Timely Topics in Nutrition

Use of body condition scores in clinical assessment of the provision of optimal nutrition

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The concept of providing optimal nutrition has been promoted by nutritionists and manufacturers of diets and feeds for a number of years. The nutrient profiles and feeding management that constitute optimal nutrition are ultimately determined by the productivity or outcome desired for each animal in a given situation. For example, running as fast as possible at maximum effort for a brief period versus running as fast as possible at less-than-maximum effort under inclement conditions for prolonged periods argues for 2 types of nutrient profiles and feeding strategies. Similarly, maximizing growth rate or milk production versus achieving more modest rates of growth or production and decreasing the risk of disease seemingly would affect nutrient profiles and feeding management. Finally, a particular disease or condition, its specific physiologic derangements, and severity of the problem can alter the nutrient profile or feeding management with regard to what is believed to be optimal.

Attaining a specific performance goal is the quintessential determinant of whether optimal nutrition has been provided, but often an intermediate or preliminary assessment is desired prior to reaching a definitive end-point. Sometimes, end-products or intermediates of physiologic reactions that are affected by nutritional manipulations can be measured with relative ease. However, in all instances, the optimal nutrient profile and feeding strategy ultimately produces a characteristic body condition that is apparent during assessment. This should not be construed to mean that all optimal nutrient profiles and feeding strategies result in an optimal body condition. Based on the desired goal for production or performance of a specific animal, an optimal nutrient profile and feeding strategy may produce a **body condition score (BCS)** that is slightly more or slightly less than midscale BCS.[1-3]

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Use of a Scoring System to Assess Body Condition

Assessing body condition by assigning a BCS is a subjective, semi-quantitative method of evaluating body fat and muscle. Methods for assigning a BCS have been developed for production (cattle, sheep, goats) and companion (dogs, cats, horses) animals.[4-12] Body condition spans a continuum that body condition scoring attempts to partition that continuum into a finite number of categories. The categories can be as few as 3 but generally 5-, 6-, or 9-integer scales predominate the literature.[4-8,10-14] The integer categories within a scale can be further divided into 1 to 9 subcategories making the total scores or divisions within a body condition scoring method any number between 5 (5-integer scale, no subdivisions) and 41 (9-integer scale divided to 0.1 units). The specific score is assigned based on 1 or more characteristics of the animal being scored. The characteristics can be visual, palpable, or both, and can involve single or multiple regions of the body. Palpable characteristics are used in species and breeds that have hair of sufficient length to prevent observation of subcutaneous fat and superficial musculature.[8,13] However, palpable characteristics can be incorporated into BCS protocols used on short-haired species,[5,12] and purely visual protocols for judging the shape of an animal's silhouette have been proposed for species with coats that normally obscure observation of subcutaneous fat and superficial musculature.[14]

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In general, animals with mid-range BCS have superficial bony prominences that can be readily palpated but not seen. Bony prominences are progressive-

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ly harder to locate by palpation as BCS increases from mid-range values. Bony prominences generally become indiscernible at maximum BCS. For body conditions whose values are less than mid-range scores, bony prominences become more easily observed or palpated and extend above the contour of the skin as BCS decreases. The exception to the previous statements is the dairy cows; bony prominences important to assigning BCS generally are always seen for mid-range scores, with some prominences remaining visible for all but the maximum scores.

Most of the protocols are easy to learn and require minimal notation for documenting a score. Even the most complicated and evolved protocol can be learned relatively quickly through application and practice. Despite the ease of obtaining a BCS, a survey of 200 veterinary hospital records for animals examined at Texas A&M University during the past 12 months suggests that < 10% had a BCS recorded as part of the information gathered on the animal. The subjective nature inherent in assigning a BCS and, thus, the semi-quantitative nature of the information might lead to the belief that a BCS is an unreliable opinion that is imprecise and conveys relatively little information of clinical benefit. However, it has been documented in several studies[6,7,12,a] that body condition scoring is reliable when performed in accordance with specific protocols and that it does convey useful clinical information.

Reliability of Body Condition Scoring

The usefulness and reliability of a BCS are dependent on 3 aspects: repeatability, reproducibility, and predictability.[16] Repeatability is the ability of an assessor to assign the same score for the same animal during repeated examinations, provided the animal's body condition has not changed. Repeatability is an assessment of within-assessor variability or within-assessor precision. Reproducibility is the ability of 2 or more assessors to independently assign the same score for the same animal. Reproducibility is an assessment of between-assessor variability or between-assessor precision. Reproducibility also indicates the likelihood that all parties in a discussion understand the body condition of the animal when a BCS is stated as well as the associated consequences of that body condition in regard to the desired goal for that animal.

Intuitively, better repeatability and reproducibility should be obtained when each category or subcategory of body condition is unequivocally described. Some scales that have a range of 1 to 5 for 5 categories can have subcategories at an interval of 0.1 and provide up to 41 divisions. However, average repeatability is generally reported to be slightly < 0.5 when using scales that have detailed descriptions and rationales for assigning BCS ranging from 1 to 5 or 1 to 9 with subdivisions at intervals of ≥ 0.25.[6,7,12] Similarly, average reproducibility has been assessed at 0.25 to slightly more than 0.5 for those scales. Correlations for inter-assessor agreement in protocols providing detailed descriptions for each category have ranged from 0.8 to 0.95.[6,7,12] Assessors will generally change the BCS by the same magnitude when scoring various animals with differing body conditions, even when each assessor assigns a different score for the same animal.[4] Thus, the relative change in body condition among animals or for the same animal during a specified interval of time tends to be consistent among assessors when they use a defined-criteria system. An assessor's experience with body condition scoring influences the score assigned to an animal within the BCS scale, indicating that, similar to most physical examination techniques, there is a learned art to assessing body condition.[4,12,a] Given the results for intra- and inter-assessor variation, it seems reasonable to limit the number of divisions to approximately 17, which is a scale with values ranging from 1 to 5 with intervals of 0.25 or a scale with values ranging from 1 to 9 with intervals of 0.5. For dairy cattle, evidence indicates that as animals approach the outer extremes of body condition (< 2.5 or > 4.0 on a scale of 1 to 5 with intervals of 0.25), it is impossible to subdivide each category as finely as is possible for body conditions that have mid-range scores.[12]

Predictability is the ability of the BCS to reflect actual body components of an animal. The body component most often of interest is body fat, but sometimes body muscle, or its loss, is of interest in animals with scores that are less than mid-range. To assess predictability, the component being predicted must be measured by some method other than the BCS protocol. Such methods can include direct analysis of the carcass by means of chemical or physical[17,18] partitioning of components, or indirect estimation of components by use of techniques such as isotope dilution,[17,19] ultrasonography,[11,20] or dual-energy x-ray absorptiometry.[6,7] When BCS and body fat have been measured concurrently, the coefficient of determination (ie, r^2) indicating the amount of variability in body fat that can be explained by the BCS has ranged from 65 to 90%.[6,7,11,18,19] Methods of assigning a BCS that assess multiple body regions generally correlate better with total body fat than those that assess only 1 or 2 locations on an animal. In general, reports[6,7,11,18,19] indicate that body fat at mid-range score is 15 to 25% of body weight and increases or decreases 5 to 7% for each 1-integer increment in BCS, when using a scale that has a range of 1 to 9.

Two other aspects of predictability are worth remembering, even though the explained variability and incremental increase in body fat with each condition score appear to be reasonable to excellent. First, the estimated increase in body fat with each BCS is somewhat dependent on the range of body fat for the animals in the study group being used to investigate the association as well as the range for condition scores assigned to each animal in the study group. Ideally, the minimum and maximum condition scores should correspond to the minimum and maximum body fat possible for animals of the particular species being studied. It is rare that animals with such extreme compositions will be readily available or readily producible for a trial assessing the prediction capabilities of a BCS protocol. Thus, it is incorrect to assume that extreme condition scores represent the absolute extremes possible in body fat, especially at the upper end of the BCS range. Second, it is the average body fat of all animals assigned a given condition score that becomes associated with that score, and, thus, there is variation in the

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amount of body fat within each score. The SE for predicting body fat content is generally ± 3 to 5%, making the 95% confidence interval for prediction for body fat ± 6 to 10%.[6,7,18,19]

Use of Body Condition Scoring

Is a system that measures body fat wiht 95% confidence to ± 10% sufficiently adequate to be clinically useful? It is certainly good enough to be used to place animals in thin, average, and overweight categories. This can be useful in convincing clients that their pet or animals in their herd or flock need to be fed more, less, or differently from the manner that is currently being used. The argument is often made that body weight alone is as good as, or better than, BCS in making such decisions.[15] This may be true in species or herds in which body weight for a given body condition varies little among individuals. However, a BCS is extremely useful for assessing the appropriateness of a given weight in species with body weights that vary several hundred-fold among the smallest and largest breeds within the species or among individual animals within the same breed in which weight and size of adults vary appreciably. Although body condition sometimes may be correlated with body weight,[7] a BCS is generally independent of weight or frame size, indicating that additional information is gained from the BCS.[4-6,12]

Dairy cattle—Although body condition scoring may be useful for quantifying body fat and other tissue reserves to some extent, it is not absolutely necessary to convert a BCS into an amount of body tissue for the BCS to be interpretable in a prognostic manner. Reports for dairy cattle indicate a preferred, relatively narrow range of BCS (3.5 to 4.0) for cows at the beginning of lactation to enable them to maximize milk yield and composition, increase the number of cows observed in estrus, and decrease the prevalence of some common postparturient diseases during the first third of lactation.[1,2,21] It has become clear from several studies that cows entering the nonlactating period should not lose much, if any, body condition during the nonlactating period.[21,22] In fact, it was suggested in 1 study[2] that cows should enter the nonlactating period with a BCS of 3.0 to 3.5 and gain weight to increase body condition (by up to 1.0 BCS) to maximize milk production during the first third of the subsequent lactation. Maintenance of appropriate body condition during the nonlactating period appears to minimize the risk for several periparturient diseases as well as reproductive inefficiency during the subsequent lactation.[21,22] However, cows should not become over-conditioned (ie, BCS > 4.0 on a scale of 1.0 to 5.0) during the nonlactating period, because it has been reported that such cows have a higher incidence of ketosis, unobserved estrus, cystic follicles, and lameness as well as a decrease in milk production during the first 90 to 150 days of lactation.[21-23] There are expected changes of 0.5 to 1.0 in BCS during lactation and the nonlactating period that are associated with maximum milk production and health. Changes within this range are detectable when assessed at monthly intervals.[1,2,5,21] Among cows that have a decrease between 0.5 and 1.5 for BCS during the first third of lactation, those that lose body condition the fastest have the fastest increase in milk production and attain greater peak production than cows of similar parity that lose less body condition.[1,2,5] It is speculated that this change in body condition relates to a cow's ability to convert tissue reserves to milk during the period of her lactation when maximum nutrient consumption cannot meet metabolic requirements. Although peak production is higher for cows that lose more condition in early lactation, the persistence of their lactation curve is not as great as for cows that lose less condition, and there is some debate as to which variable is ultimately more important for maximizing total milk production during a lactation.[2,5] However, nutritional management of cows throughout the nonlactating period and early lactation to attain the aforementioned body conditions results in more milk produced during the first 90 to 120 days of lactation (an increase of 170 to 545 kg [375 to 1,200 lb], depending on the herd, study, and amount of correction for fat content[1,2,5,21,23]). Thus, BCS in dairy cattle can be used as a management tool for making decisions on nutritional goals for maximization of milk production and minimization of disease.

Horses—Body condition scoring is also useful for managing feeding programs to optimize and predict the performance of horses, generally measured in terms of reproductive efficiency and work. The BCS impacts the reproductive efficiency of broodmares. Mares that have given birth or enter the breeding season with a BCS < 5 (on a scale of 1 to 9) have lower pregnancy rates (55 to 79% vs ≥ 89%) and require more time to conceive (2.6 to 3.7 vs 1.2 to 1.5 cycles/conception), compared with mares with a BCS ≥ 5.[3] Increasing body condition (from 5 to 9) may slightly increase pregnancy rate and result in fewer cycles per conception, but benefits for these variables are small and feed costs large for mares with a BCS ≥ 7. Also, mares with a BCS ≥ 5 maintained pregnancy better after 90 days of gestation than thinner mares.[3] Thus, reproductive efficiency is maximized by maintaining broodmares at a BCS of 5 to 7 (scale of 1 to 9) throughout lactation, breeding, and gestation.

Inadequate or excessive amounts of body condition can adversely impact performance of horses doing physical, competitive work. Horses with a BCS > 7 that are doing moderate work require longer to recover from work, as indicated by plasma lactate concentrations and respiration rates, compared with horses with a BCS of 5 that are doing similar work, presumably because excess body condition inhibits dissipation of heat generated from muscular activity.[24] Although too much condition may inhibit heat dissipation and hasten fatigue in working horses, too little condition also is detrimental to performance. The BCS of a designated horse was superior to a number of other weight-related measures for that horse when used for predicting whether horses would complete a 160-km (100-mile) endurance trial or be eliminated for metabolic reasons.[25] The 360 horses included in that study ranged in BCS from 1.5 to 5.5 (scale of 1 to 9), and 222 hors-

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es had a BCS < 5. Horses with BCS < 5 were at substantial risk for elimination from the endurance trial for metabolic reasons, compared with horses with a BCS of 5 or 5.5. Furthermore, the closer the BCS of a horse was to a value of 5, the greater the distance the horse was able to go before being eliminated from the endurance trial. The authors estimated that an additional 31.8 km (19.9 miles) were completed for each 1-integer increase in BCS within the range of scores observed.

Cats and dogs—In cats and, in particular, dogs in which typical adult weights vary greatly among breeds, the BCS is a good indicator of overweight and obese conditions. Epidemiologic surveys that have used BCS estimated that 25 to 30% of dogs and cats examined by veterinarians are carrying excess weight (BCS of 3.5 to 4.0 on a scale of 1.0 to 5.0) with about 5% being obese (BCS ≥ 4.5).[10,13,14,26] In 1 survey,[14] for which investigators had the objective of determining the prevalence of health problems in dogs and cats examined at veterinary clinics in the United States, participating veterinarians assigned a BCS to all dogs and cats admitted, using a defined-criteria, 5-category scale (range of 1 to 5). Approximately 5% of the dogs and cats admitted had BCS ≥ 4.5, which is similar to results reported in other surveys, but only 2% had obesity identified as a diagnosis on their coding sheets for health problems. Several explanations could account for the fact that more than half the obese dogs and cats were not recognized as such, 1 being that not every veterinarian considers obesity to be a disease or even a problem until the excess weight adversely impacts some other disease or problem.[27] Regardless of the reasons, the fact that more than half of the obese dogs and cats were not coded as such suggests that the importance of the BCS was not integrated into the overall assessment of each animal's health. Obesity has been estimated to be the most prevalent manifestation of malnutrition in dogs and cats in Western society and to adversely impact glucose metabolism and hepatic function.[28-31] Obesity also has been associated with nonallergic skin disorders and lameness.[31,32] As little as 11% excess body weight can cause an increase in required medication for control of signs of pain in dogs with osteoarthritis,[32] and 10% excess body weight is roughly half the excess weight required to declare that an animal is obese, using the conservative definition for obesity of 20% above optimal body weight. Loss of the 10% excess weight to achieve a mid-range BCS in osteoarthritic dogs produces clinical benefit, as determined by evaluation of the opinion of the owners and alleviation of the need to use medication to control signs of pain attributable to arthritis.[32]

Although monitoring body condition alone might not be sufficiently sensitive to provide timely changes to a weight reduction plan in animals that do not appear to be losing weight, the underlying goal of most weight loss programs for companion animals is to return animals to a mid-range BCS. Achieving this goal is associated with losing a finite amount of weight, but accomplishment is ultimately determined by assessing each animal's body condition. Furthermore, because modern commercial foods are generally being fed to most healthy companion animals, the ultimate determinant for the amount of food that is sufficient is the amount that maintains an animal in a mid-range BCS.

Conclusion

Analysis of results of the aforementioned studies reveals that body condition scoring can be a useful guide to the nutritional adequacy of an animal or group of animals. As such, the BCS reflects the consequences of food and nutrient intake during the previous weeks or months. The BCS is not a replacement for monitoring and recording of body weight; rather, it should be used in conjunction with body weight and the goals for an animal when assessing the appropriateness of body weight and feeding management. Body condition scoring currently appears to be an underutilized tool for diagnostic, prognostic, and monitoring purposes. I recommend that practitioners select and become comfortable with a BCS protocol applicable to the species with which they are regularly involved. When several protocols exist for the same species, consideration should be given to the number of regions assessed on an animal by each protocol and the detail of descriptions provided by the protocol for differentiating among various scores. Consideration also should be given for the degree to which a BCS protocol has been assessed for repeatability, reproducibility, and predictability. The final step for using body condition scoring to its fullest extent involves recording and interpreting the BCS in regard to its importance for health or productivity of an animal or group of animals and then educating the client of this importance.

[a]Graham JF, Clark AJ, Spiker SA. The repeatability and accuracy of condition scoring beef cattle (abstr), in *Proceedings*. Aust Soc Anim Prod 1982;15:684.

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