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Original Research Article

Vascular Studies in Rural Population

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Abstract

Introduction: Aoritc Augmentation indexes (AIxs) and pulse wave velocity (Pwv) are arterial stiffness parameters. They can be studied by pulse wave analysis noninvasively. Before use, AoAix and Pwv need normative baseline study to find the predictors. However the data about arterial stiffness from rural population of Andhrapradesh is still undetermined. ***Method:*** Pwv and AoAix was measured in the carotid-femoral pathway in 1235 rural inhabitants of Nellore district and clinical parameters were recorded. ***Result:*** Pwv was greater after the fourth decade of life (8.12 ± 1.5) than in youngers less than 40 years. The Pwv was higher in hypertensives of older than 40 years, diabetics and dyslipidemic patients. Major positive significant predictors of PWV were age, Body Mass Index, and systolic blood pressure; whereas for AIx was age alone. ***Conclusion:*** This is the first study conducted in 1235 subjects of rural population of Nellore district which determines the relationship of Pwv with age and other risk factors. Pwv shows a lower in subjects less than 40 years compared to older persons with a strong relationship to the process of arterial aging, the development of hypertension and cardiovascular risk. This baseline data can be used as a reference for future studies.
Keywords: Augmentation index, nonhypertensive, pulse wave velocity.

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INTRODUCTION

Vascular ageing is defined as changes in mechanical & structural properties of vascular wall, leading to the loss of arterial elasticity and reduced arterial compliance. Stiffening of arteries is a natural aging process oxidation stress, micro vascular inflammation, endothelial damage, and imbalance in trace elements may result increased vascular stiffness. Arterial stiffness is associated with risk of cardiovascular events like myocardial infarction and cerebrovascular accident. Cross linking of adjacent collagen fibers by advanced glycation end products also results vascular stiffness. Speed of travel of pulse wave is known pulse wave velocity and is associated with stiffness of arteries. Stiffness of the arteries compromise windKassel effect of the arteries which is responsible for steady flow. Increased stiffness results left ventricular hypertrophy and endothelial dysfunction. Stiff arteries results increased pulse wave velocity and reflected wave arrival early in systole thereby increasing load on the heart. The measurement of carotid to femoral pulse wave velocity (Pwv) is considered the gold standard method for arterial stiffness assessment in daily practice because of its easy use, low cost, and high reproducibility [1]. There are no population-based studies that evaluate arterial stiffness from populations of Nellore in Andhrapradesh state. At present, there are no reference values of PWV based on healthy normotensive Andhrapradesh population studies involving adolescents, young adults, and older people that take into account factors influencing PWV values such aging.

The aim of this current study was to establish standard ranges of Pwv and AoAix in rural population population without any ECG changes and also to setup normal ranges of Pwv and AoAix in rural population according to age.

METHODOLOGY

Research approach: Quantitative Approach
Research design: Descriptive design

Sample: 20-60yrs of age people who fulfill the inclusive criteria

Sample size: 1235 samples were selected from rural areas of Nellore district.

Sampling technique: Convenience sampling technique.

Inclusion criteria: 20-60yrs of age.

Exclusion criteria: below 20yrs and above 60yrs and with acute illness.

Demographic data including age, Smoker, BMI (Asian guidelines), and known hypertensive, diabetic, hyperlipaedemic are assessed. Augumentation index (AOX) and Pulse wave velocity (PWV) measured based on Periscope report. Reference values of PWV come mostly from multicenter registries [22].

Table-1: Staging of the blood pressure According to Indian Hypertension Guidelines-III (IHG-III)

Category	Systolic (mm Hg)		Diastolic (mm Hg)
Optimal**	<120	and	<80
Normal	<130	and	<85
High-normal	130-139	or	85-89
Hypertension***			
Stage 1	140-159	or	90-99
Stage 2	160-179	or	100-109
Stage 3	>180	or	>110
Isolated systolic hypertension			
Grade 1	140-159	and	<90
Grade 2	>160	and	<90

*Not taking antihypertensive drugs and not acutely ill. In addition to classifying stages of hypertension on the basis of average blood pressure levels, clinicians should specify presence or absence of target organ disease and additional risk factors.
**Optimal blood pressure with respect to cardiovascular risk is below 120/80 mm Hg. However unusually low readings should be evaluated for clinical significance.
***Based on the average of two or more blood pressure readings taken at least on two visits after an initial screening.

RESULTS

With regard to age, 24.2% were between 20-30 years, 7.7% were between 31-40 years, 22.5% were between 41-50 years and 35.6% were between 51-60 years.

In association to habits 7.3% had habit of smoking and 3.4% had habit of tobacco.

Regard to Body Mass Index in rural areas, among 644 samples**,** 5.7% were under weight, 41.9% were normal weight, 16.1% were overweight and 36.3% were obese.

In % distribution of HTN in Rural areas, among 1235 samples**,** 24.9% were Optimal, 21.4% were normal,19.2% were High normal and 12.1% were Stage-1, 5.2% were Stage-2, 2.7% were Stage-3 and 10.9% were Grade-1Systolic hypertension and, 3.6% were Grade-2.

In context to fasting plasma glucose, among 1235 samples, 60% had Normal glucose profile, 31.8% had increased glucose profile and 8.3% had decreased. According to WHO normal FPG is below 110 mg dl, impaired fasting glucose 111-125mg and Diabetic state is above 126 mg/dL.

In association total Cholesterol, out of 1235 samples, 68.5% had normal cholesterol and 31.5% had increased cholesterol. In association to LDL cholesterol, out of 1235 samples, 82.8% had normal LDL cholesterol and 17.2% had increased LDL cholesterol. In relation to VLDL out of 1235 samples, 73.8% had normal VLDL, 24.8% had increased VLDL and 1.4% had decreased VLDL levels. Concerning triglycerides (TGL) out of 644 samples, 63.2% had normal triglycerides 35.3% had increased triglycerides and 1.4% had decreased triglyceride levels. HDL normal in 36.9% and decreased in 55.6% of subjects

Pwv and AoAix

Out of 1235 samples 46.1% had Normal AO AIX, 13.2% had Borderline AO AIX, 14.3% had Mild AO AIX, 11.2% had Moderate AO AIX, 4.5% had High AO AIX, and 10.6% had Very High AO AIX.

Out of 1235 samples, 57.6% had normal pulse wave velocity, 7.45% had Borderline pulse wave velocity, 8.7% had mild Borderline pulse wave velocity, 9.6% had moderate Borderline pulse wave velocity, 5.7% had high Border line pulse wave velocity, and 11% had very high aortic stiffness.

Table-2: Description of clinical parameters of the rural population of Nellore district

Variable	Mean (Range)
Age (years)	36.4 ± 20.8 (range: 20–60)
BMI (kg/m^2)	23.84 ± 4.25
SBP (mmHg)	119.85 ± 18.21 (range: 90–139)
DBP (mmHg)	72.65 ± 7.95 (range: 55–90)
MAP (mmHg)	86.95 ± 9.12 (range: 64.5–107.2)
Total blood cholesterol (mg/dL)	178.5 ± 28.2 (range: 120–210)
Serum triglycerides (mg/dL)	122.5 ± 25.9 (range: 80–168)
Blood sugar (mg/dL)	85.2 ± 15.2 (range: 65–195)

Out of 1235 samples 57.6% had normal pulse wave velocity, 7.45% had Borderline pulse wave velocity, 8.7% had mild Borderline pulse wave velocity, 9.6% had moderate Borderline pulse wave velocity, 5.7% had high Border line pulse wave velocity, and 11% had very high aortic stiffness.

Table-3: Distribution of pulse wave velocity (Periscope) in urban population

Sl.no	Pulse wave velocity	Percentage
1	Normal	57.6%
2	Border line	7.45%
3	Mild	8.7%
4	Moderate	9.6%
5	High	5.7%
6	Very High Aortic stiffness	11%
7	Severe	9.1%
	Total	**100%**

Table-4: Distribution of AOIX (Augmentation index) in rural population

Sl No.	Periscope report	Percentage
1	Normal AO AIX	46.1%
2	Border line AO AIX	13.2%
3	Mild AO AIX	14.3%
4	Moderate AO AIX	11.2%
5	High AO AIX	4.5%
6	Very High AO AIX	10.6%
7	Severe	8.6%
	Total	**100%**

DISCUSSION

Cardiovascular health is the determinant of overall health and well being [2]. Arterial stiffness is a parameter determining vascular health and a predictor of cardiovascular disease. Pulse wave velocity (Pwv) and augmentation index are markers of arterial stiffness. Pwv and AIx have predictive values for cardiovascular morbidity and mortality and gaining popularity to seek for beyond brachial blood pressure (bBP) cardiovascular testing [3]. Age, anthropometric measures, ethnicity, and blood pressure are confounders affecting PWV and Aix [4-11]. Hence, before using these validated and potential tools, normative studies are needed. We aimed to establish reference values of rural population at our district setup.

Age was found to be the most significant parameter affecting Pwv and AIx. Values showed a trend of increase across all age group decades from 20 to 60 years, in line correlating with most of the previous studies [11-15]. Across all age groups, Pwv showed more significant increase than AIx. It can be explained by altered elastin to collagen ratio with aging in aorta with reduction in compliance and giving stiffness [16]. Our study showed that AIx increases more steeply with age than PWV in younger individual and PWV changes markedly with age in older individuals. This can be due to the method used by previous studies which did not measure PWV of study individuals. Hence, age should be accounted as the prime factor while interpreting results of these two parameters.

Apart from age and gender, Pwv was significantly predicted by BMI and SBP; and AIx was significantly predicted by BMI. These reports were supported by previous studies [11-14]. Stiffness increases with obesity, so BMI is a predictor of PWV. Similarly, SBP, an indicator of decreased compliance, was positively affecting PWV in study individuals.

Diabtes & Pwv

Among adults with normal FPG levels shows, Normal Pwv 39.7%, Border line Pwv are 4.7%, Mild

4.2%, Moderate Pwv are 5.4%, High Pwv are 3.2%, Very High Pwv are 0.7% and Severe increase in Pwv are 4.2%. In the adults with Increased FPG levels shows, Normal Pwv are 15.6%,Border line Pwv are 1.7%, Mild Pwv are 3.4%, Moderate Pwv are 2.8%, High Pwv are 2.7%, Very high Pwv are 1.2% and Severe increase in Pwv are 3.2% and in the adults with Decreased FPG levels shows, Normal Pwv are 4.4%, Border line Pwv are 0.5%, Mild Pwv are 0.8%, Moderate Pwv are 0.8%, High Pwv are 0.5% and Severe increase in Pwv are 0.5%.

Diabetes & Ao Aix

Among adults with normal FPG levels shows, Normal Ao Aix are 32.3%, Border line Ao Aix are 6.9%, Mild Ao Aix are 8.9%, Moderate Ao Aix are 6.4%, High Ao Aix are 1.8%, Very High Ao Aix are 1% and Severe increase in Ao Aix are 4.9%.

In the adults with Increased FPG levels shows, Normal Ao Aix are 3.5%,Border line Ao Aix are 5.2%, Mild Ao Aix are 5%, Moderate Ao Aix are 3.5%, High Ao Aix are 2.8%, Very high Ao Aix are 1% and Severe increase in Ao Aix are 1.2% and in the adults with Decreased FPG levels shows, Normal Ao Aix are 11.6%, Border line Ao Aix are 1%, Mild Ao Aix are 0.8%, Moderate Ao Aix are 1.2% and Severe increase in Ao Aix are 1%.

Hypertension and AI

Majority were having normal BMI in both hypertensive (10.20%) and Non hypertensives (32.87%).

The adults with 12.2% DM and 27.9% DM+HTN are Normal Ao Aix, the adults with 4.1% DM, and 8.8% DM+HTN are having Borderline Ao Aix, the adults with 4.8% DM and 10.2% DM+HTN are having Mild Ao Aix, the adults with 2.8% DM, and 10.2% DM+HTN are having Moderate Ao Aix, the adults with 1.4% DM, and 6.8% DM+HTN are having High Ao Aix, the adults with 3.4% HTN are having Very high Ao Aix and the adults with 2.7% DM, and 3.4% DM+HTN are having Severe increased in Ao Aix.

Smoker & AI

46.5% smokers had Normal AOAIX, 13.4% smokers had Borderline AOAIX, 14.6% smokers had Mild AOAIX, 11.0% smokers had Moderate AOAIX, 4.6% smokers had High AOAIX, 1.9% smokers had Very high AOAIX and 8.1% smokers had Severe AOAIX.

Smoker & PWV

58.4% smokers had Normal, 7.2% smokers had Borderline, 8.8% smokers had Mild, 9.7% smokers had Moderate, 5.7% smokers had High, 1.7% smokers had Very high and 8.4% smokers had Severe increased in PWv.

BMI & Pwv

Hypertension is observed in 5.506% of underweight of people and 27.29% of obese persons.

In Underweight Category, the adults falls under Normal Pwv are 3.9%, Border line Pwv are 0.6%, Mild Pwv are 0.4%, Moderate Pwv are 1.3%, High Pwv are 0.6%, Very High Pwv are 0.3% and Severe increase in Pwv are 1.2%.

In normal Category, the adults falls under Normal Pwv are 21.6%, Border line Pwv are 2.0%, Mild Pwv are 3.6%, Moderate Pwv are 2.3%, High Pwv are 1.6%, Very High Pwv are 0.7% and Severe increase in Pwv are 4.3%, in overweight, the adults falls under Normal Pwv are 8.4%, Border line Pwv are 1.9%, Mild Pwv are 1.9%, Moderate Pwv are 1.79%, High Pwv are 1.0%, Very high Pwv are 0.1% and Severe increase in Pwv are 0.9%.

In Obese Category, the adults falls under Normal Pwv are 58.4%, Border line Pwv are 7.2%, Mild Pwv are 8.8%, Moderate Pwv are 9.7%, High Pwv are 5.9%, Very High Pwv are 1.7%, and Severe increase in Pwv are 8.4%.

BMI & Aix

In Underweight Category, the adults falls under Normal Ao Aix are 3.7%, Border line Ao Aix are 0.9%, Mild Ao Aix are 0.9%, Moderate Ao Aix are 1.0%, High Ao Aix are 0.4%, Very High Ao Aix are 0.4% and Severe increase in Ao Aix are 0.9%, in Normal Category the adults falls under Normal Ao Aix are 0.3%, Border line Ao Aix are 4.9%, Mild Ao Aix are 5.9%, Moderate Ao Aix are 2.5%, High Ao Aix are 2.1%, Very High Ao Aix are 6.1.% and Severe increase in Ao Aix are 2.6%, in overweight, the adults falls under Normal Ao Aix are 7.1%, Very High Ao Aix are 0.7% and Severe increase in Ao Aix are 3.3%, in Mid AO AIX Category the adults falls under Normal Ao Aix are 6.8%, Border line Ao Aix are 2.9%, Mild Ao Aix are 3.2%, Moderate Ao Aix are 1.6%, High Ao Aix are 0.7% and Severe increase in Ao Aix are 0.9%. And in Obese Category the adults falls under Normal Ao Aix are 19.6%, Border line Ao Aix are 4.8%, Mild Ao Aix are 4.5%, Moderate Ao Aix are 5.8%, High Ao Aix are 1.3%, Very High Ao Aix are 0.7% and Severe increase in Ao Aix are 3.0%.

PWV and AIx correlated with each other with varying significance and age group difference. Before 50 years, there is accelerated AIx due to early wave reflection and unchanged incident wave; and after 50 years, there is accelerated PWV due to amplified incident wave [11]. However, our observations are in line with Mitchell *et al*., [17] who found no change in wave reflection up to 60 years. AIx and PWV cannot be used interchangeably as evidenced by a study showing the different effect of nitroglycerine on both [18]. Even in our study apart from age, predictors were not similar

for both. PWV is true indicator of aortic stiffness while AIx is more an indicator of wave reflection than stiffness. Hence, measurement of both offers an advantage which possible with precision by PWA.

Arterial stiffness is the earliest manifestation of anatomical or physiological vessel wall disease [19]. It develops in arteries where atherosclerosis is low and even in population with low risk of atherosclerosis. It has prognostic implications with reference to cardiovascular events in diagnosed individuals relation with HTN; and is important for risk stratification [20-22]. With aging from 20 to 80 years, bBP increases only 25% while Pwv increases 200%. Normotensive individuals with increased arterial stiffness are at risk of future cardiovascular events. Our previous study supports the statement [23]

CONCLUSION

This research is the first population-based study of an rural population in Nellore district, Andhrapradesh that provides normal values of the pulse wave velocity in rural population. Our data provide relevant clinical information to daily clinical practice setting with PWV cut-off values for each age group with the CI 95%. Moreover, a significant increase in the PWV growth rate after the fourth age decade was confirmed. This supports the idea for an increase in the cardiovascular risk accompanying the ageing process.

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