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RELATIONSHIP BETWEEN THE BODY CONDITION INDEX AND THE MODIFIED HENNEKE BODY CONDITION SCORE IN CHILEAN HORSES

RELACIÓN ENTRE EL ÍNDICE DE CONDICIÓN CORPORAL Y LA CALIFICACIÓN DE CONDICIÓN CORPORAL DE HENNEKE MODIFICADA EN CABALLOS RAZA CHILENA

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ABSTRACT

The Henneke Scoring System is a method of evaluating a horse's body condition. The aim of this study was to determine the relationship between the body condition index and the modified Henneke body condition score in Chilean horses (total sample and by sex). Measurements were taken in 50 Chilean horses in training (11 stallions, 15 geldings and 24 mares). The modified Henneke body condition score was estimated for each horse; wither height, heart girth, belly girth, and neck circumference were measured to calculate the body condition index. The mean values of the body measurements obtained were compared to the Henneke body condition scores by sex using the Analysis of Variance and Tukey's multiple comparison test. Pearson correlations were calculated between the body condition index and the modified Henneke body condition score. There was a moderate correlation between the methods in the total sample (r = 0.424, P = 0.0022), but no correlation was observed in stallions (r = -0.256, P = 0.447). However, a high correlation was observed in geldings (r = 0.701, P = 0.0036) and a moderate correlation in mares (r = 0.398, P = 0.054). The study was limited due to the low variation in body condition between the horses. The results suggest that body condition index is not a good method estimate the modified Henneke body condition score in Chilean horses in training. Further studies are required to adapt the formula to horses with different conformation, pregnancy or feeding management.

Key words: equine, Chilean horse, body condition index, Henneke body

RESUMEN

El sistema de evaluación de Henneke se usa para medir la condición corporal en caballos. El objetivo de este estudio fue estimar la relación entre el índice de condición corporal y la calificación de la condición corporal de Henneke **modificada, en caballos de raza chilena (muestra total y por sexos). Las mediciones se realizaron en 50 caballos raza chilena en competencia (11 sementales, 15 caballos y 24 yeguas). La calificación de la condición corporal de Henneke modificada fue estimada en cada caballo, y su altura a la cruz, perímetro torácico, perímetro abdominal y perímetro cervical fueron medidos para calcular el índice de condición corporal. Los promedios fueron comparados para cada sexo usando el análisis de varianza y la prueba de comparación múltiple de Tukey. Se**

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calculó la correlación de Pearson entre el índice de condición corporal y la calificación de la condición corporal de Henneke modificada. El índice de condición corporal mostró una correlación moderada con la calificación de la condición corporal de Henneke en caballos raza chilena en general (r = 0,424; P = 0,447), pero no hubo correlación en los sementales (r = -0,256; P = 0,447). Se observó una alta correlación en los caballos (r = 0,701; P = 0,0036) y una correlación moderada en yeguas (r = 0,398, P = 0,054). Las limitaciones del estudio fueron la poca variación de la condición corporal en los caballos. Los resultados indican que el índice de condición corporal no es un buen método para estimar la calificación de la condición corporal de Henneke modificada en caballos raza chilena en competencia. Se requieren estudios adicionales para adaptar la fórmula a caballos con diferente conformación, preñez y nutrición.

Palabras clave: equino, caballo chileno, índice de condición corporal, condición corporal de Henneke

INTRODUCTION

The amount of body fat is an indicator of the energetic balance (Gill et al., 2017), which can affect the reproductive performance (Morley and Murray, 2014) and sports performance in horses (Harker et al., 2011; Fonseca et al., 2013). Furthermore, body fat is an indicator of the risk of lameness and equine metabolic syndrome (McCue et al., 2015). The percentage of body fat in equines is variable and ranges from 1.1 to 35.6% (Gunn, 1987; Dugdale et al., 2012; Burrows, 2017).

The percentage of body fat in equines can be estimated more precisely by measuring the total body water content by means of a deuterium oxide dilution (Dugdale et al., 2011) and/or a bioelectrical impedance analysis (Ward et al., 2016).

Body condition is a reflection of the stored body fat (Harris and Schott II, 2013). The Henneke body condition score (BCS) (Henneke et al., 1983) is a method described to estimate the body condition in equines based on visual inspection and palpation. BCS is a practical method commonly used in research (Abo El-Maaty et al., 2017; Fowler et al., 2017; Muñoz et al., 2019), as well as by owners and riders around the world (Carter and Dugdale, 2013; Morrison et al., 2017). However, BCS is considered to be a subjective method (Mottet et al., 2009).

Potter et al. (2015) proposed a new body condition index (BCI) to estimate the percentage of body fat using body measurements, which they evaluated in 22 horses of different types and breeds (seven Standard bred horses, eight mixed breed ponies and seven Andalusian or Andalusian cross horses). BCI (Pearson r = 0.772) and BCS (Pearson r = 0.745) showed a high correlation with the percentage of body fat obtained by the dilution of deuterium oxide. On this basis, the authors suggested that BCI could be an objective, useful and practical form to estimate the BCS in field conditions (Bailey, S.R. University of Melbourne, Australia. Personal communication).

The BCI has not been validated in any other particular breed of horse. Therefore, the aim of this study was to estimate the possible relationship between the BCI and the modified BCS in Chilean horses.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of the Faculty of Veterinary Sciences, University of Concepción. Informed consent was given for every horse included in this study.

Animals

A convenience sample was taken in farms and equestrian centers in Chile that agreed to collaborate with the study, reaching a total of 50 adult Chilean horses in training for the Chilean rodeo, between 5 to 15 years of age (11 stallions, 15 geldings, and 24 mares). All of the animals were kept stabled for at least three months before measurements were made. Animals with signs of lameness or any condition that potentially increased the volume of the anatomical regions measured were excluded from the study.

Body measurements

All measurement were made during the spring (September to November) of 2017. For every individual, the three measurements were all made in 15 to 20 minutes. All animals were evaluated between 08:00 and 10:00 AM and before receiving any food.

To measure wither height (H), heart girth (HG), belly girth (BG) and neck circumference (NC), each individual with hackamore and halter was placed over a flat, hard surface in a calm environment. All of the measurements were made in centimeters and performed three times on the left side of the horse by an experienced evaluator.

Before measuring H, the hooves of each horse were cleaned. H was measured on horses standing with forelimbs hooves parallel and hindlimbs with hooves separated by no more

than 15 centimeters. The measurements were made with an aluminum stick (Master Cheng™, Taiwan) leveled to the ground and parallel to the horse. All the horses had horseshoes, and thus the height of forelimb horseshoes was subtracted from H. The horizontal arm supplied with a spirit-level was placed at the highest point of the withers, which was previously identified by palpation and marked with blue paint (van de Pol and Sloet van Oldruitenborgh-Oosterbaan, 2007). HG was measured at the end of the expiratory pause, caudal to the point of the elbows and immediately behind the caudal extremity of the withers. BG was measured at the end of the expiratory pause, at the widest point of the belly, approximately two-thirds of the linear distance between the point of the shoulder and the point of the hip. NC at the mid-chest was measured perpendicular to the top line of the crest, approximately half way between the poll and withers (Dugdale et al., 2010). This measurement was made with the neck at a relaxed position in an angle of approximately 45° (Kearns et al., 2006).

To measure BG, the HG, and NC, an ergonomic circumference measuring tape was used (Seca™ 201, Germany).

Body Condition Index

BCI is an index based on anatomical measurements in centimeters, which include H, HG, BG and NC (Potter et al., 2015), developed to fluctuate from 1 to 9 in horses and ponies (Bailey, S.R. University of Melbourne, Australia. Personal communication), calculated with the following formula:

$$BCI = \left(\frac{HG^{0.5}+BG+NC^{1.2}}{H^{1.05}}\right)^{2.2}$$

Modified Henneke body condition score

The modified BCS is based in the system proposed by Henneke et al. (1983), consisting of a visual inspection and palpation of fat in six anatomical regions of the horse (neck, withers, loin, tailhead, ribs and shoulders). Each area is assessed individually in a 9 points scale (from 1: very poor, to 9: extremely fat) (Table 1). Scores in each area are totaled and then divided to give the BCS, where the modification by Koehne (1992) allows decimal values. The scoring to obtain the BCS was performed by an experienced evaluator.

Data analysis

Central tendency and dispersion estimates for H, HG, BG, NC, BCI, and BCS were calculated. The repeatability of consecutive measurements performed by the same evaluator was calculated as the intraclass correlation obtained in a linear model, where horse and measurement were random factors. The means were compared for each sex using the analysis of variance and Tukey's multiple comparison test. Pearson's lineal correlations were calculated between BCS and BCI.

RESULTS AND DISCUSSION

A moderate correlation between the BCI and the BCS in the Chilean horses was observed. The descriptive statistics of the body measurements, BCI and BCS, are shown in Table 2. Even though minimum and maximum values (Table 2) may suggest an ample range of values, there was low variation between the measurements, recording a variation coefficient between 2.35 and 8.44%, with the majority in the range from 2.35 to 5.87%.

Body measurements

The standard of the Chilean horse establishes that H ranges from 138 to 148 cm for males (stallion and geldings), and from 136 to 146 cm for mares (Porte, 1993; García et al., 1997). Fifty-six percent of the animals fell below the lower limit of the official standard (males 53.8%; mares 58.3%). Similar results have been reported but in a lesser proportion than in the present study (Muñoz et al., 2012; González, 2017). Apart from the aforementioned, it was expected that H would be higher in stallions than in mares since the ideal fixed standard of stallions is two cm higher than mares (Porte, 1993). In fact, the mean H of stallions and geldings of our study was at 138.1 cm, which corresponds to exactly 2 cm more than the average H for mares.

In the Chilean horse, the breed standard establishes that HG vary between 162 and 182 cm in males, and 2 cm more in mares (Porte, 1993). Ten percent of all the individuals were below the lower limit of the breed standard. All the males evaluated were in this range. However, 20.8% of the mares had a HG above the standard. A higher HG in mares in Chilean horses has been reported in several other studies (García et al., 1997; Muñoz et al., 2012; González, 2017). In this sense, a study by Muñoz et al. (2012) reported individuals of both sexes under the lower limit, while studies conducted by García et al. (1997) and González (2017), reported that 100% of the mares were under the standard, while 10.4% and 3.4% of the males in those studies, respectively, were under the lower limit established by the breed's standard.

To our knowledge, there are no previous reports on BG in Chilean horses. A BG larger than the HG in the same individual was expected because the torso of Chilean horses is barrel-

Table 1. The Henneke Body Condition Scoring System.
Tabla 1. Sistema de Henneke para la calificación de la condición corporal.

Condition score	General condition	Neck	Withers	Loin	Tailhead	Ribs	Shoulder
1	Very poor	Individual bone structure visible	Bone easily visible. No fat	Spine bones visible. End feel pointed	Tailhead and hips bone very visible	Ribs very visible and skin furrows between ribs	Bone structure very visible
		Animal extremely emaciated; no fatty tissue can be felt					
2	Very thin	Bones just visible. Animal emaciated	Withers obvious, very minimal fat covering	Slight fat covering over vertical and flat spin projections. Ends feel rounded	Tailhead, hip bones obvious	Ribs prominent, slight depression between ribs	Bone structure can be outlined
3	Thin	Thin, flat muscle covering	Withers accentuated with some fat cover	Fat build-up halfway on vertical spines, but easily discernible. Flat spinal bones not felt	Tailhead prominent. Hip bones appear rounded but visible. Pin bones covered	Slight fat cover over ribs. Rib outlines obvious	Shoulder accentuated, some fat
4	Moderately thin	Neck some fat, not obviously thin	Withers not obviously thin, smooth edges	Slight ridge along back	Fat can be felt	Faint outline visible	Shoulder not obviously
5	Moderate	Neck blends smoothly into body	Withers rounded over top	Back level	Fat around tailhead beginning to feel spongy	Ribs cannot be seen but be easily felt	Shoulder blends smoothly into body
6	Moderately fleshy	Fat can be felt	Fat can be felt	May have slight inward crease	Fat around tailhead feels soft	Fat over ribs feels spongy	Fat layer can be felt
7	Fleshy	Visible fat deposits along neck	Fat covering withers is firm	May have slight inward crease down back	Fat around tailhead is soft and rounded off	Individual ribs can still be felt	Fat build-up behind shoulder
8	Fat	Noticeable thickening of neck	Area along withers filled with fat	Crease down back evident	Tailhead fat very soft and flabby	Difficult to feel ribs	Area behind shoulder f illed in flush with body
		Fat deposited along inner buttocks					
9	Extremely fat	Bulging fat	Bulging fat	Obvious deep crease down back	Building fat around tailhead	Patchy fat over ribs	Bulging fat
		Fat along inner buttocks may rub together. Flank filled in flush					

Adapted from Henneke et al. (1983).

Table 2. Mean values ± standard deviation (minimum and maximum values) for wither height (H), heart girth (HG), belly girth (BG), neck circumference (NC), body condition index (BCI) and modified Henneke body condition scoring (BCS) of the total number of Chilean horses under study and classified by sex.

Tabla 2. Valores promedio ± desviación estándar, (valores mínimo y máximo) de la altura a la cruz (H), perímetro torácico (HG), perímetro abdominal (BG), perímetro cervical (NC), índice de condición corporal (BCI) y calificación de la condición corporal de Henneke modificado (BCS) del total y por sexo de los caballos raza chilena.

Sex (n)	H cm	HG cm	BG cm	NC cm	BCI	Modified BCS
Stallions (n = 11)	139.8 ± 3.3a (134.0 - 144.0)	174.0 ± 4.4 (167.7 - 179.7)	185.4 ± 3.7 (180.0 - 192.0)	103.1 ± 5.1a (94.0 - 110.0)	8.0 ± 0.9 (6.6 - 9.4)	5.5 ± 0.5a (4.7 - 6.2)
Geldings (n = 15)	136.8 ± 3.8 (131.0 - 145.0)	171.4 ± 5.4 (164.0 - 180.0)	185.9 ± 6.6 (178.0 - 197.0)	94.2 ± 7.9b (80.7 - 107.0)	7.4 ± 1.0 (5.6 - 9.1)	4.8 ± 0.6b (3.8 - 5.7)
Mares (n = 24)	136.1 ± 3.8b (127.0 - 141.0)	175.5 ± 7.5 (165.0 - 190.0)	189.0 ± 8.3 (175.0 - 201.7)	93.2 ± 7.5b (81.7 - 106.0)	7.5 ± 1.3 (5.7 - 10.7)	5.2 ± 0.7 (3.7 - 6.2)
Total (n = 50)	137.2 ±3.9 (127.0 - 145.0)	173.9 ± 6.5 (164.0 - 190.0)	187.2 ± 7.1 (175.0 - 201.7)	97.5 ± 8.1 (80.7 - 110.0)	7.6 ± 1.1 (5.6 - 10.7)	5.1 ± 0.7 (3.7 - 6.2)

Different letters between means within column indicate statistically significant difference ($P < 0.05$).

shaped and the widest part is behind the place where HG is measured (Porte, 1993; Thomas 2005).

A difference between the NC of stallions compared to that of geldings and mares was reported in a previous study on Chilean horses (González, 2017). In the present study, all the mean values for NC were slightly higher. The highest NC found in stallions is associated with fat deposits in the back part of the neck, as reported in Andalusian horses (Martin-Gimenez et al., 2016). In addition, fat deposits have a moderate heritability in equines (Sánchez et al., 2017).

Body condition index

There are no previous reports on BCI in Chilean horses. The BCI obtained resulted in 14% of the individuals higher than 9. As one of the authors indicated ((Bailey, S.R. University of Melbourne, Australia. Personal communication), the BCI score was developed to fluctuate in a scale between 1 and 9 in horses and ponies in order to be equivalent to the modified BCS despite the fact that measurement units are different between both methods. This result shows that BCI should be adapted to the particularities in conformation of Chilean horses, probably because conformation is a greater problem than variation when calculating BCI in horses.

Modified Henneke body condition score

There are only three previous reports regarding BCS in Chilean horses, with values ranging from 3 to 9 (González et al., 2012; Soto and Galecio, 2012; Muñoz et al., 2019). This is in agreement with our findings as all the horses in the present study were within those values. However, no horses recorded BSC ≥ 7, which differs from the findings of González et al. (2012) and Soto and Galecio (2012) who reported BCS values between 7 and 9 in 14% and 79.6% of the horses, respectively. On the other hand, the study conducted by Muñoz et al. (2019) reported that 56.3% of Chilean elite rodeo horses in training presented BCS values between 7 and 8. The differences in the BCS observed between stallions and geldings did not coincide with the previously reported findings (Gonzalez, 2017).

With regards to the BCS in general, a study reported that BCS was not related to either H or HG in quarter horses (Henneke et al., 1983). In contrast, another study indicated that fat percentage is correlated with both measurements (Abo El-Maaty et al., 2017). Dugdale et al. (2012) pointed out that a correlation exists between the H and BG with BCS, but not with the HG. In addition, other researchers have reported that BCS is correlated to the relationship HG:H (Carter et al., 2009; Fowler et al., 2017). On the other hand, an investigation pointed out that BG should not be used to estimate BCS because it depends on the tonicity of the abdominal muscles and distention of the bowels, which is dependent on food consumption (Kienzle and Schramme, 2004).

Correlation BCI and BCS

Pearson correlation coefficient between BCI and BCS was moderate and statistically significant for Chilean Horses (r = 0.424, P = 0.0022). However, within each sex category the relationships between BCI and BCS was different. A high correlation was observed in geldings (r = 0.701, P = 0.0036), similar to what was reported by Potter et al. (2015); a moderate correlation observed in mares (r = 0.398, P = 0.054); and a negative but not statistically significant correlation was observed in stallions (r = -0.256, P = 0.447). The difference in sign of the covariance observed in stallions seems to be influenced principally by the averages of H and NC that were significantly higher in that sex category. The difference correlation of geldings and mares seems to be influenced by the higher HG and BG in the mares, even though the differences of these measurements were not statistically significant.

Potter et al. (2015), reported a high correlation between both BCI and BCS, and body fat percentage estimated by deuterium oxide dilution in Standardbred horses. However, this was not observed in Chilean horses. This demonstrates that breed conformation is a factor affecting the estimation of body fat by BCI, an index based in body measurements.

An important aspect related to conformation present in the study was the higher value of NC mean in Chilean stallions.

The limitations of our study were the lack of a sufficient representative number of individuals with each of the qualifications of BCS. In addition, it would have been of interest to include Chilean horses on pasture and mares in gestation as those animals would have a possibly higher BG.

CONCLUSION

Correlations obtained between BCS and BCI in Chilean horses allowed to conclude that the proposed formula by Potter et al. (2015) is not adequate for Chilean horses. Future studies are necessary to modify the formula. This could potentially adapt the formula to horses with different conformation, pregnancy or feeding management.

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