Int. j. adv. multidisc. res. stud. 2024; 4(6):692-696

Received: 15-10-2024
Accepted: 25-11-2024

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Correlation between Morphometric Parameters and the Body Weight of Donkeys

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DOI: https://doi.org/10.62225/2583049X.2024.4.6.3497
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Abstract

In the literature, multiple mathematical formulas exist for estimating the body weight of donkeys. These formulas have been developed in various parts of the world for different types of donkeys and, practically, cannot be directly applied to calculate the weight of donkeys in the Balkans. We modified these formulas to suit the type of donkeys for which we have precise body weight data and corresponding morphometric parameters. Among all the proposed formulas, the most accurate, nearly 100% precise, is the application of nanogram analysis.

Keywords: Donkey, Weight, Formula

Introduction

To gain a complete understanding of the body structure of donkeys, it is necessary to measure a significant number of morphometric parameters. Additionally, determining the body weight of an individual is highly beneficial. Naturally, the easiest and most accurate method of determining body weight is by weighing the animal on a scale designed for livestock. These scales can be mechanical, which are the most commonly used, or digital (electronic scales), which are becoming more popular due to their higher accuracy.

However, fieldwork often does not allow for the use of scales, as they are simply unavailable. In such cases, the body weight of the animal must be estimated. There are individuals who, based on years of experience working with donkeys, can estimate weight fairly accurately, but such individuals are rare. To obtain an approximate value as close as possible to the actual weight, numerous formulas for estimating donkey body weight are used. In addition to formulas derived from empirical practice, published studies exist where authors use formulas developed for horses to determine donkey weights.

To evaluate the accuracy of these formulas, we conducted practical testing. Since the proposed formulas often produce results that significantly deviate from the actual weights of donkeys (measured directly using a scale), we also adapted these formulas to suit the type of donkeys measured on the scale, with known body weights and morphometric parameters.

Materials and Methods

For this study, 16 donkeys were measured. These donkeys did not belong to any specific breed but represent the most common type found in the Balkans. In addition to their body weights, measured on a mechanical livestock scale, the following parameters were recorded: Height at the withers, Body length, measured from the shoulder joint to the tuber ischii, Heart girth, measured immediately behind the scapula.

Results

The average height at the withers of the analyzed donkeys was 107.54 cm (range: 96.1–113.3 cm), while the average body weight was 145.0 kg (range: 108.0–163.0 kg).

When body weight is compared to height at the withers, a relationship can be established, determining how many kilograms correspond to 1 cm of height. This approach can provide an approximate estimation of the donkey's body weight.

In our study, for every 1 cm of withers height, an average body weight of 1.34 kg (range: 1.12–1.44 kg) can be expected.

Our results are consistent with Hafner (2013) [1], who states that donkeys with a withers height of up to 1.10 m have a maximum body weight of 205 kg.

When it comes to chest girth and body weight in the donkeys we studied, it was determined that, on average, each centimeter of chest girth corresponds to 1.25 kg (range: 1.05–1.37 kg) of body weight. Interestingly, there is not much difference between the average body weight per centimeter of withers height (1.34 kg) and chest girth (1.25 kg). This implies that body weight in donkeys can be approximately determined by measuring either chest girth or withers height, without relying on any formula.

Analysis of Existing Formulas

For horses, the use of the "Horse & Pony Weighing Tape" to estimate body weight is very common. By measuring the chest girth, the approximate body weight of the horse can be read directly from the tape. This tape is also sometimes used to estimate donkey body weight.

However, when we measured the chest girth of donkeys and compared the weight indicated by the tape to their actual body weight, we found that the weight determined by the tape was, on average, 14.1% (range: 11.3–18.4%) lower than the actual weight.

In an extensive study on determining donkey body weight in West Africa, conducted by Nininahazwe PC, Roamba RC, Kalandi M, Ahmed HD, Ouedraogo GA, and Sawadogo GJ (2017) [3], involving 1,352 donkeys from Burkina Faso, Mali, Niger, and Senegal, it was found that the average body weight was 126.0 ± 17.1 kg, the average withers height was 99.5 ± 3.67 cm, and the average body length was 104 ± 6.53 cm. The chest girth in the studied population was 104.4 ± 6.53 cm.

Based on these results, the authors concluded that, on average, each centimeter of withers height corresponds to 1.05 kg of body weight. Furthermore, the chest girth of donkeys in West Africa was 4.9% greater than their withers height.

From their findings, two formulas were developed to estimate body weight based on chest girth. One formula, which we tested on a group of donkeys we studied, is:

$$BW = 2.55 \times HG\ (\text{cm}) - 153.49$$

Where: BW – body weight; HG – chest girth

Applying this formula to donkeys in West Africa gives an average body weight of 133.16 kg, which is 8.9% less than the actual average weight. Practically, this formula can be used to approximate the body weight of donkeys in Serbia, provided that 9% is added to the calculated result.

In some cases, the literature also suggests using the formula developed by Yagil and Etszion (1980) [11] for estimating the body weight of Bactrian camels:

$$BW = 7.5 \times HG - 340$$

Where: BW – body weight; HG – chest girth

In its original form, this formula is entirely unsuitable for donkeys. However, we modified it empirically by reducing the coefficient from 7.5 to 4.27, resulting in the formula:

$$BW = 4.27 \times HG - 340$$

Where: BW – body weight; HG – chest girth

This modified formula can be used to approximate donkey body weight in our region. The actual body weight determined by scale measurements differs by approximately 5% from the weight calculated using the modified formula. This 5% should be added to the result.

Frequently used formulas for determining donkey body weight are those originally designed for horses (Pejić, 1991) [4]. One such formula is:

$$BW = (5.60623338 \times GH) - 544.987205$$

Where: BW – body weight; GH – chest girth

In the observed population of donkeys, this formula cannot be used to approximate body weight as it provides highly unreliable results. However, through empirical analysis and modification of the coefficient, we arrived at a revised formula:

$$BW = (5.60623338 \times GH) - 485.987205$$

The same author (Pejić, 1991) [4] proposed another formula for determining horse body weight, which is also sometimes applied to donkeys:

$$BW = GH^2 \text{ x } BL/10835.81 + 22.9$$

Where: BW – body weight; GH – chest girth (cm); BL – body length

Analyzing our real-world data on donkey body weight and the results obtained using this original formula, we concluded that it is entirely unreliable. By empirically modifying the formula, we arrived at:

$$BW = GH^2 \text{ x } BL/10835.81 + 10$$

Where: BW – body weight; GH – chest girth (cm); BL – body length

Using this modified formula to calculate the body weight of the studied donkeys, whose actual weights are known, the deviations were only a few percent.

To estimate the body weight of horses, tables are available that provide approximate body weight based on chest girth measurements (www.cons.pvgazeta.info). Analyzing real data compared to the values in this table reveals that it is not

realistic for donkeys, as shown by our research. Based on the analysis of our data, we conclude that using this table yields underestimated donkey body weights, with deviations ranging from 4.2% to 8.7%, averaging 6.54%. Approximately, when using this table, 10% should be added to the obtained value.

For estimating horse body weight, a formula developed by Platonov and Dzeverin (www.meagradina.com) is also used. The authors created the method (formula) in 2004 and claim 96% accuracy. The formula is based on empirical coefficients and chest girth measurements.

The original form of the formula is as follows:

$$BW=37.82 \cdot W+53.01 \times B+3.74 \times L+3.95 \times T-867.47$$

Where: BW – Body weight; W – Coefficient ranging from 0–1. The maximum value (1) is used for heavy horses; B – Coefficient ranging from 0–1; L – Body length; T – Chest girth.

In its original form, this formula cannot be used for approximating donkey body weight. However, in a modified form, where the coefficients W, B

B are used at their maximum value (1), and instead of subtracting 867.47 as indicated in the original, the value is reduced by 840, approximate values for donkey body weight can be obtained. The differences from actual values are inconsistent, with some results being lower and others higher than real measurements. These differences are minor, and the modified formula can be used for approximate donkey body weight estimation.

On the website www.nakrmsikone.cz, a formula is provided for approximate horse body weight estimation. The original formula is:

$$BW= OG^2 \times DT/11877.4$$

Where: BW – Body weight; GH – Chest girth; DT – Body length.

This formula, in its original form, can be used for approximate donkey body weight estimation. Comparing our real results with those obtained using this formula, the calculated values are 4.5% lower, which can be considered fairly accurate for an approximate estimation.

Determining Donkey Body Weight: A Comparative Analysis of Formulas.

Original Formula by K.I. Dujsembaev.

The original formula for determining horse body weight, as proposed by Professor K.I. Dujsembaev on the website www.zootehznikoff.ru, is as follows:

$$BW=BH \times 2,323$$

Where: BW = body weight, BH = chest girth.

When applied to donkeys in our research, this formula failed to yield relevant results. After empirical adjustments, replacing the coefficient 2,323 with 1,32 provided a modified formula:

$$BW=BH \times 1,32$$

This modified formula produced approximate and reasonably accurate values for donkey body weight.

Formula from Shveiny Decimeter Method

The www.cons.pvgazeta.info website proposes another formula for horse body weight:

$$BW=BH^2 \times BL/11.900$$

Where: BW = body weight, BH = chest girth, BL = body length (measured from the shoulder joint to the tuber ischii).

This formula proved unsuitable for donkeys in our research. Modifying the denominator to 10,500 resulted in a more applicable formula:

$$BW=BH^2 \times BL/10.500$$

Where: BW = body weight, BH = chest girth, BL = body length (measured from the shoulder joint to the tuber ischii).

Formula by Lemma and Haile (2011) [2].

Lemma and Haile developed a formula for estimating donkey body weight in Ethiopia:

$$BW=BH^2 \times BL/8.700$$

Where: BW = body weight, BH = chest girth, BL = body length (measured from the shoulder joint to the tuber ischii).

When applied to our donkeys, this formula significantly overestimated the body weight, making it inapplicable in our regional context.

The approximate determination of a horse's body weight can also be performed using the formula provided by W. Durst (www.https://happy-horses.ru/7-sposobov-opredelenya-vesa-loshadi/). The formula is relatively simple, determining the horse's body weight based on chest girth and a corresponding coefficient. The original formula is as follows:

$$BW = BH \times K$$

BW – body weight; BH – chest girth; K – coefficient. The author specified that for heavier horses, a coefficient of 3.5 is used, for medium-weight horses 3.1, and for light horses 2.7.

Regardless of the coefficient used, it is not possible to determine the approximate weight of a donkey. Empirically, we have found that for donkeys, a coefficient of 1.3 can be applied. Using this coefficient yields approximate body weight values for donkeys that differ from the actual values by only a few percent.

The same website also suggests that the approximate body weight of a horse can be determined using a formula defined by A. Matorin:

$$BW = 6 \times BH – 620$$

BW – body weight; BH – chest girth

In our case, it was not possible to obtain realistic approximate weight values for donkeys using this formula. Empirically, we were unable to modify the formula to suit donkeys, so we do not recommend its use for determining the approximate body weight of donkeys.

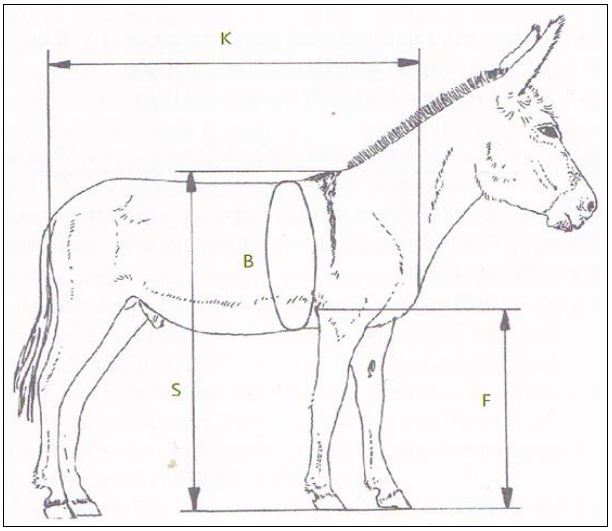
Wissdorf and colleagues published a book in 2020 on the differences in body conformation between donkeys and horses. Among other topics, they included a formula for determining donkey body weight, stating that it was originally published by Hafner in 2013. Interestingly, the formula was misquoted in their work, likely due to a technical error. They presented the formula in the following form:

$$BW = HV - HE \text{ x } BH \text{ x } BL/3.500$$

Where: BW = body weight, HV = height at the withers, HE = height at the elbow, BH = chest girth,
BL = body length (measured from the shoulder joint to the tuber ischii).
The correct formula, as originally published by Hafner in 2013, is:

$$BW=(HV - HE) \text{ x } BH \text{ x } BL/3.500$$

Where: BW = body weight, HV = height at the withers, HE = height at the elbow, BH = chest girth



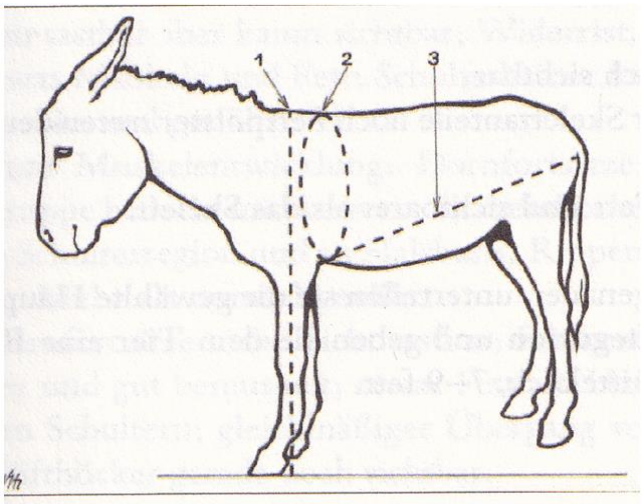
Picture 1: Morphometric parameters of the donkey body weight used to calculate the body mass (Hafner, 2013) [1]

Using Hafner's formula, the estimated body weight exceeded the actual weight by 5.8%. This margin of error suggests the formula is generally applicable in the Balkan region.
Formula by Pearson (2000). Pearson's formula, as cited by Wissdorf *et al.*, is:

$$BW= BH^{2,12} \text{ x } EH^{0,688} /3.801$$

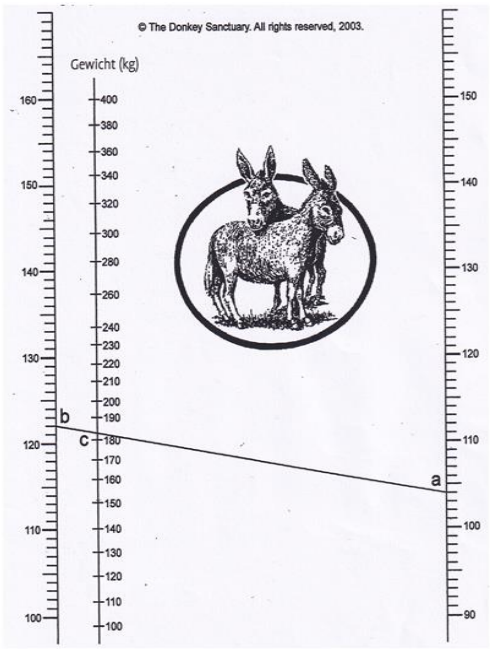
Where: BW - body weight; BH - chest girth; *E*H - distance from the olecranon to the tuber ischii.

It is quite interesting, and from a zootechnical perspective, somewhat unusual, that the measurement used for calculations is the length of the distance from the tip of the elbow joint to the tuber ischii. While the position of the tuber ischii is stable, the position of the olecranon depends on several factors, primarily the angles of the foreleg. Depending on these angles, the olecranon shifts either forward or backward. Consequently, donkeys with an identical actual body length, measured from the shoulder joint to the tuber ischii, but differing foreleg angles, will have unequal distances from the olecranon to the tuber ischii when measured this way.
We have not been able to verify the accuracy of this formula, as we have never measured the aforementioned distance from the tip of the elbow joint to the tuber ischii.
This formula introduces variability due to the olecranon's position, which depends on forelimb angles, making it unsuitable for consistent application in donkey weight estimation.



Picture 2: Parameters for determining the weigt of a donkey according to Pearson (Wissdorf i sar. 2020.) [6]

In the literature available to us, the most accurate method for determining the body mass of donkeys in our region is represented by the Nomogram published by Svendsen in 2009. To determine body mass, it is necessary to measure the height at the withers and the chest girth. Svendsens presented a nomogram requiring two measurements: Height at the withers, Chest girth.



Picture 3: Nomogram for determining the body mass of a donkey (Svendsens, 2009) [5]

The a-b line connects the height at the withers (a) and the chest girth (b), while (c) represents the body mass.
The nomogram allows estimation of body weight within a 10 kg margin of error, making it a reliable tool for practical use.
Proposed Modified Formula
Based on a comprehensive review and practical testing, we propose the following formula for estimating donkey body weight in the Balkan region:

$$BW = BH \times BL/90$$

Where: BW = body weight, BH = chest girth (measured behind the scapula), BL = body length (measured from the shoulder joint to the tuber ischii).

Conclusion
Formulas used in other regions or continents are generally unsuitable for donkeys due to the significant morphological heterogeneity of the species. Each formula must be empirically tested and tailored to the local population of donkeys. The proposed formula, along with the Svendsens nomogram, offers practical and reasonably accurate methods for estimating donkey body weight in our region.

References
1. Hafner M. Esel halten. Ulmer Verlag, 2013.
2. Lemma A, Haile A. Estimation of weight and age of working donkeys in Ethiopia. Tropical Animal Health and Production. 2011; 43(3):591-600.
3. Nininahazwe PC, Sow A, Roamba RC, Kalandi M, Ahmed HD, Ouedragao GA, *et al*. West African donkey, s liweweight estimation using body measurements. Veterinary World. 2017; 10(10):1221-1226.
4. Pejić N. Ishrana konja. Poljoprivredni fakultet, Univerzitet u Novom Sadu, 1991.
5. Svendsens E. Eselbuch. Ulmer Verlag, 2009.
6. Wissdorf H, Jedrbi H, Miriam Meier-Schellersheim. Unterschiede in der Anatomie von Esel/Muli und Pferd. Utzverlag GmbH, 2020.
7. www.cons.pvgazeta.info
8. www.https://happy-horses.ru/7-sposobov-opredelenya-vesa-loshadi/
9. www.nakrmsikone.cz
10. www.zootehznikoff.ru
11. Yagil R, Etzion Z. Estimation of the weight of camels (Camelus dromederius) by external measurements. Journal of the American Veterinary Medical Association. 1980; 177(11):1255-1258.