Anthropometric parameter-based assessment for cardiovascular disease predisposition among young Indians

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Abstract

AIM: To assess the predisposition for cardiovascular diseases among young Asian Indians by anthropometric data analysis.

METHODS: One hundred and thirty males and 329 females aged between 15 and 26 years, attending health care check-ups at VIT University, were included in this study. Their body mass index, systolic and diastolic blood pressure, waist circumference, waist-to-hip ratio, pulse rate and pressure, along with mean arterial pressure, were measured and the data analyzed as per World Health Organization guidelines.

RESULTS: Based on the analysis, 54% of the male population was found to be predisposed to cardiovascular disease. Of these, approximately 40% were at highest possible risk, with greater than threshold values of body mass index, waist circumference and waist-to-hip ratio. Females were found to have lower risk. Both genders showed significant correlation ($P < 0.0001$) between body mass index and waist circumference. Waist-to-hip ratio correlated significantly only in males with the former index whereas it correlated significantly with waist circumference in both genders. Receiver operating curve analysis, when performed, showed optimal sensitivity and specificity for body mass index and waist circumference.

CONCLUSION: The above results indicate that seeds of cardiovascular disease may have been sown at a young age in Asian Indian populations. Interventional measures are advised to prevent accelerated atherosclerosis leading to premature cardiovascular disease.

Key words: Cardiovascular disease predisposition; Young Asian Indians; Anthropometric biomarkers; Body mass index; Blood pressure

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INTRODUCTION

Current World Health Organization reports state that 36 million people die globally of non-communicable diseases: of these, 49% of mortality is due to cardiovascular disorders (CVD), with major causalities from India$^{[1]}$. This country has undergone a rapid economic development resulting in a simultaneous epidemiological transition to a sedentary and unhealthy lifestyle$^{[2]}$. Such practices result in elevated body mass index, abnormal blood pressure, etc., which account for the development of non-communicable diseases such as CVD$^{[3,4]}$. The World Health Organization reports that by 2020, 69%...
of all deaths will be due to these diseases, with maximum contribution from cardiovascular disorders. The burden would also be severe in India as young youths are expected to be the victims. The objective of this study is to investigate young Asian Indians, who may be at risk, so that interventional measures may be initiated and awareness created among them. The focus would be mainly on controlling the modifiable risk factors which may directly or indirectly help in delaying the onset/progression of disease.

MATERIALS AND METHODS

Study data were obtained from 130 males and 329 females who attended University Health check-ups at Vellore Institute of Technology University, Vellore, India. The anthropometric parameters, viz., height (cm), weight (kg), waist circumference (WC, cm), hip circumference (cm), systolic blood pressure (SBP, mmHg), diastolic blood pressure (DBP, mmHg) and pulse rate (PR, \( m^{-1} \)) were measured by standard techniques. Using these data, body mass index (BMI) = weight/height\(^2\) (kg/m\(^2\)), Waist-to-hip ratio (WHR), the pulse pressure (PP) = (SBP - DBP) and mean arterial pressure (MAP) = (DBP + PP/3) were calculated.

Following this, anthropometric data were analyzed according to World Health Organization and National Heart, Lung and Blood Institute guidelines. Accordingly, the flow chart indicated in Figure 1 was followed for screening and sorting populations as “At-Risk”, “High-Risk” and “Highest-Risk”.

Statistical analysis

One-way analysis of variance (ANOVA) and Spearman correlation tests were performed and receiver operation curve (ROC) was plotted using Graph Pad Prism (Trail Version). Two-tailed \( P \) values of less than or equal to 0.001 were regarded as significant.

RESULTS

The mean values of BMI, systolic, diastolic and mean arterial blood pressure, along with pulse parameters and waist measurements, are given in Table 1. The cut-off value of BMI as per World Health Organization guidelines is 23 (public health action point)\(^{[9,10]}\) and our measured mean values were 23.5 and 22.93 kg/m\(^2\) in males and females, respectively. Detailed study of the risk strategy in classifying the screened population for predisposition for cardiovascular disease revealed that 54% of the male population are “At-Risk”, of which 72.9% were at “Highest Risk”. In the case of females, approximately 42% are “At-Risk”, and among them 59% and 52% are at “High-Risk” and “Highest-Risk”, respectively (Figure 2). By World Health Organization definition, an individual’s predisposition for cardiovascular disease is directly proportional to the level of risk, BMI, WC and WHR\(^{[11]}\). One-way ANOVA was used for comparison of all the risk groups with controls and within each gender. Significant difference (\( P < 0.0001 \)) was found upon comparing control group (without obesity) with obese group with and without raised WC and higher WHR in both genders together in all combinations. The values

| Parameters                        | Male          | Female         | Risk cut-off value |
|----------------------------------|---------------|----------------|-------------------|
| Body mass index (kg/m\(^2\))     | 23.60 ± 3.752 | 22.93 ± 4.554  | ≥ 23              |
| Systolic blood pressure (mmHg)   | 118.07 ± 8.079| 112.89 ± 7.959 | ≥ 130             |
| Diastolic blood pressure (mmHg)  | 85.30 ± 5.865 | 80.80 ± 7.131  | ≥ 90              |
| Mean arterial blood pressure     | 96.23 ± 4.535 | 91.56 ± 5.381  |                   |
| Pulse rate (per minute)          | 75.45 ± 5.242 | 73.71 ± 5.312  | ≥ 85              |
| Pulse pressure                   | 32.76 ± 10.42 | 32.04 ± 10.81  | ≥ 40              |
| Waist circumference (cm)         | 84.19 ± 11.00 | 75.33 ± 9.544  | ≥ 85 (men) and ≥ 80 (women) |
| Waist-to-hip ratio               | 0.93 ± 0.04   | 0.84 ± 0.05    | ≥ 0.88 (men) and ≥ 0.81 (women) |

Table 1 Mean values of the parameters analyzed (mean ± SD)

![Figure 1 Risk assessment methodology. BMI: Body mass index; WC: Waist circumference; WHR: Waist-to-hip ratio.](image)

![Figure 2 Risk percentage comparison (n = 329 women and n = 130 men).](image)
were not significant only when controls were compared with the obese group without raised WHR in men. This significant comparison clearly proves the importance of each parameter individually and in combinations for risk evaluation (Figure 3).

The correlations between BMI, WC and WHR are shown in Table 2. BMI was highly correlated in both genders with WC, whereas the latter showed similar correlation with WHR also. The correlation between WHR and BMI was, however, lesser in the case of males and negligible in the case of females. The World Health Organization has reported elevated blood pressure as an independent marker for cardiovascular disease [12]. An individual with systolic pressure greater than 130 mmHg and/or diastolic pressure more than 90 mmHg is said to be hypertensive [13]. Based on this premise, ROC was plotted between the control and hypertensive groups, to test the level of sensitivity and specificity of BMI, WC and WHR, and results proved that these parameters can be used in combination to predict an individual’s predisposition for CVD (Table 3).

**DISCUSSION**

The current study used a multivariate approach, where we included data based on an individual’s anthropometric parameters such as systolic and diastolic blood pressure, mean arterial pressure, age, height, weight, body mass index, waist and hip circumferences and their ratio, pulse pressure and pulse rate of young Asian Indians. An earlier study on 1421 subjects of Omani Arab origin has reported that CVD distribution was higher among the said population by screening them with non-invasive parameters such as BMI and WC [14]. The WHR in this study showed a very significant difference which is in accordance with two previous reports which suggests WC as an independent predictor of CVD [16,17]. The WHR in this study showed a very significant difference which is in accordance with two previous reports which suggests WC as an independent predictor of CVD [16,17].

| Parameters | Men | Women |
|------------|-----|-------|
| Correlation of BMI vs waist circumference | 0.88<sup>b</sup> | 0.78<sup>b</sup> |
| Correlation of BMI vs WHR | 0.50<sup>b</sup> | 0.09<sup>b</sup> |
| Correlation of waist circumference vs WHR | 0.63<sup>b</sup> | 0.43<sup>b</sup> |

Table 2  Spearman correlation values for men and women

BMI: Body mass index; WHR: Waist-to-hip ratio. <sup>b</sup>P < 0.0001.

| Parameters | Men | Women |
|------------|-----|-------|
| Area under the curve | 0.6163 | 0.5975 |
| Specificity (%) | 59.04 | 52.53 |
| Sensitivity (%) | 55.19 | 62.61 |
| Area under the curve | 0.5941 | 0.5872 |
| Specificity (%) | 51.81 | 36.36 |
| Sensitivity (%) | 65.96 | 75.65 |
| Area under the curve | 0.5497 | 0.5108 |
| Specificity (%) | 91.57 | 33.67 |
| Sensitivity (%) | 19.15 | 64.00 |

Table 3  Receiver operating curve analysis

**Figure 3**  Control vs raised body mass index in men (A) and woman (B).

WC: Waist circumference; WHR: Waist-to-hip ratio. <sup>a</sup>P < 0.0001 is significant.
ceding reports, one conducted on 9206 Australians and the other on obese adult women[18,19]. However, findings from other studies showed that among the non-invasive parameters, BMI and WC correlated better than BMI and WHR[20]. Conversely, a follow-up study conducted on 25,000 participants over 6 years and other studies have proposed that WC and WHR are significantly associated with CVD[21-23]. Thus, it is suggested that the obesity parameters, BMI and WC with WHR, would lead to a better diagnosis for CVD predisposition[24]. This is also in agreement with a study performed on 1800 subjects that showed a positive relationship between the obesity parameters and CVD[25]. A recent study on detection of cardiovascular risk factors by indices of obesity in a Japanese population reported that the anthropometric data were comparable to dual energy X-ray absorptiometry[26].

In conclusion, in the screened population, 50% of males and 40% of females may be predisposed to CVD. As this population is fairly young, preventive measures when undertaken may delay the onset of atherosclerosis. This may eventually prevent cardiovascular disease. The study also shows that body mass index, WC and WHR significantly correlate with optimal diagnostic values, which can be used to evaluate the risk index.

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