

SEASONAL DYNAMICS OF URINARY CREATININE IN CAPTIVE SLOTH BEARS (*Melursus ursinus*): IMPLICATIONS FOR NON-INVASIVE MONITORING AND PHYSIOLOGICAL ASSESSMENT

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Abstract

*Urinary creatinine is widely used as a normalization factor in wildlife endocrinology and physiological monitoring; however, its reliability depends on species-specific validation. The present study evaluated urinary creatinine concentrations in captive sloth bears (*Melursus ursinus*) to assess the effects of season, sex, and body weight under managed-care conditions. A total of 240 urine samples were collected non-invasively from 80 rehabilitated sloth bears (40 males, 40 females; aged 1-30 years) across three seasons (summer, monsoon, and winter) at the Agra Bear Rescue Facility, India. Creatinine concentrations were estimated using Jaffe's reaction method. Seasonal variation was observed, with higher mean concentrations during summer, intermediate levels during monsoon, and lower values during winter, although variability overlapped across groups. No significant correlation was found between urinary creatinine and body weight in any season, and sex-related differences were inconsistent. These findings indicate that urinary creatinine in sloth bears is influenced by seasonal physiological and environmental factors rather than by body mass or sex, challenging the assumption that it is a stable correction factor. From a welfare and research perspective, this study highlights the importance of species-specific validation of non-invasive biomarkers to ensure accurate interpretation of physiological data in captive wildlife populations.*

Keywords: Sloth bear, non-invasive monitoring, Jaffe's reaction, urinary creatinine, seasonal variation

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1. INTRODUCTION

Creatinine, a non-enzymatic by-product of muscle metabolism (Braun et al., 2003; Finco, 1997), is commonly used as a correction factor in urinary-based endocrine and physiological studies due to its presumed stable excretion (Miller et al., 2004). However, emerging evidence suggests that creatinine dynamics are influenced by species-specific physiology, environmental conditions, and metabolic adaptations, necessitating careful validation in wildlife species.

The sloth bear (*Melursus ursinus*), a myrmecophagous ursid endemic to the Indian subcontinent, is classified as “Vulnerable” and remains a species of significant conservation concern (Dharaiya et al., 2016). Despite extensive rehabilitation efforts, particularly in rescued populations, baseline physiological parameters remain inadequately characterized, limiting the accuracy of non-invasive monitoring tools.

In wildlife research, urinary creatinine is frequently used to normalize hormone metabolite concentrations (Miller et al., 2004). However, in ursids, seasonal metabolic adaptations including changes in activity, diet, and renal physiology may influence creatinine excretion independent of body mass (Hissa et al., 1994). This study was therefore designed to evaluate urinary creatinine dynamics in captive sloth bears, with particular emphasis on seasonal variation, sex differences, and body weight associations, while also addressing the broader implications for welfare-oriented physiological monitoring in managed populations.

2. MATERIALS AND METHODS

A longitudinal, non-invasive study was conducted over one year (March 2021-February 2022) on 80 captive sloth bears (40 males and 40 females; age range 1-30 years) housed at the Agra Bear Rescue Facility, Wildlife SOS, India.

Urine samples (n = 240) were collected using a validated non-invasive floor pit method (Ilayaraja et al., 2021), ensuring minimal disturbance and stress to the animals. Sampling was evenly distributed across three seasons: summer, monsoon, and winter to capture seasonal variation. Body weight was recorded using standardized procedures at the time of sample collection.

Urinary creatinine concentrations were determined using Jaffe’s reaction method (Bonsnes & Taussky, 1945), with absorbance measured via a calibrated microplate reader and quantified using standard calibration curves.

Statistical analyses included descriptive statistics, Pearson’s correlation, and linear regression to evaluate relationships between creatinine concentration, body weight, sex, and season. Statistical significance was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

Urinary creatinine concentrations demonstrated moderate seasonal variation, with higher values observed during summer, intermediate levels during monsoon, and lower concentrations during winter. However, substantial overlap in variability across groups suggests complex physiological regulation rather than simple environmental influence. Sex-based differences were inconsistent across seasons (summer: males 0.52 ± 0.2 mg/ml, females 0.60 ± 0.3 mg/ml; monsoon: males 0.47 ± 0.2 mg/ml, females 0.51 ± 0.3 mg/ml; winter: males 0.52 ± 0.2 mg/ml, females 0.43 ± 0.2 mg/ml), indicating that sexual dimorphism does not significantly influence creatinine excretion in this species (Fig. 1).

Critically, correlation analysis revealed no meaningful association between body weight and urinary creatinine across all seasons (Fig. 2). Extremely low R^2 values (<3%) indicate that body weight contributes negligibly to variability in creatinine levels, contradicting conventional assumptions derived from domestic species.

These findings suggest that urinary creatinine in sloth bears is regulated by multifactorial influences, including: hydration status, renal function, seasonal metabolic adjustments, dietary variability, individual physiological differences

As illustrated in Figure 2, the scatter plots show weak and inconsistent relationships between body weight and creatinine across seasons, reinforcing the absence of predictive association. Seasonal variation, particularly elevated values during summer, may reflect increased metabolic activity and dietary protein intake, while lower winter values likely correspond to reduced activity and metabolic downregulation.

4. WELFARE AND PRACTICAL IMPLICATIONS

From a wildlife veterinary and management perspective, these findings carry significant implications:

- Urinary creatinine should not be assumed as a universally stable correction factor in sloth bears
- Misinterpretation may lead to inaccurate endocrine or physiological assessments
- Seasonal physiological changes must be integrated into monitoring protocols
- Non-invasive biomarkers require species-specific validation to avoid flawed clinical decisions

This is particularly critical in captive and rehabilitated populations, where physiological monitoring directly influences nutrition, health management, and welfare outcomes.

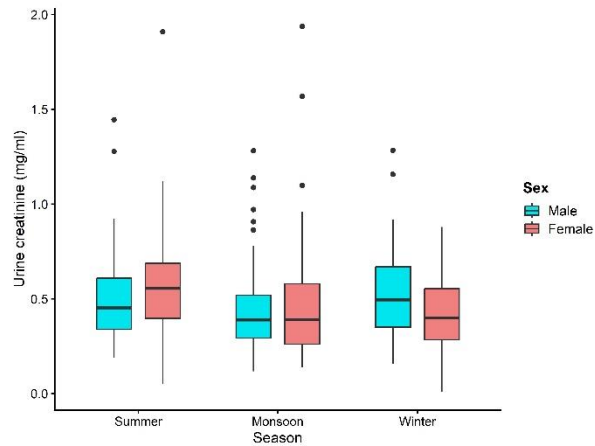


Figure 1. Seasonal variation in urinary creatinine concentrations (mg/ml) in captive *M. ursinus* by sex, showing no consistent sex-related differences across seasons.

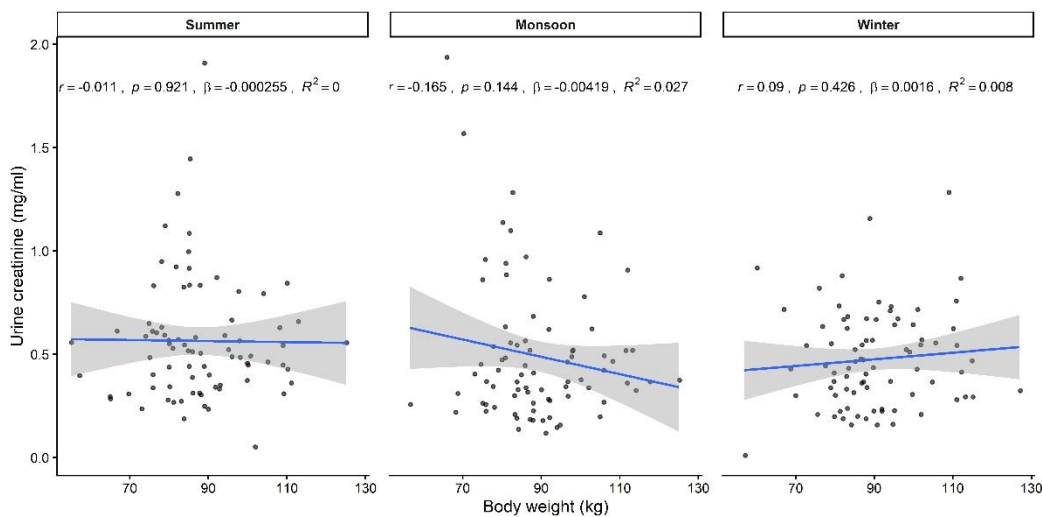


Figure 2. Relationship between body weight (kg) and urinary creatinine concentrations (mg/ml) across seasons, indicating non-significant associations

CONCLUSION

The present study demonstrates that urinary creatinine concentrations in captive sloth bears exhibit seasonal variability but are not significantly influenced by body weight or sex. These findings challenge the assumption of creatinine as a stable normalization factor and underscore the necessity for species-specific validation in non-invasive wildlife research. From a broader perspective, this study reinforces the importance of integrating physiological science with welfare-driven management, ensuring that monitoring tools accurately reflect the biological

realities of the species under care. In wildlife medicine, accuracy in interpretation is a cornerstone of welfare what we measure must truly reflect what the animal experiences.

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