Evaluation of angular, linear, and body index measures of pêga donkeys (*Equus Asinus*) from southeast of Brazil

Avaliação de medidas angulares, lineares e do índice corporal de burros-do-pêga (*Equus Asinus*) do sudeste brasileiro

Evaluación de medidas angulares, lineales y del índice corporal de burros pêga (*Equus Asinus*) del sureste de Brasil

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ABSTRACT
The objective of this study was to perform body evaluation of Pêga donkeys (40 females and 10 males) from the Southeast Region of Brazil. Hippometer, measuring tape, and artrogoniometer were used, considering the left antimere of the animals in a forced quadrupedal position. The analysis of variance showed a difference (p<0.05) between males and females for chest width, CPr, withers height, croup height, body length, back-loin length, posterior pastern length, and the angle of the tibiometatarsal joint. The values for body length, anterior pastern length, scapulohumeral angle, and metacarpophalangeal joint differed (p<0.05) between farms. Compactness index 1 and conformation index classified the animals as suited for saddle activities, and compactness index 2 classified them as suited for light drafting. The dactylothoracic index classified the animals into eumetric. Cannon load index was similar between sexes and between states. The load on the back by step index was 167.9±12.6 kg, and the LGI was 95.9±6.0 kg, equal between sexes and higher for the animals from RJ. It is concluded that the Pêga breed has sexual dimorphism and regional selection, interfering with morphometry and aptitude for saddle and light draft.

Keywords: Morphometrics, Conformation, Biometry.

RESUMO
O objetivo deste estudo foi realizar a avaliação corporal de burros Pêga (40 fêmeas e 10 machos) da Região Sudeste do Brasil. Hipômetro, fita métrica e artrogoniômetro foram utilizados, considerando a antímera esquerda dos animais em posição quadrupedal forçada. A análise da variância mostrou diferença (p<0,05) entre machos e fêmeas para a largura do tórax, CPr, altura da cernelha, altura do crup, comprimento do corpo, comprimento do lombo traseiro, comprimento da pastagem posterior e o ângulo da articulação tibiometatarsal. Os valores de comprimento do corpo, comprimento da pastagem anterior, ângulo escapuloumeral e articulação metacarpofalângea diferiam (p<0,05) entre as fazendas. O índice de compacidade 1 e o índice de conformação classificaram os animais como aptos para atividades de sela, e o índice de compacidade 2 classificou-os como aptos para a redação de luz. O índice dactilotorácico classificou os animais em eumétricos. O índice de carga do canhão foi semelhante entre os sexos e entre os estados. A carga no índice back by step foi de 167,9±12,6 kg, e o LGI foi de 95,9±6,0 kg, igual entre os sexos e superior para os animais do RJ. Conclui-se que a raça Pêga tem dimorfismo sexual e seleção regional, interferindo com a morfometria e aptidão para sela e calado leve.

Palavras-chave: Morfometria, Conformação, Biometria.

RESUMEN
El objetivo de este estudio fue realizar una evaluación corporal de burros Pêga (40 hembras y 10 machos) de la Región Sureste de Brasil. Se utilizó hipómetro, cinta métrica y artrogoniômetro, considerando el antímero izquierdo de los animales en posición cuadrupeda forzada. El análisis de la varianza mostró una diferencia (p<0,05) entre machos y hembras para el ancho del pecho, la CPr, la altura de la cruz, la altura del crup,
la longitud del cuerpo, la longitud del lomo trasero, la longitud de la protuberancia posterior y el ángulo de la articulación tibiometatarsiana. Los valores para la longitud del cuerpo, la longitud anterior de la cuartilla, el ángulo escapulohumeral y la articulación metacarpofalángica diferían (p <0,05) entre las granjas. El índice de compacidad 1 y el índice de conformación clasificaron a los animales como adecuados para las actividades de silla de montar, y el índice de compacidad 2 los clasificó como adecuados para la redacción ligera. El índice dactilotorácico clasificó a los animales en eumétricos. El índice de carga del cañón fue similar entre sexos y entre estados. La carga en la espalda por índice de paso fue de 167,9±12,6 kg, y la LGI fue de 95,9±6,0 kg, igual entre sexos y mayor para los animales de RJ. Se concluye que la raza Pêga tiene dimorfismo sexual y selección regional, interfiriendo con la morfometría y la aptitud para el sillín y el tiro ligero.

**Palabras clave:** Morfometría, Conformación, Biometría.

**1 INTRODUCTION**

Equine breeding in Brazil continues to grow, reaching about 6 million animals in 2020, although the released data did not cover the herds of donkeys and mules (IBGE, 2020). According to the Food and Agriculture Organization, in 2014, Brazil had the eleventh largest donkey herd in the world. Equines serve many purposes, and for each of them, animals of various types are needed, i.e., with specific characteristics related to conformation, aptitude, temperament, training, and performance (Lage *et al.*, 2009; Cunha, 2020).

Donkeys have rusticity and resistance to withstand great efforts, suggesting an aptitude for draft work, but evaluating some body indexes may indicate aptitude for another purpose, such as racing (Fonseca *et al.*, 2016). Thus, morphometric evaluation is essential to choose and proceed to breed characterization and differentiation, being estimated through associations between linear measures of many body parts, considering that it is necessary to have a compatible body profile to perform any activity. Body measures can be evaluated together, increasing the ability to understand changes over time, making it possible to develop objective selection criteria and replace subjective evaluations (Brum, 2010; Pimentel *et al.*, 2014; Moreira, 2016).
Morphometric data of donkeys are extremely scarce. Thus, the objective of this study was to evaluate linear, angular, and body index measures of Pêga donkeys (*Equus asinus*), checking through data if it was possible to infer aptitude and body capacity, among other characteristics of Pêga donkeys in Brazil.

2 METHODOLOGY

All procedures had consent, and this research was approved by the Ethics Committee on Animal Use of the Universidade Estadual do Norte Fluminense Darcy Ribeiro (protocol 499/2021). Morphometric, angular, and body index measures were performed on 50 Pêga donkeys, ten males (10) and forty females (40), aged between 4 and 9 years. The animals belonged to two properties, one located in the state of Rio de Janeiro and the other in the state of Minas Gerais. The animals were reared for reproduction and sale of female breeders. They were kept in a semi-intensive grazing system and received mineral salt, forage (*Cynodon dactylon*: coast-cross, Tifton 85, and Vaquero grass), water *ad libitum*, and concentrate feed for equines. All animals were vaccinated annually against encephalomyelitis, influenza, rhinopneumonitis, tetanus, and dewormed twice a year. The morphometric evaluations (Table 1) were made with a metal hippometer (Walmur®-2 meters) and a measuring tape (300 cm).

The angular measures (Table 1) were taken using an arthrogoniometer. All measurements were performed individually by a single evaluator using the left antimere of the animals in a forced quadrupedal position on a rigid, smooth, and flat floor. Body indexes were calculated as described in Table 2, following the definitions previously mentioned by others authors.

<table>
<thead>
<tr>
<th>Linear Measures</th>
<th>Topograph description of linear measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Head Lenght (THL):</td>
<td>Distance from the nuchal crest to the rostral end above the upper incisors (muzzle);</td>
</tr>
<tr>
<td>Forehead length (Frontal bone)</td>
<td>Distance from the nuchal crest to the line drawn between the eyes starting from the medial angle of the eye;</td>
</tr>
<tr>
<td>FL:</td>
<td></td>
</tr>
<tr>
<td>Bridge of nose length (BNL):</td>
<td>Distance from the interorbital midline to the rostral end above the upper incisors;</td>
</tr>
<tr>
<td>Depth of head (DH):</td>
<td>It was measured through a perpendicular line drawn from the angle of the hemimandible to bridge</td>
</tr>
</tbody>
</table>

Table 1. Characterization of linear and angular measures of Pêga donkeys
of nose (transition region between nasal and frontal bone, passing through the medial angle of eye;)

Left interlabial width: (LIW) Distance from the left labial commissure to the rostral end, near the lower incisors (muzzle)
Inteauricular width (IAW): Distance between the two prominent outer ears;
Internasal width (INW): Distance between the most prominent bony points on the dorsal surface of the midline of the eyes;
Ear length (EL): Distance between the wings of the nostril laterally left and right.
Croup width (CW): Distance between the base of the ear and the distal tip.
Croup length (CL): Through the distance from the right ischial tuberosity to the tip of the left ischial tuberosity;
Chest width (ChW): Distance between the wing of the ileum and the ischial tuberosity.
Cannon perimeter (CPr): By measuring the circumference in the median region of the cannon of the left forelim, formed by the metacarpal bones II, III and IV;
Interauricular width (IAW): Distance between the two prominent outer ears;
Thoracic perimeter (TPr): Through the narrowest portion of the thorax, caudally to the withers, in the dorsal portion of the last thoracic vertebrae, and ventrally in the caudal part of the sternum;
Withers height (WH): From the highest point of the interscapular region to the ground;
Croup height (CH): From the highest point of the sacral tuberosity of the ileum to the ground;
Body length (BL): Between the greater tubercle of the humerus and the ischial tuberosity;
Back-loin length (BLL): Distance between the meeting point of the shoulder blades and the last lumbar vertebra.
Chest width (ChW): Distance between the wing of the ileum and the ischial tuberosity;
Anterior pastern length (APL): Distance between the middle of the metacarpophalangeal joint and the middle of the proximal interphalangeal joint.
Posterior pastern length (PPL): Distance between the middle of the metacarpophalangeal joint and the middle of the proximal interphalangeal joint.
Anterior cannon length (ACL): Distance between the middle of the radioulnar metacarpal joint and the middle of the metacarpophalangeal joint.
Posterior cannon length (PCL): Distance between the middle of the tibiofibular metatarsal joint the middle of the metatarsophalangeal joint.
Weight (W): It is estimated by the formula: Body Mass - Thoracic perimeter3 x constant 80.
Scapula-ground angle; Angle between scapula and ground;
Scapulohumeral angle; Angle between scapula and humerus;
Humeroradial angle; The angle between the humerus and the radius/ulna;
Metacarpophalangeal angle; Angle between the metacarpal bone and the anterior phalanx;
Anterior phalanx-ground angle; Angle between the posterior phalanx and the ground;
Hip-ground angle; Angle between hip and ground;
Hip angle; Angle between hip and femur;
Femorotibial angle; Angle between femur and tibia/fibula
Tibiometatarsal angle; Angle between tibia/fibula and metatarsal;
Metatarsophalangeal angle; Angle between the metatarsal and the anterior phalanx;
Posterior phalangeal-ground angle; Angle between the posterior phalanx and the ground;

Source: Authors

Table 2: Characterization of body indexes evaluated in Pêga donkeys.

<table>
<thead>
<tr>
<th>Body Index</th>
<th>Description</th>
<th>Formula</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compactness index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (ICC1)</td>
<td>It relates the estimated weight divided by the withers height, multiplying the result by one hundred.</td>
<td>ICC1 = <em>Weight</em> x 100/Heigh at Withers</td>
<td>Heavy draft: &gt; 3.15;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Light draft: +/- 2.75;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Saddles: &lt; 2.6</td>
</tr>
<tr>
<td>Compactness index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (ICC2)</td>
<td>It corresponds to the estimates weight divided by the wither’s height substracted</td>
<td>ICC2 = <em>Weight</em> x 100/Heigh at Withers - 1</td>
<td>Heavy draft: &gt; 9.5;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Light draft: +/- 9.5 - 8</td>
</tr>
</tbody>
</table>
from the value 1, multiplied by one hundred.

Body Index (BI)
It relates body length chest perimeter.

\[
I_{\text{Corp}} = \frac{\text{Body length} \times 100}{\text{Chest perimeter}}
\]

Dactylothoracic index (DTI)
It relates the cannon perimeter to the chest perimeter.

\[
I_{\text{DTI}} = \frac{\text{Cannon perimeter} \times 100}{\text{Chest perimeter}}
\]

Cannon load index (CLI)
It relates the cannon perimeter to the weight.

\[
I_{\text{Cam}} = \frac{\text{Cannon perimeter} \times 100}{\text{Weight}}
\]

Conformation index (CI)
Allows assessing the amplitude of the horse.

\[
I_{\text{Conf}} = \frac{\text{Cannon perimeter}^2}{\text{Height at Withers}}
\]

Load on the back by step index (LBI)
Ratio of the product of the squared chest perimeter with constant 98 and the withers height.

\[
I_{\text{CP}} = \frac{\text{Cannon perimeter}^2 \times 98}{\text{Height at Withers}}
\]

Load on the Back at Gallop Index (LGI)
Ratio of the product of the squared chest perimeter with constant 56 and the withers height.

\[
I_{\text{CG}} = \frac{\text{Cannon perimeter}^2 \times 56}{\text{Height at Withers}}
\]

Saddles: \(< 7.75 - 6.\)
Longilineal BI \(\geq 90\)
Mediolineal \(86 \leq BI \leq 85\)
Brevilineal \(< 11.5\)
Hypermetric \(DTI > 10.8\)
Eumetric \(10.5 \leq DTI \leq 10.8\)
Hypometric \(DTI < 10\)

Conformation index (CI)
Allows assessing the amplitude of the horse.

Source: Authors

Means and Univariate procedures were applied in the SAS program (SAS University Edition, 2021) for data consistency (means, standard deviation, maximum and minimum values, and coefficient of variation) and normality test. Analyses of variance were performed to test the effect of sex and property within the state (GLM procedure, SAS, University Edition, 2021). The Tukey-Kramer test compared the means for effects of sex and property at 5% probability.

3 RESULTS AND DISCUSSION

The results can be seen in Table 3. The analysis of variance showed a difference (p<0.05) between males and females for ChW, CPr, WH, CH, BL, BLL, PPL, and the
angle of the tibiometatarsal joint. There was a difference between properties (p<0.05) for BL, APL, scapulohumeral angle, and metacarpophalangeal joint.

The ICC1 indicated that the evaluated Pêga donkeys have aptitude for saddle, and the ICC2 indicated aptitude to perform light draft. The CI was equal for both sexes and states, indicating that they are animals without aptitude for draft work and with aptitude for saddle and racing activities. BI indicated that males and animals from the state of Minas Gerais are longilineal, and females and animals from the state of Rio de Janeiro are mediolineal. The DTI classified the Pêga donkeys as eumetric.

Table 3. Means and standard deviation of linear, angular, and body index measures of Pêga donkeys

<table>
<thead>
<tr>
<th>Effects</th>
<th>Sex</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Male (N=10)</td>
<td>Females (N=40)</td>
</tr>
<tr>
<td>THL (cm)</td>
<td>57.1 ± 3.0a</td>
<td>56.6 ± 1.7a</td>
</tr>
<tr>
<td>FL (cm)</td>
<td>33.7 ± 4.0a</td>
<td>32.2 ± 3.8a</td>
</tr>
<tr>
<td>BNL (cm)</td>
<td>18.8 ± 1.8a</td>
<td>17.8 ± 1.8a</td>
</tr>
<tr>
<td>DH (cm)</td>
<td>28.0 ± 1.3a</td>
<td>27.3 ± 0.9a</td>
</tr>
<tr>
<td>LIW (cm)</td>
<td>8.7 ± 0.7a</td>
<td>9.2 ± 0.8a</td>
</tr>
<tr>
<td>IAW (cm)</td>
<td>6.5 ± 1.0a</td>
<td>7.1 ± 1.1a</td>
</tr>
<tr>
<td>IOW (cm)</td>
<td>21.0 ± 0.8a</td>
<td>21.1 ± 0.6a</td>
</tr>
<tr>
<td>INW (cm)</td>
<td>7.1 ± 0.8a</td>
<td>6.2 ± 1.5a</td>
</tr>
<tr>
<td>EL (cm)</td>
<td>32.5 ± 2.3a</td>
<td>32.0 ± 2.5a</td>
</tr>
<tr>
<td>CW (cm)</td>
<td>36.6 ± 9.8a</td>
<td>40.4 ± 3.8a</td>
</tr>
<tr>
<td>CL (cm)</td>
<td>41.3 ± 4.6a</td>
<td>40.1 ± 5.3a</td>
</tr>
<tr>
<td>ChW (cm)</td>
<td>33.2 ± 3.8a</td>
<td>29.7 ± 2.4b</td>
</tr>
<tr>
<td>CPr (cm)</td>
<td>16.6 ± 0.7a</td>
<td>15.6 ± 1.2a</td>
</tr>
<tr>
<td>TPr (cm)</td>
<td>151.7 ± 7.0a</td>
<td>148.8 ± 8.1a</td>
</tr>
<tr>
<td>WH (cm)</td>
<td>1.35 ± 0a</td>
<td>1.3 ± 0b</td>
</tr>
<tr>
<td>CH (cm)</td>
<td>1.4 ± 0a</td>
<td>1.3 ± 0b</td>
</tr>
<tr>
<td>BL (cm)</td>
<td>1.4 ± 0a</td>
<td>1.3 ± 0b</td>
</tr>
<tr>
<td>BLL (cm)</td>
<td>56.8 ± 5.4a</td>
<td>57.6 ± 4.7b</td>
</tr>
<tr>
<td>APL (cm)</td>
<td>7.2 ± 1.3a</td>
<td>8.0 ± 1.5a</td>
</tr>
<tr>
<td>PPL (cm)</td>
<td>7.7 ± 1.4a</td>
<td>8.7 ± 1.2b</td>
</tr>
<tr>
<td>ACL (cm)</td>
<td>22.9 ± 1.8a</td>
<td>21.7 ± 3.5a</td>
</tr>
<tr>
<td>PCL (cm)</td>
<td>29.2 ± 2.9a</td>
<td>28.3 ± 2.5a</td>
</tr>
<tr>
<td>W (kg)</td>
<td>280.8 ± 38.6a</td>
<td>265.9 ± 45.4a</td>
</tr>
<tr>
<td>Scapula-ground angle</td>
<td>99.6 ± 6.5a</td>
<td>99.4 ± 7.2a</td>
</tr>
<tr>
<td>Scapulohumeral angle</td>
<td>80.3 ± 12.8a</td>
<td>81.9 ± 12.0a</td>
</tr>
<tr>
<td>Radiohumeral angle</td>
<td>110.15 ± 15.6a</td>
<td>146.8 ± 23.3a</td>
</tr>
<tr>
<td>Metacarpophalangeal angle</td>
<td>138.3 ± 11.5a</td>
<td>144.0 ± 11.9a</td>
</tr>
<tr>
<td>Anterior phalanx-ground angle</td>
<td>-</td>
<td>111.9 ± 8.7a</td>
</tr>
<tr>
<td>Hip-ground angle</td>
<td>46.3 ± 8.8a</td>
<td>47.5 ± 5.3a</td>
</tr>
</tbody>
</table>
Hip angle  
Femorotibial angle  
Tibiometatarsal angle  
Metatarsophalangeal angle  
ICCI  
ICC2  
CI  
BI  
DTI  
LBI  
LGI  
CLI  

<table>
<thead>
<tr>
<th>Measure</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip angle</td>
<td>89.6 ± 4.7a</td>
<td>86.4 ± 9.0a</td>
<td>88.9 ± 4.7a</td>
<td>86.1 ± 9.0a</td>
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</tr>
<tr>
<td>Femorotibial angle</td>
<td>80.7 ± 8.7a</td>
<td>80.9 ± 12.3a</td>
<td>84.0 ± 8.7a</td>
<td>79.3 ± 12.3a</td>
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<td></td>
</tr>
<tr>
<td>Tibiometatarsal angle</td>
<td>141.5 ± 9.0a</td>
<td>135.0 ± 8.8a</td>
<td>136.9 ± 9.0a</td>
<td>136.1 ± 8.8a</td>
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</tr>
<tr>
<td>Metatarsophalangeal angle</td>
<td>152.6 ± 9.0a</td>
<td>154.1 ± 8.7a</td>
<td>149.2 ± 9.0a</td>
<td>149.2 ± 9.0a</td>
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</tr>
<tr>
<td>ICC1</td>
<td>2.1 ± 0.2a</td>
<td>2.0 ± 0.3a</td>
<td>2.1 ± 0.3a</td>
<td>2.0 ± 0.3a</td>
<td>1.9 ± 0.9a</td>
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<tr>
<td>ICC2</td>
<td>8.2 ± 0.9a</td>
<td>9.0 ± 1.5a</td>
<td>9.1 ± 1.6a</td>
<td>9.1 ± 1.6a</td>
<td>8.2 ± 0.9a</td>
<td></td>
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</tr>
<tr>
<td>CI</td>
<td>1.7 ± 0.1a</td>
<td>1.7 ± 0.1a</td>
<td>1.7 ± 0.2a</td>
<td>1.7 ± 0.2a</td>
<td>1.6 ± 0.1a</td>
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<td></td>
</tr>
<tr>
<td>BI</td>
<td>91.0 ± 3.3a</td>
<td>88.4 ± 4.7a</td>
<td>87.6 ± 4.7a</td>
<td>87.6 ± 4.7a</td>
<td>91.6 ± 2.7b</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DTI</td>
<td>10.8 ± 0a</td>
<td>10.5 ± 0a</td>
<td>10.8 ± 0a</td>
<td>10.8 ± 0a</td>
<td>10.5 ± 0a</td>
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</tr>
<tr>
<td>LBI</td>
<td>167.9 ± 12.6a</td>
<td>167.5 ± 12.5a</td>
<td>169.9 ± 17.5a</td>
<td>169.9 ± 17.5a</td>
<td>162.7 ± 9.2a</td>
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</tr>
<tr>
<td>LGI</td>
<td>95.9 ± 7.0a</td>
<td>95.7 ± 6.0a</td>
<td>97.1 ± 10.0a</td>
<td>97.1 ± 10.0a</td>
<td>92.9 ± 5.3a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLI</td>
<td>6.0 ± 0.9a</td>
<td>6.0 ± 1.0a</td>
<td>5.9 ± 1.1a</td>
<td>5.9 ± 1.1a</td>
<td>6.2 ± 0.6a</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Means followed by different letters in the same column differ statistically by Tukey-Kramer test at 5% probability; number of individuals (N); males (M); females (F); Rio de Janeiro (RJ); Minas Gerais (MG); centimeters (cm); meters (m); kilograms (kg); total head length (THT); forehead length (FL); bridge of nose length (BNL); depth of head (DH); left interlabial width (LIW); interauricular width (IAW); Interorbital width (IOW) internasal width (INW); ear length (EL); croup width (CW); croup length (CL); chest width (ChW); shin perimeter (SP); thoracic perimeter (TPR); withers height (WH); croup height (CH); body length (BL); back-loin length (BLL); anterior pastern length (APL); posterior pastern length (PPL); anterior cannon length (ACL); posterior cannon length (PCL); weight (W); compactness index 1 (ICC1); compactness index 2 (ICC2); conformation Index (CI); body index (BI); dactylothoracic index (DTI); load on the back by step index (LBI); load on the back at gallop Index (LGI); cannon load index (CLI).

Source: Authors

The LBI was 167.9 ± 12.6 kg, and the LGI was 95.9 ± 6.0 kg, equal for both sexes but higher for animals from Rio de Janeiro than for Minas Gerais. The CLI was similar for males and females and between states. WH, CH, and BL are essential measures that characterize the breed as they present slight variation and indicate the animals’ height. These measures influence the aptitude, type, and angles of the joints of thoracic and pelvic limbs. Consequently, they also influence how the gait affects the rider, as longlineal animals provide better comfort to the rider. The value obtained for WH was 1.35 m for males and females, CH was 1.40 m for males and 1.3 m for females, and BL was 1.4 ± 0 for males and 1.3 ± 0 for females. All measures were within limits established by the Brazilian Association of Pêga Donkey Breeders and corroborate the studies that also evaluated this breed. Pêga donkeys are bigger than other national breeds such as Nordestina and Brazilian donkeys.

ChW and TPr are measures that influence the animal’s aptitude. Animals with great thoracic width have great thoracic volume and respiratory and digestive capacity, improving the ability to withstand physical exertion. A wide chest is desirable for equines.
adapted to draft work but undesirable for saddle because the exaggerated distance between forelimbs can impair the gait. TPr is one of the most variable morphological measures, and it can be influenced by the health and physiological status of the animal, such as obesity and pregnancy. The values for ChW were 33.2 ± 3.8 cm for males and 29.7 ± 2.4 cm for females, and TPr was 151.7 ± 7.0 cm for males and 148.8 ± 8.1 cm for females. These values are similar to those of Brum and Moreira. However, the values found in our study are above that recommended by ABCJPÊGA, which are 148 cm for males and 144 cm for females. Our values were also higher than those of Pimentel et al., who evaluated donkeys of the Nordestina breed, and lower than those of Costa and Pacheco, which evaluated donkeys of the Brazilian breed. The ChW found in the present study was similar to that of equines adapted to saddle, indicating that Pêga donkeys have aptitude for such activity. Croup measures influence the animal's gait and reproductive issues. Long croups have long muscles, which result in great contraction capacity and amplitude of strides of the hind limbs. These characteristics are desirable for national runners, jumpers, and marchers. A wide croup influence the quality of labor. Females with wide croup are less likely to have dystocia labor. BLL influences the animal's gait. The lumbar vertebrae of donkeys are more reinforced, with shorter spinous processes and wider transverse processes. This conformation increases the strength of the lumbar spine, decreasing its flexibility. The values for CL were 41.3 ± 4.6 cm for males and 40.1 ± 5.3 cm for females, CW was 36.6 ± 9.8 cm for males and 40.4 ± 3.8 cm for females, and BLL was 56.8 ± 5.4 cm for males and 57.6 ± 4.7 cm for females. Our values were similar to those observed by Brum and Moreira, who evaluated the same breed, and higher than Escodro et al., who evaluated Nordestina donkeys. The BLL values were similar to Brum, who evaluated male Pêga donkeys, and lower than Moreira, who evaluated female Pêga donkeys. Our results disagree with Araújo. According to this author, donkeys may have a longer back-loin than horses.

The evaluation of CPr, ACL, PCL, APL, and PPL helps to indicate draft capacity, quality of movements, and they are related to the equines' aptitude. These measures also influence the angles of the joints of limbs and, consequently, the animal's impulsion and propulsion capacity. The values for CPr were 16.6 ± 0.7 cm for males and 15.6 ± 1.2 cm
for females, lower than Moreira and Brum, who also evaluated Pêga donkeys. However, our values were lower than Pimentel et al., which evaluated draft donkeys, and lower than Costa and Pacheco, which evaluated Brazilian donkeys. Escodro et al., studied draft equines and observed that horses have greater draft capacity than mules and Nordestina donkeys. The values found in the present study for Pêga donkeys are similar to Escodro et al. For draft mules, indicating a similar draft capacity between these animals. On the other hand, the values for ACL, PCL, APL, and PPL (22.9 ± 1.8 cm for males and 21.7 ± 3.5 cm for females; 29.2 ± 2.9 cm for males and 28.3 ± 2.5 cm for females; 7.2 ± 1.3 cm for males and 8.0 ± 1.5 cm for females; 7.7 ± 1.4 cm for males and 8.7 ± 1.2 cm for females, respectively) were higher than those found by Moreira (2016), who evaluated female Pêga donkeys, and Costa and Pacheco, who evaluated Brazilian donkeys.

Values such as FL, BNL, DH, LIW, IAW, IOW, and INW, observed in Table 3, are little mentioned in the literature for donkeys and horses. However, a complete evaluation of morphology is essential for the quality of movements, breed characterization, and it is related to aptitude.

The evaluation of THL and DH is important because they can evaluate the breed expression of animals. Head and neck play an important role in the animal's athletic capacity. They influence gait quality, interfering with body motion's biodynamics. The values obtained for THL were 57.1 ± 3.0 cm for males and 56.6 ± 1.7 cm for females, similar to those by Moreira and Brum when evaluating the same breed, and higher than those of Costa and Pacheco (2017) that evaluated Brazilian donkeys. The values found for DH were 28.0 ± 1.3 cm for males and 27.3 ± 0.9 cm for females, higher than those found by Moreira and Brum.

The region of the bridge of nose must be wide to allow good air passage. An excessively concave bridge of nose can result in the narrowing of the air passage. The excessively convex profile, especially in racehorses, can interfere with the animal's visual field. Wide forehead signals intelligence by delimiting the brain cavity, and a narrow forehead is related to lymphatic animals, traditionally less intelligent and willing (Nascimento, 1999). According to the Brazilian Association of Pêga Donkey Breeders, the head must be long, proportional, and harmonious, with well-defined contours, a wide
and flat forehead, viewed from a trapezoidal profile, and pointed towards the muzzle. The profile should be rectilinear at the forehead and from smoothly convex to rectilinear at the bridge of nose. The values obtained for FL and BNL were 33.7 ± 4.0 cm for males and 32.2 ± 3.8 cm for females, and 18.8 ± 1.8 cm for males and 17.8 ± 1.8 cm for females, respectively.

Although the ears primarily assist hearing, they also indicate the animal's emotions and temperament. In blood equines, ears are erect and react to any sound, quickly moving from one position to another. On the other hand, in lymphatic equines, ear movements can be slow, with a heavy and drooping auricle. According to the Brazilian Association of Pêga Donkey Breeders, the ears must be large, firm, well directed and implanted, parallel, medium width, and delicate texture, with a lanceolate or funnel shape. The results obtained for EL were 32.5 ± 2.3 cm for males and 32.0 ± 2.5 cm for females. The IAW was 6.5 ± 1.0 cm for males and 7.1 ± 1.1 cm for females, higher than those observed by Rodrigues et al. (2017) who evaluated Pêga donkeys in the state of Paraná.

Size and positioning of eyes interfere with equine action and temperament. Small and/or asymmetrical eyes negatively affect vision, which may indicate nervousness, unpredictability, and bad temper, simply by reducing the visual field. According to the Brazilian Association of Pêga Donkey Breeders, the eyes must be vivid and expressive. The values for IOW were 21.0 ± 0.8 cm for males and 21.1 ± 0.6 cm for females.

Dilated and flexible nostrils facilitate the entry of large amounts of air and good functioning of the respiratory system. A mouth with a medium opening allows great sensitivity to the brake, and firm, symmetrical lips with good mobility favor the bite. According to the Brazilian Association of Pêga Donkey Breeders, the nostrils must be wide and flexible. The values obtained for INW were 7.1 ± 0.8 cm for males and 6.2 ± 1.5 cm for females.

No numerical data were found in the literature regarding equine lip measures. This is very important for the fit of the mouth and horse's harmony with the rider, requiring further studies on topographic limits and measures recommended for a saddle-type horse. Donkeys have a more prominent lip opening than other equines due to adaptive issues of
the species, being less selective about feeding. According to the Brazilian Association of Pêga Donkey Breeders, the mouth must be well torn, with mobile, firm, and juxtaposed lips. The values for LIW were 8.7 ± 0.7 cm for males and 9.2 ± 0.8 cm for females.

The Brazilian Association of Pêga Donkey Breeders establishes that animals must be medium-sized and robust, with a healthy status and low fat accumulation. The average results were 280 kg for males and 265 kg for females, corroborating to others authors (Brum, 2010; Moreira, 2016).

The scapula-ground angle can vary from 45 to 70 degrees, from 45 to 55 degrees for draft and saddle animals, and above 55 degrees for racing equines, in which a good angle influences the animal's balance as the lower the angle, the lower the stride. The values of 99.6 ± 6.5 for males and 99.4 ± 7.2 for females suggest that Pêga donkeys may also have aptitude for racing, indicating a great capacity for impulsion, joint flexibility, stride, and reduction of vertical friction. The type of management during breeding can influence the angles of joints of the pelvic limbs. In the present study, an angular difference in the thoracic limbs was observed comparing the properties.

The scapulohumeral angle is essential for impulse. Scapulae with greater inclination have greater area for muscle insertion and allow greater flexibility and amplitude of the movements of thoracic limbs. The values of 80.3 ± 12.8 for males and 81.9 ± 12.0 for females of Pêga donkeys were similar to those found by Cunha et al. (2020) who evaluated Brazilian Sport horses. Moreover, our values were higher than those of Santiago et al., and Ramires et al., who evaluated Mangalarga Marchador and Quarter horses in roping competitions, respectively. The inclination of the shoulder blade determines the range of movement and the length of stride. An inclined shoulder blade allows forward and upward movements, an important characteristic for jumping horses, and a slightly inclined shoulder blade restricts the range of movements. The data obtained in the present study suggest a possible potential of donkeys for performing jumps.

The values of the humeroradial (110.15 ± 15.6 for males and 146.8 ± 23.3 for females) and metacarpophalangeal angles (138.3 ± 11.5 for males and 144.0 ± 11.9 for females) were similar to those obtained by Meneses et al., who evaluated Quarter horses,
and lower than Lage et al., Santiago et al., and Ramires et al., that worked with Mangalarga Marchador and Quarter horses.

The croup inclination observed in the present study results in a less favorable insertion of the gluteal and hamstring muscles, impairing the extension of the pelvic limbs. However, impulse potentiation occurs when these muscles' shorter length is compensated by greater volume. The values for the hip-ground angle were similar to those described for Quarter horses (Meneses et al., 2014) but lower than those described for Mangalarga Marchador (Lage et al., 2014) and Brazilian Sport horses (Cunha et al., 2020).

The hip angle was 89.6 ± 4.7 for males and 86.4 ± 9.0 for females. The values were similar to those described for Quarter horses and lower than those observed in Mangalarga Marchador (Lage et al., 2014; Nascimento, 1999; Santiago et al, 2014). The values obtained in the present study and those described for Quarter horses (Meneses et al., 2014) describe a more inclined thigh, providing great propulsion of pelvic limbs and, consequently, a great explosion for snatch in races.

The smaller the tibiofemoral angle, the better the flexion of hocks, which facilitates the propulsion of pelvic limbs, and better flexibility for sudden stops such as those performed by Quarter animals (Camargo, 1971). The tibiofemoral angle of 80.7 ± 8.7 for males and 80.9 ± 12.3 for females were similar to those described for Quarter horses (Meneses et al., 2014) and lower than those for Mangalarga Marchador breed (Lage et al., 2014; Nascimento, 1999).

The values for the tibiometatarsal angle of 141.5 ± 9.0 for males and 135.0 ± 8.8 for females were similar to those described for Quarter breed animals (Meneses et al., 2014) and lower than those described for Mangalarga Marchador and roping Quarter horses. Although there are no data for donkeys, commonly, animals with tibiometatarsal angles less than 140 degrees are unfit for speed sports such as racing and able to perform light or heavy draft (Nascimento, 1999). Values for the metatarsophalangeal angles of 152.6 ± 9.0 for females were higher than the metacarpophalangeal angles. This possibly occurs to favor propulsion by the pelvic limbs when the animal initiates motion. This is observed in Quarter horses.
ICC1 and ICC2 refer to aptitude, i.e., to the type of exercise to be performed. The results revealed that the animals have dual aptitude since the ICC1 indicated that donkeys are saddle animals corroborating Fonseca et al. (Fonseca et al., 2016) and ICC2 pointed out that the animals are capable of performing light draft. When associating ICC1 and ICC2, it should be considered that these indices only indicate the animal's ability, so the results should not be taken in absolute terms (Fonseca et al., 2016). In addition, possible trade-offs between measures leading to improved animal performance should be considered. The main characteristic of Pêga donkeys is their gait, making them more efficient in saddle activity than draft work compared to Nordestina donkeys (Brum, 2010; Oliveira, 2004).

BI classifies equines into longilineal, mediolineal, and brevilineal. The results of this study corroborate Rodrigues et al., who classified donkeys as longilineal as they showed superior results compared to horses and mules. It also corroborates Fonseca et al., which classified all racing donkeys evaluated by them as longilineal. A study with male Pêga donkeys described that most (42.85%) of the animals were longilineal, morphofunctionally fitting as racing animals with aptitude for speed (Brum, 2010). Donkeys have rusticity and resistance to withstand great efforts, which is why they are used for draft work, but that index indicates that the breed has aptitude for racing. Both activities require physical effort, which is why they are considered multifunctional animals.

DTI indicates the relationship between the animal's mass and the limbs that support it, classifying equines into hypermetric, eumetric, and hypometric. The result indicates that they are eumetric (medium equines) and reinforces the aptitude of the Pêga breed for saddle activities. This corroborates Moreira who evaluated Pêga donkeys in the state of São Paulo and emphasizes that the Pêga breed is adapted to saddle and light draft activities. In a study conducted with Nordestina donkeys, they were classified between intermediate and draft. Rodrigues et al., compared Quarter horses with Pêga donkeys and mules and reported no significant difference in DTI.

The CLI reflects the ability of the animal's extremities to displace its body mass. The results obtained in this study are similar to Moreira, also with Pêga donkeys.
However, they are lower than Pimentel et al, who evaluated Nordestina donkeys. Pimentel et al., also reinforce that donkeys have a higher CLI than horses. The data suggest that Pêga donkeys have lower CLI than Nordestina donkeys.

CI indicated that the evaluated animals do not have aptitude for draft work but saddle and racing activities, corroborating the findings by others studies (Pimentel et al., 2014; Moreira, 2016; Escodro et al., 2014; Rodrigues et al., 2017) Nordestina donkeys are also in this classification, demonstrating that donkeys generally have conformation for saddle activities, despite being more used for draft work (Oliveira, 2004), reinforcing the dual aptitude of the species.

The index of load on the back indicates the weight the animal can withstand without excessive effort on the back. The results indicated that animals from Rio de Janeiro have a higher index than animals from Minas Gerais. The findings are higher than those described for donkeys from the state of Rio Grande do Norte used for racing. It indicates a possible selection based on the animal’s size in different states of the country and this selection directly influences the LBI and LGI and, probably, is related to the activities recommended for these animals.

4 CONCLUSIONS

It is concluded that Pêga donkeys, males and females, have differences in conformation associated with sexual dimorphism. There is a difference according to the breeding location, probably due to the influence of regional selection. The Pêga donkeys that were evaluated had morphological characteristics that indicate double aptitude. Although they are considered rustic animals and widely used for draft work, the greatest aptitude in this study is for saddle because they have a gait and can perform only light draft so that it does not cause damage to the animal's body.
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