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# ASSOCIATION OF ANKLE BRACHIAL INDEX IN MIDDLE AGED AND ELDERLY WITH THEIR CARDIOVASCULAR RISK FACTORS: A CROSS-SECTIONAL STUDY

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Contribution

FA,AAM,NSB conceived the idea,designed and conducted the study and analyzed the data. MAB,ASA,MAB helped in acquisition of data and did statical analysis. All authors contributed significantly to the submitted manuscript.

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## ABSTRACT

**Objective:** To find the association of individual cardiovascular risk factor and the number of cardiovascular risk factors with Ankle Brachial Index.

**Methodology:** This cross sectional study was conducted at Cardiology Executive and Family Medicine clinics of Aga Khan University Hospital, Karachi for a period of 1 year between 1st May 2009 and 30th April 2010. The risk factors included were age, gender, hypertension, diabetes mellitus, dyslipidemia, smoking and obesity. The systolic blood pressure level was noted in both the brachial arteries and then systolic pressure was measured in both the posterior tibial and dorsalispedis arteries with a standardized method using 8 MHz Doppler probe. The value of Ankle Brachial Index was determined as the ratio of the mean of the ankle systolic pressures to the mean of brachial systolic pressures. The data was analyzed using SPSS version 21.

**Results:** About 100 participants were screened for cardiovascular risk factors with an interview-based questionnaire. The ankle brachial index was below normal (0.9) in 40% off patients. Of cardiovascular risk factors, hypertension and dyslipidemia were significantly associated with ankle brachial index values ($p<0.05$) . As the number of cardiovascular risk factors increase, there is a proportionate decrease in ankle brachial index.

**Conclusion:** Peripheral arterial disease is more likely to occur in patients with dyslipidemia and hypertension. The risk of peripheral arterial disease increases with increase in number of cardiovascular risk factors in middle aged and elderly. These patients require a more stringent control of their risk factors to prevent complications.

**Key Words:** Ankle Brachial Index, Peripheral arterial disease, cardiovascular risk factors.

## INTRODUCTION

The incidence of peripheral arterial disease (PAD) has been on the rise over the last few decades. The most important reasons for this phenomenon is ageing and increased prevalence of cardiovascular risk factors such as type 2 diabetes mellitus, obesity and smoking.[1] PAD occurs as a result of occlusion of arterial lumen of lower extremities by atherosclerotic plaques. It is one of the most important manifestations of systemic atherosclerosis. The presence of PAD signifies a high risk of cardiovascular morbidity and mortality even in asymptomatic subjects.[2,3] Peripheral arterial disease, even in current era, remains a grossly under-diagnosed condition, with recent epidemiological figures estimating the prevalence of PAD in North America and Europe to be 27 million cases. It is further estimated that while 10.5 million of the subjects are symptomatic; majority is asymptomatic and possibly unidentified.[4]

The ratio of resting ankle to brachial systolic pressure provides an index that has been used widely in clinical and epidemiological studies to assess the patency of lower extremity arterial system and to screen for PAD. ABI has a sensitivity of 95% and specificity of 99% for angiographically documented PAD.[4] Because it also allows the detection of asymptomatic subjects, epidemiologic studies in the last 20 years have based their definition of PAD on the ankle brachial index. A low Ankle brachial index (ABI) has been reported to be a marker for risk of coronary and cerebrovascular disease and an independent predictor of cardiovascular disease and all-cause mortality.[2] The main strategy, therefore, has been to improve the detection of subjects with PAD in order to prevent further cardiovascular morbidity and mortality and improve the accuracy of diagnoses. Given the well-recognized association between PAD and other forms of atherosclerotic disease, several studies in different populations have investigated the use of ABI in prediction of future events of Coronary artery disease in particular.[1,4]

The Edinburgh artery study established that inclusion of ABI in investigations significantly improved prediction of fatal MI over and above that of conventional risk factors.[5] Ethnic and demographic differences have been observed in the value of ABI in healthy population in different studies worldwide. The Multi-Ethnic Study of Atherosclerosis (MESA) study suggested that intrinsic ethnic and gender differences exist in ABI value, small in magnitude, but of higher significance. It showed that there are significantly low values of ABI in the black population in comparison with non-Hispanic white people.[6] The Chennai urban population study concluded that prevalence of PAD in urban South Indian population is considerably lower than that reported in European and US studies despite high prevalence of coronary artery disease reported in this population.[7]

If our population has lower ABI than other populations whether cardiovascular risk factors are present or not, then routinely measuring ABI may help in detecting asymptomatic peripheral artery disease and consequentially, may play an important role in preventing PAD. But based on factors associated with PAD, it can be safely predicted that its prevalence is considerably high in South Asian population due to very high prevalence of diabetes mellitus and coronary artery disease in this population.[8,9] Many studies have been done worldwide to determine association of low ABI with cardiovascular risk factors. The Korean study found a strong associated between ABI and many cardiovascular risk factors including age, smoking, body mass index and high blood pressure.[1] Similarly, the Indian study concluded that ABI has significant correlation with age more than 50 years and hypertension.[7] One study investigated the association of presence of varying number of cardiovascular risk factors from one to four with ankle brachial index.[10] We could not find any study done on Pakistani population related to measurement ABI and assessment its relationship with number of cardiovascular risk factors.

We conducted this study to determine the distribution of ABI in middle aged and elderly, being a high risk population for developing peripheral arterial disease in a tertiary care hospital in Karachi and to find the association of individual cardiovascular risk factors and the number of cardiovascular risk factors with ABI.

## METHODOLOGY

This was a cross sectional study conducted at the Cardiology, Executive and Family Medicine clinics of Aga Khan University Hospital, Karachi for a period of 1 year between 1st May 2009 and 30th April 2010. These clinics were chosen as most of the patients visiting them are middle aged and elderly with varying number of cardiovascular risk factors. A formal ethical approval for conducting the study was obtained from the Ethics Review Committee (ERC) of the Aga Khan University.

We randomly included subjects irrespective of their associated cardiovascular risk factors. The sample collection was done through convenient non-probability technique. All individuals in the age group of 40-75 years with or without above mentioned cardiovascular risk factors were included in the study while we excluded individuals with lower limb gangrene, who have gone leg surgery and those unwilling to give consent. The variables included in the study were patient's demographic status (age and sex) and known cardiovascular risk factors (Hypertension, Diabetes mellitus, Smoking, Dyslipidemia, Body mass index and physical activity).The main outcome was ankle brachial index.

Middle-aged and elderly patients at the study setting clinics were assessed for inclusion by the principal investigator

after taking informed written consent. Their initial assessment was done for variables like pulse, blood pressure, temperature, height and weight. An interview-based questionnaire was filled as a data collection tool to assess for presence of various cardiovascular risk factors. This questionnaire was designed by the principal investigator to determine the presence of various cardiovascular risk factors. Then the ABI was measured by the principal investigator himself with the standard method as explained by McDermott et al.[13] Participants were rested in supine position for at least 5 minutes before measurement. Using a bidirectional Doppler with a hand-held 8 MHz probe, and a standard mercury sphygmomanometer, systolic blood pressure was measured in the following order: right brachial artery, right dorsalispedis and posterior tibial arteries, left dorsalispedis , left posterior tibial arteries and left brachial artery. Arm cuffs of different sizes were used to accommodate different examinees. Two sets of reading were taken. The higher of the two systolic blood pressure values were used to calculate the ABI. The value of <0.9 was considered as having peripheral arterial disease. Confidentiality of all the clinical information of the patients was maintained. Patients in need of urgent medical care were appropriately referred.

Data was entered and analyzed on IBM SPSS version 21. Frequencies and proportions were calculated for categorical variables such as gender and cardiovascular risk factors using Chi Square. Mean and Standard deviations were calculated for ankle brachial index. Multiple binary logistic regression was used to model the relationship between ABI and various cardiovascular risk factors.

## RESULTS

A total of 110 subjects were interviewed for assessing their cardiovascular risk factors. There were 10 exclusions at the stage of interview. Two were excluded because they had undergone arterial surgery in their legs. One subject already had established DVT and 7 were not sure about one or more of their cardiovascular risk factor status. The ankle brachial index of the remaining 100 subjects was calculated using the standard method described above.. The data was analyzed with SPSS 21.

**Table 1: Distribution of Baseline Characteristics and Cardiovascular Risk Factors in study population (n=100)**

| | | Ankle-Brachial Index | | | |
|---|---|---|---|---|---|
| | | Normal n=60 | | Abnormal n=40 | |
| | | n | % | n | % |
| **Age** | 40-50 | 27 | 69.2% | 12 | 30.8% |
| | 51-60 | 21 | 58.3% | 15 | 41.7% |
| | 61-75 | 12 | 48.0% | 13 | 52.0% |
| **Gender** | Female | 21 | 55.3% | 17 | 44.7% |
| | Male | 39 | 62.9% | 23 | 37.1% |
| **Body Mass Index** | <25 | 18 | 75.0% | 6 | 25.0% |
| | 25-30 | 38 | 55.1% | 31 | 44.9% |
| | >30 | 4 | 57.1% | 3 | 42.9% |
| **Hypertension** | No | 44 | 72.1% | 17 | 27.9% |
| | Yes | 16 | 41.0% | 23 | 59.0% |
| **Diabetes mellitus** | No | 43 | 60.6% | 28 | 39.4% |
| | Yes | 17 | 58.6% | 12 | 41.4% |
| **Smoker** | No | 42 | 65.6% | 22 | 34.4% |
| | Yes | 18 | 50.0% | 18 | 50.0% |
| **Dyslipidemia** | No | 42 | 67.7% | 20 | 32.3% |
| | Yes | 18 | 47.4% | 20 | 52.6% |
| **Ischemic heart disease** | No | 53 | 63.9% | 30 | 36.1% |
| | Yes | 7 | 41.2% | 10 | 58.8% |
| **Physical activity for 30 mins** | No | 28 | 56.0% | 22 | 44.0% |
| | Yes | 32 | 64.0% | 18 | 36.0% |

Most of the participants included in the study were male (62%). There were more patients in the middle age category (65%). About 76 patients had a high BMI > 25 (Table 1). Despite random selection of sample, the proportion of patients with diabetes mellitus (29%) and Ischemic heart disease (17%) was quite low as compared to other cardiovascular risk factors (Table 1).Of 100 study participants included, 60 were found to have normal ankle brachial index while 40 had an ABI below 0.9. The Mean reading of Ankle Brachial Index was 0.905 with a SD of 0.0658.

The association of various cardiovascular risk factors with ABI was estimated by univariate analysis.

**Table 2: Univariate Regression Analysis for Association of Cardiovascular Risk Factors with Ankle Brachial Index ( n= 100)**

| CV risk factors | Adjusted Odds Ratio | 95% CI | P values |
|---|---|---|---|
| **Age** | 1.926 | 0.771-4.810 | 0.232 |
| **Gender** | 0.729 | 0.32-1.656 | 0.449 |
| **BMI** | 2.429 | 0.868-6.793 | 0.226 |
| **Hypertension** | 3.721 | 1.592-8.694 | 0.002 |
| **Diabetes mellitus** | 1.084 | 0.45-2.611 | 0.857 |
| **Smoker** | 1.909 | 0.83-4.389 | 0.126 |
| **Dyslipidemia** | 2.33 | 1.107-5.351 | 0.044 |
| **IHD** | 2.524 | 0.87-7.319 | 0.082 |
| **Physical activity** | 0.716 | 0.32-1.6 | 0.414 |

Of the various cardiovascular risks, Hypertension and dyslipidemia were found to have significant association with low ABI. While association of Ischemic heart disease with low ABI was not very significant (Table 2).The association of the number of cardiovascular risk factors with ABI values was found significant (p=0.003) (Figure 1). This indicates that with the increase in the number of cardiovascular risk factors, there is a significant decrease in the value of ABI. Another significant result is that the participants having more than 3 cardiovascular risk factors at a time have significantly more chances of having low ABI (p=0.002, OR=3.752, 95% CI=1.577– 8.934) than those having 3 or less cardiovascular risk factors (Table 3).

**Figure 1: Correlation of Ankle-Brachial Index with the Number of Cardiovascular Risk Factors (n=100)**

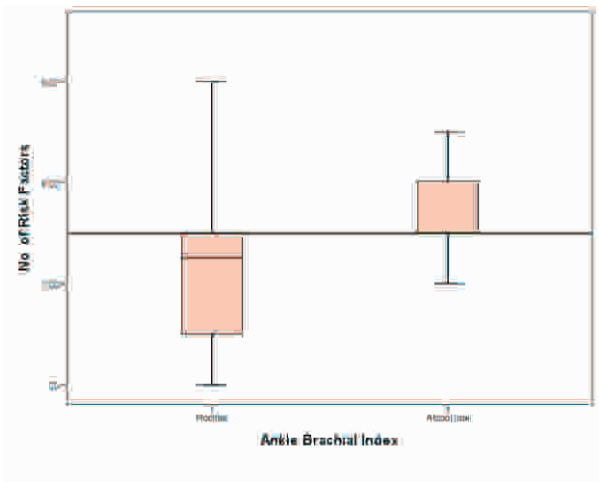


**Table 3: Comparison of Ankle-Brachial Index in the Two Groups According to the Number of Cardiovascular Risk Factors.**

| | | Ankle Brachial Index | | |
|---|---|---|---|---|
| | | Normal | Abnormal | Total |
| No. of Risk Factors | <=3 | 43 | 18 | 61 |
| | >3 | 14 | 22 | 36 |
| Total | | 57 | 40 | 97 |

## DISCUSSION

Our study has come out with many significant findings. First of all, a high percentage of the subjects (40%) had low ABI values. None of the subjects having one or no cardiovascular risk factor had low ABI. The univariate analysis shows that the subjects with ABI<0.9 are more likely to be hypertensive and dyslipidemic, although ischemic heart disease also had weak association with low ABI. The other factors age, gender, BMI, diabetes mellitus, smoking and physical activity independently did not has significant impact on ABI. Age and BMI had significant association with ABI in the Korean study.[1] The study on South Indians also showed advancing age as the most significant factor associated with peripheral arterial disease.[7]

Study findings regarding effect of hypertension and dyslipidemia have been supported by past studies and negated by a few of them. The Korean study which aimed at finding correlation of known cardiovascular risk factors and ankle brachial index value also found hypertension and dyslipidemia to have a significant association with peripheral arterial disease. [4] Similarly the Chennai urban population study carried out in a selected south Indian population deduced that hypertension had marked correlation with the ABI values but did not find any association between serum lipid levels and ABI. [7] However according the MESA study, neither hypertension nor dyslipidemia has any significant association with peripheral arterial disease.[6]

Although diabetes mellitus and smoking are considered major risk factors for arterial atherosclerosis as supported by one of the recent studies, this study has not shown any considerable association between these factors and ABI values. [15] The Chennai Urban study also supports out findings as it concludes that low ABI was not prevalent among smokers and newly-diagnosed diabetics.[7] It showed a marked decrease in ABI values among diabetics only after middle-age. This means that age is a significant factor while evaluating the impact of diabetes mellitus on ABI value. As for smoking, there might be some genetic protection against its negative influence on ABI. Further studies are needed to prove this hypothesis.

Our study has not shown a significant association of established ischemic heart disease with low ABI values. This is in contrast to the findings of the previous studies including the Edinburgh artery study and the Strong Heart study.[2,5] According to a systematic review, ABI can be helpful in detecting asymptomatic individuals who were clinically diagnosed as having coronary artery disease.[14] It has been proven that ABI reflects the extent of atherosclerosis in the overall body vasculature including the coronary arterial system and hence, increases the risk of cardiovascular disease.[15-18] Therefore, ABI can be very useful in the prevention of Ischemic heart disease.

Surprisingly, there was no significant impact of exercise or physical activity on the ABI value. This is in contrast to the findings drawn by McDermott et al. in his studies on leg function and circulation. [19,20] . Another study done by Barone Gibbs et al concluded that daily exercise may help in preventing or delaying the progress of peripheral arterial disease. [21] Overall research data related to the relationship of exercise with peripheral arterial disease is limited.

With increase in the number of cardiovascular risk factors in a subject, there is a corresponding increase in the risk of developing peripheral vascular disease.[22] Subjects with more than three cardiovascular risk factors are at significant risk of developing PAD. Recently, a cohort study was published which assessed the association of four known cardiovascular risk factors with ABI individually as well as together in men. It found that each of smoking, hypertension, dyslipidemia and type 2 was significantly and individually associated with a higher risk of Peripheral artery disease. It also concluded that the greater the number of these risk factors present together, the higher the risk of low ABI. The hazard ratio for each additional risk factor compared was found to be 2.06. [10] It is possible that our finding is coincidental. Also some cardiovascular risk factors might be contributing more to the development of peripheral arterial disease than others. Therefore, there is no definite conclusion in this regard.

There are several factors that were not taken into account and which can have a direct bearing on the results. Firstly, the duration of risk factors like diabetes, hypertension and dyslipidemia was not considered. Similarly, it could not be determined how well these cardiovascular risk factors have been adequately controlled with medications and lifestyle modifications and for what time period did they remain uncontrolled. It is a possibility that risk factors like diabetes mellitus may cause peripheral vascular disease with significant confounding effect from other cardiovascular risk factors like hypertension and dyslipidemia.

It needs to be further established whether genetic protection plays a role in preventing peripheral vascular disease in subjects with significant cardiovascular risk factors in our population. A study done on multi-ethnic Asian population in Singapore showed that as compared to Chinese individuals, PAD was more common in Indian and Malay ethnic groups, especially in women.[23] On comparison with findings of some other studies, [1,7,10]. This study finds weak association of known cardiovascular risk factors like diabetes mellitus and smoking with peripheral arterial disease.

## CONCLUSION

Peripheral arterial disease is more likely to occur in patients

with more than three cardiovascular risk factors. Those with increased number of risk factors are more at risk of developing PAD and therefore, should be monitored more vigorously for ABI. Patients of hypertension and/or dyslipidemia have more chances of having low ABI. Hence, adequate control of these disorders is very important. Type II diabetic patients may develop peripheral artery disease due to additional role of dyslipidemia which develops sooner or later in these patients.


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