



International Journal of Veterinary Sciences and Animal Husbandry



ISSN: 2456-2912

NAAS Rating (2025): 4.61

VET 2025; 10(12): 322-325

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www.veterinarypaper.com

Received: 18-09-2025

Accepted: 19-10-2025

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Liver function profiles with special emphasis on bile acids in sloth bears (*Melursus ursinus*): Influence of age and sex

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DOI: <https://www.doi.org/10.22271/veterinary.2025.v10.i12e.2838>

Abstract

Serum biochemical parameters related to liver function, with emphasis on bile acids, were evaluated in 85 rehabilitated sloth bears (*Melursus ursinus*) to establish reference values and assess the influence of age and sex. Analytes Measured Included Albumin (ALB), Alkaline Phosphatase (ALKP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), bile acids (BA), gamma-glutamyl transferase (GGT), globulin (GLOB), lactate dehydrogenase (LDH), total bilirubin (TBIL), and total protein (TP). Bears were stratified into two age groups (≤ 15 years, $N=10$; ≥ 16 years, $N=75$) and further analyzed by sex. No significant age-related differences were found for ALB, ALKP, ALT, AST, BA, GGT, LDH, or TBIL. TP was significantly higher in older bears ($P=0.042$), and GLOB showed a near-significant trend toward elevation ($P=0.054$). Among bears ≥ 16 years, females had significantly higher BA concentrations than males ($P=0.015$). These findings provide the first reference data on bile acids in sloth bears and indicate relative stability of liver-associated serum biochemistry across age groups, with subtle variations in protein metabolism and sex-specific differences in bile acid regulation.

Keywords: Sloth bear, liver function, bile acids, age-related variation, sex-related variation, clinical pathology

Introduction

The Sloth bear (*Melursus ursinus*) is an insectivorous ursid native to the Indian subcontinent and is currently listed as "Vulnerable" by the IUCN and protected under Schedule I of the Wildlife (Protection) Amendment Act (2022). Threats including habitat loss, fragmentation, and anthropogenic conflict have led to significant population declines (Dharaiya *et al.*, 2016) [2].

Wild carnivores in managed care often exhibit unpredictable temperaments, complicating clinical evaluation. Accordingly, reliable clinical pathology reference intervals are indispensable for health monitoring and decision-making. Serum biochemical profiles offer insight into metabolic status, organ function, and early subclinical disease (Geffré *et al.*, 2009; Friedrichs *et al.*, 2012) [5, 6], and are influenced by age, nutrition, stress, activity level, and captivity-related factors (Dontas *et al.*, 2011; Janyamethakul *et al.*, 2017) [3, 8].

Previous work has documented biochemical and haematological values in sloth bears (Veeraselvam *et al.*, 2014; Arun *et al.*, 2019) [1, 13], but detailed assessments of hepatobiliary markers particularly bile acids are lacking. Bile acids play an essential role in lipid digestion, nutrient absorption, and cholesterol metabolism (Engelking *et al.*, 1980; Sutherland, 1989) [4, 12], and are sensitive indicators of hepatobiliary function (Schlesinger & Rubin, 1993) [10]. Despite their diagnostic relevance, bile acids have been studied in only a few ursid species (*Ursus arctos*; Græslí *et al.*, 2014 and *Ursus americanus*; Solá *et al.*, 2006) [7, 11].

This study provides the first characterization of bile acids and associated liver biochemical parameters in captive sloth bears. It further evaluates age- and sex-related differences to generate clinically relevant baseline values to support veterinary care and conservation management.

Materials and Methods

Study population

Eighty-five rehabilitated sloth bears housed at the Agra Bear Rescue Facility (Wildlife SOS, India) were included. Bears were categorized into two age groups: Group I (≤ 15 years): N=10 (8 males, 2 females) and Group II (≥ 16 years): N=75 (29 males, 46 females). All individuals received a consistent diet comprising seasonal fruits and multigrain porridge.

Sample collection and biochemical analysis

Blood samples were collected from the cephalic vein using operant conditioning techniques (Maharana *et al.*, 2025) [9] and standard vacutainer systems. Serum was separated after clotting and centrifugation. Ten liver-associated biochemical parameters were analyzed using a Catalyst One chemistry analyzer (IDEXX Laboratories): ALB, ALKP, ALT, AST, BA, GGT, GLOB, LDH, TBIL, and TP.

Statistical analysis

All analyses were performed in R (version 4.5.0). Descriptive statistics included means, standard deviations, and 95% confidence intervals. Independent t-tests evaluated differences between age and sex groups. Significance was set at $p < 0.05$.

Results and Discussion

Across the study population, body weight did not differ significantly between age groups.

Age-related differences

No significant differences were observed between age groups for ALB, ALKP, ALT, AST, BA, GGT, LDH, or TBIL (Table 1). GLOB was higher in older bears, although not significantly so. TP was significantly higher in older bears ($P=0.042$), consistent with age-associated increases documented in other URSIDS (Græslis *et al.*, 2014) [7].

Sex-related differences

Among bears ≥ 16 years, females displayed significantly higher BA concentrations than males ($P=0.015$). No sex-based differences were observed for the remaining parameters (Table 2). Hormonal or metabolic factors may contribute to these findings, aligning with similar observations in other bear species (Solá *et al.*, 2006; Græslis *et al.*, 2014) [7, 11].

To further illustrate these patterns, scatter plots with overlaid boxplots were generated for all parameters (Figure 1). These visualizations show overlapping distributions across most age-sex categories.

Acknowledgment

The authors express their sincere gratitude to the Co-Founders of Wildlife SOS, Mr. Kartick Satyanarayan and Ms. Geeta Seshamani, for their visionary leadership and unwavering support. We also thank the Uttar Pradesh Forest Department for their continued collaboration, and extend our appreciation to the Wildlife SOS animal care staff for their dedicated efforts and valuable contributions to this program.

Table 1: Liver biochemical parameters (Mean $\pm$ SD) stratified by age group

Age group	≤ 15 years	≥ 16 years	P-Value
Sex & sample size (N)	Combined (N=10)	Combined (N=75)	
Body weight in kg (Mean ± SD)	101.35±12.09	98.08±14.52	
Measurand (unit)	Mean ± SD		
ALB (g/dL)	2.36±0.7	2.42±0.54	0.7857
ALKP (U/L)	30±16.79	28.25±13.58	0.7583
ALT (U/L)	21.2±8.59	21.6±7.45	0.8909
AST (U/L)	85.9±19.16	84.87±15.65	0.8732
BA (μmol/L)	18.96±4.63	18.05±4.79	0.5733
GGT (U/L)	9.4±8.66	14.52±13.39	0.1236
GLOB (g/dL)	3.08±1.34	4.04±1.07	0.0545
LDH (U/L)	1379.5±201.62	1262.76±256.31	0.1203
TBIL (mg/dL)	0.17±0.11	0.22±0.11	0.2119
TP (g/dL)	6.26±0.63	6.75±0.7	0.0423

Table 2: Liver biochemical parameters (Mean $\pm$ SD) stratified sex within age groups (≤ 15 years and ≥ 16 years)

Age group	≤ 15 years			≥ 16 years		
Sex & sample size (N)	Male (N=8)	Female (N=2)	P-Value	Male (N=29)	Female (N=46)	P-Value
Body weight in kg (Mean ± SD)	104.75±9.58	87.75±14.5		106.36±10.7	92.86±14.25	
Measurand (unit)	Mean ± SD			Mean ± SD		
ALB (g/dL)	2.31±0.73	2.55±0.78	0.895	2.37±0.74	2.46±0.37	0.547
ALKP (U/L)	31±18.88	26±1.41	0.894	26.72±13.12	29.22±13.91	0.436
ALT (U/L)	22.5±9.23	16±0	0.356	22.86±9.88	20.8±5.38	0.309
AST (U/L)	85.62±21.17	87±12.73	0.792	82.52±11.32	86.35±17.81	0.258
BA (μmol/L)	19.42±4.99	17.1±3.11	0.533	16.44±4.26	19.09±4.87	0.015
GGT (U/L)	10.5±9.46	5±0	0.894	12.86±12.45	15.57±13.99	0.386
GLOB (g/dL)	3.01±1.5	3.35±0.64	0.888	3.97±1.28	4.08±0.93	0.687
LDH (U/L)	1386.88±183.48	1350±357.8	0.888	1224.97±298.55	1286.59±226	0.345
TBIL (mg/dL)	0.15±0.08	0.25±0.21	0.554	0.23±0.12	0.21±0.1	0.312
TP (g/dL)	6.35±0.42	5.9±1.41	0.895	6.79±0.74	6.72±0.69	0.719

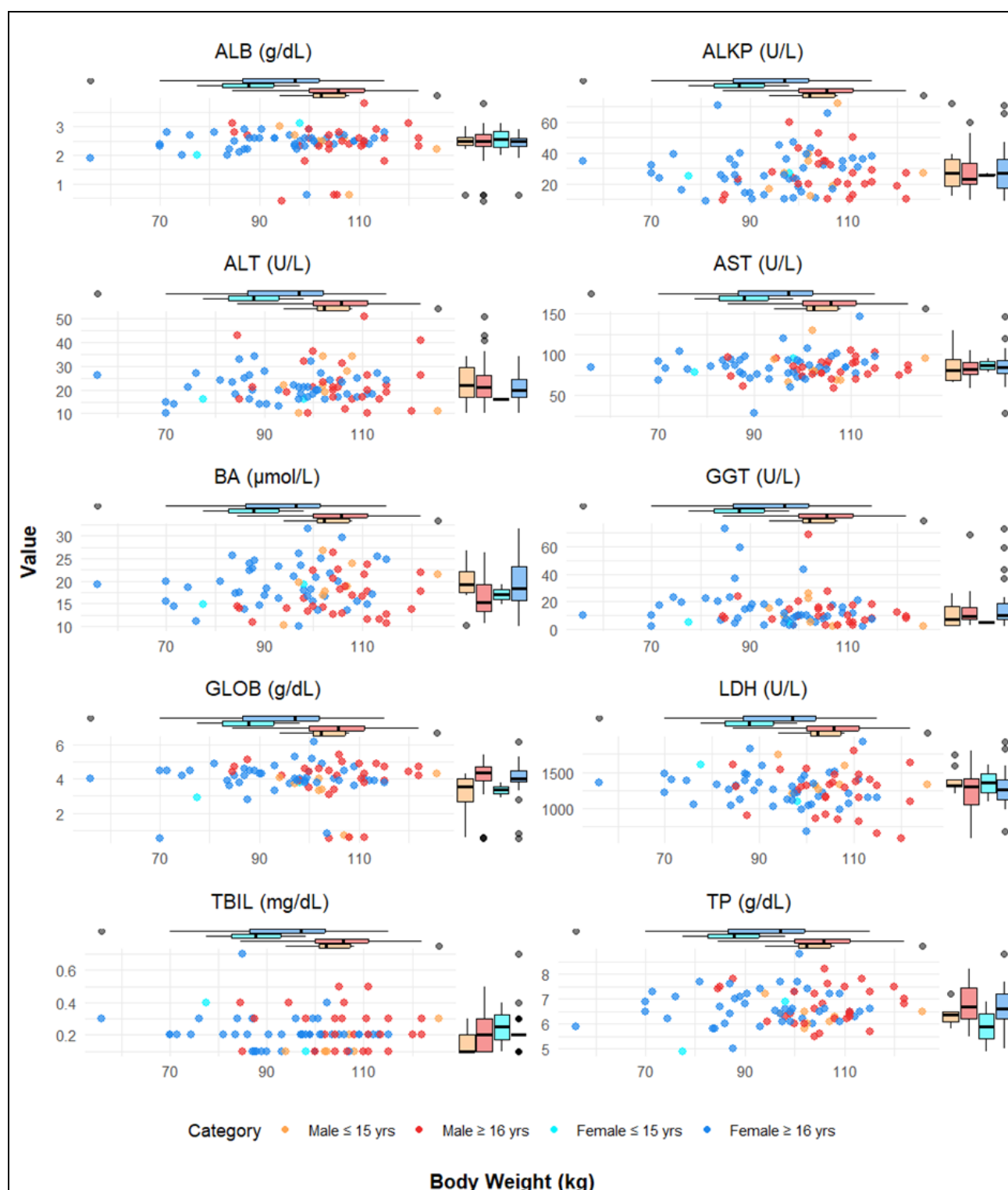


Fig 1: Scatter plot showing individual values with overlaid boxplots summarizing group medians and interquartile ranges stratified by age and sex

Conclusion

This study provides the first baseline reference values for bile acids in sloth bears and demonstrates age-related differences in total protein and sex-related differences in bile acid concentrations. These results support improved clinical assessment, monitoring, and management of captive sloth bears.

Conflict of Interest

Not available

Financial Support

Not available

Reference

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How to Cite This Article

Selvaraj I, Maharana SS, Adhithyan NK, Sha AA, Baijuraj MV. Liver function profiles with special emphasis on bile acids in sloth bears (*Melursus ursinus*): Influence of age and sex. *International Journal of Veterinary Sciences and Animal Husbandry.* 2025;10(12):322-325.

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