# STABLE MICROCLIMATE INFLUENCE ON PHYSIOLOGICAL ATTRIBUTES IN HORSES

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## ABSTRACT

A set of physiological values was measured in a total of sixteen horse individuals age 5 to 15, there were 13 mares and 3 geldings. A few sensors monitoring the temperature and humidity of the surroundings were placed in the stable; the data was saved every fifteen minutes. the measurements were taken in morning hours, when all horses were asleep. We were particularly interested in the following data: breath frequency per minute, heart beats per minute and body temperature measured in rectum. All collected data were recorded into Microsoft Excel and also processed using Pearson's correlation function in Unistat 5.1. According to the calculated results, it can be said the microclimate of the observed stable is appropriate for horse stabling.

A relatively high value of the correlation coefficient (r = 0.85**) was found on the first day of our research – July 19th, 2013. This value has been found when calculating of the relation of breath frequency and environment temperature.

Contrary to that, a low correlation value indicates there is actually no relation between the heartbeat frequency and environment temperature.

Various values of correlation have been found for the relation of relative environment humidity and the breath frequency of horses. An insignificant positive correlation is found on August 9th, 16th and 23rd, a medium-high correlation is identified on August 30th (r = 0.55), while on September 13th, 2013, it is statistically provable that the breath frequency is rising alongside with the relative environment humidity (r = 0.54**).

A dependency closing in on medium negative correlation has been found for relative environment humidity and heartbeat frequency during the second stage of our research. In this timeframe, the relative environment humidity was rising, while the heartbeat frequency was dropping.

Observing the dependency of relative environment humidity and body temperature has provided us with variable correlation (both negative and positive). The only statistically significant correlation has been found on August 16th, 2013; this was a positive correlation (r = 0.66**).

**Key words:** horse, stable, physiological values, breath frequency, heartbeat frequency, body temperature

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## INTRODUCTION

The stabling conditions for horses have to follow certain etic and technological standards to fulfill the basic and psychical needs of horses – sufficient amount of space, movement, light, Bering, feed and ventilation. (Dušek *et al*., 2007).Every horse stable has to fulfill several criteria for horse accommodation; regardless if the horses are used in sports, work, or are just bred. Inadequacies of stabling conditions can have negative impact on colt development, performance or the health of a given horse (Navrátil, 2007).

Every stable should meet a few crucial requirements; constant temperature being one of them. In summer period, the optimum temperature in the stable should be between 20 and 25 Celsius degrees, while in winter everything above 6 Celsius degrees is acceptable. To summarize, an optimal temperature lies in the interval circumscribed with +6 Celsius degrees low and +25 Celsius degrees high (Navrátil, 2007; Regner, 2009). A temperature span, in which a certain species does feel hot or cold, is called thermal comfort zone. The thermal comfort zone varies per species. Beyond the borders of the thermal comfort zone, two extremes are defined. If the temperature is too low, the thermoregulation mechanism of an individual will not be capable of producing sufficient warmth to maintain constant body temperature, and the individual suffers from being cold. This state is called hypothermia. On the other side, when the individual is not capable of keeping the body temperature low enough, a state called hyperthermia occurs. If the individual is exhibited to these extremes for too long, he will die of hypothermia, or overheating (Klabzuba a Kožnarová, 2006).

The optimal stable humidity has been defined by Navrátil (2007) and Dušek *et al.* (2007) as a range between 60-80%. Regner (2009) presents the optimal relative humidity as 75%, while Dušek *et al.* specifies the maximum acceptable humidity is 85%.

The main focus of our work was assessing the physiological values of horses - body temperature, breath and heartbeat frequency in a stable. A total of sixteen thoroughbred horses was observed.

## MATERIAL

Observed sample: 16 thoroughbred horses

Measuring tools:

Central meteorology station TFA 30.3039

4 additional sensors

Heartbeat measuring device Polar Equine Belt for Wear link Transmitter

Thermometer for livestock

## METHODS

Physiological values were measured in 16 warm-blooded horses; 13 mares and 3 geldings aged between 5 -15 yeas, all of them in full work process. Every horse has been assigned a number from 1 to 16. The daily routine consisted of early morning grain feed /approx. 6 a.m.) followed by release to a pasture. During the day, every horse had to go through a light work under the saddle. In the evening, the horses were sent back to the stable and they received their evening feed. The research took place between July 19$^{th}$, 2013 and September 20$^{th}$, 2013 and was conducted in a private stable Filip, which is located approximately 20 kilometers south of Brno. Humidity sensors were installed in the stable with their position picked accordingly to avoid their exposure sunlight

and draught. The temperature and relative humidity values were measured every 15 minutes; collected data were stored in a central meteorology device TFS 30.3039. The sensors were also equipped with protective shields to ensure safety of both the sensors, and the horses.

All measurements were conducted in morning hours to ensure the horses are in a quiescent state. A few physiological factors were observed in horses; firstly, the breath frequency was measured, then a special band with Equine Polar heartbeat sensor was belted to the horse's chest. The heartbeat frequency was then displayed on special watch. It was necessary for all three measurements all horses were used to the morning livery. The last measurement taken was body temperature; this value was obtained from a thermometer in the horse's rectum. Some of the observed horses were overreacting to this procedure, therefore this part of the research was scheduled as the last one. All obtained values have been recorded into Microsoft Excel work sheet. The relation of horse's physiological values and the microclimate in the stable was then processed in Unistat 5.1 using Pearson's correlation.

## RESULT AND DISCUSSION

All measurements were conducted in morning hours from July 19th to September 20th, 2013. The heartbeat frequency value was measured in horses, which were not in work regime. The lowest figure we observed was 26 beats per minute, while the maximum was 49 beats per minute, as seen in Tab. 1. Comparing to authors of previous studies listed below, no match was found for our minimal detected value. The heartbeat frequency is the most variable physiological trait we were observing; whenever an excitation occurs in the given individual, the heartbeat frequency rises up very quickly. The spanning of values obtained varies from 5 to 20 beats in various individuals. The large variability of this magnitude is documented by a large value for its standard deviation (Tab. 2).

It was crucial for the horse not to be distracted / excited by outer factors when the measurements were taken. When the individual got excited, it was necessary to wait until the heartbeat frequency goes back to normal. The most common figures for heartbeat frequency were 35 – 38 beats per minute; these values are then corresponding with Reece (1998). Reece actually defined two groups of horses;“thoroughbred“ ones, with heartbeat frequency varying from 38 to 48 beats per minute, and „other horses“ with values belonging to interval 32 – 44 beats per minute. As per Kapitzke (2008), the heartbeat frequency of an adult horse is 30 - 40 beats per minute. Reece (1998) inclines to an interval of 32 - 44 beats per minute, but also defines a thoroughbred horse's heartbeat frequency of 38 - 48 beats per minute. Regner (2009), contrary to Kapitzke, says the lowest heartbeat frequency of a horse is 40 beats per minute, while the top border is at 50 beats. Navrátil (2007) claims the quiescent heartbeat frequency of a horse is 36-45 beats per minute. Švehlová (2010) suggests the lowest values of all authors; 28 - 40 beats per minute. Our measurements, taken between July 19th and September 20, 2013 correspond with standards most authors suggest. Our values varied from 29 beats per minute to 48 beats per minute.

*Tab. 1 Heartbeat fraquency in 16 horses*

*Výběrové charakteristiky*

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rozsah | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 |
| Průměr | 33,00 | 34,50 | 35,63 | 36,00 | 34,13 | 40,63 | 33,00 | 33,88 | 35,00 | 33,88 | 32,63 | 35,13 | 36,88 | 41,63 | 40,13 | 39,50 |
| Minimum | 30,00 | 32,00 | 33,00 | 32,00 | 31,00 | 36,00 | 26,00 | 30,00 | 31,00 | 29,00 | 30,00 | 30,00 | 29,00 | 35,00 | 36,00 | 38,00 |
| Maximum | 35,00 | 36,00 | 38,00 | 39,00 | 39,00 | 48,00 | 37,00 | 37,00 | 37,00 | 38,00 | 38,00 | 40,00 | 49,00 | 47,00 | 44,00 | 42,00 |
| Rozpětí | 5,00 | 4,00 | 5,00 | 7,00 | 8,00 | 12,00 | 11,00 | 7,00 | 6,00 | 9,00 | 8,00 | 10,00 | 20,00 | 12,00 | 8,00 | 4,00 |
| Rozptyl | 2,25 | 1,25 | 2,48 | 4,00 | 7,11 | 20,98 | 12,50 | 5,61 | 3,25 | 8,11 | 6,98 | 11,61 | 30,36 | 12,98 | 5,86 | 1,25 |
| Směrodatná odchylka | 1,50 | 1,12 | 1,58 | 2,00 | 2,67 | 4,58 | 3,54 | 2,37 | 1,80 | 2,85 | 2,64 | 3,41 | 5,51 | 3,60 | 2,42 | 1,12 |
| Variační koeficient | 0,05 | 0,03 | 0,04 | 0,06 | 0,08 | 0,11 | 0,11 | 0,07 | 0,05 | 0,08 | 0,08 | 0,10 | 0,15 | 0,09 | 0,06 | 0,03 |

*Tab. 2 Heartbeat fraquency on daily basis*

*Výběrové charakteristiky*

| | A19.7. | A9.8. | A16.8. | A23.8. | A30.8. | A6.9. | A13.9. | A20.9. |
|---|---|---|---|---|---|---|---|---|
| Rozsah | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 |
| Průměr | 36,63 | 35,88 | 35,44 | 36,13 | 34,63 | 35,69 | 35,69 | 37,69 |
| Minimum | 31,00 | 31,00 | 30,00 | 30,00 | 30,00 | 26,00 | 30,00 | 29,00 |
| Maximum | 42,00 | 39,00 | 41,00 | 45,00 | 41,00 | 48,00 | 44,00 | 49,00 |
| Rozpětí | 11,00 | 8,00 | 11,00 | 15,00 | 11,00 | 22,00 | 14,00 | 20,00 |
| Rozptyl | 10,11 | 6,36 | 7,62 | 15,86 | 9,86 | 27,84 | 16,21 | 33,34 |
| Směrodatná odchylka | 3,18 | 2,52 | 2,76 | 3,98 | 3,14 | 5,28 | 4,03 | 5,77 |
| Variační koeficient | 0,09 | 0,07 | 0,08 | 0,11 | 0,09 | 0,15 | 0,11 | 0,15 |

The values we were able to collect for breathing frequency of 16 observed horses can be found in Tab. 3. Breathing frequency varies from 7 to 14 intakes per minute, which makes it the second least variable physiological value we were measuring. In different individuals, the span of breathing frequency varied from 2 to 7 intakes per minute. These values correspond to study performed by Navrátil (2007), who declares the physiological breathing frequency of a horse is between 6 and 16 intakes per minute. Our minimal observed value does not correspond with Kapitzke (2008), who suggest the breathing frequency of a horse is between 10 - 15 intakes per minute. Therefore, our minimal value is lower by 3 than his. Similarly to Kapitzke (2008), Regner (2009) and Reece (1998) suggest the breathing frequency of an adult horse is 10 – 14 intakes per minute. On the other hand, Švehlová (2010), comes up with a larger span of acceptable values: 8 – 16. The most common values of breathing frequency were 8 – 10 intakes per minute. However, when the environment temperature rises above 16.5 $^{o}$C, the breathing frequency of horses rises also. On the following dates, the highest value (14 intakes per minute) was found in the horses: July 19$^{th}$ (19.1 $^{o}$C), August 9$^{th}$ (21.6 $^{o}$C), August 23$^{rd}$ (17.8 $^{o}$C).

*Tab. 3 Breathing fraquency in 16 horses*

*Výběrové charakteristiky*

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rozsah | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 |
| Průměr | 9,63 | 9,38 | 9,13 | 9,63 | 9,50 | 9,50 | 9,00 | 8,88 | 10,38 | 10,50 | 9,50 | 9,13 | 9,25 | 9,75 | 9,63 | 9,00 |
| Minimum | 8,00 | 7,00 | 7,00 | 8,00 | 7,00 | 8,00 | 8,00 | 7,00 | 7,00 | 8,00 | 8,00 | 8,00 | 7,00 | 8,00 | 8,00 | 8,00 |
| Maximum | 12,00 | 14,00 | 11,00 | 12,00 | 12,00 | 14,00 | 12,00 | 11,00 | 14,00 | 14,00 | 14,00 | 12,00 | 14,00 | 14,00 | 13,00 | 10,00 |
| Rozpětí | 4,00 | 7,00 | 4,00 | 4,00 | 5,00 | 6,00 | 4,00 | 4,00 | 7,00 | 6,00 | 6,00 | 4,00 | 7,00 | 6,00 | 5,00 | 2,00 |
| Rozptyl | 2,98 | 4,48 | 1,86 | 1,48 | 1,75 | 4,00 | 1,75 | 1,61 | 3,48 | 4,00 | 3,50 | 1,61 | 4,19 | 4,19 | 2,73 | 0,50 |
| Směrodatná odchylka | 1,73 | 2,12 | 1,36 | 1,22 | 1,32 | 2,00 | 1,32 | 1,27 | 1,87 | 2,00 | 1,87 | 1,27 | 2,05 | 2,05 | 1,65 | 0,71 |
| Variační koeficient | 0,18 | 0,23 | 0,15 | 0,13 | 0,14 | 0,21 | 0,15 | 0,14 | 0,18 | 0,19 | 0,20 | 0,14 | 0,22 | 0,21 | 0,17 | 0,08 |

*Výběrové charakteristiky*

| | A19.7. | A9.8. | A16.8. | A23.8. | A30.8. | A6.9. | A13.9. | A20.9. |
|---|---|---|---|---|---|---|---|---|
| Rozsah | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 |
| Průměr | 10,44 | 10,19 | 9,31 | 10,75 | 9,31 | 8,94 | 8,00 | 8,94 |
| Minimum | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 7,00 | 7,00 | 8,00 |
| Maximum | 14,00 | 14,00 | 11,00 | 14,00 | 12,00 | 11,00 | 9,00 | 11,00 |
| Rozpětí | 6,00 | 6,00 | 3,00 | 6,00 | 4,00 | 4,00 | 2,00 | 3,00 |
| Rozptyl | 4,75 | 4,40 | 1,21 | 3,44 | 1,34 | 1,06 | 0,63 | 0,93 |
| Směrodatná odchylka | 2,18 | 2,10 | 1,10 | 1,85 | 1,16 | 1,03 | 0,79 | 0,97 |
| Variační koeficient | 0,21 | 0,21 | 0,12 | 0,17 | 0,12 | 0,12 | 0,10 | 0,11 |

*Tab. 4 Breathing fraquency on daily basis*

The body temperature proved to be the most constant value from the free values observed (Tab. 5). This indicates a very good ability of the horse's body to react to unstable external conditions. Even if the body temperature was as much as 10.5 $^{o}$C different in one horse in different environment temperature, the actual differences between horse individuals were very small, as proven by the low figure of standard deviation. In our observation, the value of 35.92 $^{o}$C has been identified as minimum (Tab. 6). This specific value cannot be found in any previous study and can be a

consequence of consumption of higher volume of cold water. While cold water consumption can be one of the causes, the other ones are exhaustion of the organism, poisoning and cardiovascular defects. On the other hand, the highest observed value was 38.26 °C. According to Reece (1998), Regner (2008) and Švehlová (2010), this value is slightly above the standards.

Various authors have various opinions on standard body temperature then: Kapitzke (2008) claims it is 37.5 – 38.2 °C, Navrátil (2007) says standard is somewhere between 37.5 – 38.5 °C, Regner (2009) suggests 37.5 – 38,0 °C. Švehlová (2010) is speculating about 37.0 – 38.0 °C. Reece (1998) is the only one, who differentiates between stallions 37.2 – 38.1 °C and mares 37.3 – 38.2 °C. Another interval is provided by Ende & Isenbügel (2006): 37.5 – 38.3 °C. Švehlová (2010) explains a few occasions when the body temperature might be above normal; physical work (max. + 3.0°C), neural stimulation / hot weather ( max +1.0°C), food consumption (max +1.0°C) and some temperature abnormalities might occur with rectum inflammation or constipation.

*Tab. 5 Body temperature in 16 horses*

*Výběrové charakteristiky*

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rozsah | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 |
| Průměr | 37,83 | 37,77 | 37,76 | 37,40 | 37,51 | 37,34 | 37,61 | 37,63 | 37,63 | 37,51 | 37,32 | 37,81 | 37,84 | 37,68 | 37,33 | 37,69 |
| Minimum | 37,26 | 37,42 | 37,50 | 36,01 | 37,08 | 36,77 | 36,09 | 36,94 | 36,77 | 37,08 | 36,22 | 36,97 | 37,60 | 37,22 | 35,92 | 37,30 |
| Maximum | 38,26 | 38,02 | 38,06 | 38,22 | 37,88 | 37,70 | 38,17 | 38,16 | 38,11 | 38,08 | 38,04 | 38,28 | 37,97 | 37,97 | 38,09 | 38,02 |
| Rozpětí | 1,00 | 0,60 | 0,56 | 2,21 | 0,80 | 0,93 | 2,08 | 1,22 | 1,34 | 1,00 | 1,82 | 1,31 | 0,37 | 0,75 | 2,17 | 0,72 |
| Rozptyl | 0,09 | 0,03 | 0,03 | 0,39 | 0,08 | 0,10 | 0,40 | 0,15 | 0,16 | 0,12 | 0,31 | 0,14 | 0,02 | 0,06 | 0,49 | 0,06 |
| Směrodatná odchylka | 0,30 | 0,17 | 0,17 | 0,62 | 0,28 | 0,32 | 0,64 | 0,39 | 0,41 | 0,34 | 0,56 | 0,37 | 0,13 | 0,25 | 0,70 | 0,24 |
| Variační koeficient | 0,01 | 0,00 | 0,00 | 0,02 | 0,01 | 0,01 | 0,02 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,00 | 0,01 | 0,02 | 0,01 |

*Výběrové charakteristiky*

| | A19.7. | A9.8. | A16.8. | A23.8. | A30.8. | A6.9. | A13.9. | A20.9. |
|---|---|---|---|---|---|---|---|---|
| Rozsah | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 | 16,00 |
| Průměr | 37,66 | 37,71 | 37,74 | 37,75 | 37,76 | 37,42 | 37,33 | 37,45 |
| Minimum | 36,77 | 36,89 | 36,72 | 37,50 | 36,92 | 36,09 | 35,92 | 36,22 |
| Maximum | 38,16 | 38,08 | 38,28 | 38,06 | 38,26 | 37,96 | 38,17 | 38,17 |
| Rozpětí | 1,39 | 1,19 | 1,56 | 0,56 | 1,34 | 1,87 | 2,25 | 1,95 |
| Rozptyl | 0,17 | 0,08 | 0,12 | 0,02 | 0,15 | 0,19 | 0,43 | 0,21 |
| Směrodatná odchylka | 0,41 | 0,28 | 0,34 | 0,14 | 0,38 | 0,44 | 0,65 | 0,46 |
| Variační koeficient | 0,01 | 0,01 | 0,01 | 0,00 | 0,01 | 0,01 | 0,02 | 0,01 |

*Tab. 6 Body temperature on daily basis*

The relation between relative humidity, environment temperature and the physiological traits of horses was processed using Pearson's correlation in Unistat 5.1 (see Tab. 7).

On July 19th, 2013 the correlation quotient value is (r = 0.85**). A statistically significant difference was observed in increasing the horse breath frequency with rising temperature in the stable. This result is, however, a subject to further discussion, as the increase in breath frequency can also be cause by stress factors - strange person, strange odors and manipulation the horse has not experienced before. A low correlation between heartbeat frequency and temperature in the stable does not indicate any dependency. Therefore, it can be concluded the temperature in the stable does not have any impact on the breath frequency of horses. There is one exception; on August 30th, the relation shows a medium degree of dependency.

The dependency of body temperature on temperature of environment has only shown low correlation coefficient, both for negative and positive values. Te data we obtained are very variable and clearly indicate there is no influence of environment temperature on body temperature. The only exception of this conclusion is research performed on August 16th, 2013, when the correlation coefficient reached a value of -0.7, which would be a statistically significant value.

*Tab. 7 Relation between environment temperature and physiological values of horses*

| Physiological value / day | 19.7. | 9.8. | 16.8. | 23.8. | 30.8. | 6.9. | 13.9. | 20.9. |
|---|---|---|---|---|---|---|---|---|
| Breath frequency | 0,85** | 0,12 | -0,20 | -0,00 | -0,64 | -0,00 | -0,49 | -0,05 |
| Heartbeat frequency | -0,37 | -0,17 | 0,37 | -0,21 | 0,47 | -0,21 | 0,37 | 0,27 |
| Body temperature | -0,29 | 0,18 | -0,70** | -0,13 | 0,08 | 0,15 | 0,08 | 0,32 |

The relation between relative humidity of the environment and the breath frequency of horses indicated a weak positive correlation on August 9th, 16th and 23rd (r = 0.55), while a medium correlation was identified on September 19th. On September 13th, it is statistically significant and provable that with rising environment humidity the breath frequency rises as well (r = 0.54**). However, this result is contradicted by the measurement one day earlier, when a negative correlation ( r = -0.60**) was found.

We have also found that the environment humidity might affect the heartbeat frequency. Firstly, it looked like there is no relation between the two at all, while later a slight negative correlation was observed. This occurrence was statistically significant in last two measurements recorded. During this timeframe, the relative environment humidity was on the rise, while the heartbeat frequency values were lowering. When it comes to correlation of environment humidity and body temperature, the results vary. We have experienced both positive and negative correlation. Tab. 8 shows for example measurement from July 19$^{th}$ (r = -014) and another one from August 9$^{th}$ (r = 0.14). A statistically significant dependence was only identified on August 16$^{th}$ (r = 0.66**); this indicates a medium dependence and suggest with rising environment humidity the body temperature rises also.

*Tab. 8 Correlation of microclimate (relative humidity) and physiological traits of horses*

| Physiological value / day | 19.7. | 9.8. | 16.8. | 23.8. | 30.8. | 6.9. | 13.9. | 20.9. |
|---|---|---|---|---|---|---|---|---|
| Breath frequency | 0,41 | 0,11 | 0,13 | 0,11 | 0,55 | -0,60** | 0,54** | 0,00 |
| Heartbeat frequency | 0,04 | 0,06 | -0,05 | -0,08 | -0,36 | -0,24 | -0,44** | -0,47** |
| Body temperature | -0,14 | 0,14 | 0,66** | 0,21 | -0,26 | 0,33 | -0,05 | -0,23 |

## CONCLUSIONS

The values obtained from our measuring in the stable environment (temperature 7.5$^{o}$C - 19.3$^{o}$C, relative humidity 64% - 92%) were within standards except for one day, when a relative humidity was bordering on its maximum value. This was caused by a broken drinker n one of the boxes. With this one exception, the values were fitting the criteria for horse stabling. the body temperature we detected varied from 36.01$^{o}$C to 38.26$^{o}$C and the heartbeat frequency values were between 28 and 40 beats per minute. Breath frequency was between 8 and 14 breath per minute. the microclimate (environment temperature and relative humidity) has shown both positive and negative correlations with most of the physiological values.

It has been proven by using methods of statistics that healthy horse individuals have good thermoregulation mechanisms to help them keep their body temperature balanced in variable conditions. The biggest differences between various individuals has been found in heartbeat

frequency (4 – 20 heartbeats per minute), while the lowest difference was found in body temperature (0.37 °C – 2.21 °C).

It would be interesting to watch horses when in discomfort in the future.

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