Prevalence of high coronary risk by the conicity index in economically active individuals in São Paulo

Prevalência de alto risco coronariano pelo índice de conicidade em indivíduos economicamente ativos em São Paulo

Luciana Rossi[1]
Clara Korukian Freiberg[2]

RESUMO
Introdução: Atualmente é crescente o desafio de se aplicar uma técnica antropométrica acurada, reprodutível, de fácil execução e de melhor detecção precoce do risco de doenças crônico degenerativas. O objetivo do trabalho compreendeu avaliar o impacto na prevalência de diagnóstico de Risco Coronariano Elevado (RCE) pela adoção do Índice de Conicidade (IC). **Método:** A amostra consistiu de 627 indivíduos provenientes de vários segmentos populacionais. As medidas antropométricas coletadas foram: circunferência da cintura (CC); peso e estatura e calculou-se o IC. Com estes dados, determinou-se a prevalência, por gênero, de risco coronariano elevado (RCE), levando-se em conta o ponto de corte para população brasileira. **Resultados:** A prevalência de risco para o fenótipo predisponente para RCE, segundo os pontos de corte propostos, exibe diferença gênero específica, sendo para o sexo masculino de 38,6% e feminino de 41,6%. O IC exibe vantagem frente a outros marcadores abdominais de gordura visceral (MAGV), por incluir em sua fórmula a relação da medida de circunferência para dada altura e peso, o que permite comparações diretas de adiposidade abdominal individual ou populacional. Esta reação apresenta maior impacto na avaliação de RCE no grupo das mulheres.

Unitermos:
Antropometria. Fatores de risco. Doenças cardiovasculares/prevenção & controle. População em idade de trabalhar.

Key words:
Anthropometry. Risk factors. Cardiovascular diseases/prevention & control. Working-age population.

ABSTRACT
Introduction: There has been an increasing challenge of using an accurate, reproducible and easy-to-perform anthropometric technique that early detects the risk of chronic degenerative diseases. The aim of this work was to assess the prevalence of high coronary risk (HCR) diagnosis using the conicity index (CI). The sample consisted of 627 individuals from several population segments. **Methods:** The collected anthropometric measures were waist circumference (WC), weight and height, which were used to calculate the CI. Based on these results, we determined the prevalence, by gender, of high coronary risk, adopting the cutoff point for Brazilians. **Results:** The prevalence of risk of HCR-predisposing phenotype, according to the proposed cutoffs, presented sex-specific differences, for men 38.6% and women 41.6%. CI has an advantage over others visceral fat anthropometric markers (VFAM) since the includes in its calculation the circumference measure for a certain height and weight, which allows direct comparisons of the individual population abdominal adiposity. This was particularly evident for data from women.

Endereço para correspondência:
Luciana Rossi
Centro Universitário São Camilo Pompéia
Rua Raul Pompéia, 144 – Pompéia – São Paulo, SP, Brasil – CEP: 05025-010
E-mail: lrossi@usp.br

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1. Doutoranda do PRONUT – USP. Docente do Centro Universitário São Camilo, São Paulo, SP, Brasil.
2. Mestre em Nutrição Humana Aplicada – USP. Docente do Centro Universitário São Camilo, São Paulo, SP, Brasil.

INTRODUCTION

The World Health Organization[1] estimates that the so-called "Obesity Outbreak" already reaches more than 1 billion of overweight adults, of which a minimum of 300 millions are clinically obese[2]. The index most commonly employed to evaluate the nutritional status is body mass index (BMI), especially due to its easy utilization, good relation with body fat for the population in general, acceptance by the scientific community and prediction of the development of metabolic disorders and several other diseases; however, when used alone, it is not a good indicator of the increase in death rates. In 1835, Quételet was the first scientist to note that the weight of healthy adults is proportional to the square of their height[3]. In 1972, Keys and collaborators identified BMI as highly correlated to adiposity and since then this index has been extensively studied as a phenotypic marker of generalized obesity in adults[4]. There are several valid criticisms of the use of BMI as a nutritional status evaluator, especially due to the interpretation of its values since it does not differentiate body composition; in addition, the cutoffs among distinct populations may influence obesity prevalence, and considering BMI a continuous variable, the 1 kg/m^{-2} increase is associated with a 6% increase in the total risk of stroke[5] from 23 kg/m^{-2}. Therefore, although studies on obesity have shown BMI longevity, the relation between obesity and coronary risk is controversial since there is a subgroup of obese individuals presenting ischemic heart disease (IHD) in contrast to nonobese individuals with abdominal fat accumulation and manifesting these diseases[6]. Hence, the challenge remains to apply an accurate, reproducible and easy-to-perform anthropometric technique that early detects the risk of chronic degenerative diseases[7,8].

The *INTERHEART* study[9] aimed to evaluate the importance of IHD risk factors worldwide, especially for the Latin America population[10], and concluded that abdominal obesity, smoking and hypertension are among the most important modifiable risk factors for acute myocardial infarction. Abdominal adiposity has presented a strong relation with morbidities and mortalities due to IHD, as noted during 24 years by the *Framingham Heart Study*[11], in which 597 men and 468 women developed IHD, and 248 men and 150 women died from associated causes.

Obesity is an important risk factor for cardiovascular diseases and diabetes. Before the manifestation of clinical signs, the evaluation of intra-abdominal fat mass or visceral fat, predictor of higher risk, can be more accurately performed through magnetic resonance imaging or computerized tomography, sophisticated and accurate laboratory procedures; however, costs with equipment, sophisticated protocols and diagnostic evaluations allow their application in epidemiological studies[12]. On the other hand, doubly indirect methods such as anthropometric indexes are fast, easy to perform, reproducible and accurate, and have been suggested for obesity detection and body fat localization: waist-hip ratio (WHR)[1], sagittal abdominal diameter (SAD)[13], waist circumference (WC)[14] and conicity index (CI) among others[15], also named visceral fat anthropometric markers (VFAM).

In 1991, Valdez[16] proposed the conicity index (CI) based on its high correlation with abdominal adiposity and HCR. Similarly, several studies presented high correlation of CI with total cholesterol concentration and low-density lipoproteins (LDL), demonstrating its potential as visceral fat marker (VFM) for central obesity, acting as a good predictor for cardiovascular risks, better than the indicators of generalized obesity (BMI)[7,17,18].

CI is based on the presupposition that when the human body morphological profile presents higher fat concentration in the central region, it then has a shape of double cone with a common base, whereas lower fat quantities in the central region of the body lead to a cylinder-like appearance[19]. Based on this presupposition, other approaches to CI have been proposed, especially revealing three body types: biconcave, cylindrical and biconic (Figure 1)[20].

To mathematically express CI, measures of weight, height and waist circumference are employed in the following equation[16]:

$$CIndex = \frac{WaistCircumference(m)}{0.109 \times \sqrt{\frac{BodyWeight(kg)}{Height(m)}}}$$

CI has been recognized as a good indicator of central obesity. Currently, the greatest limitation for its use as a predictor of coronary diseases is the inexistence of cutoffs capable of discriminating high coronary risk in Brazil. Thus, Pitanga and Lessa[21] carried out an extensive study in order to determine sensitivity and specificity, identifying the best cutoffs to discriminate high coronary risk (HCR).

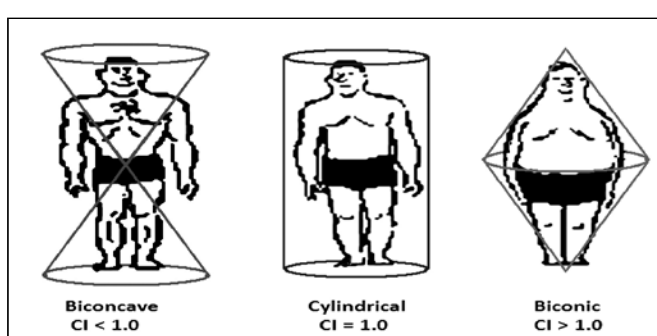

Figure 1 *- Body types described by using the conicity index.*

The use of C index in the body composition analysis seems interesting based on its promising correlation with most diseases and disorders associated with obesity, including diabetes[22], metabolic syndrome[23] and obstructive sleep apnea syndrome (OSA)[24].

The main advantage of C index over other VFAM such as waist-hip ratio is that these measures allow immediate comparisons of the body fat distribution pattern among individuals presenting differences in weight and height, whereas high C index values may be more strongly associated with predisposing risk factors for metabolic and cardiovascular diseases than other anthropometric indicators of abdominal obesity[25]. However, a consensus was not yet reached on how these measurements must be done and which of them are better predictors of cardiovascular risk[26].

The aim of this work was to evaluate the impact on the prevalence of high coronary risk (HCR) diagnosis by adopting the conicity index (CI) for a representative sample of economically active individuals from different population segments of São Paulo City according to sex.

METHODS

Sample

Sampling points were evaluated as to their intrinsic consistency, as described in the section Selection Criteria. Thus, 989 data were collected and the final sample consisted of 627 individuals aged between 30 and 68 years old, 42.1% men and 57.9% women, from several population segments, including telemarketing attendants, Traffic Engineering Company (CET) officers, cargo workers, housemaids, metallurgists, military police officers, supermarket cashiers, nurses and workers of several segments (weaving, electrical products, graphics).

The present longitudinal observational study has been developed since 2005 under the approval of a Research Ethics Committee (nº 025/05).

Selection Criteria

Forms containing the following information were excluded: data recorded earlier than two years ago; waist circumference (WC) values of one same sampling unit with variation of more than 1 cm, as established by the acceptable index of intra-rater variation[27]; incoherent, incomplete or erroneously recorded anthropometric measures; individuals younger than 30 years old or who disagreed with data collection and did not sign the Free Informed Consent Term.

Anthropometric Measures

Weight (kg) was obtained by using a digital scale (100 g precision) and the evaluated person kept in standing position, barefoot, wearing as little clothing as possible, without ornaments or additional weight. Height (cm) was measured with a standard portable stadiometer (1 cm precision) and the evaluated person kept positioned in Frankfurt plan[27]. Waist circumference (WC, in m) was measured twice, adopting the mean value of the measures of each individual; the localization followed the standardization proposed by Pitanga and Lessa[21], according to the IV SOCESP's Guideline[28], i.e. the evaluated person kept in standing position, at the end of expiration, in the mean point between the last costal arch and the anterosuperior iliac crest, using inelastic anthropometric tape measure (1 cm precision). After data collection, was calculated, classifying HCR according to the criterion of Pitanga and Lessa[21], >1.18 for women and >1.25 for men; body mass index was also calculated following the equation in kg/m^{-2}, with the nutritional status classified according to WHO[1].

Statistical Analysis

Continuous variables were descriptively analyzed based on the values of central tendency (mean) and dispersion (standard deviation). To detect statistical differences among age, weight, height and BMI, signed-rank nonparametric tests were applied, setting $p<0.05$ for null hypothesis rejection[29]. The statistical software R 2.10.1 *(The R Foundation for Statistical Computing®)* was used for analyses.

RESULTS

The sample anthropometric profile and the data separated according to sex are shown in Table 1, including descriptive statistics.

Graphs showing the relation between WC (m) and ratio were obtained and cutoffs for both WC[30] and CI[21] were added for men (Figure 2) and women (Figure 3). The graphic representation of data according to sex indicated 4 zones of peculiar features:

- Zone I: HCR;
- Zone II: absence of HCR.

The prevalence of HCR for the predisposing phenotype of coronary disease according to the proposed cutoffs presented sex-specific differences.

DISCUSSION

The sample consisted of a wide range of subsamples from different population segments in order to keep its representativeness by body composition heterogeneity and occupational physical activity level. The sample features are shown in Table 1, and statistical differences were observed for age, weight, height, WC and IC according to sex. Nutritional status classification based on body mass index[1] indicated overweight for the sample in general (26.01 ± 4.28 kg/m^{-2}) and women (26.29 ± 3.28 kg/m^{-2}), and eutrophy for men (25.80 ± 4.87 kg/m^{-2}).

Table 1 – Anthropometric profile of the sample in general and according to sex.

	General (n=627)			Men (n=264)			Women (n=363)		
Variables	**M (SD)**	**Min**	**Max**	**M (SD)**	**Min**	**Max**	**M (SD)**	**Min**	**Max**
Age (years)	41.4 (7.9)	30.0	68.0	40.0 (7.2)	30.0	66.0	42.5 (8.2)	30.0	68.0
Weight (kg)	71.1 (14.6)	41.2	126.3	79.4 (12.6)	46.8	120.5	65.1 (13.0)	41.2	126.3
Height (m)	1.65 (0.10)	1.40	1.94	1.74 (0.07)	1.48	1.94	1.59 (0.06)	1.40	1.81
WC (cm)	85.2 (11.6)	58.5	130.0	90.2 (10.3)	63.0	124.0	81.7 (11.4)	58.5	130.0
BMI (kg/m^2)	26.01 (4.28)	15.46	46.39	26.29 (3.28)*	18.05	35.76	25.80 (4.87)	15.46	46.39
CI	1.19 (0.08)	0.81	1.51	1.23 (0.08)	0.81	1.51	1.17 (0.08)	0.94	1.41

Legend: M: mean, SD: standard deviation, Min: minimum, Max: maximum, WC: waist circumference, BMI: body mass index, CI: conicity index.
*without statistical difference between sexes.

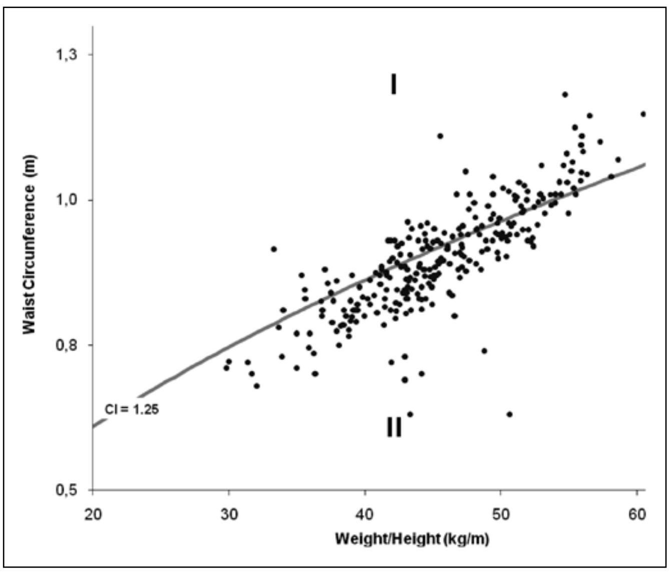

Figure 2 – *Relation between waist circumference and weight/height in men. São Paulo, 2010.*

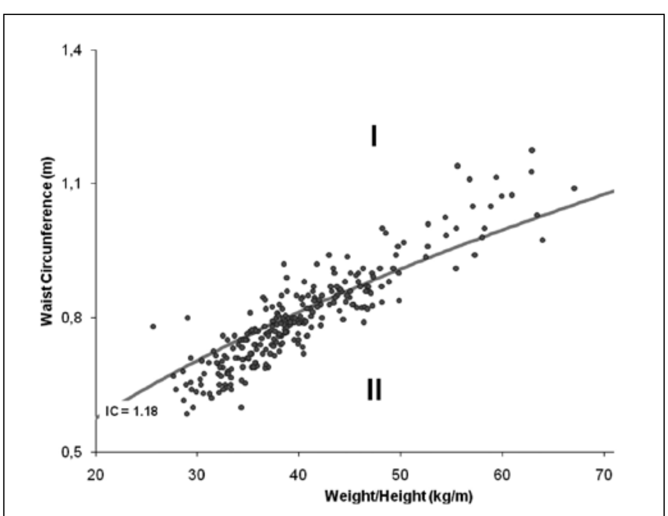

Figure 3 – *Relation between waist circumference and weight/height in women.*

The relation between severe obesity (BMI>30 kg/m^{-2}) and increased death risk due to chronic diseases is well known. However, under lower adiposity levels such a relation is more conflicting due to the late evidence between weight excess in the cardiovascular disease and mortality[31]. Among visceral fat markers (VFM), anthropometric ones (VFAM) have been most frequently employed, and BMI most frequently studied[32,33] due to its relation to increased risk of myocardial infarction, stroke and sudden death. Other markers that currently have better potential as VFAM include WC, waist-hip ratio (WHR) and CI since they do not depend on overweight and obesity[32]. For the Brazilian population, new VFAM and their respective cutoffs have been proposed and evaluated, including CI, which has demonstrated higher accuracy degree than other clinically established markers such as BMI itself, WC and WHR[6,7,11,24]. Considering that body fat distribution and accumulation in the abdominal region have been described as the type that offers the highest risk, there is the need of reflecting about its sex-specific accumulation, a fact recorded since 1956 by Vague[34], who described male (android) and female (gynoid) differentiation degrees for obesity.

In agreement with other studies, the present results showed differences in the sex-specific prevalence of HCR by using distinct VFAM[10], being for women 41,6% and men 33,7%. Differences in body fat accumulation and metabolism according to sex are known to influence coronary disease rates[32]. The higher prevalence of women with HCR is already documented on some papers that indicate the differences in stock and metabolism of body fat by gender influences the prevalence of coronary heart disease, especially in females[35].

A relevant issue concern is the problem related to the determination of a cutoff for IC as potential VFAM for HCR in Brazilian people whose comparative evidence show that compared to others VFA, as CC, BMI the CI has better sensitivity and specificity for both males (73.91% e 74.92%) and females (73.39% e 61.15%)[13,18]. Additionally, the CI in Brazilian women between 30-49 years, the average age of this study (42.5 ± 8.2 years old) has demonstrated better predictive value of HCRs, remembering that cardiovascular diseases are the leading cause of death from 40 years of age[36].

Epidemiological studies with the female Brazilian population indicated that this group presents are most exposed to cardiovascular risks, especially due to changes in lifestyle and eating habits[12]. Although the contribution of factors such as sex hormones, growth hormone and corticosteroids to the fat distribution pattern has been widely reported, modifiable factors influencing it are less known, including smoking, physical activity level and healthy diet[30,32]. A 5cm reduction in WC through restrictive diet and low-intensity walk (3x/week) experimentally decreased coronary disease by 11% in men and 15% in women[30].

Finally, the adoption of a CI for Brazilian women should take into consideration its great predictive potential as VFAM for HCR, although its advantages and limitations must be evaluated, similarly to most epidemiological studies (Table 2).

Since CI is an indicator of body fat distribution, expressing abdominal waist circumference relative to the circumference of a cylinder originated from weight and height and assuming a constant body density, its value would theoretically range from 1.0 (perfect cylinder) to 1.73 (perfect biconic shape). Thus, its use for women would allow HCR detection with higher accuracy considering VFAM and the establishment of normality goals to be reached in order to monitor its effectiveness in the Public Health scope of multi- and inter-professional interventions, especially involving physical activity and diet.

Table 2 – Description of advantages and limitations of using conicity index as visceral fat marker to determine high coronary risk.

Advantages	Limitations
• Better anthropometric indicator for young women (30 to 49 years old) • Independent of the association with BMI as WHR and WC • Weight and height are considered, allowing comparison among individuals • Normality values can be calculated for the projection of interventions (CI = 1.0) • Risk marker for metabolic syndrome, diabetes, sleep apnea and other diseases.	• Dependent on ethnic component • Cutoff ranging with age • Scale and anthropometer are required, besides a tape measure • Cutoff set in Salvador City – Bahia State, Brazil

CONCLUSION

The conicity index has advantages over other visceral fat markers to detect high coronary risk since it includes in its calculation the circumference measure of height and weight, which allows direct comparisons among individual or population abdominal adiposity for different somatotypes. This was particularly evident for sampling data from women due to the known gynoid distribution of sex-specific fat mass. Further applications not including HCR determination would be markers of risk of metabolic syndrome, diabetes, sleep apnea, among others, expanding thus their predictive and applicable potential in Public Health.

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Local de realização do trabalho: Centro Universitário São Camilo, São Paulo, SP, Brasil.