ARTICLES
Archives of Veterinary Science
https://www.ufpr.br/

Preliminary data on coat coverage and grooming interfering with the thermal comfort of lhasa apso and shih tzu dogs

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Submitted: 19/07/2024
Accepted: 22/09/2024

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Abstract: This report aimed to investigate the effects of grooming on thermal comfort in Lhasa Apso and Shih Tzu dogs exposed to different ambient temperatures. A randomized block design in a 3 x 2 factorial scheme was used, with 3 different temperatures associated with whether the animal was groomed. Six adult dogs were used, consisting of Lhasa Apsos and four Shih Tzus. The dogs were exposed to temperatures of 17, 25, and 33°C before and after grooming. Physiological parameters (blood pressure, heart rate, respiratory rate, rectal temperature, ambient temperature, ITU, and body surface temperature) were measured using infrared thermography with a portable IRT camera. The images were analyzed using FLIR Tools™ software with an emissivity of 0.97. Variance analysis was performed to evaluate the isolated effects and interactions between the factors of coat coverage and ambient temperature at the 5% significance level. No interaction was found between the treatments, nor were there isolated effects of the factors on the physiological parameters evaluated. A temperature of 33°C was associated with a higher rectal temperature ($p<0.05$) in the animals. Ungroomed dogs exposed to temperatures of 25 and 33°C had ITU values above the thermal comfort limit. In terms of body temperature, there was a significant interaction effect between coat coverage and the environment under different climatic conditions ($p<0.05$). The surveyed grooming dogs exhibited greater body temperatures at all temperatures tested. Grooming did not reduce the effects of thermal stress caused by different climatic conditions, indicating that grooming is not advisable for these animals.
Keywords: environment, welfare, infrared thermography, thermoneutrality, dog grooming.

1. Introduction

Currently, discussions about animal welfare, encompassing both production and companion animals, are common (Johnson & Lee, 2021). Both should have their physical and mental states preserved (Smith et al., 2020). Conversely, for companion animals, care aimed at enhancing quality of life is essential (Lemanza-Garcia et al., 2019). To ensure animal welfare, one crucial parameter is the evaluation of thermal comfort. This requires identifying situations that promote discomfort and employing means to ensure better thermal conditions in the environment (Neto, 2014). Behavioral changes in animals can indicate heat stress, necessitating strategies related mainly to environmental management to ensure homeothermy (Galvão et al., 2019).

An animal can experience various physiological disturbances, including stress, irritability, aggression, lack of appetite, and changes in physiological parameters when it is outside its thermal comfort zone. In extreme or persistent situations, this can even result in death (Carter et al., 2018). In tropical countries, where high temperatures are frequent, dogs face even greater challenges. Due to their naturally higher body temperature compared to humans, they are more susceptible to problems like hyperthermia, which occurs when the body's core temperature rises to dangerous levels. This can lead to symptoms such as shortness of breath, dehydration, and, in severe cases, circulatory collapse (Santos et al., 2022). Dogs with specific conditions, such as obesity, advanced age, or pre-existing diseases, are even more vulnerable to the effects of extreme heat (Martins, 2021). To prevent hyperthermia, owners must keep dogs in ventilated environments, ensure access to fresh water, and avoid physical activities during the hottest hours of the day. Additionally, the use of dog-specific sunscreens may be recommended in certain situations (López et al., 2022).

Many owners choose to trim their dogs' fur during hot weather to alleviate thermal stress. However, this raises a relevant question: does the coating act as a thermal insulator, both in heat and cold or is this practice a myth? Studies suggest that, in some breeds, especially those with double coats, fur can function as a natural protection, both to retain heat in cold weather and to insulate the body in high temperatures, minimizing external heat absorption (Maria et al., 2018). Thus, the practice of trimming should be considered based on the type of coat and climatic conditions, so as not to compromise the animal's health.

If an animal is outside its thermal comfort zone, various physiological disturbances can be triggered, such as stress, irritability, aggressiveness, lack of appetite, and altered physiological parameters, potentially leading to death in drastic or persistent situations (Carter et al., 2018). As pet owners often groom their dogs during hot weather to minimize thermal stress, several relevant points must be considered, such as whether it is true or a myth that fur serves as thermal insulation during hot weather and protection against the cold (Maria et al., 2018).

The relationship between humans and their pets has become an emotional bond where the pet often plays the role of a family member rather than just a companion (Lemanza-Garcia et al., 2019). With this closeness, most owners associate the animal's fur with heat and cold, comparing it to humans and thus grooming their pets during periods of higher temperatures (Silveira et al., 2015). Dogs cool their bodies through panting, keeping their mouths open to allow heat exchange with the environment (Hall et al., 2021). The anterior hypothalamus regulates and maintains body temperature within a narrow range, known as the hypothalamic "set point" (Cunningham and Klein, 2007; Gardner and Mary, 2017). The hypothalamus integrates information from central and peripheral body receptors to influence heat loss or heat-conserving processes. In geriatric patients, these processes may be impaired, leading to excessive heat loss or difficulty maintaining body temperature, which can result in hypothermia or hyperthermia. Diseases of old age can also predispose elderly pets to thermal issues such as heat stroke (Cunningham and Klein, 2007). Body temperature is regulated by balancing heat input and heat output, with metabolism, muscle function, and heat dissipation through evaporation, conduction, convection, and radiation playing significant roles. Age-related changes, such as loss of subcutaneous fat, can affect these heat-regulating processes (Cunningham and Klein, 2007).

The absence of sweat glands also complicates the animal's cooling process, as their plantar and palmar pads favor thermogenesis and thus do not participate effectively in thermoregulation (Clark-Price et al., 2021). The present study aimed to determine the influence of grooming on Lhasa Apso and Shih Tzu dogs subjected to different thermal conditions to ascertain whether fur coverage affects animal comfort.

2. Materials and Methods

2.1. Facilities, Animals, and Experimental Design

Six dogs aged between two and twelve years were used in the study, including two from Lhasa Apso and four from Shih Tzu, with an average weight of 5.420 kg. The experimental design was a randomized block design with a 3 x 2 factorial design, consisting of three different temperatures and the presence or absence of grooming. All dogs had long fur, averaging five to six centimeters in length. Thermographic images were captured between 8:00 AM and 12:00 PM from a distance of approximately 0.5 meters. This distance was chosen to ensure clear and accurate thermal measurements while minimizing potential distortion in the images. Thermographic images were taken between 8:00 AM and 12:00 PM. This experiment was approved by the Animal Ethics Committee of Unigran under protocol 055/18.

2.2. Procedures and Evaluation of Physiological Parameters

On the first day of the experimental phase, the animals were taken to a climate-controlled room with the ambient temperature adjusted for thermal comfort (25°C) to allow for adaptation to the environment and the presence of other animals for one hour. The owners were previously instructed to refrain from grooming their animals for the last two months. Following the adaptation period, an anamnesis was conducted to evaluate physiological conditions, including rectal temperature, heart rate, respiratory rate, and blood pressure, using the Doppler method (Menêses et al., 2020).

The respiratory rate (RR) (breaths per minute) was measured by observing chest movements for 15 seconds. Rectal temperature (RT) (°C) was measured using a digital thermometer until an audible signal was emitted. For the Doppler Medmega, model DV610 Ind. Equip. Médicos Ltda. (Franca, SP), the animals were positioned in right lateral recumbency. Systolic pressure was determined at the point when the pulse signal became audible again, and diastolic pressure was identified when the audible signals abruptly diminished or changed in tone, becoming muffled (Figure 1).

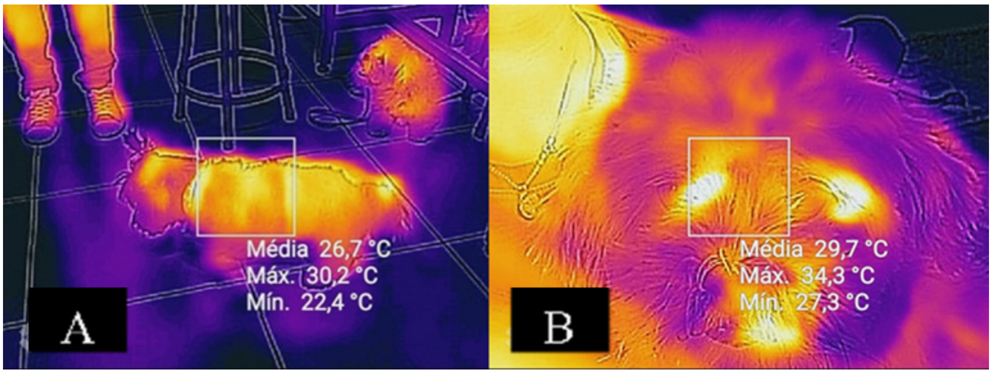

Figure 1 – Thermography of a Shih Tzu dog used in the study. The diagrams on the animal's body represent the specific locations focused on obtaining the temperature averages. A: average temperature on the back of a dog. B: average temperature on the top of the head of a dog. Média: avarage. Máx: maximum. Mín: minimum.

2.3. Thermal environment Resultados

After the adaptation period and the measurement of physiological parameters, the ambient temperature was increased to 33°C. After one hour at this temperature, the same protocol for measuring physiological parameters was followed. On the second day of the experiment, the animals were again kept at an ambient temperature of 25°C for acclimation. After completing the anamnesis protocol, the temperature was lowered to 17°C. After one hour at this temperature, the protocol for analysis was conducted.

Thermographic images were obtained using a portable IRT camera (FLIR ONE PRO – iOS, Thousand Oaks, USA), and the images were analyzed using the FLIR Tools software (https://www.flir.eu/browse/industrial/software/). Two photographs were taken of the following body regions: the head (eyes, muzzles), inside the ears, and the whole body; ten points were marked, totaling 144 images analyzed. The emissivity index (ε) used was 0.97, and the distance was one meter (Galvão et al., 2019). Two days after thermography, the animals were taken to a pet shop for bathing and grooming, and their fur was trimmed to a length of 1.5 to 2 cm. One week after grooming, to eliminate the stress effect of the procedure, the animals were again brought to the laboratory to repeat the same procedures conducted without grooming.

2.4. Temperature–Humidity Index (THI)

Using the temperature and humidity data obtained from the ambient thermometer, the temperature-humidity index (THI) was calculated for the analysis times. The equation used for the THI calculation was proposed by Thom (1959):

$$THI = Ts + 0.36 \times To + 41.2$$

where: Ts = dry-bulb thermometer temperature in °C, and To = dew point temperature in °C

2.5. Statistical analyses

The data were subjected to residual normality analysis using the Shapiro–Wilk test and variances were compared using Levene's test. Subsequently, an analysis of variance (ANOVA) was conducted to evaluate the effects of interactions between fur coverage and ambient temperature factors.

When significant interactions were observed and when isolated effects were observed for different temperatures, the Tukey test was performed at the 5% significance level. When only main effects were observed for fur coverage, the F test was used, which was also significant at the 5% level. Statistical analyses were performed using R software version 3.5.2.

3. Results

There was no interaction between treatments, and no isolated effects of the factors were observed for the physiological parameters of heart rate, respiratory rate, or blood pressure. There was no effect of grooming on the animals' rectal temperature; however, when exposed to a temperature of 33°C, the rectal temperature was greater than that measured under cold stress conditions (17°C) ($p<0.05$) (Table 1).

Variable	Cov	Temp					P -Value		
		17	25	33	Average	SEM	Cov	Temp	Cov*Temp
Rectal temperature (C°)	With	37.500	38.125	38.800	38.141				
	Without	37.250	38.283	38.250	37.927	0,238	0.4440	0.0057	0.5803
	Average	37.375b	38.204ab	38.525A					
Heart rate	With	101.666	94.666	100.000	98.777				
	Without	114.666	116.833	111.666	114.388	6,69	0.0526	0.9590	0.8345
	Average	108.166	105.750	105.833					
Respiratory rate	With	36.333	48.00	42.166	42.166				
	Without	31.000	45.083	48.833	41.638	5,137	0.9297	0.1616	0.6861
	Average	33.666	46.541	45.500					
Blood pressure	With	211.706	182.814	181.543	192.021				
	Without	215.316	182.912	211.650	203.293	8,961	0.2847	0.0685	0.4425
	Average	2.135.116	182.863	196.596					

Table 1 – Physiological parameters of *Lhasa Apso* and *Shih Tzu dogs* sheared or not sheared under different ambient temperatures. Means followed by lowercase letters on the same line differ significantly according to Tukey's test ($p<0.05$).

Table 1 presents physiological measurements under two conditions: with and without a specific factor. Measurements were taken at three temperatures (17°C, 25°C, and 33°C). Average: the mean values for each condition and temperature, SEM: standard error of the mean, COV: coverage (measures the joint variability between the variable and temperature), TEMP: effect of temperature on the variable, COV*TEMP: interaction between coverage and temperature, and P-value: statistical significance of the interaction.

At 17°C, the difference in the Temperature-Humidity Index (THI) between groomed and ungroomed animals is minimal, suggesting that grooming has a limited impact in cold conditions. At 25°C, although the relative humidity is higher for groomed animals, the THI is slightly reduced, indicating that grooming may provide some thermal relief. However, at 33°C, the THI for groomed animals is higher, suggesting that grooming is not sufficient to mitigate thermal stress in extreme heat conditions (Table 2).

Temperature °C	Relative humidity pain air %	THI
	Ungroomed animals	
17	55	60
25	69	73
33	54	81,2
	Animals with grooming	
17	53	59,6
25	80	73,7
33	59	82,6

Table 2 – Temperature and humidity index (UTI, %) related to the thermal comfort of the animals at different temperatures and in different situations (with and without grooming).

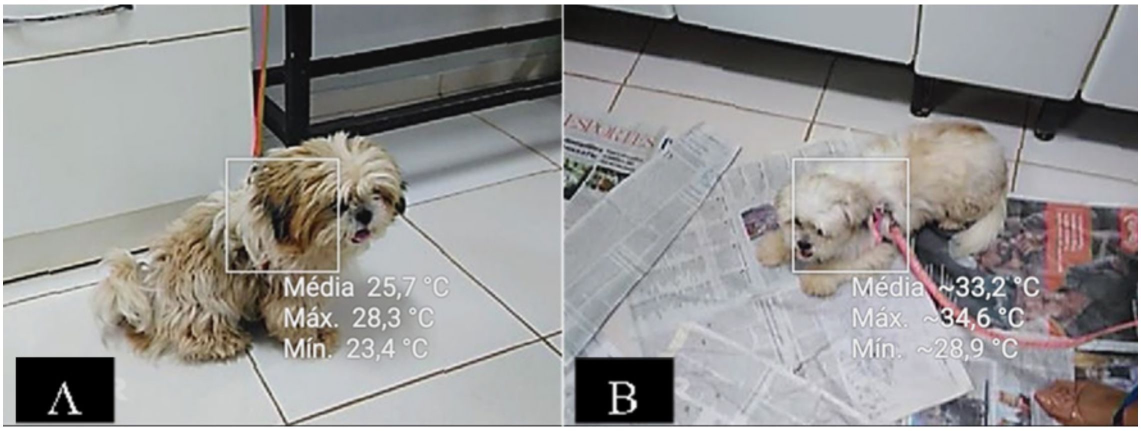

Figure 2 – A: average temperature of a dog without grooming. B: average temperature of a groomed dog. The images depict the average body temperature of the animal without grooming and the animal with grooming. Média: avarage. Máx: maximum. Mín: minimum.

The average temperature of the animals' body parts increases with ambient temperature, but the impact of the specific factor varies. For head temperature, the difference between conditions with and without hair coverage is small and not significant ($P > 0.05$). However, for ear temperature, the factor with or without hair coverage had a significant effect ($P < 0.05$), indicating that it alters how ear temperature is regulated under different temperature conditions. The most pronounced impact is observed in body temperature, where the factor without hair coverage significantly influences thermal regulation, leading to a higher thermal sensation for the animal (Table 3).

http://dx.doi.org/10.5380/avs.v29i3.96194

Variable	Cov	Temp (C°) 17	25	33	Average	SEM	P -Value Cov	Temp	COV*TEMP
Head T°	With	23.083	27.416	31.750	27.416b				
	Without	24.033	27.691	33.266	28.330A	0,352	0.0324	0.00001	0.4689
	Average	23.558C	27.554B	32.50A					
Ear T°	With	27.266Cc	30.466Bb	34.716Aa	30.816				
	Without	23.783Cd	32.041Ba	34.18Aa	30.002	0,465	0.1408	0.00001	0.0024
	Average	25.525	31.254	34.450					
Body T°	With	22.883Cc	26.416Bb	33.633Aa	27.644				
	Without	25.450Cb	29.900Ba	33.716Aa	29.688	0,29	0.00001	0.00001	0.0008
	Average	24.166	28.158	33.675					

Table 3 – Thermographic body evaluation of Lhasa Apso and Shih Tzu dogs sheared or not under different ambient temperatures. Averages followed by lowercase letters in the same row and uppercase letters in the same column differ significantly according to Tukey's test ($p<0.05$). TEMP: temperature. COV: Coverage.

4. Discussion

It should be noted that due to the manipulations and restraints of the animals for the measurement of physiological parameters, there was agitation, and the animals were in a different environment from their usual surroundings. According to Feitosa et al. (2004), the respiratory rate (RR) and heart rate (HR) for small dogs should be within 18 to 36 (RR) and 60 to 160 (HR), respectively, which is consistent with the results obtained in the study.

Additionally, we must consider systolic blood pressure (SBP), which is much different from the reference value of 150. We should consider "white coat syndrome," in which dogs feel threatened in some way by veterinarians, becoming agitated and causing interference with the results. According to Mariti et al. (2015), veterinarians should be aware that any dog, regardless of previous experience or past stress, can become stressed by unfamiliarity with the place, the type of manipulation, and the presence of strange noises, corroborating what occurred in this study.

In the presence of a stressor, the autonomic nervous system is activated, and signals are transmitted to the body through the sympathetic and parasympathetic nervous systems. This results in the release of adrenaline and noradrenaline into the bloodstream, which act on various organs, causing changes in heart rate, blood pressure, salivation, and panting (Ferreira, 2020). This stress can be caused by climatic elements such as temperature, solar radiation, and humidity, which directly affect animal performance. Climatic stress can occur due to cold or heat, with the main signs being related to an increase in the respiratory rate (Azêvedo et al., 2009). The animals showed an increase in the respiratory rate when the temperature was 25°C or 33°C. An increase or decrease in the respiratory rate is related to the duration and intensity of the stress (Martello et al., 2004).

Dogs are homeothermic, and according to Souza and Batista (2012), they must maintain their body temperature within narrow limits throughout the 24 hours. To achieve a balance in thermogenesis, homeothermic processes are regulated by modulating thermogenesis and intensifying different thermolysis mechanisms. Rectal temperature is considered the most appropriate measure for domestic animals, providing a good indication of central temperature. Dogs normally have a temperature of 38.9°C to 39.2°C (Robison, 2008). In this study, the rectal temperature of the animals increased at ambient temperatures of 25°C and 33°C.

A value equal to or less than 70 in the temperature–humidity index (THI) indicates a condition of comfort, while the values above are related to a state of danger and emergency (Silva, 2000). In this sense, animals subjected to temperatures of 25°C and 33°C, regardless of whether they were grooming, had compromised thermal comfort. Even animals that appear to be in thermoneutrality may be subject to inadequate humidity and temperature conditions that compromise their thermal comfort.

Regarding the thermal body of the animals, there was an isolated effect of temperature ($p<0.05$) in the head region, with an increase in temperature. Concerning ear temperature, an interaction between ambient temperature and fur coverage was observed. Dogs without grooming had a lower ear temperature at 17°C, while the ear temperature at 25°C with grooming was lower than that of ungroomed animals. However, the ear temperature was similar between groomed and ungroomed dogs when subjected to an ambient temperature of 33°C (Table 3). Skin temperature reflects comfort or stress sensation and is an important indicator of thermal stress and animal welfare. Prolonged exposure to stressful conditions, leading to chronic or thermal stress, contributes to the development of pathologies and reproductive losses. Thus, there is a need to understand the physiology of this stress and the animal's response to this influence (Martello et al., 2004).

An increase in rectal temperature is a critical indicator, demonstrating that homeostatic attempts have failed (Cunha et al., 2019). As animals exposed to heat conditions try to maintain homeostasis, rectal temperature may rise due to difficulty in dissipating excess heat (Santos, 2021). Heat dissipation mechanisms, such as evaporation, conduction, and convection, are mobilized to regulate internal temperature. However, if these mechanisms are insufficient, rectal temperature can rise, reflecting thermal stress (Lima, 2022). Monitoring rectal temperature is essential for assessing the effectiveness of heat dissipation processes and for implementing appropriate strategies to manage animal welfare under extreme environmental conditions (Rocha-Silva et al., 2023). To understand the thermodynamic processes of heat loss in dogs, attention must be given to several factors, such as heat loss. Conduction occurs when the body is in direct contact with a cooler surface (Robbins et al., 2017). Convection is the direct loss of heat between the body and the atmosphere (Souza et al., 2017), and radiation is the direct loss of heat to the environment. Evaporation, which is mainly responsible for maintaining body temperature in mammals (Clark-Price et al., 2021), mainly occurs in dogs through the evaporation of moisture from the nose and tongue (panting dogs lose much more heat), which is the primary mechanism of heat loss in dogs. This effect is maximized by increased blood flow in these areas in heat, full exposure of the tongue, and increased salivation, leading to cooling of the circulating blood and the entire body (Ribeiro et al., 2018).

Grooming to reduce heat aims to increase convection and conduction when performed on the belly, allowing greater contact of the skin with cold surfaces when the dog lies down. However, in the present study, there was no reduction in temperature in the grooming animals. In contrast, grooming animals showed higher temperatures. At a thermal stress temperature of 33°C, grooming was not able to minimize the effects of the environment. Bruchim et al. (2004), reported that in environments with relative humidity above 35%, the evaporation efficiency significantly decreased in dogs. Regardless of whether they were grooming or had fur, dogs evaluated at temperatures of 25°C to 35°C were under thermal stress due to the humidity present, which hindered heat dissipation by evaporation, corroborating the present study. It is evident that dogs mainly rely on panting to assist in heat loss by evaporation (Robinson et al., 2008). Therefore, grooming was not efficient for this loss.

Considering the results, it is possible to observe that a dog's coat plays a crucial role in animal welfare and heat protection. The fur acts as an insulating barrier, helping to regulate body temperature and protect the skin from damage caused by adverse environmental conditions (Franceschi, 2020). In hot climates, a thick coat can limit efficient heat dissipation, contributing to thermal stress if the dog does not have access to adequate cooling measures such as shade and freshwater (Hirahata, 2022). On the other hand, grooming or partial removal of the coat can improve the dog's ability to adapt to heat by promoting better thermal exchange and reducing the risk of hyperthermia (Arruda et al., 2020). However, excessive grooming can also compromise the dog's natural protection against sunlight and other environmental factors, affecting its well-being (Camaralac, 2023).

5. Conclusion

Different climatic conditions interfere with animal thermal comfort and coat coverage. Ambient temperature interacted with the removal of the dogs' coats, causing an increase in body temperature. Grooming the dogs did not diminish the effects of thermal stress caused by different climatic conditions.

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