International Journal of Yoga, Physiotherapy and Physical Education
www.sportsjournal.in
ISSN: 2456-5067
Received: 05-05-2023, Accepted: 20-05-2023, Published: 05-06-2023
Volume 8, Issue 3, 2023, Page No. 40-44

Comparison of ankle brachial index between normal BMI and different obesity grades

Rutuja Nakhate[1], Shweta Kulkarni[2]
[1] Intern, Tilak Maharashtra Vidyapeeth's College of Physiotherapist, Pune, Maharashtra, India
[2] Associate Professor, Tilak Maharashtra Vidyapeeth's College of Physiotheraphy, Pune, Maharashtra, India

Abstract
A sedentary lifestyle has caused adverse effects on people's life causing health problems like cardiovascular problems obesity hypertension etc. In is project we are studying the relationship between ABI and different BMI and obesity grades. The ankle brachial index is a simple method used to determine the risk of peripheral arterial disease in people with different body mass index and different obesity groups.
By using simple formula
AIB=highest systolic ankle pressure / highest systolic brachial pressure

Keywords: sedentary, health problems, obesity, relationship, ankle brachial index, peripheral arterial diseases

Introduction

Body-mass index (BMI) is a metric used for defining a measurement and proportion of human body. It is used to classify humans into different categories according to their body mass [7]. BMI is calculated as weight in kilograms divided by height in centimetres (weight in kg/ height in cm). The body-mass index is used to classify overweight and obese population. This method is also used to assess weight loss programs [4].

The body-mass index classification for the Asian population varies from that of the European population. As per the World Health Organisation (WHO), the criteria developed by WHO to measure BMI are not suitable for the Asian population, as the individuals have different associations between BMI, percentage of body fat, and health risks, from the European population. However, there is no precise recommendation for the Asian population [6]. Universal BMI categorization is not suitable among the diverse Asian populations, as Asians display strikingly different obesity-related characteristics [6].

There is significant statistical inverse correlation between BMI and systolic and diastolic blood pressure. Higher BMI is an important risk factor for developing peripheral arterial diseases (PAD) in the general population [1]. PAD is defined as narrowing and blockade of peripheral arteries. A severe manifestation of PAD can cause limb loss, critical limb ischemia, and even death if not treated timely. Previous analyses show that patients with PAD have a high incidence of major cardiovascular events [3]. Obesity may be casually related with PAD after keeping in check underlying health issues like hypertension, hyperglycaemia, and dyslipidaemia. Moreover, it has been researched that patients with PAD have a higher chance of developing major cardiovascular events (CVEs) [4]. Obesity has been recognized as a risk factor for incident CVEs in the general population [9]. According to The Physician's Health Study, cardiovascular risk increases linearly and significantly with higher level of BMI [7].

Classification of BMI [18]

According to the World Health Organisation (WHO), the Asian-BMI classification is divided into normal range, overweight, Obese-I, and obese-II. The WHO recommends BMI value of 23 kg/cm to 25 kg/cm as cut off point as overweight for the Asian population. The population with BMI ranging from 25 kg/cm to 30 kg/cm fall into Obese-I category; whereas the population with BMI higher than 30 kg/cm falls in the obese-II category.

Table 1: Classification of BMI

Nutritional status	BMI
Normal range	18.5- 22.9
Overweight	23- 24.9
Obese-I	25- 29.9
Obese-II	>30

The ankle-brachial index (ABI) has also been called the ankle-arm index, the ankle-brachial blood pressure index, the ankle-arm ratio, or the Winsor Index. The term ABI was recommended by the recent American Heart Association Proceeding on Atherosclerotic Peripheral Vascular Disease. The ABI is the ratio of the systolic blood pressure (SBP) measured at the ankle to that measured at the brachial artery. ABI is an indicator of atherosclerosis at other vascular sites and can be defined as a marker for cardiovascular events. An abnormally elevated ankle brachial index (ABI) has been correlated with increased cardiovascular disease (CVD) risk. The longitudinal relationships of various measures of obesity with an abnormally high-ABI is studied in this project [7].

PAD indicates high-risk of coronary heart disease and stroke. PAD is typically asymptomatic before progressing to clinical stages. ABI is a simple, inexpensive, can diagnose PAD before symptoms, improve prognosis, and can delay further complications [5].

ABI has drawn attention to prognostic marker for cardiovascular events. ABI ranging between 1-1.4 indicates healthy individual, value lower than 1 or less than 0.9 indicates progressive level for developing PAD. ABI is

characterised as low < 0.9, borderline > 0.9, normal 1-1.4, and higher > 1.4 [2].

In order to have accurate ABI the test should be performed with proper equipment's needed for testing ABI and defined protocol. Arm pressure is obtaining by palpating brachial artery, ankle pressure is obtaining by palpating dorsalis pedis pulse located at dorsum of the foot and posterior tibial pulse located behind the medial malleolus. To discard hydrostatic pressure from the ankle on which the test should be performed the patient should be in supine position. As the position is supine the ankle cuff and arm cuff are aligned with the level of right atrium and hydrostatic pressure is assumed to be zero. If the patient is in seated or standing position, there can be error or the false reading of ABI while taking ankle blood pressure. Brachial pressure / Arm blood pressure can be accurate while taken in sitting position [1].

Calculation of ABI patient should be in supine position brachial pressure should be calculated in both the arms by using sphygmomanometer, highest systolic reading obtains by comparing both upper limb is considered as numerator. Ankle pressure it calculated by using same method highest systolic pressure after comparing both lower limb pressure is considered as denominator [11].

ABI= Highest Systolic ankle pressure/ Highest systolic brachial pressure

Higher BMI cause cardio vascular problems, and abnormally elevated ankle brachial index is correlated with increased cardiovascular risk. Aim is to examine relation between different BMI and their ankle brachial index (ABI) [6]. Obesity is major factor leading to high ABI measurement. In this the effect of BMI with correlation with abnormal ABI (low or high ABI) and both factors causing cardio vascular problems. In this we examine how ABI is notably affected by different BMI grades [10].

Sedentary lifestyle in young adults and middle-aged population is seen that is watching television, playing video games, work life of IT workers, causing major health crises obesity. Unhealthy diet like eating junk food which contains high fat sugar and salt more than requirement of our daily body need, various types of fast food such as pizza, burger, cold drink, etc. causing obesity in population [14]. Obesity is one of the number one health problem. Obesity is major risk factor causing cardio vascular disease, coronary artery diseases, peripheral arterial diseases, etc. ABI is one of the simple methods to diagnosis peripheral arterial disease risk and to assess cardiovascular predication in general population [10].

Aim and objectives

Aim

- To study ankle-brachial index in obese population.

Objectives

- To study ankle brachial index in obese population using ABI formula.

Hypotheses

- **Null Hypothesis:** ABI is not affected in obese people.
- **Alternative Hypothesis:** ABI is affected in obese people.

Materials and methodology

- **Materials:** Consent form, cell phone, internet, pencil, laptop, notepad, pen, table, sphygmomanometer.
- **Study design:** Survey based
- **Sampling method:** Convenient
- **Sample size:** 80
- **Target population:** Obese population
- **Study setup:** In a room where a plinth is available, along with digital sphygmomanometer, weighing scale, and stadiometer.

Inclusion and exclusion criteria

- **Inclusion criteria**

1. Population of both genders, male and female.
2. Obese and healthy population.
3. Age group between 18-60 years.

- **Exclusion criteria**

1. Those who are not willing to participate.
2. Population below age group of 18 years and above 60 years.
3. Having underlying diseases.

Outcome measures

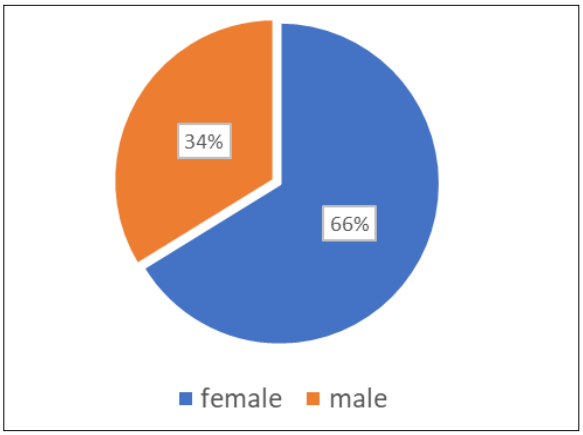
Using ankle-brachial index (ABI).

Result & data analyses

Result 1: gender distribution

Table 2: BMI classification

Nutritional Status	BMI
Normal range	18.5- 22.9
Overweight	23- 24.9
Obese- I	25- 29.9
Obese- II	>30



Graph 1.1

Interpretation

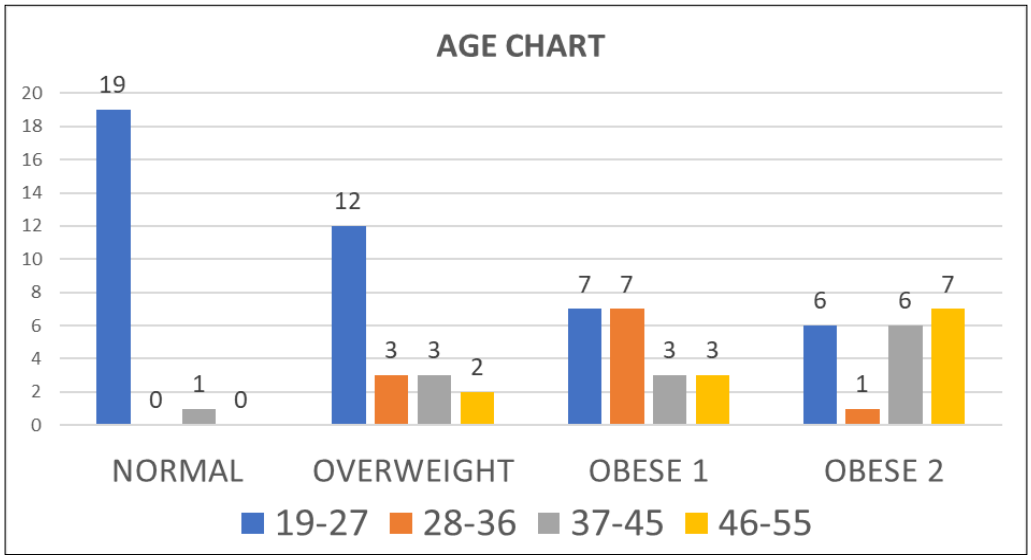
Graph 1.1 shows that in this study

- 34% of the participants were male.
- The remaining 66% of the participants were female.

Result 2: age chart

Table 3: BMI distribution of the population

Age group	Normal	Overweight	Obese I	Obese II
19- 27	19	12	7	6
28- 36	0	3	7	1
37- 45	1	3	3	6
46- 55	0	2	3	1



Graph 1.2

Interpretation

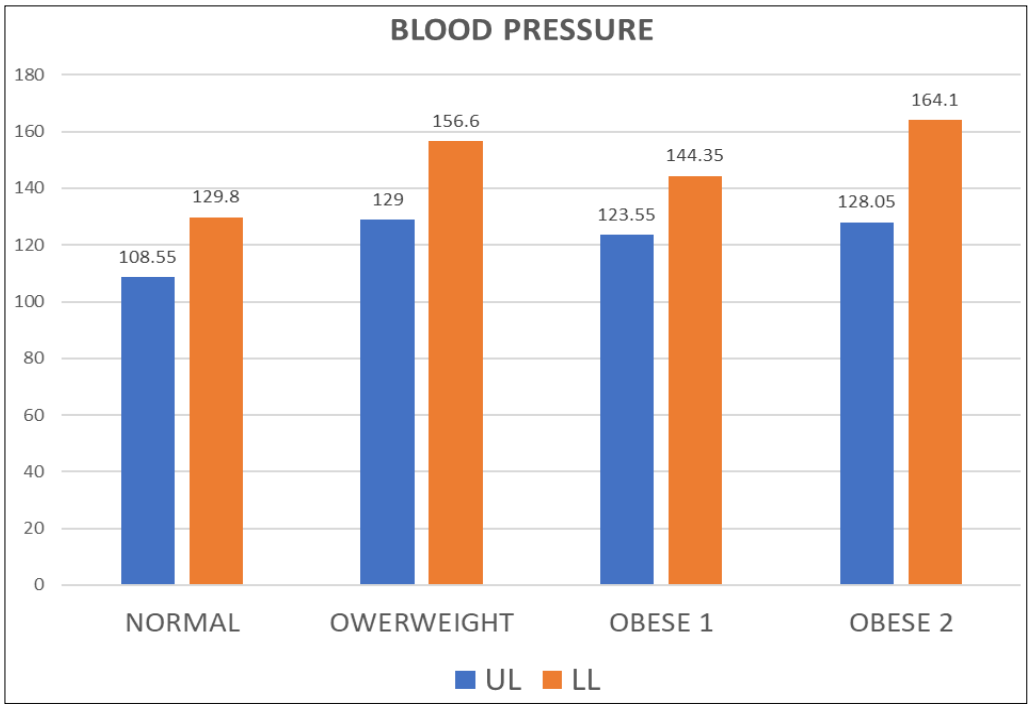
Graph 1.2 shows that

- Between the ages of 19-27 years: 43% were normal, 27% were overweight, 16% were obese I, and 14% were obese II.
- Between the ages of 28-36 years: 0% were normal, 27% were overweight, 64% were obese I, and 9% were obese II.
- Between the ages of 37- 45 years: 8% were normal,23% were overweight, 23% were obese I, and 46% were obese II.
- Between the ages of 46- 55 years: 0% were normal, 17% were overweight, 25% were obese I, and 58% were obese II.

Result 3: blood pressure

Table 3: UL and LL blood pressure in the population

Blood Pressure	Upper Limb	Lower Limb
Normal	108.5	129.8
Overweight	129	156.6
Obese I	123.55	144.35
Obese II	128.05	164.1



Graph 1.3

Interpretation

Graph 1.3 shows that

- Blood pressure for Normal UL was 46% and for LL 54%.
- Blood pressure for Overweight UL was 45% and for LL 55%.
- Blood pressure for Obese I UL was 46% and for LL 54%.
- Blood pressure for Obese II UL was 44% and for LL 56%.

Mean: 135.5± 18.26

Result 4: comparison of ABI & BMI

Table 4: p-value

Particulars	Mean ± SD
ABI	1.20 ± 0.06
BMI	26.85± 5.76
p-value	0.06

Discussion

The purpose of this study was to understand the association of ABI between different BMI grades among the population. The study has a total of 80 participants, of which 27 are male and 53 are female (as shown in Graph 1) [3].

Sedentary lifestyle has been gradually increasing over the years. Sedentary lifestyle is defined as an individual taking less than 5000 steps per day [12]. Greater BMI is a risk factor for developing peripheral arterial diseases (PAD). PAD is a disorder characterized by decreased blood flow to the limbs, due to an obstruction or narrowing of the vessel tributaries. The occurrence of PAD increases with age and increase in life expectancy, leading to increased number of people living with PAD, especially among those over the age of 80 [8].

PAD is exceedingly common in selected risk population but diagnosis of PAD is not established promptly. So specific diagnostic approach to obtain accurate diagnosis should be used by clinicians. The ABI test widely used to detect PADs by a diverse range of practitioners. It is a sensitive and cost-effective screening tool for PAD [3]. In comparison with other diagnostic methods, ABI is superior because it is a simple, non-invasive test, and can be determined in routine check-ups. The normal range for ABI is between 0.9 and 1.4. An abnormal ankle-brachial index- below 0.9 is an influential indication of cardiovascular risk [2]. ABI values above 1.3-1.4 correlate with major adverse cardiovascular events.

Table 5: Interpretations and Recommendations of various ABI values [19]

ABI value	Interpretation	Recommendation
>1.4	Calcification/ Vessel hardening	Refer to vascular specialist
1-1.4	Normal	None
0.9-1	Acceptable	None
0.8-0.9	Some arterial disease	Treat risk factors
0.4-0.8	Moderate arterial disease	Refer to vascular specialist
<0.4	Severe arterial disease	Refer to vascular specialist

ABI between 0.4 to 0.9 is considered as mild to moderate PAD, and ABI of less than 0.4 is considered as severe PAD. The ABI value of less than 0.9 is strongly associated with other cardiovascular risk factors and with PAD occurrence. ABI values greater than 1.4 are considered abnormal, but it is not necessarily a diagnostic of peripheral arterial disease. Here, the pedal arteries are stiff and cannot be compressed by the blood pressure cuff [1].

For taking ABI measurement, the patient should be in supine position after five minutes of rest. A cuff is placed around the ankle for measurement of both dorsalis pedis and posterior tibial arteries using a digital sphygmomanometer, and the highest systolic pressure in one of the limb is noted. Same technique is used for both the arms for measuring brachial artery pressure. The higher of the two ankle pressures is divided by the brachial pressure. Thus, the PAD severity is assessed according to the levels of ABI [13].

ABI is calculated by dividing higher systolic blood pressure measured in the ankle by the higher systolic pressure in the brachial artery [11]. There is an inverse correlation between BMI, diastolic and systolic blood pressure. The risk of peripheral arterial diseases increases in patients with higher BMI. PAD is defined as blockade of peripheral arteries. Previous analyses show that major cardiovascular events take place with patients having PAD. Sedentary lifestyle can cause obesity, and obesity may be casually related to PAD, after keeping in check, underlying health issues like hypertension, hyperglycaemia, and dyslipidaemia. PAD is typically asymptomatic before progressing to clinical stages. ABI can detect PAD and can delay further complications [4].

According to Graph 2 [15] of the study, the highest rate of normal BMI fell in the category of 19-27 years with the result at 43%. Out of the remaining population in the age group, 27% were overweight, 16% fell in obese I category, and 14% fell in obese II category. As the age increased, the case of obesity increased in general. Categories aged 28-36 years, 37-45 years and 46-55 years showed a higher range of BMI than the young population of 19-27 years. Among the ages of 28- 36 years, 27% of the population was overweight, 64% fell in obese I category, and 9% fell in obese II category. The older range of 37- 45 years showed that 8% of the population had a normal BMI, 23% were overweight, 23% fell in obese I category, and 46% fell in obese II category. The oldest age group of 46- 55 years, had the greatest number of obese II patients at 58%. Population falling within the obese I category were at 25%, overweight at 17%, and 0% within the normal BMI range.

A study by *Marinos Elia* in 'Obesity in the Elderly' shows that there is a general increase in BMI and weight with age, until the age of 60. As per a study by *Suman Dua* in the article 'Body Mass Index Relates to Blood Pressure Among Adults' states that the overweight and obese population tends to have hypertension than those with a normal BMI. Further, the article 'Exercise Evaluation of Upper vs. Lower Extremity Blood Pressure Gradients in Paediatric and Young Adult Participants' by *Sandra K. Knecht* states that systolic blood pressure in the leg is higher than the arm [4].

According to Graph 3 [16], the people with higher BMI showed a higher range of systolic pressure in the upper as well as lower limb when compared with the people having a normal-ranged BMI. The average UL pressure in people having normal BMI was 108.55 and LL pressure was 129.8 whereas, the average UL pressure in overweight population was 129 and LL pressure was 156.6. Obese I population had an average UL pressure of 123.55 and LL pressure of 144.35. The population falling in obese II category had a higher average UL pressure at 128.05 and LL pressure at 164.1.

As per an article by *Geoffrey H Tison* in 'Usefulness of Baseline Obesity to Predict Development of a High Ankle-Brachial Index' weight and BMI are associated with an abnormal ankle-brachial index (ABI). An abnormally elevated ABI is associated with increased cardiovascular disease (CVD) risk [1].

Conclusion

This study shows that as the age increases, the person's obesity increases as well, and in turn increases the BMI. Higher BMI is associated with increased systolic pressure in

the upper and lower limb. The study also shows that the systolic blood pressure in the leg is elevated than the arm. Higher BMI as well as high weight is associated with an abnormal ankle-brachial index. To conclude, a higher range of ABI increases the risk of cardiovascular disease in the general population.

The *p*-value of the population data is 0.06.

References

1. Tison GH, Ndumele CE, Gerstenblith G, Allison MA, Polak JF, Szklo M. Usefulness of baseline obesity to predict development of a high ankle brachial index (from the Multi-Ethnic Study of Atherosclerosis). Am J Cardiol,2011:107(9):1386-91. doi: 10.1016/j.amjcard.2010.12.050. Epub 2011 Mar 4. PMID: 21377643; PMCID: PMC3079000, https://doi.org/10.1016/j.amjcard.2010.12.050
2. Potier L, Abi Khalil C, Mohammedi K, Roussel R. Use and Utility of Ankle Brachial Index in Patients with Diabetes, European Journal of Vascular and Endovascular Surgery,2011:41(1):110-116. ISSN 1078-5884, https://www.sciencedirect.com/science/article/pii/S1078588410005 99X
3. Schramm K, Rochon PJ. Gender Differences in Peripheral Vascular Disease. Semin Intervent Radiol,2018:35(1):9-16. doi: 10.1055/s-0038-1636515. Epub 2018 Apr 5. PMID: 29628610; PMCID: PMC5886764, https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0038-1636515
4. Dua S, Bhuker M, Sharma P, Dhall M, Kapoor S. Body mass index relates to blood pressure among adults. N Am J Med Sci,2014:6(2):89-95. doi: 10.4103/1947-2714.127751. PMID: 24696830; PMCID: PMC3968571. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3968571/
5. Julio A, Carbayo Juan A, Divisón Julio Escribano, Juan López Abril, Enrique López de Coca, Luis M, *et al*. Using ankle-brachial index to detect peripheral arterial disease: Prevalence and associated risk factors in a random population sample, Nutrition, Metabolism and Cardiovascular Diseases,2007:17(1):41-49. ISSN 0939-4753, https://www.sciencedirect.com/science/article/pii/S0939475305002140
6. Korhonen PE, Seppälä T, Järvenpää S, *et al.* Body mass index and health-related quality of life in apparently Healthy individuals. Qual Life Res,2014:23:67–74. https://doi.org/10.1007/s11136-013-0433-6
7. Victor Aboyans, Michael H Criqui, Pierre Abraham, Matthew A Allison, Mark A Creager, Curt Diehm F, *et al*. Measurement, and Interpretation of the Ankle-Brachial Index, A Scientific Statement From the American Heart Association, 2012, 126(24). https://doi.org/10.1161/CIR.0b013e318276fbcb
8. Joyce Hei Tong Lau, Huda Khan, Richard Lee, Larry S, Lockshin Anne Sharp, Jonathan Buckley, *et al*. Tackling Obesity in aged-care homes: the effects of environmental cues, European Journal of Marketing, 10.1108/EJM-07-2021-0512,2022:56(11):3054-3077. https://doi.org/10.1038/oby.2001.126
9. AB Newman, DS Siscovick, TA Manolio, J Polak, LP Fried, NO Borhani, *et al*. Ankle-arm index as a marker of atherosclerosis in the Cardiovascular Health Study, 1993, 88(3). https://doi.org/10.1161/01.CIR.88.3.837
10. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of All-Cause Mortality with Overweight and Obesity Using Standard Body Mass Index Categories: A Systematic Review and Meta-analysis. JAMA,2013:309(1):71–82. https://doi:10.1001/jama.2012.113905
11. RF Burton. Why is the body mass index calculated as mass/height2, not as mass/height? Annals of Human Biology,2007:34(6):656-663 https://doi.org/10.1080/03014460701732962
12. A step-defined sedentary lifestyle index: <5000 steps/day Authors: Catrine Tudor-Locke, Cora L. Craig, John P. Thyfault, and John C. Spence AUTHORS INFO & AFFILIATIONS Publication: Applied Physiology, Nutrition, and Metabolism, 2012. https://doi.org/10.1139/apnm-2012-0235
13. Critical review of Ankle Brachial Index Author Tahir H Khan, Falahat A Farooqui, Khusrow Niazi Publisher: Bentham Science publishers. https://doi.org/10.2174/157340308784245810
14. Association between low ankle-brachial index and accelerometer-derived sedentary and exercise time in the asymptomatic general population Jacquelyn P Kulinski1, Monika Sanghavi2, Colby R Ayers2, Sandeep R Das2, Subhash Banerjee2, Jarett D Berry2, Tayo Addo2, James A De Lemos2 and Dharam J Kumbhani2 https://journals.sagepub.com
15. Obesity in Elderly, Prof. Marinos Elia, https://doi.org/10.1038/oby.2001.126
16. Gender Differences in Peripheral Vascular Disease Kristofer Schramm Department of Radiology, University of Colorado School of Medicine, Aurora, Colorado Paul J. Rochon Department of Radiology, University of Colorado School of Medicine, Aurora, Colorado https://www.thieme-connect.com
17. Population differences in body composition in relation to the body mass index. Norgan NG Author information European Journal of Clinical Nutrition, 1994. https://europepmc.org
18. An Epidemiological Study of Overweight and Obesity Among Women in an Urban Area of North India Sangeeta Girdhar, Sarit Sharma, Anurag Chaudhary, Priya Bansal, and Mahesh Satija https://www.ncbi.nlm.nih.gov
19. The Role of Ankle-Brachial Index for Predicting Peripheral Arterial Disease Marius RAC-ALBU,a Luminita ILIUTA, b Suzana Maria GUBERNA, c and Crina SINESCUd https://www.ncbi.nlm.nih.gov