

## Equations for estimating the body aesthetic of young women

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Published online: June 30, 2019

(Accepted for publication: June 18, 2019)

DOI:10.7752/jpes.2019.02177

### Abstract.

The objective was to develop an equation capable of predicting the aesthetic note using anthropometric and body composition data. Participated in this study 80 women with a median age of 22 (18-35). Anthropometric measures and body composition were measured: abdomen / hip ratio (AHR); Body Mass Index (BMI), visceral fat area (VFA), muscle mass (MM), fat mass (FM), waist hip ratio (WHR), somatotype, circumferences and skinfolds. The aesthetic note was given by a jury of 20 professionals of physical education, being 10 men and 10 women, with the respective average ages of  $29.90 \pm 3.84$  and  $35.20 \pm 8.72$  years. The aesthetic scores attributed by the women ( $4.84 \pm 1.36$ ) were statistically higher ( $p < 0.0001$ ) than the men's scores ( $3.36 \pm 1.15$ ). The correlation between aesthetic notes attributed by women and men was very strong ( $r = 0.90$ ,  $p < 0.0001$ ). The variables abdominal bend, IAQ, MG / height<sup>2</sup>, calf bending, calf circumference and BMI contributed significantly to predict the general aesthetic note, and remained in the final multiple linear regression model by the Stepwise method. In order to predict the aesthetic note attributed by men, the predictive variables resulting from the multiple linear regression were abdominal bending, IAQ, ectomorphy, calf circumference, AGV, calf flex and for the scores attributed by women, abdominal flexion, abdominal circumference, calf circumference and mesomorphy were the ones that contributed significantly. The equations containing anthropometric and body composition variables were able to reasonably predict women's aesthetic note.

**Key words:** beauty; esthetics; body composition; anthropometry

### Introduction

Beauty is defined as a mental attitude, as well as a cultural expression that has become the object of desire, independent of age and social class, and is seen by each individual differently<sup>1</sup>. Therefore, it is a relative concept in which each person contemplates within himself, involving preference and particular taste, generating different visions of what it is to be beautiful<sup>2</sup>.

Nowadays beauty standards range from children to men, women and the elderly, since everyone seeks to feel beautiful within society<sup>3</sup>. Vash<sup>3</sup> denotes that regardless of economic crises, spending on beauty products is always high in that attractiveness influences the opinions of others, and people judged as beautiful tend to be seen as individuals with higher qualities, interpersonal skills, and kindness.

Ferrari and Silva<sup>4</sup> consider that body aesthetics appears as a value of extreme importance in modern society. Body beauty helps people achieve higher socio economic positions, gaining advantages by being perceived as being more intelligent, healthy, and happy<sup>3</sup>.

Still, being thin and longilineous results in having a more beautiful body<sup>6</sup>. In addition, studies indicate that thinness has become a predictor of fertility<sup>7,8</sup>. Therefore, the capacity of reproduction influences the attraction and choice of partners<sup>9</sup>. Therefore, beauty is an important object that directly influences social relations<sup>3</sup>. Thus, the objective of the study was to create an equation capable of predicting the aesthetic note using anthropometric and body composition data to facilitate understanding of body beauty.

## Methods

It is a cross-sectional and observational study, using a non-probabilistic and convenience sample, where 80 women with a median age of 22 years were evaluated (18-35). All volunteers, after being informed of the research procedures, underwent a physical evaluation set (anthropometric measurements, body bioimpedance) and answered questionnaires to determine the sociodemographic profile, the level of physical activity and to assess the degree of satisfaction / concern with the body shape. The recruitment of the participants lasted for one month, and was done by the dissemination through social networks, (WhatsApp © and Facebook ©), posters and directly by team members. The female participants were instructed on the previous procedures and on dressing at the time of the standardized bikini evaluation provided by the research team, for photographic record of frontal, posterior view and profile in anatomical position. These evaluations were carried out in the physical evaluation room of the Jacarezinho academy, located in the neighborhood near UFMT.

Twenty physical education professionals of both genders (ten men and ten women), aged  $29.90 \pm 3.84$  and  $35.20 \pm 8.72$  years, participated in the Fitness, Body and health, and these are directly linked to some paid activity for at least 12 consecutive months. These were contacted by those responsible for the research, and informed about the procedures of the photographic image evaluations, after the positive judgment to participate in the research was scheduled a schedule and place to be combined for the accomplishment of the evaluations and completion of the questionnaire, these evaluations were made through the presence of one of the members of the research.

The project was approved by the Research Ethics Committee of the Federal University of Mato Grosso (CEP: 981.418 / CEP / HUJM) under the number CAAE: 65133517.5.0000.5541. All the volunteers in this study signed a free and informed consent term, which provided information on preservation, integrity and the confidentiality of all participants.

### Anthropometric Assessment

All evaluations were performed by a single evaluator, thus maintaining greater reliability in the data. For all evaluations it was adopted as protocol, abstain from physical exercise on the day of the evaluation and be fasting for at least four hours. For the anthropometric measures, techniques described by Jackson and Pollock<sup>10</sup> were used. Body mass (MC) in kg and height (E) were measured in meters, using a Welmy W110H brand platform scale, with a maximum capacity of 200 kg and a precision of 100 g.

To measure the skin folds, a Lange® brand adipometer (Beta Technology INC, Santa Cruz, CA, USA) was used, with constant pressure of 10g / mm<sup>2</sup> on contact surface, accuracy of 1 mm and scale of 0-65 mm. The value recorded was the average of three consecutive measurements of the folds: subscapular, triceps, biceps, pectoral, supra iliac, abdominal, medial thigh and calf. An inextensible flexible metal tape (Cescorf) measuring 2 meters in length with a precision of 0.01 cm was used to gauge the circumference of the body segments: neck, shoulder, chest, chest, waist, abdomen, arm, forearm, hip, thigh proximal, medial thigh, calf<sup>11</sup>.

The bone diameters evaluated were the humeral biepicondyle and the femoral bicondyle. The first one was evaluated with the elbow flexed at 90° and the caliper rods at 45° in relation to the joint; the second was evaluated with the volunteer in the seated position forming a 90° angle at the knee joint at a 45° angle at the instrument placement.

The hip abdominal index was calculated according to Rosenvaum et al.<sup>12</sup>; the waist hip ratio by the formula described by Lohman et al.<sup>13</sup> the somatotype by the formulas adapted by Brito et al.<sup>14</sup>, of the Heath and Carter spreadsheet<sup>15</sup>. The percentage of fat mass (% MG), total MG in kg, skeletal muscle mass in kg (MM), body mass index (kg / m<sup>2</sup>) and area of visceral fat (VFA) in cm<sup>2</sup> were analyzed by a InBody S10 Bioimpedance Apparatus which is a multi-frequency body composition analyzer.

### Data analysis

The Kolmogorov-Smirnov test was used to analyze the data distribution. Due to the non-normality of the data, the Wilcoxon test was used to compare the aesthetic note attributed by men and women and the Spearman correlation to verify the associations between the aesthetic scores attributed by men and women. Multiple stepwise linear regression (Stepwise) was performed to predict the aesthetic note of the volunteers, in this method the predictive variables are added to the model according to the capacity that it possesses to predict the output variable. Each time a predictor is added to the equation, a removal test is done on the less useful predictor in an attempt to identify and remove some redundant predictor. Two models were used to predict the general aesthetic note, attributed by men and attributed by women. The first regression model was made using all anthropometric variables and body composition measured, as well as age. In the second model, only variables of easy measurement were used: body mass, height, age, circumferences, BMI, IAQ and WHR.

The level of significance was set at 5% ( $p < 0.05$ ). Data are presented descriptively in tables and text as mean and standard deviation for parametric and median, minimum and maximum data for non-parametric data.

## Results

Table I shows the profile and body composition of the sample in mean and standard deviation and mean and median. The mean age of the volunteers was 22 (18-35) years, mean height  $1.63 \pm 0.06$  m, BMI was within the normal range of  $23.1$  (18-37.2)  $\text{kg} / \text{m}^2$  and waist circumference with a mean of  $72.64 \pm 7.34$  cm.

Table I. Profile and body composition of the sample of young women.

	(n=80)
<b>Age (years)</b>	22 (18-35)
<b>Height (m)</b>	$1,63 \pm 0,06$
<b>Body mass (kg)</b>	$63,8 \pm 12,1$
<b>BMI (<math>\text{kg} / \text{m}^2</math>)</b>	23,1 (18-37,2)
<b>FM (kg)</b>	18,4 (7,3-49,5)
<b>FM (%)</b>	$29,23 \pm 8,08$
<b>MM (kg)</b>	$24,38 \pm 3,65$
<b>MM (%)</b>	$38,69 \pm 4,62$
<b>FM/height<sup>2</sup> (<math>\text{kg} / \text{m}^2</math>)</b>	$7,19 \pm 3,01$
<b>MM/height<sup>2</sup> (<math>\text{kg} / \text{m}^2</math>)</b>	$14,57 \pm 1,93$
<b>AGV (<math>\text{cm}^2</math>)</b>	76,1 (17,7-223)
Circumferences (cm)	
<b>Neck</b>	$32,24 \pm 1,86$
<b>Shoulder</b>	$96,8 \pm 4,8$
<b>Chest</b>	87,6 (77-113)
<b>Breastplate</b>	$90,8 \pm 8,4$
<b>Arm</b>	27,9 (22,1-39,8)
<b>Forearm</b>	$24,59 \pm 2,33$
<b>Waist</b>	$72,64 \pm 7,34$
<b>Abdominal</b>	$82,79 \pm 8,74$
<b>Hip</b>	$100,5 \pm 8,41$
<b>Proximal thigh</b>	60,1 (48,2-81,5)
<b>Medial thigh</b>	$51,31 \pm 5,35$
<b>Calf</b>	$36,62 \pm 3,15$
<b>IAQ</b>	$0,82 \pm 0,04$
<b>HWR</b>	0,72 (0,64-0,82)
Skinfolds (mm)	
<b>Breastplate</b>	23,0 (8-45)
<b>Triceps</b>	$25,93 \pm 6,59$
<b>Subscapular</b>	$26,05 \pm 9,39$
<b>Bicipital</b>	14,0 (4-32)
<b>Abdominal</b>	36,5 (15-59)
<b>Suprailiac</b>	$28,14 \pm 10,76$
<b>Calf</b>	$25,98 \pm 8,46$
<b>Thigh</b>	$34,79 \pm 9,22$
<b>Gluteal</b>	50,0 (32-63)
Diameters (cm)	
<b>Umeral</b>	6,0 (5,3-7,6)
<b>Femoral</b>	8,8 (7,5-10,7)
Somatotype	
<b>Endomorphy</b>	$7,27 \pm 1,52$
<b>Mesomorphy</b>	4,3 (1,3-8,6)
<b>Ectomorphy</b>	1,8 (0,1-4,7)

SOURCE: The author (2018). BMI ( $\text{kg} / \text{m}^2$ ) – Body mass index; MG (kg) - Fat mass; FM (%) - Fat mass; MM (kg) – Skeletal muscle mass; MM (%) – Skeletal muscle mass; MG / height<sup>2</sup> ( $\text{kg} / \text{m}^2$ ) - Fat mass / height<sup>2</sup>; MM / height<sup>2</sup> ( $\text{kg} / \text{m}^2$ ) – Skeletal muscle mass / height<sup>2</sup>; AGV ( $\text{cm}^2$ ) - Visceral fat area; IAQ- Index hip abdomen; RCQ- Hip waist ratio.

The aesthetic scores attributed by the women ( $4.84 \pm 1.36$ ) were significantly ( $p < 0.0001$ ) higher than those attributed by men ( $3.36 \pm 1.15$ ) (Figure I, Chart A). The correlation between the aesthetic notes attributed by the women and the men had a very strong association ( $r = 0.90$ ,  $p < 0.0001$ ) (Figure I, Chart B).

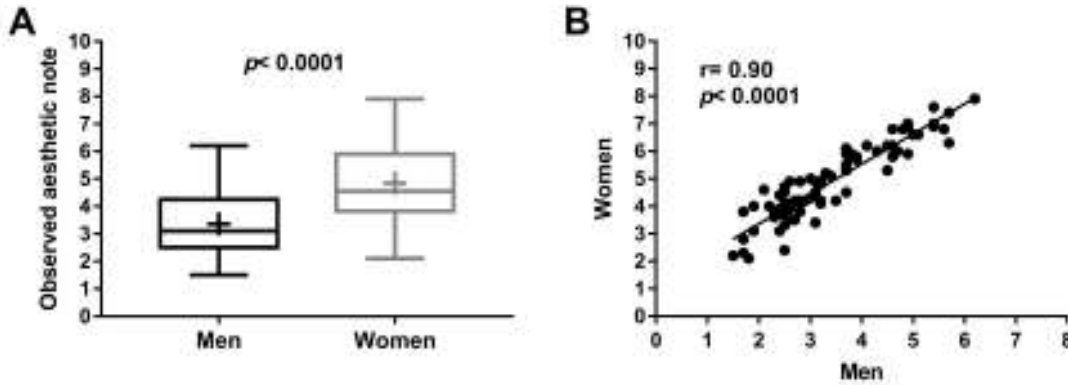


Figure I. Graph A: Comparison between averages of aesthetic notes observed: men vs. women. Graph B: Correlation between observed scores of men and women.

The line inside the box represents the median of the data, the plus sign represents the average of the data, the lower and upper rows of the boxes contain the data between the 25th and 75th percentiles and the lower and upper bars represent the minimum and maximum values as well respectively. A: Wilcoxon's test; B: Spearman correlation.

The variables abdominal bend, IAQ,  $MG / height^2$ , calf flexion, calf circumference and BMI contributed significantly to predict the general aesthetic note, and remained in the final multiple linear regression model by the Stepwise method. To predict the aesthetic note attributed by men, the predictive variables resulting from multiple linear regression were abdominal flexion, IAQ, ectomorphy, calf circumference, AGV, calf flexion. Finally, the variables abdominal flexion, abdominal circumference, calf circumference and mesomorphy were those that contributed significantly to predict women's aesthetic note (Table II).

Table II. Non-standard coefficients, standard error of coefficients and standardized coefficients obtained from the regressions made to predict aesthetic scores attributed by men, women and general.

	B	Default errorB	B
Aesthetic note (general) - 1			
<b>Constant</b>	9,932	2,097	
<b>Abdominal bend (mm)</b>	-0,036	0,013	-0,279*
<b>IAQ</b>	-8,049	2,137	0,269*
<b>FM / height<sup>2</sup> (kg / m<sup>2</sup>)</b>	-0,192	0,076	-0,473*
<b>Calfbending (mm)</b>	0,035	0,016	0,242*
<b>Circ. calf (cm)</b>	0,167	0,049	0,430*
<b>BMI (kg / m<sup>2</sup>)</b>	-0,148	0,063	-0,450*
Aesthetic note (general) - 2			
<b>Constant</b>	2,744	2,431	
<b>Circ. abdominal (cm)</b>	-0,113	0,020	-0,806*
<b>Circ. calf (cm)</b>	0,168	0,037	0,432*
<b>Height (m)</b>	5,521	1,551	0,264*
<b>Circ. pectoral (cm)</b>	-0,049	0,019	-0,335*
Aesthetic note (Mens)-1			
<b>Constant</b>	5,846	2,137	
<b>Abdominal bend (mm)</b>	-0,029	0,013	-0,242*
<b>IAQ</b>	-9,113	2,116	-0,326*
<b>Ectomorphy</b>	0,469	0,105	0,473 *
<b>Circ. calf (cm)</b>	0,144	0,039	0,396*

<b>AGV</b>	-0,012	0,003	-0,495*
<b>Calfbending (mm)</b>	0,039	0,015	0,289*
Aesthetic note (Men) -2			
<b>Constant</b>	1,628	2,366	
<b>Circ. abdominal (cm)</b>	-0,104	0,019	-0,791*
<b>Circ. calf (cm)</b>	0,165	0,036	0,454*
<b>Height (m)</b>	5,186	1,509	0,265*
<b>Circ. pectoral (cm)</b>	-0,046	0,019	-0,338*
Aesthetic note (Women)-1			
<b>Constant</b>	6,211	1,521	
<b>Abdominal bend (mm)</b>	-0,048	0,015	-0,338*
<b>Circ. abdominal (cm)</b>	-0,094	0,019	-0,605*
<b>Circ. calf (cm)</b>	0,268	0,055	0,622*
<b>Mesomorphy</b>	-0,369	0,104	-0,414*
Aesthetic note (Women)-2			
<b>Constant</b>	3,653	2,767	
<b>Circ. abdominal (cm)</b>	-0,124	0,022	-0,796*
<b>Circ. calf (cm)</b>	0,173	0,042	0,401*
<b>Height (m)</b>	5,975	1,765	0,258*
<b>Circ. pectoral (cm)</b>	-0,051	0,022	-0,317*

B: non-standardized coefficient.  $\beta$ : standardized coefficient. Number 1: multiple linear regression to predict the aesthetic note observed using all variables measured. Number 2: multiple linear regression to predict the aesthetic note observed using only variables of easy measurement. \*  $p < 0.05$ . SOURCE: The author (2017). IAQ- Index hip abdomen; BMI ( $\text{kg} / \text{m}^2$ ) - Bodymass index; Fat mass / height<sup>2</sup> ( $\text{kg} / \text{m}^2$ ) - Mass; Fat / height<sup>2</sup>; MM / height<sup>2</sup> ( $\text{kg} / \text{m}^2$ ) - Skeletalmuscle mass / height<sup>2</sup>; AGV ( $\text{cm}^2$ ) - Visceral fat area; HWR - Hip waist ratio.

The equations obtained to predict the observed general aesthetic note significantly explained the variation of the data around the mean of the aesthetic note ( $p < 0.001$ ), with 72% and 65% of the variation of the aesthetic note being explained by the model that included all variables measured and the model that included the variables of easy measurement, respectively (Figure 2, Graphs A1 and A2). The equations obtained to predict the aesthetic note attributed by the men also explained significantly the variation of the aesthetic note ( $p < 0.001$ ), 71% of the variation of the data around the aesthetic note average can be explained by the model that included all the variables measured and 62% by the model that included the variables of easy measurement (Figure 2, Graphs B1 and B2). Finally, 67% of the data variation around the mean of the aesthetic note given by the women can be explained by the model that included all the variables measured ( $p < 0.001$ ) and 63% by the model that included easy-to-measure variables ( $p < 0.001$ ) (Figure 2, Charts C1 and C2).

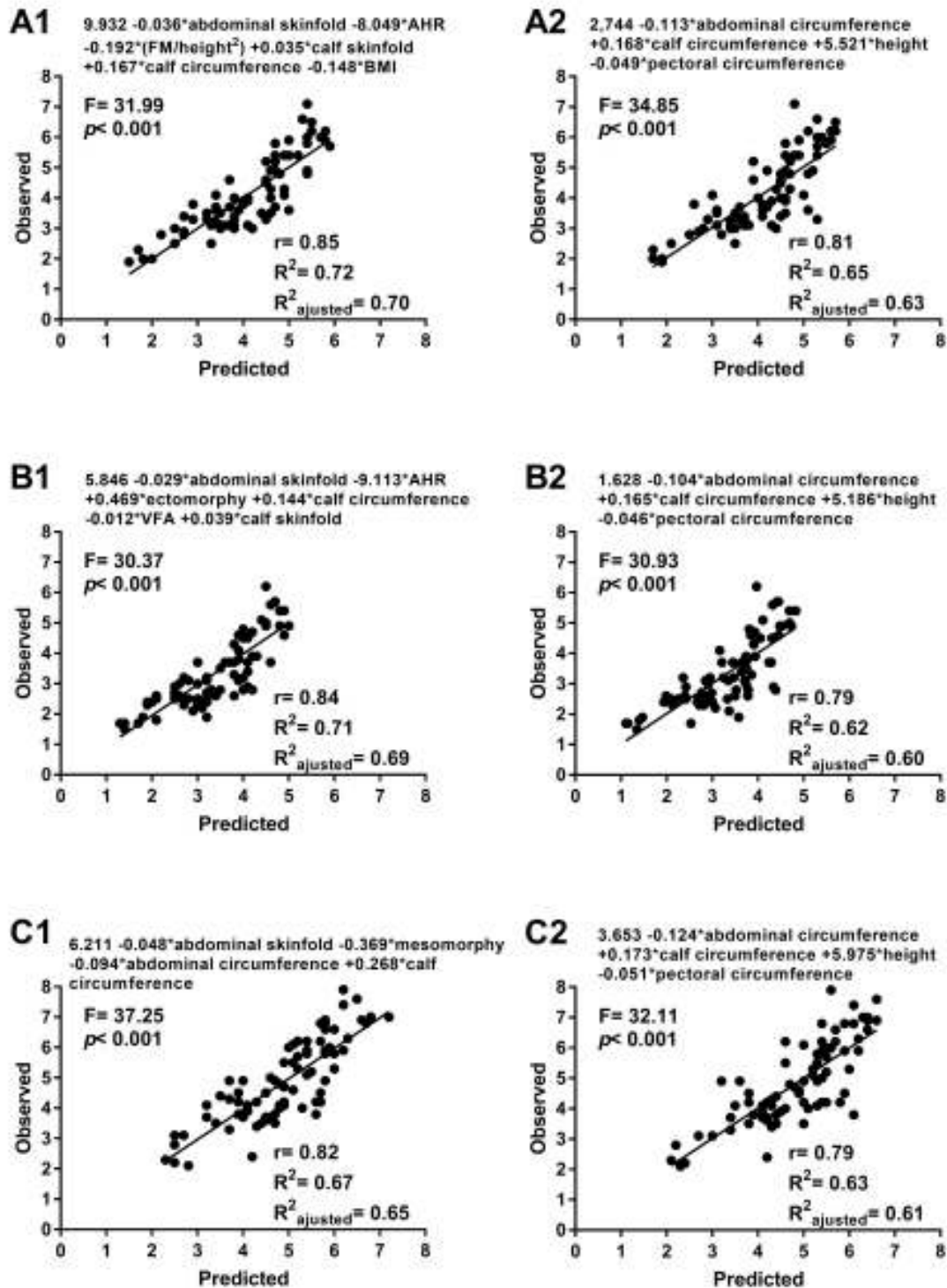


Figure II. Multiple linear regression and model residual stop predict the aesthetic scores attributed by men, women and general.

Letters A, B, C refer to the general aesthetic notes of men and women, respectively. Number 1: multiple linear regression to predict the aesthetic note observed using all variables measured. Number 2: multiple linear regression to predict the aesthetic note observed using variables of easy measurement. \* p < 0.05.

## Discussion

The findings show that women differ from men because they are less judgmental in assessing female bodies. On the other hand, men and women share considerably the same vision of what is considered beautiful in the female body. This was evidenced by two reasons: 1) the high correlation between the aesthetic scores attributed by men to those attributed by women and 2) by the same variables of easy measurement (circumferences of abdomen, pectoral, calf and height) to form the equations attributed by men and attributed by women.

Authors note that women tend to accept their own bodies by viewing photos of other bodies that do not fit the ideal profile of beauty, making this a possible factor for women's highest marks<sup>16</sup>. Brierley et al.<sup>17</sup>, when comparing female and male observers, found that women attributed higher aesthetic scores for attractiveness than men to female bodies with a given value of combined fat and muscle mass, corroborating our findings.

As a result of the general equation developed through anthropometric measurements, it is suggested that the greater abdominal bending, WHI and BMI, the lower the esthetic score, according to Stephen and Perera<sup>18</sup> who showed that men and women observing images of female bodies consider less attractive women with higher BMI values. The aesthetic jury's preference for smaller values in the abdominal fold may represent the current preference of bodies based on the "fine ideal" of athletic bodies<sup>17,19</sup>.

Some scholars point out that men and women are different in judging attractiveness<sup>20</sup>. Wang et al.<sup>23</sup> suggest that men, in judging the type of potential partner, have preferences for fairly narrow bodies. Similar to the results of this study, ectomorphy was relevant to predict the aesthetic note attributed by men.

The most significant data were abdominal bend, IAQ, visceral fat and higher values of fold and calf circumference for the aesthetic note attributed by men. For the scores attributed by the women were significant in predicting the aesthetic note, the abdominal fold, IAQ, mesomorph and calf. Both genders are currently influenced by the ideal concept of body impregnated by the media<sup>20,24</sup>. It is notorious that the effects of these processes are more influential in women, since the country's culture constantly displays women as patterns of feminine beauty models<sup>25</sup>.

The WHR, has been an important factor of prediction of attractiveness, being, analogically explained due to the direct effect of the fat content. Therefore, total body fat becomes a determinant of the attractiveness of female body shape<sup>23</sup>. Abdominal adiposity reflects on total body fat and is considered an indicator for health and fertility<sup>8</sup>.

Currently, following the trend of sports academies and centers, a "piebald" body is considered an important highlight<sup>26</sup>. We assume that the result of calf development as an attraction factor is due to the appearance of an increase in the popularity of the fit, lean and athletic body beauty pattern<sup>27</sup>.

As a controversy in the literature, the sequence of the image presentations of the volunteers may or may not influence the following aesthetic notes. According to Kramer et al.<sup>28</sup> the appearance of the previous volunteer, it is able to play an important factor in the judgment of the next evaluated ones. However, Tovée et al.<sup>20</sup> argues that the range of images presented sequentially does not influence the aesthetic note of the volunteers, because this short time from presentation to the other, causes a change in the term of attractiveness preferences, which are found in real life in the choices of partners, thus defending the hypothesis that each body has its value.

It is important to mention the limitation of this study, when not measuring measures of body sizes, such as the size of lower limbs. For such measurements are being used as an aspect of human attractiveness. Thus, new studies are suggested to predict the aesthetic note, using measures of body sizes.

## Conclusions

Men and women have considerably similar criteria for female body aesthetics, though men are more rigid in assessing the appearance of the female image than women. The equations containing anthropometric and body composition variables were able to reasonably predict women's aesthetic note.

## Acknowledgement

This study was supported and financed (Financing Code 001) by the Coordination for the Improvement of Higher Level Personnel - Brazil (CAPES). The authors thank the volunteers involved in this research.

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