Evaluating Body Condition Score with Dual-energy X-ray Absorptiometry (DEXA) in Big Brown Bats (*Eptesicus fuscus*)

Veterinary Research Scholars Program
University of Missouri

Joe Fasig[1], Sybill Amelon[2], Sarah Hooper[3]
[1]College of Veterinary Medicine, [3]Department of Veterinary Pathology, University of Missouri, [2]USDA Forest Service, Columbia, MO

Purpose

- Determine objective body composition measurements in big brown bats (*Eptesicus fuscus*) by using DEXA and use the data to evaluate the correlation with a given body condition score (BCS) assigned using a described nine point BCS system for bats

Hypothesis

- DEXA can provide an objective measurement and support the BCS system and reduce variability between observers

Background

- Body condition index (BCI) in bats is determined by mass to forearm length ratio
- Measuring forearm length can be variable among observers, creating different scores

- DEXA
  - Objectively measures:
    - **Bone mineral mass**
    - **Fat mass**
    - **Lean soft tissue mass**
  - Generates two different constant energy x-ray photon beams to differentiate the different components of a subject
  - The energy is altered when an absorber, such as a bat is placed in the path of the beam
  - Can measure three components by placing them in a two component model of body composition
    - **Fat Mass** and **Fat Free Mass**
    - **Soft Tissue Mass** and **Bone Mineral Mass**
      - In areas that contain no bone, the Soft Tissue component can be divided into its own to component model
        - **Fat Mass** and **Lean Soft Tissue Mass**

Materials and Methods

- 15 big brown bats with varying body conditions were used for this study
- Bats were placed in an anesthesia induction chamber using a gas mixture of oxygen and 5% isoflurane and after they were deeply anesthetized, they were kept under anesthesia by just placing the hose over their nose
- Photographs were taken of each bat in a dorsal and ventral recumbent position
- Weights were taken and five observers measured forearm length and assigned BCS
- Bats were then placed in a dorsal recumbent position while scanned two times by the DEXA machine
- The bats were then placed under supplemental oxygen until returned to normal respiration

Results

Table 1. Summary of Results

		Body weight (g)		Forearm Length (mm)		Body Mass Index		Body fat (%)		Official Percent Body Fat
BCS	No.	Range	Average	Range	Average	Range	Average	Range	Average	
1.0	0									20
1.5	0									25
2.0	1	17.61	17.61	44.52-46.60	45.22	0.39	0.39	21.05	21.05	30
2.5	3	14.25-17.41	15.59	42.10-46.60	44.05	0.32-0.39	0.35	20.1-31.55	25.33	35
3.0	3	14.14-22.09	16.95	41.29-48.73	45.49	0.29-0.48	0.37	12.15-42.80	26.62	40
3.5	1	25.36	25.36	48.50-51.11	49.78	0.51	0.51	52.15	52.15	45
4.0	3	23.45-28.07	25.61	42.20-49.91	46.37	0.53-0.58	0.55	52.85-56.00	54.35	50
4.5	1	29.86	29.86	47.90-50.97	47.36	0.61	0.61	65.65	65.65	55
5.0	3	29.04-41.93	34.28	44.53-51.07	48.03	0.58-0.88	0.71	57.10-73.50	65.50	60
	15									

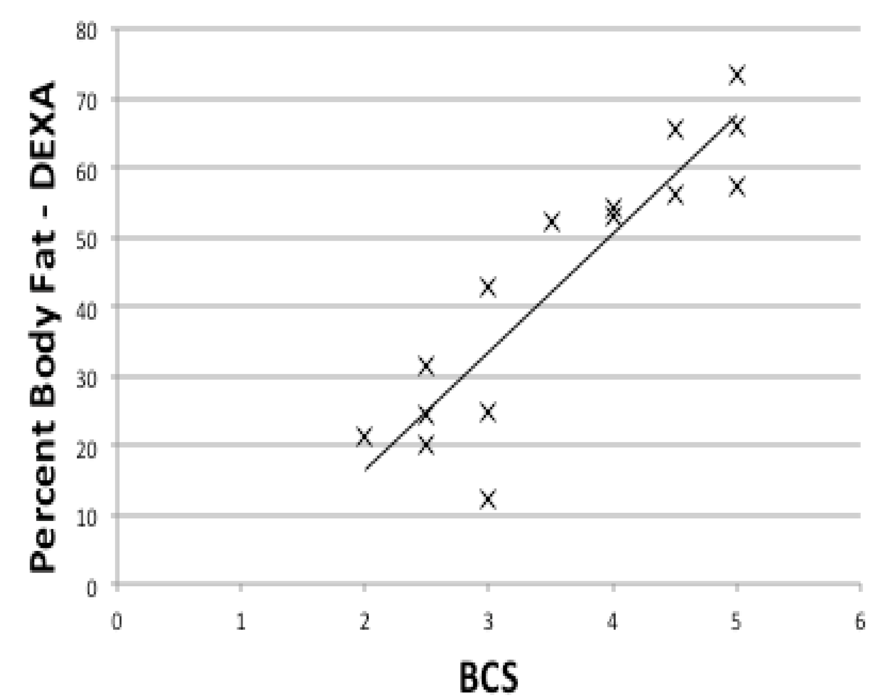


Figure 2. Average percentage of body fat measured by DEXA for each BCS

Table 2. Spearman Correlation Coefficients

	BCS	BMI	Official BCS	Total Mass by DEXA	Percent Body Fat by DEXA
BCS Observer 1	0.95	0.91	0.87	0.91	0.89
BCS Observer 2	0.96	0.89	0.89	0.88	0.93
BCS Observer 3	0.98	0.91	0.92	0.9	0.94
BCS Observer 4	0.82	0.83	0.85	0.81	0.87
BCS Observer 5	0.96	0.76	0.82	0.75	0.85
BCS	1	0.87	0.88	0.87	0.91
BMI	0.87	1	0.94	0.98	0.97
Official BCS	0.88	0.94	1	0.95	0.97
Total Mass by DEXA	0.87	0.95	0.95	1	0.96

Conclusions

- Even though, forearm measurements for BMI varied among observers, percent body fat still had a better correlation with BMI (0.97) than BCS (0.91)
- We believe that the percent body fat of the 15 captive bats did not accurately depict body conditions that would be seen in the wild, which may have skewed our data some as shown in Table 1
  - Many of our bats had very high body fat and little muscle due to their sedentary life style compared to wild bats, which may have made it difficult to assign an accurate BCS
- To account for variation in samples and to try to get a more accurate percent body fat for each BCS, we used wild bat data and the captive bat data to set bin parameters for percent body fat and BCS and titled it "Official Percent Body Fat" as seen in Table 1
  - We set the 'optimal' BCS of 3 at a percent body fat of 40% with a 10% change in each full unit
  - This provided an equal correlation between percent body fat, BCS, and BMI at 0.97

Future

- In the future, with more samples and more representative samples, we could assign a more accurate percent body fat to each BCS and improve the correlation between percent body fat and BCS
- DEXA has also been shown to have limitations such as, failing to recognize fat percentages of less than 4% and under-representing fat content when compared to chemical analysis[1]. For this reason, deuterium oxide can also be used to determine body composition

1. Summers L, Clingerman KJ, Yang X. Validation of a Body Condition Scoring System in Rhesus Macaques (*Macaca mulatta*): Assessment of Body Composition by using Dual-Energy X-ray Absorptiometry. *Journal of the American Association for Laboratory Animal Science*. 2012;51(1):88-93.

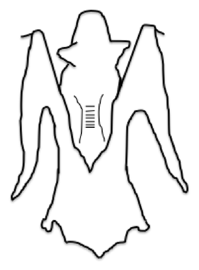
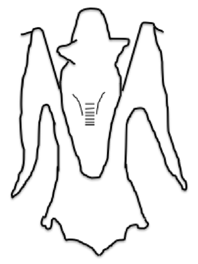
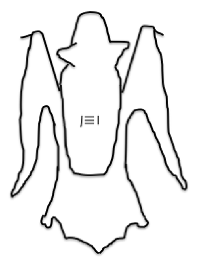
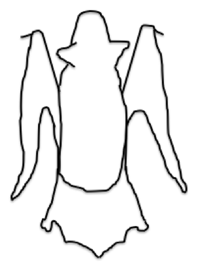
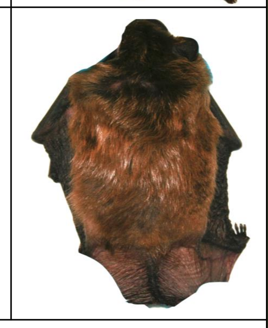
	1 Emaciated	• Segmentation of vertebral column visible • Ribs are visible • No subcutaneous fat	
	1.5 Very Thin	• Segmentation of vertebral column visible/prominent • Minute subcutaneous fat	
	2 Thin	• Segmentation of vertebral column prominent • Little subcutaneous fat over pelvis	
	2.5 Underweight	• Segmentation of vertebral column prominent and easily palpable • Ribs are easily palpable	
	3 Optimal	• Segmentation of vertebral column is palpable with little surrounding fat • Moderate subcutaneous fat over pelvis	
	3.5 Overweight	• Vertebral column is palpable with moderate surrounding fat • Moderate subcutaneous fat over pelvis	
	4 Heavy	• Vertebral column is palpable with some pressure • Subcutaneous fat around pelvis begins to bulge	
	4.5 Obese	• Vertebral column is palpable with firm pressure • Difficult to feel individual spinous processes	
	5 Grossly Obese	• Vertebral column is palpable with substantial pressure • Fat exposes hairless areas of skin • Subcutaneous fat around pelvis becomes prominent	

Figure 1. Body condition scoring chart for big brown bats

Acknowledgments

Research grant provided by USDA Forest Service
Student support provided by an endowment established by IDEXX-Bioresearch
Sarah Hooper stipend funding source NIHT32OD0111126
Special thanks to Dr. Sybill Amelon and Sarah Hooper for their guidance and Mary Timonin, Cassandra Tang-Wing, and Tricia Timpe for assisting with the project