Journal of Animal Physiology and Animal Nutrition

DOI: 10.1111/jpn.12063

ORIGINAL ARTICLE

Evaluation of a fast, objective tool for assessing body condition of budgerigars (*Melopsittacus undulatus*)

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Summary

There is currently no suitable system available for the assessment of budgerigar body condition. A tool has been developed that uses an algorithmic decision tree of yes-no answers based on physical examination to objectively guide the assessor to a body condition score. The aim of this work was to evaluate the guide. Repeatability and reproducibility were measured by four assessors on three sequential days, using 38 budgerigars of mixed sex, age and weight. Data were analysed using a 3-factor ANOVA, with Person and Bird as variable factors and occasion as a fixed factor. The association between body condition score and body fat was measured using three assessors and 63 dead budgerigars, which were chemically analysed for fat content after assessment. Data were statistically analysed to determine correlation using Spearman's Rank Coefficient. Occasion and person had no significant effect on body condition score ($p = 0.988$ and 0.347 respectively). Body condition score and percentage body fat were highly significantly correlated ($R^2 = 0.768$): percentage fat increased with increasing body condition score. The guide would appear to be a repeatable measure of body condition in budgerigars, suitable for use during physical examinations.

Keywords physical examination, companion bird, obesity

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Received: 4 September 2012; accepted: 5 February 2013

Introduction

Birds have both superficial and intra-abdominal adipose tissue but lack true intermuscular adipose tissue. The main superficial fat depots are at the back of the neck around the furcular groove, on the anterior surface of the thigh, over the breast muscle and on the back near the tail. The superficial depots usually enlarge more than the internal ones. They expand laterally as well as thicken, finally forming an almost continuous layer that is thickest over the breast and anterior surface of the thigh. In a study of 44 bird species, Pond and Mattacks (1985) showed the pattern of fat deposition described previously is followed in all species examined (including the budgerigar), except penguins, where the majority of fat is deposited in an even, constant subcutaneous layer.

Wyndham (1980) reported great variation in body fat of budgerigars. Obesity is a commonly reported form of malnutrition in birds, and assessment of body condition is a vital part of the physical examination (Van Sant, 1996; Doneley et al., 2006). Research into budgerigar nutrition requires accurate evaluation of dietary treatment effects on body condition and close assessment of general bird health. Body condition scoring (BCS) is a subjective, semi-quantitative method of evaluating body fat and muscle where assessment is based on visual and palpable characteristics. Bird scoring systems may have as few as four categories, such as the hen scoring system of Gregory and Robins (1998), but longer, more complex scales, often split into sub-categories, such as that of Kaiser (1993) predominate. An extensive search showed there is currently no system available to fulfil the budgerigar assessment needs of companion bird researchers or the wider field of avian veterinary practice. Just one type of BCS system has been devised specifically for pet birds: where the assessor selects one of five diagrams (Welle, 1995; Kaytee®, 2002). However, its application has been limited by the lack of scientific evaluation and the subjective nature of the scoring.

There are numerous BCS guides available for ornithologists, some developed specifically for internal use

in field guides (Bairlein, 1995; Griffin, 2002) and others published in ornithological journals for general application (West and Peyton, 1972; Rogers, 1991; Kaiser, 1993). This indicated development of a robust pet bird BCS guide was feasible. On the basis of this rationale, an alternative BCS guide to that of Welle (1995) was developed using an algorithmic decision tree of yes-no answers to objectively guide the assessor to a score.

The usefulness of a body condition score system is dependent on three factors: repeatability, reproducibility and the relationship between body fat and allocated score (Altman and Bland, 1983). Repeatability and reproducibility in previous studies have been considered to be the ability of an assessor to assign the same score for the same animal on separate occasions and the ability of three or more assessors to assign the same score for the same animal respectively (German et al., 2006). Reproducibility is often influenced by the experience of the assessor and indicates that BCS is often a learned art.

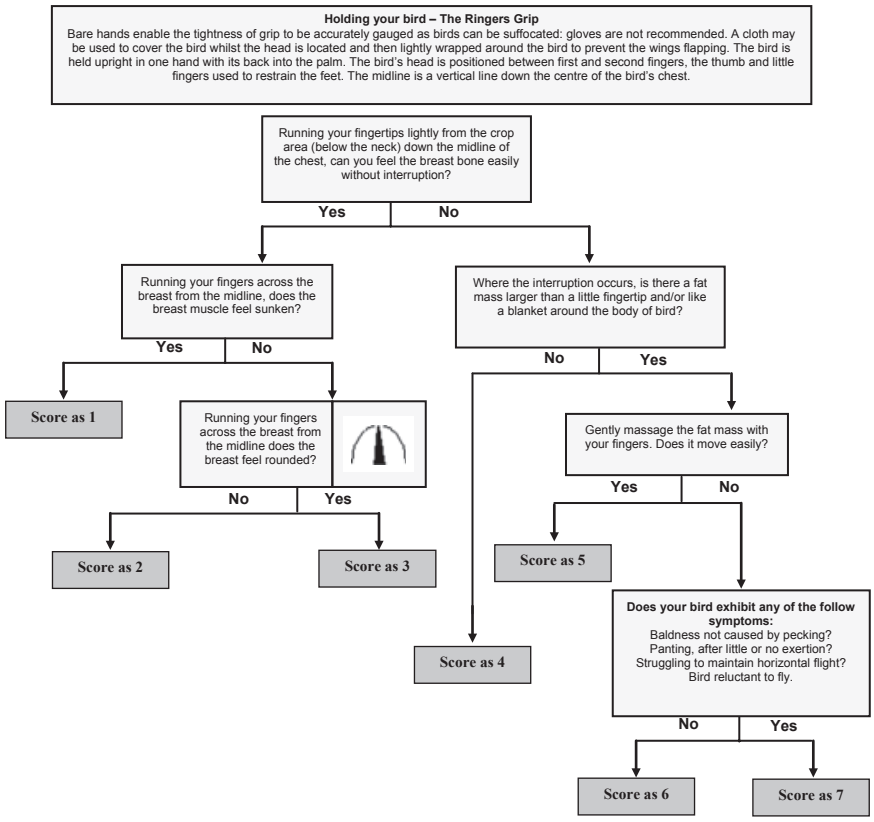
The aim of this work was to evaluate the guide as a simple tool for the assessment of body condition in budgerigars.

Materials and methods

For all assessments, birds were held in the Ringer's Grip: the bird's back is placed in the palm of the hand, and its head is held gently between the first and second fingers. The guide was used by starting with the top question 'can you feel the breast bone easily without interruption?' and working down a decision tree of yes-no answers until a score on a numerical rating scale was reached (Fig. 1).

Repeatability and reproducibility were assessed by four people, on three sequential days, using a mixed sex, mixed age group of 38 adult budgerigars covering a range of bodyweights including both wild-type and exhibition-type budgerigars. Body weight was recorded each day after BCS assessment to record any possible weight change in the birds.

For each of the three validation days, birds were caught from each selected aviary just prior to validation and caged as a group. Birds used in the study were well acclimatised to regular handling to ensure stress was minimised. Each bird was removed from the cage and briefly (30–60 s) assessed by each assessor in turn before release back into the aviary. One



Score	Description
1	**Thin** Your bird has no body fat reserves and musculature that is also below ideal condition. Recommendation: Seek expert avian advice promptly and ensure your bird avoids any form of stress.
2	**Lean** Your bird has below ideal reserves of fat and muscle. Recommendation: Seek expert avian advice to ensure your bird is offered the appropriate amount and type of food. Reassess using the WALTHAM B-FIT Guide every 2 weeks.
3	**Ideal** Your bird has ideal amount s of body fat and muscle. Recommendation: Monitor monthly to ensure your bird remains in this category.
4	**Mildly overweight** Your bird is at the upper end of the ideal range with a small amount of excess body fat. Recommendation: Provide environmental enrichment to decrease boredom and avoid overeating. Reassess using the WALTHAM B-FIT guide every 2 weeks.
5	**Moderately overweight** Your bird has an excess of total body fat. Recommendation: Avoid treats seek expert advice on increasing activity levels and ensuring your bird is offered the appropriate amount and type of diet. Reassess using the WALTHAM B-FIT guide every 2 weeks.
6	**Severely overweight** Your bird has a large amount of excess body fat that is affecting its health and well being. Recommendation: Seek expert avian advice to implement safely an appropriate weight loss plan. Reassess using the WALTHAM B-FIT guide every 2 weeks.
7	**Morbidly overweight** Your bird's health is gravely at risk. Recommendation: Seek veterinary advice immediately to introduce a supervised weight loss plan to reduce your bird's weight, increase activity levels and improve health. Ensure your bird avoids any form of stress.

Fig. 1 Decision tree for body condition score guide.

aviary was assessed at a time, and assessments were recorded privately in silence to prevent assessors from influencing each other. A mixture of naïve and experienced assessors were used on each occasion. Data were analysed using a 3-factor GLM ANOVA with person and bird as random effects and occasion as a fixed effect.

Association between body score and body fat was measured using three assessors and 63 budgerigars of mixed sex, age and body weight that had died naturally or been euthanased for health reasons. Birds were collected with signed owner consent and stored frozen at −20 °C prior to determination of body condition and body fat. Bird age was not recorded, but only adult birds were assessed in the study. Birds were defrosted, warmed to live body temperature (41 °C) and assessed exactly as in the live bird measurements for repeatability and reproducibility determination. After BCS assessment, birds were refrozen and stored at −20 °C. Chemical analysis of fat content was carried out as follows: cadavers were allowed to thaw for approximately 15 min and then plucked to remove the majority of feathers. Plucked cadavers were then minced through a small domestic mincer. The resultant material was collected, including any material left in the voids of the mincer. The mincer was washed and dried between birds. All materials from each minced bird were treated with hydrochloric acid prior to soxhlet, petroleum ether solvent extraction (AOAC method 923.03).

Data were initially analysed using a GLM ANOVA to model the relationship between BCS and percentage fat. Person was included as a factor to determine whether there was significant person to person variation. Further association analysis was carried out on pooled (person) data using Spearman's Rank Coefficient.

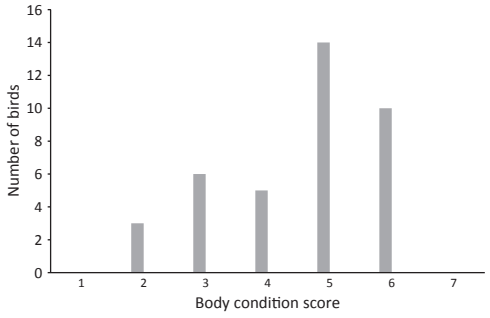


Fig. 2 Frequency of body condition scores occurrence (fitted means).

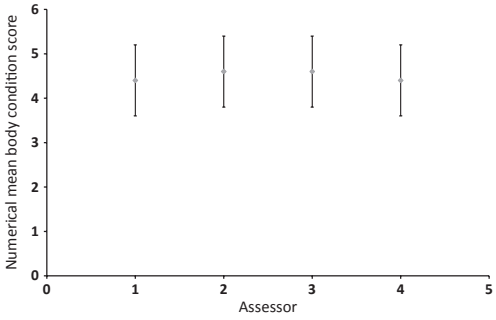


Fig. 3 Effects assessor on body condition score (fitted means).

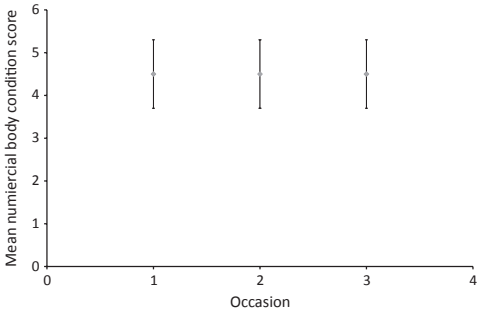


Fig. 4 Effects of occasion on body condition score (fitted means).

Results

Repeatability and reproducibility were assessed using live birds. Average bird age was 4.7 years and ranged from 2 to 9 years. Mean daily body weight (and standard error of the mean) was as follows: occasion 1: 62.8 ± 13.07 g; occasion 2: 62.6 ± 12.90 g and occasion 3: 62.2 ± 12.86 g. These data highlight the wide variation in body weight across the group of birds (CV = 20.6%) and, in contrast to this, the small variation in body weight across the three scoring occasions (CV = 0.5%), indicating that bird body weight remained stable over the 3 days of assessment.

Figure 2 shows the fitted mean body condition score value for each bird across all days and all assessors of birds used in the live bird study. Each graph point represents the average score (over all assessors and occasions) for one bird. In contrast, Figs 3 and 4 demonstrate the comparative lack of assessor or occasion effect on average score.

Statistical analysis (Table 1) confirmed there was no significant main affect of assessor or occasion on body condition score, but there was some interaction between the effects of some factors.

The wide variation in bird body condition and minimal variation in occasion and person data indicate the interaction effects are largely due to differences between birds.

Table 1 Analysis of variance for body condition score number during repeatability and reproducibility determination

Factor	DF	*F*	Mean square	p Value
Bird	37	31.91	17.01	<0.001
Occasion	2	0.01	0.01	0.988
Person	3	1.20	0.80	0.347
Bird × occasion	74	1.62	0.30	0.004
Bird × person	111	2.29	0.42	<0.001
Occasion × person	6	2.33	0.43	0.034

The association between body condition score and body fat was assessed using dead birds that had died for reasons not related to this study. Mean percentage body fat and SEM associated with each body condition score category were as follows: score 1: 2.9 ± 0.90%, score 2: 7.9 ± 1.15%, score 3: 11.0 ± 0.89%, score 4: 20.3 ± 2.17, score 5: 46.0% (single measure). No birds were categorised as higher than score 5. Analysis of variance showed the person to person variation is not significant (p = 0.100). Therefore, scores from all three assessors were pooled to give an overall estimate of correlation between BCS and percentage fat (Fig. 5). Highly significant correlations were recorded for both individual and pooled data (R^2 = 0.820, 0.865 and 0.790 for individual assessors). The overall correlation coefficient of 0.768 was also highly significant and suggests that BCS and percentage fat are highly correlated.

Discussion

The wide range of BCS in birds used for the study is in keeping with the variation in body weights. The results showed that the guide is able to provide results that are not significantly different when used by a range of assessors on more than one occasion.

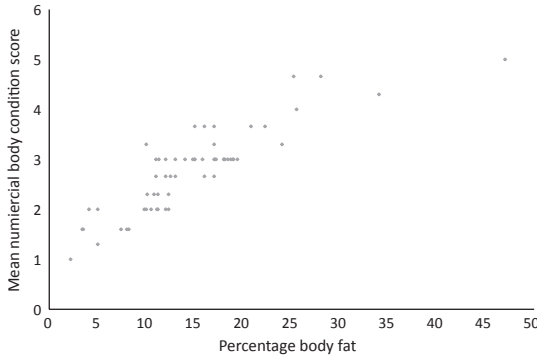


Fig. 5 Relationship between bird body fat and mean numerical body condition score.

However, the analysis revealed some interactions between certain factors. Visual inspection of pairwise plots showed that the majority of these significant interactions were due to the enormous variation in bird BCS, but the interaction between assessor and occasion indicates some assessors altered slightly in their scoring over time. Traditionally, reproducibility of BCS systems has been viewed as a learned art that is heavily influenced by the experience of the assessor (Kaiser, 1993). Although the guide is designed for use with no prior training, these results suggest that scoring alters slightly for some assessors as they become more familiar with using the guide. However, the findings of this study broadly support those of German et al. (2006); that BCS systems based on an algorithm (a decision tree) may be successfully used by naïve assessors. Whilst these results provide strong evidence on the suitability of the guide for measuring BCS in budgerigars, anomalies such as lipomas which may affect the mobility of fatty tissue may also need to be taken into account during the physical examination.

In mammals such as dogs, dual-energy X-ray absorptiometry (DEXA) is considered a near gold standard technique for the assessment of body composition (German et al., 2006). The size of budgerigars falls between the sensitivity ranges for whole animal DEXA scanning and sectioned tissue scanning (Hologic, 1992), but, as budgerigars reasonably retain their normal aspect post-mortem (Altman, 1997), scoring of dead birds was considered an viable alternative. The small mass of the birds meant they could be warmed through to body temperature within a few minutes, before significant dehydration of tissues could occur, but precise moisture loss was not recorded for the study. Whilst a superior method of assessing the precision of the guide would be to assess live birds before euthanasia and chemical analysis of fat content, this approach lay outside the ethical boundaries of this study. Therefore, correlation between body condition score and chemical analysis of dead birds was selected as the optimum viable method to determine the usefulness of this guide.

The analysis using dead birds provided further support for the earlier finding that using different assessors did not significantly alter body condition score of individual birds. The correlation between percentage body fat and mean body condition score showed a very strong, positive relationship (Fig. 5). However, it should be noted that the extremely obese end of the scale has not yet been fully assessed as the differentiation between the final two scores (6 and 7) relies upon assessment of physical mobility which could not be examined using dead birds, thus constraining the

ability of this study to fully evaluate the scoring system. It should also be noted that the use of clinical signs to differentiate between scores 6 and 7 does not consider the possibility that the signs described may be attributable to concurrent disease not directly related to obesity.

Overall, the differences amongst people and the difference between one occasion and another are small compared with the variation in scores seen amongst budgerigars, and there is a very strong correlation between body condition score and percentage body fat. Therefore, these results suggested that the guide would appear to give a repeatable and reproducible measure of body condition in budgerigars, suitable for use during physical examinations. The possible application of the guide to other companion bird species is currently under investigation. A pamphlet version of the guide is available from the authors on request.

Acknowledgements

British Trust for Ornithology Nottingham Ringer's Group, Trent Valley Budgerigar Society, Gerald Binks, Mick Freakley, Rick Watts, Lindsey Furness, Danielle Wing and George Gettinby (statistician).

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