committee clearance was obtained before the start of the study. Fortyeight subjects (23 male and 25 female) were randomly selected from the college complex within the age group of 18 to 24 years .All the subjects were asked to report to the Research Lab between 9 to 11AM on week days. Information regarding the entire

* Corresponding Author : Dr. Deben Laishram
Professor & Head,
Department of Physiology,
Shri Sathya Sai Medical College &RI,
Ammapettai. Tiruporur.603018
E.mail: deben_laishram@yahoo.com

project was explained in vernacular language and written informed consent was collected from them. Anthropometric data like height, weight.ect. was measured and they were asked to sit comfortably for another 10 minutes to make him or her accommodated to the new environment. After that, resting blood pressure was recorded using semiautomatic digital sphygmomanometer (Omron Hem 401, Japan). Three recordings were taken and the best was entered into the data sheet. Finger Photo Plethysmograph Velcro type, was attached to the subjects right index finger andDigital Polywrite (RMS Poly-D/830001/ADEX) was switched on to acquire the pulse wave. High pass filter, low pass filter and sensitivity were kept fixed. Once the acquisition was started the stability of the waves were checked and a time period was taken till good amplitude and dicrotic notch had appeared. Recording was made for 5 minutes. Whole of the recording was done in a comfortable sitting position. The recorded data was stored in a separate disk. Stored data was later analyzed using Polywrite D software v1.25.Later the data was grouped into 4 categories based upon the BMI of the subjects,

Group I	BMI < 18
Group II	BMI 18 to 24.9
Group III	BMI 25 to 29.9
Group IV	BMI > 30

The software analysis gives the parameters Pulse rate, Transit time, Reflection index (vasomotor tone), Stiffness index (large artery stiffness). Pulse pressure and Mean arterial pressure were calculated from the already determined systolic and diastolic pressure. Values are expressed in Mean +SD and significance was set at $p<0.05$.Statistical analysis was done using Graphpad prism software by One way Annova method.

3. Results

Table No.1 shows the different BMI group of subjects with their respective mean+SD values for parameters like waist hip ratio (WHR), systolic blood pressure, diastolic blood pressure, pulse rate, Transit time, Reflection time, Stiffness index.

Table 1. Comparison of various parameters among individuals with different BMI

	Group I	Group II	Group III	Group IV
BMI Kg/m2	17.65 ±0.1	21.23 + 2.1	27.19 ± 1.6	
WHR	0.80	0.84	0.86	
SBP mmHg	121.50 ±9.1	110 + 13.2	121.6 ± 7.5	
DBP mmHg	66.50 ±0.7	66.28+ 7.5	74.10± 7.2	
Pulse bpm	85.5 ± 2.1	79.42+11.4	98.20 ± 21.2	
Transit time secs	0.320 ± 0.0	0.267 + 0.33	0.249 ±0.06	
Reflection index 0 %	38.5 ± 13.4	77.36 + 9.79	66.65 ± 15.6	
Stiffness index mts/sec	5.48 ± 1.15	6.73 + 0.72	7.6 ± 3.43	
Pulse pressure mmHg	55	43.72	47.5	

Table No.2.Shows the comparative values of each mean+SD and the S.E. The comparative values of group I and II did not show any significant changes except in case of Reflection index. The mean values in Group I and II were 38.5 and 77.36 the S.E was 10.19 showing the significant changes. While comparing the mean values of group I and group III, there were significant changes in certain parameters like diastolic blood pressure, pulse rate, and reflection index. But, when the mean values of group I and group IV are compared almost all the parameters were changed significantly. Likewise, when comparing the mean values of group II and group IV, all the parameters were changed significantly. The comparative values in group III and group IV did not show any significant changes. The mean values of WHR were gradually increases as the body mass index increases being the values, gp. I-0.80, gp. II-0.84, gp. III- 0.86and gp. IV- 0.95 respectively.

Table 2. Intergroup comparison of different observed parameters in individuals of different BMI

Antibiotic (µg)	SBP mmHg	DBP mmHg	PP mmHg	TT Secs	ReflIndex %	Stiff index (mt/sec)
Group- I	121.5	66.5	85.5	0.320	38.5	5.48
Group- II	110	66.28	79.42	0.267	77.36	6.73
S.E	8.2	2.9	4.56	0.06	10.19*	0.85
Group –I	121.5	66.5	85.5	0.320	38.5	5.48
Group – III	121.6	74.1	98.2	0.249	66.65	7.6
S.E	6.92	2.33*	6.88*	0.06	10.70*	1.35
Group-- I	121.5	66.5	85.5	0.320	38.5	5.48
Group – IV	131.5	81.5	105.5	0.260	64.97	6.85
S.E	7.80*	4.54*	6.68*	0.06*	10.39*	0.86*
Group-- II	110	66.28	79.42	0.267	77.36	6.73
Group--IV	131.5	81.5	105.5	0.260	64.97	6.85
S.E	6.62	6.34	7.97	0.021	5.62	0.39
Group – III	121.6	74.1	98.2	0.249	66.65	7.6
Group-- IV	131.5	81.5	105.5	0.260	64.97	6.85
S.E	4.94	5.06	9.48	0.021	6.50	1.12

4.Discussion

We analyzed the relationship between BMI and various cardiovascular parameters giving more importance on reflection index and stiffness index which are the important determinants of small vascular wall elasticity. Higher BMI has shown higher values of reflection index and stiffness index (38.5 versus 64.97, S.E.= 10.39) and (5.48 versus 6.85, S.E.=0.86) respectively. Wildman et al. investigated the effects of body mass changes on vascular wall elasticity in healthy volunteers, 20 -40 years of age demonstrating a linear relationship between BMI and Pulse wave velocity [10].

It has been already reported that, overweight and obese persons had an increased number of adipocytes, a lipolytic activity promoting the release of free fatty acids which can accumulate in spleen, pancreas and muscles leading to the development of insulin resistance. Insulin resistance and the increased glucose levels stimulate collagen synthesis and smooth muscle proliferation, leading to structural changes in the vascular wall and to its dysfunction.[11]

The reason of increasing diastolic blood pressure in higher BMI individuals might be due to the adipocytes released angiotensin II,which increases the circulatory volume by increasing sodium retention as it has been reported by Ward et al[12].

Overweight and obese people have elevated serum Leptin which induces oxidative stress reaction in the endothelial cells resulting to increased sympathetic activity and endothelial damage which can lead to increased stiffness of the vascular wall[13]. These group of people may have elevated concentration of C-reactive protein and pro-inflammatory cytokines which is suggestive of inflammation-the key factor in the development of atherosclerosis. Elevated BMI is an independent risk factor for all-cause of mortality in man over 65 years of age. In women and younger men, BMI values exceeding 27.13 Kg/m2turned out to be an important risk factor for cvs disease and mortality [13].

5.Conclusion

Higher the body mass index, higher the waist hip ratio, diastolic blood pressure, reflection index and stiffness index (vascular wall elasticity)which are directly related determinants of cardiovascular morbidity and mortality.Higher the BMI, individuals must have this kind of non invasive procedure as an early detection of vascular wall elasticity to avoid further deterioration of the vascular wall.

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