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Original Research Article

Correlation of obesity indices with QTc interval and Ankle Brachial Index in young adult population

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ABSTRACT

Background: In recent times, obesity has acquired an epidemic status world over and in India. The association of obesity with vulnerability to cardiovascular ailments and peripheral vascular disease are well defined. The present study was designed to correlate between chosen obesity indices with electrocardiographic variables, Ankle brachial index(ABI) and systolic and diastolic blood pressure in asymptomatic young adults.
Materials and Methods: A cross-sectional study performed on 100 subjects, with equal number of male and female participants. Blood pressure, Electrocardiogram, pulse rate were recorded in the participants after resting for ten minutes. Waist circumference, hip circumference, height and weight were measured using standard protocols defined by WHO. Student's t test, ANOVA test and Pearsons correlation test were used to find the significance.
Results: Among the randomly selected 100 subjects, 46% of male and female subjects were in the obese category (Body Mass Index >25.0). Almost 38% of male and 60% of female subjects had a Waist circumference more than the cut-off value. 28% of male and 88% of female subjects were found to have a Conicity Index (CI) more than the cut-off value. Leftward shift of the mean QRS axis correlated significantly with increasing obesity indices in both sexes. A persistent increase in systolic and diastolic blood pressure was observed among obese individuals. Results in male subject show that CI correlated with QTc interval (r=0.71; p=0.001) and diastolic blood pressure (r=0.32; p=0.02). Results among female subjects show that BMI correlated significantly with systolic(r=0.34; p=0.01) and diastolic blood pressure (r=0.35;p=0.01), WC positively correlated with systolic blood pressure(r=0.32; p=0.02) and there was a significant negative correlation between WC and ABI (r= -0.42; p=0.002) and CI correlated negatively with ABI (r= -0.36; p=0.01).
Conclusion: Abdominal obesity is increasingly prevalent among young adults. The measurement of ankle-brachial index by using oscillometric blood pressure instrument can be used in primary health centers and relatively unequipped clinics for provisional diagnosis of Peripheral arterial disorder and related disorders.

1. Introduction

In recent times, obesity has acquired an epidemic status world over and in India. World Health Organisation (WHO) defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health. National Family Health survey 4 (NFHS-4) 2015-2016 reports that 19% and 21% of men and women in the age group of 15-49 years are obese.[1] An ICMR-INDIAB study states the prevalence rate of obesity and central obesity in the range of 11.8% to 31.3% and 16.9% to 36.3%.[2] This does not bode well for us, considering the high risk of lifestyle diseases it renders one susceptible to. While, at its core, it is a disease of calorific imbalance, the intricacies of its pathogenesis are debatable. From hormonal and neural mechanisms to gut microbiota, several culprits have been implicated. Genetics and epigenetics have been

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assuming prominence in the etiology of obesity in recent times.[3] Obesity is associated with diabetes, atherosclerosis, hypertension, metabolic syndromes and with vulnerability to cardiovascular ailments and peripheral vascular disease.[4] Among the various risk factors associated with coronary mortality in the Framingham study, obesity is an important independent risk factor.[5]

Various anthropometric measures like Body mass index (BMI), Waist hip ratio, Waist Circumference (WC) and Conicity Index (CI) are used in measuring total body fat and abdominal adiposity. Asian Indians phenotype with a greater abdominal obesity in spite of having a lower body mass index have been found to be more prone to diabetes, coronary artery disease than Caucasians.[6] Data from studies suggest that the cut-offs for defining overweight and obesity need to be different for Asian Indians, as they tend to develop obesity related co-morbidities at lower levels of BMI.[7] BMI is the most researched measure of generalised obesity and we have used the cut-off values as defined for Asian Indian population.[8] A higher BMI has shown correlation with the biochemical measures of obesity, such as raised blood cholesterol and triglycerides. Abdominal obesity is associated with various metabolic risk factors and studies have shown this association is stronger than generalised obesity for both cardiac factors as well as peripheral vascular diseases. WHO guidelines mention that WC, WHR are found to be superior to BMI in reflecting abdominal obesity.[9] A meta regression analysis of studies on WC and WHR as predictors for cardiovascular events, proved that both WC and WHR are associated with cardiovascular disease.[10] An Indian study found the prevalence of abdominal obesity by using WC were 46% in men and 64% in women.[11] They had used the cut off points recommended by WHO expert on obesity in Asian and Pacific population that is 90cm for men and 80 cm for women. Conicity index (CI) is another important measure of abdominal adiposity. It has a built-in adjustment of waist circumference for height and weight and has been found equivalent to other indices in predicting metabolic and cardiovascular anomalies.[12]Conicity index assigns a value that suggests where the shape of a body lies, ranging from a cylinder to a cone. A given conicity index serves as the multiplier to the circumference of a cylinder with the height and weight of the individual, to give the actual waist circumference of the person, which renders them "conical".[13] Almeida in his study has reported a cut-off point for CI as 1.25 as indicator for increased incidence of cardiovascular risk factors and CI had the highest sensitivity and specificity for the same. The cut-off points for conicity index as a high coronary risk among Brazilian adult men and women were 1.25 (73.91% sensitivity, 74.92% specificity) and 1.18 (73.39% sensitivity, 61.15% specificity) respectively.[14]

Obesity is known to cause various changes in the heart like left atrial and left ventricular enlargement, diastolic dysfunctions along with atrial and ventricular repolarization abnormalities. Electrocardiographic changes have been correlated with obesity, even in asymptomatic young adults in many studies. This correlation points to some degree of causation being established, since reduction in obesity has been seen to reverse the ECG changes, although reversal is more marked for shift in axes than durations. Even in non-obese persons, it has been observed that an increasing BMI influences these changes.[15] QRS duration, QT interval, and QTc are the most widely studied ECG parameters with regard to obesity. Ventricular arrhythmia and sudden cardiac arrest are known to occur with prolonged QT interval. The QT and QTc are found to be prolonged in obese subjects due to an autonomic dysfunction with a sympatho-vagal imbalance. QTc prolongation has been correlated with cardiac risk even in young, healthy adults.[16] Very few studies establishing the same have been conducted on women. Abdominal obesity has been correlated with a longer QRS duration as well as a shift in QRS axis, independent of age, sex, and ethnicity. General obesity also shows a linear correlation with these attributes.[17] P wave indices, especially prolonged PR interval has been widely accepted as a marker of atrial fibrillation, which may have fatal complications.[18]

Peripheral artery disease(PAD), an important component of the cardiovascular triad has been linked with obesity as one of its risk factors. Ankle brachial index(ABI) is an indicator of atherosclerosis and can serve as prognostic marker for cardiovascular events. In fact, it has been shown to predict angiographically observable PAD with 95% accuracy.[19] The normal cut-off values for ABI are between 0.9 and 1.4. Gold standard for measuring ABI is doppler, but many studies have shown that using an automated oscillometric blood pressure device can be a simple, accurate method to estimate the ABI with minimal training.[20] The high leptin concentration in obese individuals has particularly been held accountable for the vascular anomalies indicated by ABI.[21] While this index has been a remarkably good indicator for the middle aged and elderly, there aren't significant studies proving the same in young adults.

In our study, we have tried to correlate chosen obesity indices(BMI, WC, CI) with easily measured cardiovascular risk parameters- QTc interval and other ECG variables, Ankle brachial index and Blood pressure and their effectiveness as indicators of these risks in young, asymptomatic adults.

2. Materials and Methods

This cross-sectional analytical study was conducted for a period of two months in the department of physiology, Rural Medical College, Loni. Institutional Ethical clearance was obtained before the start of the study. (RMC/UG-PG /2019/04) After informing the subjects on the objectives of the study, and obtaining a written consent, the study was performed on 100 young adults of both sexes (50 each). Young adults in age group 18-26 years and willing to participate were included in the study. Subjects who were symptomatic/on medication for any of the following systemic illnesses like hypertension, diabetes, cardiac diseases, bronchial asthma, allergic disorders were excluded. Subjects indulging in any form of substance abuse and taking medication for any psychiatric illness were also excluded from the study.Various electrocardiographic variables, systolic and diastolic blood pressure and ankle brachial index were compared with obesity indices like BMI, WC and CI in all the subjects.

2.1. Anthropometric measurements

BMI was calculated as body weight in kilograms divided by body height in meter square. Standing height was measured using a wall mounted stature meter with the shoes removed and recorded to the nearest 0.1 cm. Weight was recorded using a digital weighing machine with the subject wearing light clothes and shoes off. Waist circumference (WC) was measured in standing posture using a stretch resistant tape at the midpoint between the lower margin of least palpable rib and top of the iliac crest at the end of normal expiration. CI was calculated using Valdez equation which uses weight (kg), height (m), WC(m) as follows:

$$\frac{Waist\ circumference\ (m)}{\sqrt{0.109\ x\ \sqrt{weight(kg)/height(m)}}}$$

2.2. Operational definitions

According to BMI, subjects were divided into 3 groups: Group I (18.0 -22.9 kg/m^2), Group II (23.0-24.9 kg/m$^{2)}$ Group III (>25 kg/m^2). The cut-off for WC was $\geq$ 90 cm in case of males and $\geq$ 80 cm in case of females to define abdominal obesity. The cut-off used for Conicity Index was $\geq$ 1.25 in case of males and $\geq$ 1.18 for females.

2.3. Blood pressure recording and ankle brachial index

All participants were rested for ten minutes before blood pressure measurement. Blood pressure was measured in all the four limbs starting from the right arm, right leg, left leg and left arm using a standard automated blood pressure cuff system. (Omron automatic Blood Pressure monitor) By using appropriate cuff size, blood pressure was repeated in all four limbs, whenever there was an error or difference of more than 10mm while recording. The ABI for each lower limb was calculated as the ankle systolic blood pressure divided by the highest of the two brachial systolic blood pressures.

2.4. Electrocardiography

The subjects rested for five minutes in supine position. Twelve lead electrocardiogram was performed with the paper speed of 25 mm/sec and amplitude of 10mm/mV. Heart rate, QRS duration and amplitude, PR interval, QT interval, QRS axis was measured. Corrected QT interval was calculated using Bazett's formula:

QTc = QT/± RR.

2.5. Statistical analysis

Results were expressed as mean and SD. Student's t test was used for analyzing parametric variables. For comparison of variables among more than two groups, ANOVA test was done. Pearson's correlation coefficient test was used to analyze correlation of parametric data. A p value of<0.05 was considered as significant. The data was analyzed using the SPSS software version 22.

3. Results

Data of 100 young adults (50 male and 50 female subjects) were completed and included in the final analysis of the study. The mean age of female and male subjects was 20.4years and 21.02 years respectively. The mean BMI, WC, CI were 24.08 ± 3.70, 86.09 ± 10.61, 1.25± 0.088 among the participants. Figure 1 shows the distribution of obese (BMI>25.0), Waist circumference, Conicity index among subjects(n) above the cut off point. Table 1 shows that there was a significant difference in the body mass index, waist circumference, and conicity index between the groups. Table 2 shows there was a statistically significant difference in QRS axis among male subjects (p <0.05). Systolic and diastolic blood pressure showed statistically significant increase in group III when compared to group I with respect to BMI. With respect to WC and CI there is an increase in systolic and diastolic blood pressure among subjects who have a higher cut off value (Tables 3 and 4). In Table 5, results among males show that BMI correlated positively with ABI (r=0.38; p=0.01), CI correlated with QTc interval (r=0.71; p=0.001)and diastolic blood pressure (r=0.32; p=0.02). Results among female subjects (table 6) show that BMI correlated significantly with systolic(r=0.34; p=0.01) and diastolic blood pressure (r=0.35;p=0.01), WC positively correlated with systolic blood pressure(r=0.32; p=0.02) and there was a significant negative correlation between WC and ABI (r= -0.42; p=0.002) and CI correlated negatively with ABI (r= -0.36; p=0.01).

4. Discussion

The relationship between various adiposity parameters with electrocardiographic variables, blood pressure and ankle brachial index were attempted in asymptomatic 100 young adults. Among the randomly selected 100 subjects, 46%

Table 1: Anthropometric measurements of the subject and comparison of adiposity indices between groups

Variable	Group I (Mean± SD) BMI 18.0 -22.9 kg/m^2		Group II (Mean ±SD) BMI 23.0-24.9 kg/m^2		Group III (Mean ±SD) BMI >25 kg/m^2		p value
	M-16	F-24	M-11	F-12	M-23	F-14	
Height(cm)	1.74±0.06	1.59±0.07	1.74±0.08	1.59±0.08	1.73±0.07	1.63±0.06	<0.0001*
Weight(kg)	62.56±6.52	52.16±6.48	73.81±7.96	60.39±6.67	82.04±7.10	77.46±9.95	<0.0001*
BMI (kg/m2)	20.53±1.59	20.53±1.58	24.15±0.64	23.82±0.58	27.39±2.02	28.89±2.53	<0.0001*
WC (cm)	76.36±6.50	77.03±6.78	86.32±7.43	87.43±3.80	93.64±6.31	98.96±7.54	<0.0001*
CI	1.17±0.07	1.23±0.08	1.22±0.09	1.30±0.05	1.24±0.06	1.32±0.06	<0.0001*

*Significant, BMI: Body Mass Index, WC: Waist Circumference, CI: Conicity Index, SBP:Systolic Blood Pressure, DBP: Diastolic Blood Pressure, ABI: Ankle BrachialIndex.

Table 2: Comparison of electrocardiographic variables, blood pressure and ankle brachial index among the three groups based on BMI

Parameter	Group I		Group II		Group III		p value	
	M -16	F -24	M -11	F -12	M -23	F-14	M	F
RR interval	0.78±0.11	0.76±0.10	0.77±0.12	0.84±0.23	0.73±0.12	0.79±0.11	0.06	0.81
PR interval (sec)	125.38±34.19	128.33±31.03	133±21.93	136.17±19.07	145.26±39.60	131.92±30.43	0.212	0.735
QRS duration (sec)	101.81±25.08	94.17±13.09	94.01±13.13	90.92±15.66	98.35±13.82	93.29±10.97	0.97	0.678
QTc(sec)	377.78±32.36	396.93±30.31	365.89±24.7	390.63±43.86	371.60±41.66	394.34±22.27	0.642	0.857
QRS axis	61±16.62	46.29±16.99	40.09±14.78	35±33.82	39.65±18.88	43.36±24.00	0.001*	0.412
SBP (mm Hg)	116.81±6.74	103.08±9.05	122±13.12	110.58±11.09	120.52±9.17	114.43±14.83	0.329	0.01*
DBP (mm Hg)	74.06±7.46	68.38±7.31	75.45±8.25	71.92±11.10	74±9.08	78.14±10.19	0.88	0.01*
ABI	1±0.06	1.05	1.01±0.05	1.03±0.07	1.04±0.06	1.02±0.056	0.09	0.98

*Significant, BMI: Body Mass Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, ABI: Ankle Brachial Index

Table 3: Comparison of electrocardiographic variables, blood pressure and ankle brachial index among the two groups based on WC

Parameters	WC <90 (in males) WC <80cm (in females)		WC >90cm (in males) WC >80cm (in females)		p value	
	M - 10 Mean ± SD	F- 20	M -40	F-30	M	F
RR interval	0.791±0.119	0.754±0.10	0.876±0.136	0.787±0.11	0.027	0.285
PR interval(sec)	139.19±40.08	129.30±26.64	139.194±40.08	132.20±39.41	0.347	0.559
QRS duration(sec)	102.4±15.90	95.0±13.49	99.48±13.73	93.14±7.86	0.714	0.978
QTc(sec)	378.88±38.26	402.14±27.12	346.79±80.46	389.72±33.47	0.067	0.266
QRS axis	47.87±39.56	45.75±35.28	44.47±24.06	40.76±35.01	0.070	0.428
SBP (mm Hg)	118.48±9.26	102.00±9.16	121.57±9.92	111.70±12.79	0.280	0.004*
DBP (mm Hg)	74.61±7.88	68.85±6.26	73.89±9.06	74.03±11.31	0.802	0.056
ABI	1.00±0.06	1.06±0.06	1.04±0.06	1.02±0.06	0.110	0.013*

*Significant, WC: Waist Circumference, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, ABI: Ankle Brachial Index

of male and female subjects were in the obese category (BMI>25.0). Almost 38% of male and 60% of female subjects had a WC more than the cut off value. Twenty eight percent of male subjects were found to have a CI of more than 1.25 while 88% of female subjects had CI more than 1.18. A leftward shift of the mean QRS axis occurred with increasing fatness in both men and women participants. This association was confined to the range of normal QRS axis. There was a persistent increase in systolic and diastolic blood pressure as the BMI increased and in subjects having WC, CI more than the cut-off point. Results in male subject show that BMI correlated positively with ABI, CI correlated with QTc interval and diastolic blood pressure. Among Female participants BMI correlated significantly with systolic and diastolic blood pressure, WC positively correlated with systolic blood pressure and there was a significant negative correlation between WC and ABI and CI correlated negatively with ABI.

Table 4: Comparison of electrocardiographic variables, blood pressure and ankle brachial index among the two groups based on CI

Parameters	CI< 1.25 (in males) CI< 1.18 (in females)		C I >1.25(in males) C I >1.18(in females)		p value	
	M -36	F- 6	M -14	F-44	M	F
RR interval(sec)						
PR interval(sec)	140.06±38.19	145.67±30.74	137.71±23.6	129.05±27.49	0.831	0.176
QRS duration(sec)	50.08±10.16	45.17±9.02	47.79±5.56	47.39±5.56	0.930	0.75
QTc(sec)	373.97±27.24	406.3±28.96	368.08±51.5	393.11±31.70	0.166	0.33
QRS axis	51.72±20.33	44.37±17.27	33.36±20.28	41.77±24.40	0.006*	0.797
SBP (mm Hg)	118.75±10.44	99.5±7.81	122±6.43	109.23±12.32	0.283	0.06
DBP (mm Hg)	72.86	70±7.45	78.14±72.23	72.23±10.20	0.04*	0.608
ABI	1.02	1.07±0.09	1.03±0.049	1.03±0.06	0.62	0.15

*Significant, CI: Conicity Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, ABI: Ankle Brachial Index

Table 5: Correlation between adiposity indices and electrocardiographic variables, blood pressure and ankle brachial index in males

Parameters		RR interval	PR	QRS	Qtc	Qrs axis	SBP	DBP	ABI
BMI	r-value	0.26	0.03	-0.05	-0.12	- 0.16	0.20	0.02	0.38
	p-value	0.06	0.81	0.68	0.38	0.24	0.16	0.88	0.01*
WC	r-value	0.18	0.13	0.006	-0.20	- 0.22	0.27	0.19	0.27
	p-value	0.20	0.36	0.96	0.15	0.108	0.05	0.16	0.05
CI	r-value	-0.01	0.14	0.07	0.71	- 0.26	0.23	0.32	0.21
	p-value	0.93	0.30	0.60	0.0001*	0.068	0.1	0.02*	0.14

*Significant, BMI: Body Mass Index, WC: Waist Circumference, CI: Conicity Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, ABI: Ankle Brachial Index

Table 6: Correlation between adiposity indices and electrocardiographic variables, blood pressure and ankle brachial index in females

Parameters		RR interval	PR	QRS	Qtc	Qrs axis	SBP	DBP	ABI
BMI	r-value	0.03	0.04	-0.005	-0.031	- 0.018	0.34	0.35	0.03
	p-value	0.81	0.74	0.97	0.83	0.89	0.01*	0.01*	0.81
WC	r-value	0.04	0.04	0.006	0.001	0.028	0.32	0.25	-0.42
	p-value	0.73	0.77	0.96	0.99	0.84	0.02*	0.07	0.002*
CI	r-value	-0.03	0.01	-0.05	0.08	- 0.030	0.18	0.02	-0.36
	p-value	0.79	0.94	0.71	0.57	0.83	0.19	0.84	0.01*

*Significant, BMI: Body Mass Index, WC: Waist Circumference, CI: Conicity Index, SBP: Systolic Blood Pressure DBP: Diastolic Blood Pressure, ABI: Ankle Brachial Index

Nicolau et al. in their study had assessed CI, BMI and WC as predictors along with other Coronary artery disease risk factors.[22] BMI is the most widely used index to categories obesity but it is sometimes affected by gender, social and ethnic differences. Many metabolic abnormalities including hyperinsulinemia, increased triglyceride levels, increased resistance to insulin, hypertension are known to be associated with abdominal obesity. Other mechanisms which are attributed to atherosclerosis and abdominal obesity are endothelial dysfunction, abnormal regulation of endocrine, autonomic and immune function due to cytokines secreted by adipose tissues.[23] A higher BMI has shown correlation with the biochemical measures of obesity, such as raised blood cholesterol and triglycerides. Studies involving population from Asian Indian, United States and Europe have suggested that WC alone or along with WHR maybe a better anthropometric marker when compared to BMI for they reflect abdominal fatness more specifically.[24] Electrocardiographic variables like PR interval, QRS interval, QTc are the most widely studied ECG variables in obesity. QTc interval is the time period spanning from depolarization of the ventricle to the end of repolarization, corrected for heart rate. Obesity is one of the known causes for QT interval prolongation. Prolonged QT interval is associated with sudden death and ventricular arrhythmia.[25] In our study, there was no effect of weight gain on QTc. In all the groups, QTc was within the normal value of 450ms in males and 470 ms in females. Erol et al in their study of uncomplicated obesity on QT interval have shown a positive correlation between QTc and both WC and BMI.[17] Girola A et al observed in their study that QTc did not correlate with BMI, WC in uncomplicated

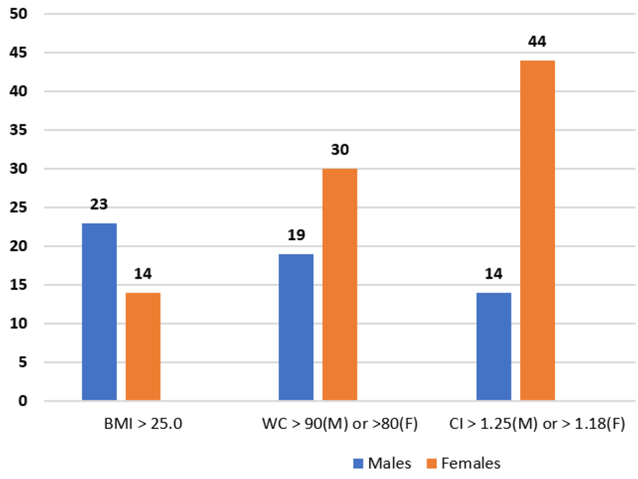

Fig. 1: Distribution of obese (BMI>25.0), waist circumference, conicity index among subjects(n)

obese or overweight individuals.[26] QRS axis deviation is well correlated with increasing fatness. This deviation has been attributed to upward shift of the diaphragm due to abdominal fat, which results in the heart getting pushed to lie in a more horizontal situation. This theory is validated by similar QRS axis shift in pregnant women. Obesity is a strong risk factor for abnormal ABI and an established risk factor for PAD. PAD findings are more common in older people. But atherosclerosis begins in childhood and is known to progress into adulthood due to various factors like increased levels of glucose, blood lipids, body weight, hypertension etc.[27] Ankle brachial index can be used as an indicator of atherosclerosis and can serve as prognostic marker for cardiovascular events. In our study, ABI was within the normal range of 0.9 to 1.3. In a systematic review it was reported that the current available evidence demonstrates that the yield of the ABI screening test in asymptomatic individual will depend on the prevalence of other traditional risk factors.[28] High and low ABI is known to increase the 10-year cardiovascular risk estimates in these individuals.[29] In our study, the average age being 21.50 years and study subjects having no other contributory risk factors, not many changes were observed in ABI reading.

5. Limitations

The study was conducted among asymptomatic young adults (18-25 years). Though studies have advocated that measurement of BP and cholesterol should begin at 20 years and then every 5 years thereafter,[30] except for blood pressure and Qrs axis deviation our study did not show any significant changes in QTc and ABI.While 100 is a significant sample size for a pilot study which we attempted here, grouping according to sex, left 50 to each group. So, there is need for a study focussing with a larger sample size, particularly in females.

6. Conclusion

ECG and oscillometric ankle brachial index can be used as quick, cheap, and convenient methods for assessment of cardiovascular risk patients. By using a digital BP apparatus, primary health care / anganwadi workers if trained correctly can make a provisional assessment of peripheral arterial anomalies in high risk patients who can then be referred to the nearest tertiary healthcare for confirmation of peripheral vascular disease, by using Doppler.

7. Source of Funding

ICMR.

8. Conflict of Interest

None.

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References

1. International institute for Population Sciences (IIPS) and ICF, 2017. National Family Health Survey (NFHS-4), 2015-2016.
2. Pradeepa R, Anjana RM, Shashank R. Joshi et al and the ICMR-INDIAB Collaborative Study Group. Prevalence of generalized & abdominal obesity in urban & rural India- the ICMR - INDIAB Study (Phase-I). *Indian J Med Res*. 2015;142(2):139–50.
3. Zhang H, DiBaise JK, Zuccolo A, Kudrna D, Braidotti M, Yu Y, et al. Human gut microbiota in obesity and after gastric bypass. *Proc Natl Acad Sci*. 2009;106(7):2365–70.
4. Lavie CJ, Milani RV, Ventura HO. Obesity and Cardiovascular Disease Risk Factor, Paradox, and Impact of Weight Loss. *J Am Coll Cardiol*. 2009;53(21).
5. Peter WF, Wilson. Established Risk Factors and Coronary Artery Disease :The Framingham Study. *Am J Hypertens*. 1994;7(7):7–12.
6. Mckeigue P. Coronary heart disease in South Asians overseas: A review. *J Clin Epidemiol*. 1989;42(7):597–609.
7. Misra A, Khurana L. Obesity and the Metabolic Syndrome in Developing Countries. *J Clin Endocrinol Metab*. 2008;93(11):s9–s30.
8. Ravikumar V. Correlation of Adiposity Indices with Electrocardiographic Ventricular Variables and Vascular Stiffness in Young Adults. *J Clin Diagn Res*. 2017;11(6):21.
9. Waist Circumferece and Waist -Hip Ratio: Report of a WHO Expert Consultation, Geneva, 8-11 December 2008.
10. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. Consensus Statement for Diagnosis of Obesity, Abdominal Obesity and the Metabolic Syndrome for Asian Indians and Recommendations for Physical activity, Medical and Surgical Management. *J Assoc Physicians India*. 2009;57(3):163–70.
11. Kurpad S, & Tandon S, & Himanshu, Srinivasan K. Waist circumference correlates better with Body Mass Index than Waist to Hip ratio in Asian Indians. *Natl Med J India*. 2002;16(11):189–92.
12. Gowda V, Philip K. Abdominal volume index and conicity index in predicting metabolic abnormalities in young women of different socioeconomic class. *J Assoc Physicians India*. 2016;5(7):1452–6.
13. Valdez R. A simple model-based index of abdominal obesity. *J Clin Epidemiol*. 1996;44:955–6.
14. Almeida RT, Alemida MM, Araujo TM. Abdominal obesity and cardiovascular risk: performance of anthropometric indexes in women.

Arq Bras Cardio. 2009;92:345–50.
15. Zierle-Ghosh A, Jan A. Body Mass Index(BMI); 2018.
16. Leotta G, Maule S, Rabbia F, Colle SD, Tredici M, Canadè A, et al. Relationship between QT interval and cardiovascular risk factors in healthy young subjects. *J Hum Hypertens*. 2005;19(8):623–7.
17. Arslan E, Yiğiner O, Yavaşoğlu I, Ozçelik F, Kardeşoğlu E, Nalbant S. Effect of uncomplicated obesity on QT interval in young men. *Pol Arch Med Wewn*. 2010;120(6):209–13.
18. Duru M, Seyfeli E, Kuvandik G, Kaya H, Yalcin F. Effect of Weight Loss on P Wave Dispersion in Obese Subjects. *Obes*. 2006;14(8):1378–82.
19. Yao ST, Hobbs JT, Irivne WT. Ankle systolic pressure measurements in arterial disease affecting the lower extremities. *Br J Surg*. 1969;56(9):676–9.
20. Price JF, Stewart MCW, Douglas AF, Murray GD, Fowkes GFR. Frequency of a low ankle brachial index in the general population by age, sex and deprivation: cross-sectional survey of 28980 men and women. *Eur J Cardiovasc Prev Rehabil*. 2008;15(3):370–5.
21. Scarpace1 PJ, Zhang Y. Elevated leptin: consequence or cause of obesity? *Front Biosci*. 2007;12:3531–44.
22. Fontela PC, Winkelmann ER, Viecili PRN. Study of conicity index, body mass index and waist circumference as predictors of coronary artery disease. *Rev Port Cardiol*. 2017;36(5):357–64.
23. Farooqi S, O'Rahill S. Genetics of Obesity in Humans. *Endocrine Rev*. 2006;7(27):710–8.
24. Bajaj HS, Pereira MA, Anjana RM, Deepa R, Mohan V, Mueller NT, et al. Comparison of Relative Waist Circumference between Asian Indian and US Adults. *J Obes*. 2014;doi:10.1155/2014/461956.
25. Leotta G, Maule S, Rabbia F, Colle SD, Tredici M, Canadè A, et al. Relationship between QT interval and cardiovascular risk factors in healthy young subjects. *J Hum Hypertens*. 2005;19(8):623–7.
26. Girola A, Enrini R, Garbetta F, Tufano A, Caviezel F. QT Dispersion in Uncomplicated Human Obesity. *Obes Res*. 2001;9(2):71–7.
27. McMahan CA, Gidding SS, Malcom GT, Tracy RE, Strong JP, and HCM. Pathobiological Determinants of Atherosclerosis in Youth Risk Scores Are Associated With Early and Advanced Atherosclerosis. *Pediatr*. 2006;118(4):1447–55.
28. Leng GC, Fowkes FGR, Lee AJ, Dunbar J, Housley E, Ruckley CV. Use of ankle brachial pressure index to predict cardiovascular events and death: a cohort study. *BMJ*. 1996;313(7070):1440–4.
29. Resnick HE, Lindsay RS, McDermott MM, Devereux RB, Jones KL, Fabsitz RR, et al. Relationship of High and Low Ankle Brachial Index to All-Cause and Cardiovascular Disease Mortality. *Circ*. 2004;109(6):733–9.
30. Zhang Y, Vittinghoff E, Pletcher MJ, Allen NB, Hazzouri AZA, Yaffe K, et al. Associations of Blood Pressure and Cholesterol Levels During Young Adulthood With Later Cardiovascular Events. *J Am Coll Cardiol*. 2019;74(3):330–41.

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