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Research Article

Determination of Serum Lactate, Body Temperature and Heart Rate During Running Exercise in Kintamani Dog

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Abstract | The physiological responses of dogs to exercise have been extensively studied in athletic breeds; however, limited research exists on underrepresented breeds like the Kintamani dog. This study investigates the cardiovascular, thermoregulatory, and metabolic adaptations of Kintamani dogs during moderate-intensity running exercise, focusing on heart rate (HR), rectal temperature (RT), and blood lactate levels (BL). Twelve clinically healthy Kintamani dogs (6 males and 6 females, aged 2–3 years) participated in controlled running exercises, with physiological parameters measured pre- and post-exercise. Blood lactate levels were analyzed using the Enzyme-Linked Immunosorbent Assay (ELISA), while HR and RT were assessed with a stethoscope and digital thermometer, respectively. Results revealed a significant increase ($P<0.05$) in mean HR from 103.61±6.77 bpm to 131.83±5.84 bpm and RT from 38.48±0.35°C to 39.48±0.65°C, demonstrating robust cardiovascular and thermoregulatory responses. Notably, BL remained stable (3.37±0.84 mg/dl pre-exercise and 3.43±0.82mg/dl post-exercise), suggesting a predominance of aerobic metabolism. Variability in individual BL responses highlighted potential differences in metabolic efficiency and recovery capabilities. These findings establish baseline physiological data for Kintamani dogs, underscoring their suitability for moderate-intensity activities in tropical climates. The study contributes to the broader understanding of breed-specific exercise physiology, with implications for training optimization, health monitoring, and performance enhancement in Kintamani dogs. Future research should expand on these findings through longitudinal studies and comparative analyses with other breeds to refine exercise and health management strategies.

Keywords | Heart rate, Kintamani dog, Lactate, Physiological, Running, Temperature

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INTRODUCTION

The study of physiological parameters in canine training has gained substantial attention globally, particularly due to its implications for optimizing performance, preventing injury, and ensuring the overall health of dogs engaged in sports and working activities. Physiological markers such as heart rate (HR), blood lactate concentration (BL), and body temperature (RT) are universally recognized as critical indicators of exercise intensity and recovery in dogs. These parameters were reliable physiological parameters to accurately assess the physiological response to effort (Pellegrino *et al.*, 2018; Söderlund *et al.*, 2023). These parameters also provide insights into cardiovascular efficiency, metabolic stress, and thermoregulation during and after physical exertion (Ferasin and Marcora, 2009).

Notably, the assessment of BL has been used to evaluate anaerobic capacity and endurance in athletic breeds like Greyhounds and Labrador Retrievers, underscoring the importance of tailoring exercise programs to individual physiological thresholds (Restan *et al*., 2024). The relevance of such studies extends beyond sports, benefiting working dogs in military, rescue, and service roles where optimal performance is critical. However, success in these roles, requires dogs to meet challenging behavioral criteria and to undergo extensive training (Bray *et al*., 2021).

Comparative studies across breeds have highlighted significant variations in physiological responses to exercise, emphasizing the need for breed-specific reference values. For instance, variations in BL and HR between Greyhounds and non-sporting breeds suggest that genetic, morphological, and environmental factors play crucial roles in determining exercise tolerance and recovery rates (Robbins *et al*., 2017). Moreover, global research has shown that thermoregulation in dogs during exercise is influenced by coat type, body composition, and climatic conditions, underscoring the need for individualized approaches to training and recovery (Jiménez *et al*., 2024). Such findings have profound implications for canine sports and working roles, where optimizing physiological performance directly impacts success and welfare. The integration of advanced monitoring tools like wearable technology further enables real-time data collection, enhancing the precision of training protocols and promoting global standards in canine health, performance, and will help improve the well-being of dogs (Hussain *et al*., 2022; Schork *et al*., 2023).

Despite the significant advancements in understanding exercise physiology in athletic breeds such as Greyhounds, critical gaps remain concerning less-studied breeds like the Kintamani dog. Kintamani dogs are recognized for their agility and growing participation in canine sports, yet their physiological responses to physical activities remain poorly documented. This study addresses a crucial novelty by focusing on the breed-specific physiological parameters of Kintamani dogs during running exercise, providing insights into their heart rate (HR), rectal temperature (RT), and blood lactate levels (BL). While previous studies have extensively examined the effects of long-distance and high-intensity training in well-known athletic breeds, little attention has been given to short-distance exercises and their immediate physiological impacts (Arokoski *et al*., 1993; Orozco *et al*., 2021; Erjavec *et al*., 2022). Furthermore, the absence of standardized reference values for HR, BL, and RT in Kintamani dogs limits trainers' and veterinarians' ability to optimize fitness regimens and prevent injuries effectively. By filling this gap, the study not only contributes baseline data specific to the Kintamani breed but also highlights the importance of incorporating genetic and morphological diversity into canine exercise physiology research.

MATERIALS AND METHODS

Study Animals

The Kintamani dogs used in this research consisted of six females, with an average age of 2–3 years and body weights ranging from 12.4 to 15.2 kg. All dogs were actively engaged in running exercises. These exercises were performed once a week for 10 to 30 minutes. Clinically, all dogs were in good health, with body condition scores ranging from 4/9 to 5/9 (Chun *et al*., 2019). The dogs were fed a commercial diet twice daily and had access to water ad libitum. All procedures were approved by the Ethics Commission of the Faculty of Veterinary Medicine, Udayana University (No. B/284/UN.14.2.9/PT.01.04/2023).

Running Exercise

The running exercises were conducted in the morning on open land. Each exercise session consisted of a 10-minute run at a normal pace, followed by a three-day rest period, and was repeated three times. After each session, samples were collected while the dogs were in a resting or sleeping position (sternal recumbency) (Temwichitr *et al*., 2020).

Blood Sample Collection and Processing

A blood sample was taken from the Savena vein of approximately 2 ml. using a 3 ml syringe. Next, the blood is transferred into a blood collecting tube with EDTA anticoagulant with a capacity of 3 ml. Place it in a cooling box and take it to the laboratory to determine the lactic acid level. Lactic acid levels were measured using a portable device (Accutrend Plus, Roche Diagnostic, Germany).

Measuring Body Temperature and Heart Rate

Heart rate, and rectal temperature were measured before training (Pre) and immediately after training (post). Heart rate is determined by measuring heart auscultation using a stethoscope, rectal temperature is measured with a digital thermometer (Microlife MT200 MT19M1).

Statistical Analysis

The data obtained is presented descriptively. The normality of the data distribution was confirmed using the Shapiro–Wilk test. Subsequently, a Student's t-test for unpaired samples was performed to compare the physiological characteristics between the groups (Pre vs.Post). Statistical significance was accepted at $P < 0.05$. All statistical calculations use SPSS V.22.0 software. Statistical significance was accepted at $P < 0.05$

RESULTS AND DISCUSSION

The physiological responses of Kintamani dogs during running exercise were measured, focusing on changes in pulse rate, body temperature, and serum lactate levels. The

Table 1: Measurement of Physiological Parameters (Heart Rate, Body Temperature and Lactic Acid) Before and After Training.

No.	Body Weight (Kg)	Before Running Exercise			After Running Exercise		
		Pulsus/minute	Temprature(°C)	Blood Lactic Acid (mg/dl)	Pulsus/minute	Tempratur(°C)	Blood Lactic Acid (mg/dl)
A1	15.4	109.33±0.57	38.10±0.10	4.13±0.50	127.66±0.57	39.46±0.57	4.03±0.57
A2	14.7	103.00±1.00	38.06±0.11	3.66±0.50	136.33±0.57	39.76±0.57	3.40±0.00
A3	15.2	111.00±1.00	38.80±.100	4.10±0.17	139.66±0.57	39.26±0.57	3.36±0.57
A4	14.9	107.33±0.57	38.70±0.00	3.80±0.00	135.66±0.57	39.50±0.00	4.36±0.57
A5	12.4	99.00±1.00	38.43±0.57	2.63±0.57	124.00±0.00	39.36±0.57	3.60±0.00
A6	13.8	92.00±0.00	38.03±0.57	1.93±0.57	127.66±0,57	39.53±0.57	1.83±0.57
Mean	14.40 ±1.12	103.61±6.77	38.48±0.35	3.37±0.84	131.83±5.84	39.48±0.65	3.43±0.82

Note: P Value in this research is 0.05.

physiological responses of the Kintamani dogs before and after running exercise are summarized in Table 1.

The average heart rate increased from 103.61±6.77 beats per minute (bpm) before exercise to 131.83±5.84 bpm after exercise ($P < 0.05$), reflecting a notable cardiovascular response to running. This rise indicates an adaptive increase in cardiac output to meet the heightened oxygen and nutrient demands of the body during exercise (Evans,1985). The mean body temperature increased modestly from 38.48±0.35°C pre-exercise to 39.48±0.65°C post-exercise ($P < 0.05$). This demonstrates an expected thermoregulatory response to physical activity, as metabolic heat production elevated during the run. Interestingly, the average serum lactic acid levels remained relatively stable, with a pre-exercise mean of 3.37±0.84mg/dl and a post-exercise mean of 3.43±0.82mg/dl ($P > 0.05$). However, individual variability was noted: some dogs exhibited slight decreases or increases in lactate levels. These variations may suggest differences in anaerobic metabolism efficiency or recovery rates among individual dogs, potentially influencing their performance and adaptation to exercise (Pellegrino *et al*., 2018).

This study demonstrates a robust cardiovascular response in Kintamani dogs during moderate-intensity running, with heart rate significantly increasing from 103.61±6.77 bpm to 131.83±5.84 bpm. This finding is consistent with research on other breeds, confirming heart rate as a reliable indicator of exercise intensity and cardiovascular health (Lopedote *et al*., 2024). Heart rate's proportional increase with exercise intensity reflects the cardiovascular system's adaptive response. However, breed-specific variability in heart rate response exists, influenced by factors such as size, environmental conditions (Alizadeh *et al*., 2023), and activity levels (Ortmeyer and Katzel, 2020). The observed cardiovascular response in Kintamani dogs suggests efficient adaptation to physical exertion, likely an evolutionary adaptation to tropical climates. This adaptability is crucial for maintaining performance and preventing cardiovascular stress during prolonged activity.

The modest rise in body temperature from 38.48±0.35°C to 39.48±0.65°C 38.52°C demonstrates effective thermoregulation, which is particularly notable given the challenges posed by tropical climates. Thermoregulation is critical during exercise, particularly in tropical climates. Elevated body temperature can impair performance and increase the risk of heat stress. Recent studies highlight breed-specific differences in thermoregulatory capacity, underscoring the need for breed-specific data (Potter *et al*., 2020). Unlike breeds that are more susceptible to heat stress, Kintamani dogs appear capable of maintaining a relatively stable thermal balance during exercise. This is consistent with studies indicating that certain breeds exhibit superior heat dissipation mechanisms (Mota-Rojas *et al*., 2021), including enhanced respiratory cooling by panting to support evaporative cooling (Slotta-Bachmayr *et al*., 2024). However, while the results suggest good thermoregulatory capacity, prolonged exercise or environmental extremes could still pose risks, warranting careful monitoring in real-world scenarios.

The near-stable serum lactate levels, averaging 3.37±0.84 mg/dL pre-exercise and 3.43±0.82 mg/dL post-exercise, indicate that the exercise protocol predominantly engaged aerobic metabolism. This finding highlights the breed's metabolic efficiency and suggests a capacity for sustained, moderate-intensity activity without inducing anaerobic fatigue. Serum lactate, a byproduct of anaerobic metabolism, typically serves as an indicator of a metabolic shift from aerobic to anaerobic energy production. Elevated levels often reflect increased exercise intensity or duration, serving as a reliable marker for fatigue and recovery (Miazga *et al*., 2023). Comparative data from athletic breeds such as Greyhounds and working breeds like German Shepherds reveal significant lactate spikes during high-intensity exercise (Cerqueira *et al*., 2018). These observations suggest that Kintamani dogs may be better suited for endurance-related tasks rather than activities requiring short bursts of high-intensity effort.

The observed inter-individual variability in lactate responses offers additional insights. For example, some dogs showed minor reductions in lactate levels post-exercise, potentially indicative of superior lactate clearance mechanisms. This could be attributed to differences in muscle fiber composition, with a higher proportion of oxidative fibers facilitating faster lactate recycling and usage as an energy substrate (Bartoloni *et al*., 2024). On the other hand, dogs that experienced slight increases in lactate levels post-exercise may represent individuals with lower aerobic conditioning or varying metabolic capacities. These findings suggest that individualized fitness assessments could enhance training protocols and optimize performance.

A key strength of this study lies in its focus on the under-researched Kintamani dog, offering valuable baseline data to advance the field of canine exercise physiology. The inclusion of diverse physiological markers namely heart rate, body temperature, and blood lactate concentration provides a comprehensive evaluation of the dogs' physiological responses to exercise. Furthermore, the controlled experimental conditions effectively mitigate external variability, enhancing the reliability and reproducibility of the findings.

However, the study also has limitations. The sample size of 6 dogs, while sufficient for preliminary insights, may limit the generalizability of the findings. Additionally, the exercise protocol involved treadmill running in a controlled environment, which may not fully replicate real-world conditions, such as uneven terrain or varying temperatures. Future studies could address these limitations by including a larger sample size and incorporating field-based exercise scenarios.

Building upon these findings, future research should investigate the long-term adaptations of Kintamani dogs to structured training programs. Longitudinal studies could evaluate how repeated exposure to exercise influences physiological markers, performance metrics, and recovery patterns over time. Moreover, examining the effects of sex, age, and genetic variations on exercise responses may yield a more comprehensive understanding of the breed's physiological capabilities and potential (Karoly *et al*., 2012).

Comparative studies between Kintamani dogs and other breeds would also be valuable, particularly in evaluating how their physiological responses differ under similar exercise conditions. Such comparisons could further elucidate the unique adaptations of the Kintamani dog and highlight its potential advantages in endurance-based activities. The findings of this study have practical implications for trainers, veterinarians, and breeders. For trainers, insights into the breed's metabolic efficiency and thermoregulatory capacity can guide the design of exercise programs that enhance performance while mitigating potential risks. For veterinarians, the physiological baseline data serve as valuable reference points for evaluating the fitness and overall health of Kintamani dogs. Breeders, in turn, may leverage these findings to highlight the breed's endurance capabilities, promoting the Kintamani dog as a versatile companion and working dog, particularly well-suited to tropical environments.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study provides foundational insights into the physiological responses of Kintamani dogs to moderate-intensity exercise. While the results affirm the breed's robustness and adaptability, further research is needed to expand on these findings and explore their implications for canine health, training, and performance optimization.

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NOVELTY STATEMENTS

The study provides new insights into the cardiovascular and thermoregulatory responses of Kintamani dogs, showing significant increases in heart rate and body temperature during exercise, yet maintaining stable lactate levels indicating efficient metabolic adaptation to physical exertion.

AUTHOR'S CONTRIBUTIONS

I Nyoman Sulabda contributed to the conceptualization, supervision, manuscript writing, review, and editing. Siswanto and Putu Devi Jayanti were responsible for sample collection and result evaluation. I Wayan Sukernayasa designed the exercise program for the study sample. I Wayan Nico Fajar Gunawan analyzed the results and drafted the manuscript. I Ketut Puja contributed to manuscript writing and review. All authors reviewed and approved the final manuscript.

Conflict of Interest

The author(s) declare(s) that there is no conflict of interests regarding the publication of this article.

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