Fall 12-4-2012

Evaluation of Industry Available Weight and Height Tapes and Other Farm Measurements to Estimate Actual Weight and Height of Various Breeds of Horses

Holly Pryor

Holly Pryor

Honors Thesis:

Evaluation of Industry Available Weight and Height Tapes and Other Farm Measurements to Estimate Actual Weight and Height of Various Breeds of Horses

Introduction

Knowing the exact weight of a horse is important as it allows you to determine the correct doses of a dewormer or medication, track weight gain or loss during training, and it is important to know when designing a feeding program. There are different methods used to estimate body weight, including the Carroll and Huntington formula, weight tapes, and weight scales, which are the most accurate. However, digital scales are expensive, and most horse owners do not own their own set. Most equine veterinarians respond to emergencies at the barn or in the pasture, not at their clinic, and an accurate way to find weight quickly is essential for administering medications (Hapgood, 2002). Additionally, by knowing the exact weight of a horse, you can determine its maintenance requirements from published data such as that presented in the NRC Nutrient Requirements of Horses (2007).

The exact height of a horse is also important information for horse owners. It can monitor growth patterns in foals and yearling horses, and in many breeds the class for competition is determined by height. Height is most commonly estimated visually, but there are also equine height tapes and commercial height sticks with increments in hands (1 hand = 10.16 cm). There has been no study published which researches the accuracy of these weight and height tapes and height sticks when compared to scales and standard measuring tapes across a variety of breeds. This is why a study incorporating scales, standard measuring tapes, weight and height tapes and height sticks along with horses of different breed types, ages, and body condition scores is needed.

Equine weight can be estimated by using subjective body condition scores. A body condition score is an estimation of the amount and distribution of fat on the horse. The body condition score is a visual tool that can help you decide if a horse needs less or more feed for its level of activity (Cumming, 2009). Carroll and Huntington (1988) devised a nomogram which can be used to estimate a horses' weight by using body condition score and exact height.

Statement of the Problem

Proper nutrition is essential for desired growth, especially in young developing horses. The ability to measure accurate height and weight is important to ensure that the plane of nutrition or amount of medication given is appropriate.

Objective of the Study

(1) To compare electronic scale weight to that estimated by the Purina and SureMeasure weight tapes and the Carroll and Huntington formula from measurements on young and mature horses of different genders and breeds; and

(2) To compare height from a measuring tape in centimeters to that estimated by the Purina and SureMeasure height tapes and the Jeffers Aluminum Measuring Stick.

Literature Review

Importance of Proper Nutrition

Proper nutrition is required for desired growth, reproduction and performance. Nutritional requirements vary depending on breed, age, gender and level of activity (NRC, 2007). The NRC (2007) provides experimentally-based values that are used to formulate rations for horses. However, some producers do not have knowledge of the NRC (2007), and use

subjective body condition score or a commercially available weight tape to determine if their horses are receiving proper nutrition.

Body Condition Score and Weight

Cumming (2009) gives a step by step detailed approach to condition scoring a horse on a scale from 0-5. He explains that the horse should be visually assessed in all areas that fat is laid down, including the neck, the withers and shoulders, the top line along the whole body from behind the shoulders to the tail head, and the ribs. Cumming (2009) explains that as the horse fattens, each of these areas fills out and becomes smoother. Each area is described in detail, with descriptions of how appearance changes from low body condition to high. Instructions on how to use a weight tape and measure height, condition score, and length are also provided. Visual images are provided to illustrate how to take measurements and what different body condition scores look like.

Carroll and Huntington (1988) reported estimates of body weight from linear measurements and condition score of a large number of horses that varied in levels of fitness, and established standards for the procedure of condition scoring. Weight, height at the withers, heart girth and length from point of shoulder to point of buttocks were recorded on 372 horses. Horses were placed into one of five different height categories and then grouped according to condition score. Correlations were calculated between weight and height, heart girth, length, condition score, and girth^2 * length. The authors stated that deviations from the desired body condition, changes in workload, pregnancy and lactation are the main factors which influence the feed requirements of a horse. Condition scoring can be used to monitor the response to changes in the horse's diet. The study found that if a horse's condition score and approximate height are

known, the weight of the horse can be estimated, and it can be estimated even better using a nomogram when the exact height of the horse is known. Weight can also be accurately estimated from the formula:

$$Weight\ (kg) = \frac{girth^2 * length}{Y}$$

where the average value of the divisor (regression coefficient), denoted as Y, was 11,900. This value of Y estimated weight with more accuracy than some previously published values.

Estimating Equine Weight

Cumming (2009) discussed estimating equine body weight. Several options include using a weight tape around the horses' girth and taking measurements of the horses' girth and length to use with the formula designed to calculate live weight. Cumming states that a weight tape is not as accurate in heavily pregnant mares or in racehorses carrying little fat, and that the equation is most accurate for horses in condition score 2 to 3.

Gibbs and Householder (2003) give a different formula for estimating body weight using heart girth and body length. Research indicates that 88% of horse owners underestimate weight by an average of 84.37 kg. They conducted a field study with 12 horses of Arabian, Quarter Horse or Thoroughbred breeding. Measurements were obtained and weight was estimated with the formula, and estimated weight was then compared to an actual scale weight. They found that the procedure averaged within ± 10.89 kg of actual weight, which was better than the 84.37 kg average underestimation by visual means alone. The authors conclude that the prediction equation appears to be a more reliable method for estimating weight than visual observation alone, and horse owners should be able to utilize the formula to better manage their horses.

Wagner and Tyler (2011) evaluated the accuracy of a commercial weight tape and the body weight estimation formula evaluated by Carroll and Huntington (1988) compared to a portable livestock scale. Weight measured by the scale, height at the withers, heart girth circumference, and body length measurements were all recorded for horses in the study. Two variations of the body length measurement were used, measuring distance from point of the shoulder to the ischial tuberosity (point) or to the midpoint of the distance between the widest part of the stifle and the tail when viewed from the rear (stifle). They found that the two formula weight estimations and the weight tape estimation were significantly different from the actual weight and from each other. Their study found that the estimation formula using body length measurement with the point endpoint most closely estimates the actual body weight of horses.

Hapgood (2002) investigated the development of new equine weight estimation models while analyzing the comparative accuracy of various existing methods. Data were collected on 77 horses, and five new weight estimation models were developed. Age, breed and gender were recorded for each horse in the sample. Additionally, a visual estimate was taken of the horse prior to it being weighed on a scale. Weight estimates using three different commercially available weight tapes were also taken on horses in the sample. Hapgood found that the girth weight tape predicts only one weight for all horses with the same heart girth measurement and does not account for variations in height and length. This study found that calculating equine weight via a formula utilizing heart girth and length is the most accurate measure.

Breed Standards

Each breed has a standard of characteristics that are used to confirm that a certain animal does indeed match the requirements for its breed type. These standards are published in The Official Horse Breeds Standards Guide (Lynghaug, 2009).

The American Quarter Horse Association standards state that the generally acceptable height of a Quarter Horse is 14.3 – 15.1 hands, with weight ranging from 500.0 – 590.9 kg. The Quarter Horse has a much more muscular build when compared to other common riding horses of its height, which is what makes it unique from the other breeds used in this study.

The Arabian Horse Association standards are based on the fine bones and unique skeleton of the breed. It has fewer vertebrae in the back (usually twenty-three vertebrae as compared to twenty-four in most other equine breeds), as well as in the tail. The Arabian horse generally measures 14.1 – 15.1 hands at the withers and weighs 363.6 – 500.0 kg. The unique skeletal properties of the Arabian horse, combined with its lighter build, make it an individual breed type within this study.

The Gypsy Vanner Horse Society has breed standards that describe an animal with the look of a small to average sized horse with a draft horse type body. The breed has heavy muscling with heavy to medium-heavy bone compared to other horses of the same height group. The average height for a Vanner is between 13.2 and 15.2 hands tall, and their average weight is from 500.0 – 772.72 kg.

American Miniature Horses have two different breed associations, the American Miniature Horse Association and the American Miniature Horse Registry. The American Miniature Horse Association height standard states that a Miniature Horse must measure not more than 34 inches (86.4 cm) at the withers at the last hairs of the mane, while the American

Miniature Horse Registry has two height classes. Their standards state that an individual must not measure more than 34 inches (86.4 cm) at the base of the last hair on the mane for Division A, and not more than 38 inches (96.5 cm) for Division B. This designation of division heights creates a need for an accurate device with which to measure height. There is not an average weight for horses stated in their breed standards.

The last breed type used in this study is the Thoroughbred. The Jockey Club is the official registry for Thoroughbred horses, and they define them as a horse that stands a little over 16 hands on average. There is not an average weight listed in the breed standard, but it describes a horse that is lean and muscular, with very little body fat. The breed has light but strong bones, which makes for a very unique body type.

Methods and Materials

Data were acquired from horses of 5 different breed types for this study. Each of the breed types were selected due to availability and size variation across breeds. It was verified that all female animals used in this study were not pregnant at the time of measurement.

Materials used to obtain measurements in this study included: a custom designed portable digital scale, the Jeffers Aluminum Height Stick, the Purina horse height and weight tape, the SureMeasure horse height and weight tape, and a standard measuring tape in centimeters. A laptop computer equipped with Microsoft Excel was used for recording data.

The data for Gypsy Vanner horses were collected at a show at the Fort Worth Stockyards. All other horses were located at their home farms. The researcher traveled to the location of the

horses for data collection. Assistants were used for scribing data as well as helping with assembly and tear down of the portable scale. At most locations, the horses were handled by their owners, but when necessary an assistant would handle the animal during data collection. Twenty-two Gypsy Vanners, 20 Miniature Horses, 28 Thoroughbreds, 20 Arabians, and 22 Quarter Horses were measured for this study, for a total of 112 horses.

Each horse was measured with the Jeffers Aluminum Measuring Stick. Height estimations were recorded from the Purina height tape and SureMeasure height tape. Weight estimates were also recorded from the Purina height tape and the SureMeasure tape. An assistant then aided in collection of height, heartgirth, and length in centimeters using the measuring tape. The body condition score of the horse was determined by visual evaluation on a scale of 0-5. Finally, the horse was led onto the digital scale to determine actual weight in kilograms. After ensuring that all measurements were accurately recorded, the horse was then returned to its stall or other living area.

Data were analyzed using the CORR procedure of SAS (Version 9.3, SAS Inst. Inc., Cary, NC). Pearson's correlations were calculated within and across breed for height in centimeters compared to each of the height estimates, and within breed for scale weight compared to each of the weight estimates.

Results and Discussion

Simple Means

The data collected were first evaluated for simple means by breed and device, as illustrated in Tables 1 to 5. These evaluations indicated that Gypsy Vanner horses were a very diverse group, as they had higher standard deviations for most traits than the other breeds, as

illustrated in Table 1. Thoroughbreds had the smallest standard deviation for most traits, shown in Table 3, which indicates that they were a more uniform group within breed type. Quarter Horses were unique with respect to body condition score, as all individuals used within this breed type had the same body condition score and therefore no standard deviation for this trait, which can be seen in Table 5.

Table 1. Simple means for traits measured within Gypsy Vanner Horses.

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Stick Height (cm)	22	141.72	9.08	125.00	156.00
Purina Height (cm)	22	144.81	8.57	129.54	158.75
SM Height (cm)[1]	22	143.34	8.72	128.27	157.48
Height (cm)	22	143.28	8.54	127.00	156.84
Purina Weight (kg)	22	457.70	114.01	231.33	594.21
SM Weight (kg)[2]	22	411.10	101.34	221.35	559.73
Heartgirth (cm)	22	177.37	18.15	140.97	201.93
Length (cm)	22	155.52	14.16	130.81	182.88
Scale Weight (kg)	22	454.11	103.81	254.01	621.42
CH Formula (kg)[3]	22	421.73	115.37	218.45	618.79
BC Score[4]	22	4.06	0.30	4.00	5.00

1 – SureMeasure height (cm); 2 – SureMeasure Weight (cm); 3 – Carroll and Huntington Formula (kg); 4 – Body Condition Score (0 = very poor, 5 = very fat).

Table 2. Simple means for traits measured within Miniature Horses.

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Stick Height (cm)	20	--	--	--	--
Purina Height (cm)	20	84.84	4.15	75.44	92.46
SM Height (cm)	20	80.15	6.71	64.01	91.44
Height (cm)	20	84.11	7.22	68.58	93.35
Purina Weight (kg)	20	88.11	28.89	40.82	145.15
SM Weight (kg)	20	79.54	25.22	40.82	122.02
Heartgirth (cm)	20	96.84	11.33	76.20	113.67
Length (cm)	20	87.82	9.90	76.20	100.33
Scale Weight (kg)	20	69.63	20.86	34.93	110.22
CH Formula (kg)	20	71.64	22.39	35.32	105.48
BC Score	20	2.75	0.55	2.00	4.00

1 – SureMeasure height (cm); 2 – SureMeasure Weight (cm); 3 – Carroll and Huntington Formula (kg); 4 – Body Condition Score (0 = very poor, 5 = very fat).

Table 3. Simple means for traits measured within Thoroughbred Horses.

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Stick Height (cm)	28	158.48	3.65	152.00	165.00
Purina Height (cm)	28	159.79	3.51	154.94	167.64
SM Height (cm)	28	157.93	3.13	152.40	163.83
Height (cm)	28	158.36	3.29	153.04	167.01
Purina Weight (kg)	28	477.57	44.65	412.77	566.99
SM Weight (kg)	28	416.43	37.44	353.35	498.04
Heartgirth (cm)	28	179.98	6.24	170.18	194.31
Length (cm)	28	163.44	6.46	147.32	175.26
Scale Weight (kg)	28	462.62	45.51	383.74	569.26
CH Formula (kg)	28	446.29	46.23	369.32	556.07
BC Score	28	2.96	0.33	2.00	4.00

1 – SureMeasure height (cm); 2 – SureMeasure Weight (cm); 3 – Carroll and Huntington Formula (kg); 4 – Body Condition Score (0 = very poor, 5 = very fat).

Table 4. Simple means for traits measured within Arabian Horses.

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Stick Height (cm)	20	145.28	7.82	127.00	155.00
Purina Height (cm)	20	147.70	8.68	125.73	157.48
SM Height (cm)	20	145.86	8.52	125.73	154.94
Height (cm)	20	144.91	8.49	126.37	154.94
Purina Weight (kg)	20	391.68	94.52	215.46	512.56
SM Weight (kg)	20	336.47	76.76	190.51	454.05
Heartgirth (cm)	20	165.45	15.02	133.99	185.42
Length (cm)	20	148.78	11.36	128.27	165.74
Scale Weight (kg)	20	369.18	77.26	229.52	480.81
CH Formula (kg)	20	348.83	82.30	193.50	459.35
BC Score	20	4.05	0.51	3.00	5.00

1 – SureMeasure height (cm); 2 – SureMeasure Weight (cm); 3 – Carroll and Huntington Formula (kg); 4 – Body Condition Score (0 = very poor, 5 = very fat).

Table 5. Simple means for traits measured within Quarter Horses.

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Stick Height (cm)	22	144.50	8.27	130.00	159.00
Purina Height (cm)	22	146.60	8.25	132.06	158.75
SM Height (cm)	22	144.40	8.20	130.81	157.48
Height (cm)	22	144.84	8.15	130.81	157.48
Purina Weight (kg)	22	401.32	99.88	244.94	539.77
SM Weight (kg)	22	359.80	96.92	221.35	584.23
Heartgirth (cm)	22	168.82	17.09	141.61	203.84
Length (cm)	22	156.50	13.89	134.62	181.61
Scale Weight (kg)	22	427.14	107.58	279.41	641.83
CH Formula (kg)	22	384.63	108.82	231.12	629.65
BC Score	22	3.00	--	3.00	3.00

1 – SureMeasure height (cm); 2 – SureMeasure Weight (cm); 3 – Carroll and Huntington Formula (kg); 4 – Body Condition Score (0 = very poor, 5 = very fat).

Correlations

Correlation coefficients were also calculated for this study, and data is presented in Tables 6 and 7. Table 6 illustrates the highly correlated values for height, and from this table it can be shown that as true height increased, so did height as measured with all of the devices. All values are significant ($P \leq 0.05$). All devices used to estimate height of Gypsy Vanners were highly correlated ($r = 0.99$) to actual heights. Miniature horses had the lowest r value observed, but this value was still highly correlated to true height.

Table 6: Correlation coefficients between height measured with tape measure and the Jeffers Aluminum Height Stick, Purina height tape, and SureMeasure height tape.

Height Estimate	Gypsy Vanner	Thoroughbred	Quarter Horse	Arabian	Miniature	Overall
Stick	0.99	0.90	0.99	0.94	-	0.98
Purina Height	0.99	0.92	0.99	0.93	0.84	0.99
SureMeasure Height	0.99	0.97	0.97	0.93	0.94	0.99

Table 7 illustrates the highly correlated values for weight. This shows that as true weight increased, so did weight as estimated with the devices. All values are significant ($P \leq 0.05$). Miniatures had an r value of 0.98 for all devices used to measure weight, while Thoroughbreds had the most diverse range of r values.

Table 7: Correlation coefficients between scale weight and weight estimates using Purina weight tape, SureMeasure weight tape, and the Carroll and Huntington Formula.

Weight Estimate	Gypsy Vanner	Thoroughbred	Quarter Horse	Arabian	Miniature	Overall
CH Formula[1]	0.97	0.95	0.99	0.98	0.98	0.99
Purina Weight	0.94	0.89	0.88	0.97	0.98	0.98
SureMeasure Weight	0.94	0.91	0.98	0.97	0.98	0.98

1 – Carroll and Huntington Formula

Weight data from this study agrees with that collected in the study by Wagner and Tyler (2011). Wagner and Tyler (2011) found that the Carroll and Huntington formula using body

length measurement with the point endpoint was the most accurate for estimating body weight, and data collected in this study show that using that measurement for length has an r value of 0.99, which indicates a very large correlation between estimated weight calculated and true weight. Hapgood (2002) also found that using a formula utilizing heart girth and length to calculate weight is the most accurate measure.

Conclusion

Weight estimates using the Purina weight tape, SureMeasure weight tape, Carroll and Huntington formula, and actual weights using a digital scale were recorded for 112 horses of 5 different distinct breed types. Height estimates were also collected from the same individuals using the Purina height tape, SureMeasure height tape, and Jeffers Aluminum Measuring Stick, and actual height was measured using a measuring tape in centimeters. The correlations between actual and estimated weight and height were significant for all breeds evaluated.

Implications

Data from this study indicate that, while not 100% accurate, industry available weight and height tapes as well as other farm measurements can be used comfortably by horse owners to estimate height and weight on their animals. These estimates can be used with a high level of confidence to keep track of growth patterns in their horses, and can help horse owners feel safe when administering a medication or dewormer. These data show that a weight tape is also a useful device for a veterinarian to have on hand when traveling to a farm so that he or she does not have to rely on visual estimates to determine medication doses. Breeds which have standards based on height as well as breed type should feel comfortable using a height measuring device when determining registration acceptability of horses.

While it is always preferred to measure using a standard measuring tape in centimeters, data from this study recommends using the SureMeasure to measure height in Thoroughbred and Miniature horses. A Gypsy Vanner and Arabian can be measured with any of the devices, but it is preferred to measure a Quarter Horse with a Jeffers Aluminum Height Stick or Purina height tape instead of the SureMeasure height tape. Overall, the Purina and SureMeasure height tapes are better to use than the Jeffers Aluminum Height Stick when measuring horses.

Data from this study also demonstrate that the Carroll and Huntington formula may be used to measure Gypsy Vanners, Thoroughbreds, Quarter Horses, and Arabians when a digital scale is not available. It is not recommended to use a Purina weight tape for Thoroughbreds or Quarter Horses. Either the Purina or SureMeasure weight tapes can be used to measure a Gypsy Vanner or an Arabian when it is not feasible to use the Carroll and Huntington formula. A Miniature can be measured with any of the weight devices. Overall, the Carroll and Huntington formula is the best way to measure weight on any of the breeds when a digital scale is not available.

LITERATURE CITED

Carroll, C.L., and P.J. Huntington. 1988. Body condition scoring and weight estimation of horses. Equine Vet. Journ. 20(1):41-45.

Cumming, B. 2009. Estimating a horse's condition and weight. Primefacts. Primefact 928, pages 1-10.

Gibbs, P.G. and D.D. Householder. 2003. Estimating horse body weight with a simple formula. Texas A&M University Department of Animal Science Equine Sciences Program. Fact sheet.

Hapgood, A. 2002. Accuracy of alternative equine weight estimation models utilizing new variable. HTML Web page. http://oas.uco.edu/02/papers/hapgood02.htm. Accessed online Nov 9, 2011.

Lynghaug, F. 2009. The Official Horse Breeds Standards Guide: The complete guide to the standards of all North American equine breed associations. Voyager Press, Minneapolis, MN.

NRC. 2007. Nutrient Requirements of Horses. 6th rev. ed. Natl. Acad. Press, Washington, DC.

Wagner, E.L., and P.J. Tyler. 2011. A comparison of weight estimation models in adult horses. Journ. Equine Vet. Sci. 2011:1-5.