Can accelerometer devices be a reliable tool for measuring horse lying behavior? A pilot study

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Abstract

Sleep plays a crucial role for animal welfare due to its significant biological function of restorative properties. To achieve paradoxical sleep, horses need to lie down, therefore lying has been reported as an effective animal-based indicator. Accelerometer devices are commonly used in cattle to continuously monitor lying behavior. The aim of this study was to understand whether accelerometers attached to the leg can be a reliable device to accurately monitor horse lying behavior. As a pilot, three horses were equipped with a MSR145 Data Logger to monitor the daily duration of lying behaviour, as well as the length and frequency of lying bouts over a period of 5 consecutive days. The accelerometer was positioned within the stable boot on the left front limb of the horses when they were housed in single boxes. The data were extracted, checked for the positioning of the sensor and the data variability, and then analyzed in continuous using the raw data time series. The accelerometer was always mounted correctly and there was a modest data variability on the daily lying time. Mean lying time over 24 hours was 171 minutes with 3 to 5 lying bouts of mean duration of 30 minutes each. Horses showed an individual lying down pattern that was similar over the 5 days. Our preliminary results showed that the accelerometer can be a reliable, useful, and well accepted tool to monitor lying behavior of horses kept in single box. These preliminary results open the possibility to further investigation regarding horse athlete sleep patterns, especially during traveling for competitions.

Keywords

Horse welfare, lying, accelerometer, PLF, horse behavior

Introduction

Horse behavior can provide valuable insight into their current subjective state, thus being a good indicator of their current welfare. Among the different daily routinary behaviors, sleep plays a crucial role for animal welfare due to its significant biological function of restorative properties and its cognitive role in memory consolidation. Horses, as a prey species, usually have a daily total sleep ranging from 3 to 5 hours (Houpt et al. 1986; Arnold 1984). In horses it is well known that alterations of lying behavior can be an indicator of poor welfare or health issues (Kelemen et al. 2021; Auer et al. 2021; Greening and McBride 2022). The lack of sleep, known as sleep deprivation, is a common problem and a major stressor for horses, causing changes in both behavior and affective state. To achieve paradoxical sleep, i.e. Rapid Eye Movement (REM), horses need to lie down for a sufficient time. Lying has been reported as an effective animal-based indicator of the welfare of stabled horse (Chaplin and Gretgrix 2010). However, measuring this behavior in animals by direct or video observations can be a time-consuming process, especially in horses which spend a relatively small proportion of their day lying down. Accelerometer devices are commonly used in cattle to continuously monitor lying behavior for several months and years (Swartz, McGilliard, and Petersson-Wolfe 2016; Henriksen and Munksgaard 2019). So, understanding the sleep patterns of horses is crucial for ensuring their welfare and performance. Sleep is essential for physiological and psychological well-being in all animals, including horses. However, monitoring equine sleep presents

unique challenges due to their nature as prey animals and their adaptations to a polyphasic sleep pattern. Traditional methods of sleep monitoring in horses, such as direct observation or EEG recordings, are labor-intensive and often impractical. In recent years, the use of accelerometers has emerged as a promising tool for monitoring equine sleep patterns (Burla et al. 2017; DuBois et al. 2015). Accelerometers are motion-sensing devices that measure changes in acceleration, allowing for the detection of movement patterns associated with sleep and wakefulness. In horses, accelerometers can be attached to the body using specially designed halters, girths, or leg bands. These devices provide continuous, objective data on activity levels, allowing researchers and horse owners to monitor sleep duration, quality, and patterns over extended periods. In this context, the aim of this study was to understand whether accelerometers attached to a front limb within the stable boot can be a reliable device to accurately monitor and measuring horse lying behavior, highlighting its significance, challenges, and potential benefits.

Material and Methods

As a pilot, three horses were involved in the data collection. Horses were equipped with an accelerometer to monitor in a non-invasive and continuous way the daily duration of lying behaviour (horse in recumbency), as well as the length and frequency of lying bouts over a period of 5 consecutive days as described by DuBois and colleagues (2015).
The triaxial accelerometer MSR145 data logger (MSR Electronics GmbH, Seuzach, Switzerland), previously validated in the literature for estimating the lying behavior of the horse (Burla et al. 2017) was used. The accelerometer (1 cm x 2 cm x 1 cm) was positioned within the stable boot on the left front limb of the horses when they were housed in single boxes as showed in Figure 1. The sensor was positioned by orienting the y axis parallel to the limb, the x axis in the cranial direction and the z axis (lateral) perpendicular to the limb and then the same was secured using an elastic band. The data logger was set up with a sampling interval every 0.02 seconds. Data related to standing, movement and lying were captured using accelerometric time-series along three components. The MSR145 data logger recorded the horse's movements during stable confinement and, due to its small size and specific placement, did not cause any distress to the animal.

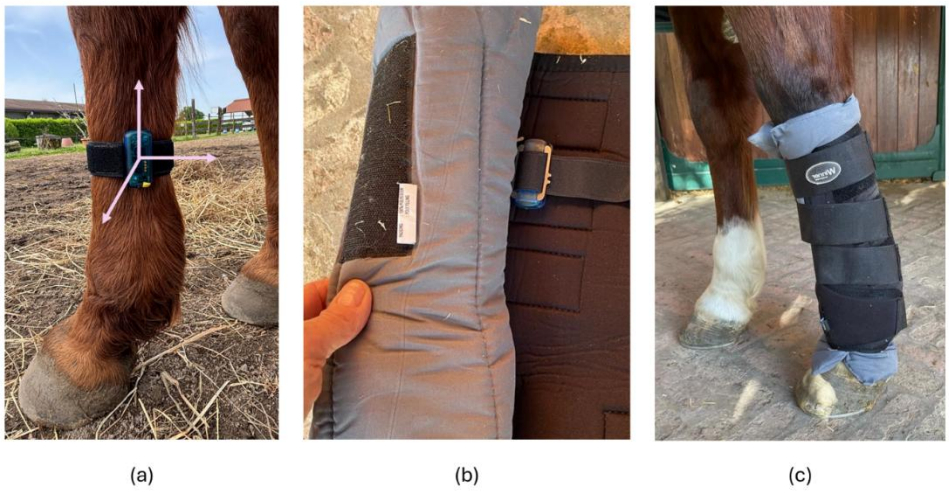

Figure 1 – Pictures showing how the sensor (MSR145 Data Logger) was positioned on the left front limb (a), within the stable boot (b) and (c).

The data were extracted and then analyzed in continuous using the raw data time series. Before processing the data, two types of preliminary numerical checks and data-cleaning were carried out. A first check with the aim of evaluating the correct positioning of the accelerometer on the horse's limb

during the monitoring period. A second control with the aim of quantifying the variability of the data in the time-series of the different horses. Then, for each horse, estimates of hourly and daily lying time were obtained by summing the decubitus measurements at one hour and one day, respectively. Frequency and duration of lying bouts and daily sleep patterns were also assessed.
The protocol of this study was approved by the Animal Welfare Committee of the University of Milan (OPBA_137_2023).

Results and Discussion

The check regarding the evaluation of the positioning of the accelerometer on the horse's limb during the monitoring period provided a fully acceptable result, confirming that for each horse the accelerometer was always mounted in the correct position and the accelerometer was maintained in the correct position during the whole duration of the experimental acquisitions. The check aiming at quantifying the variability of the data in the time-series of the different horses showed modest variability in the data on the daily lying time of the various animals.
An example of accelerograph for one horse over a period of 24 hours is reported in Figure 2. Mean lying time over 24 hours was 171 minutes with 3 to 5 lying bouts of mean duration of 30 minutes each. Horses showed an individual lying down pattern that was similar over the 5 days of measurements.

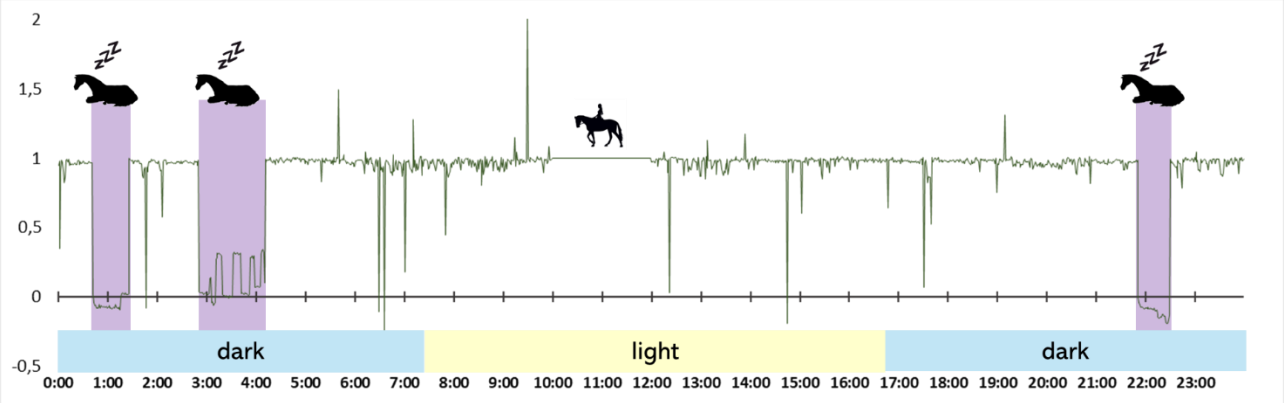

Figure 2 – Accelerograph reporting the lying bouts of one horse over 24 hours. The horse was lying down three times (0:40-1:25; 2:50-4:10; 21:50-22:30) for a total daily lying time of 165 minutes.

Despite their potential, the use of accelerometers in equine sleep monitoring is not without challenges. Interpretation of accelerometer data requires careful consideration of factors such as movement thresholds, device placement, and individual variations in sleep patterns. Moreover, distinguishing between different sleep stages (e.g., REM sleep, deep sleep) based solely on accelerometer data may be challenging, as these devices primarily detect gross motor activity rather than neural activity. Therefore, combining accelerometer data with other physiological measures, such as heart rate variability or EEG, may enhance the accuracy of sleep monitoring in horses.

Conclusions

This pilot study aimed to understand whether accelerometers attached to the leg can be a reliable device to accurately monitor and measuring horse lying behavior. Our preliminary results showed that the MSR145 Data Logger positioned on the left front limb within the stable boot can be a reliable, useful, and well accepted tool to monitor lying behavior of horses kept in single box. These

preliminary results open the possibility to further investigation regarding horse athlete sleep patterns, especially during traveling for competitions.

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