Analysis of movement mechanics in the training process of sport horses

Eva Mlyneková[1]*, Ivan Imrich[2], Eva Strapáková[3], Jana Ivanič-Porhajášová[4],
Martin Massányi[1], Dušan Solár[1], Tomáš Kanka[2]

[1]Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources,
  Department of Animal Husbandry, Slovak Republic
[2]Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources,
  Department of Veterinary Sciences, Slovak Republic
[3]Slovak Agricultural University Nitra, Faculty of Agrobiology and Food Resources,
  Department of Genetics and Animal Breeding Biology, Slovak Republic
[4]Slovak Agricultural University Nitra, Faculty of Agrobiology and Food Resources,
  Department of Environment and Biology, Slovak Republic

The aim of the study was to determine the effect of training process on changes of quantitative and qualitative indicators of the movement mechanics of sport horses. A load controller was used to evaluate the motion mechanics. The training load was divided into three stages with different lengths, speeds and degrees of load. Tested animals were 14 horses of Slovak Warmblood breed. Our results have shown that gradual increase of load in the tested horses resulted in better spaciousness of movement, which was reflected in the elongation of the horse´s stride, regular movement and significant energy of the pelvic limbs ($p < 0.05$). From our findings we can state that the effect of gender did not have significant effect on the number and length of steps in each degree of load. We have noticed a significant difference ($p < 0.05$) in the "number of steps" parameter between the age categories of horses in the age up to 7 years (3.460 ±619) and the category aged up to 14 years (3.383 ±572). Gradual increase of the training load led to the economization of the movement and the long-term training process sled to the adaptation of the organism to repeated load.

Keywords: horse, movement mechanics, training, treadmill, load

1   Introduction

Training is a physiological process by which the body improves basic life manifests, movement habits, movement characteristics and abilities – speed, endurance, dexterity (Halo et al., 2008). Training in general is a long-term process of adaptation of organism to repeated and properly performed physical activity (Arfuso et al., 2016; McBrid and Mills, 2012). Sport horses require systematic, diverse and adherent training (McGreevy, McLean, 2007), conditioned not only by the quality of his genofond but also by nutrition, quality of rearing, the standard of zootechnical care and quality of rider and trainer (Halo et al., 2008). Movement mechanics are best expressed in the requirements for movement – purity of gaits, quality and regularity of gaits (Moore, 2010). Becker et al. (2011) state that in sport riding horses, the quality of the gaits has significant impact on horse´s value. According to Clayton (2004), models of horse movement can be studied by study of entire body or analysis of individual parts of body. The gait of horses can be scientifically analysed in one step. One step is defined as a repeated unit of movement of individual limbs in fully cycle of movement and is measured from one step of the limb to the next step according to Leleu (2005). Each gait is a uniform, rhythmic, automatically repeating pattern for an individual horse. Horse locomotion studies have made extensively used the

*Corresponding Author: Eva Mlyneková, Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Department of Animal Husbandry, Tr. Andreja Hlinku 2, 949 76 Nitra, Slovakia; e-mail: eva.mlynekova@uniag.sk. ORCID: https://orcid.org/0000-0001-5650-5110

load controllers. The treadmill was first used in horses (Persson, 1967) and has become an important tool in various researches and accessory in veterinary experiments, because it allows the mechanics of the movement to be recorded with high accuracy. Swedish warm-blooded horses shown shorter lengths of steps (Fredricson et al., 1983) compared with French riding horses where elongation of steps was noted (Barrey et al., 1993). Also in studies focusing on horse performance, such as Straub and Hoppeler (1989) found differences in treadmill and riding training and assumed that horses needed less energy for performance on the treadmill. Connected to this issue, the aim was to evaluate the impact of the training process on quantitative and qualitative indicators of motion mechanics.

2   Material and methods

2.1 Experimental setup

The experiment was carried out in Experimental centre at Department of Animal Husbandry, Faculty of Agrobiology and Food Resources (Slovak University of Agriculture, Nitra, Slovakia). Experiment was performed exclusively in the mornings, and the observed animals were tested in the same order. The load test was performed on a HorseGym 2000 horse motion regulator. The regulator is controlled by a computer unit, where time interval in minutes (min), speed (km/h) and smooth ascent of the belt (°) can be set. In order to comply with the principles of welfare and health safety under load, the device is equipped with safety sensors, which in the event of disturbance of horse stability will immediately stop the load regulator.

2.2 Biological material

In the experiment we analyzed 14 horses of the Slovak Warmblood breed, which is the most widespread breed in Slovakia and is most used in equestrian sport. The tested horses were housed in a box housing with sawdust bedding, fed thrice a day with a complete feed mixture balanced according to each animals weight and light amount of load. Bulk feed was fed in the morning and in the evening *ad libitum*. The tested horses weighed 575 ±25 kg and before the training underwent training with light load for the duration of 12 months. Horses that took part in the experiment were divided into three groups based on sex – 3 stallions, 5 geldings and 6 mares; and based on age into another three groups – up to 7 years of age (7 individuals), 8–14 years old (3 individuals) and horses older than 15 years (4 individuals).

2.3 Division of training activities over the duration of the experiment

The training load was divided into three stages. Each stage of the experiment lasted for 2 weeks with the following length, speed and degree of load:

Stage 1 lasted for total of 35 minutes and consisted of following activities: 20 minutes walking with 0° elevation, 4.9 km/h; 15 minutes walking uphill with elevation of 3°, 4.9 km/h.

Stage 2 lasted for total of 45 minutes and consisted of following activities: 20 minutes walking with 0° elevation, 4.9 km/h; 10 minutes walking uphill with elevation of 3°, 4.9 km/h; 10 minutes walking uphill with 4° elevation; 4.9 km/h; 5 minutes uphill with 6° elevation, 4.9 km/h.

Stage 3 lasted for total of 25 minutes and consisted of following activities: 5 minutes waling with 0° elevation, 5.8 km/h; 5 minutes walking uphill with 3° elevation, 5.8 km/h; 5 minutes walking with 5° elevation, 5.8 km/h; 5 minutes walking with 7° elevation, 5.8 km/h; 5 minutes walking with 0° elevation, 5.8 km/h.

2.4 Evaluation of movement mechanics during individual stages of training load

We monitored the parameters of the motion mechanics in all training stages of the experiment, including: the number of steps and the length of the step (m). The number of steps was determined using an ACRA LTH5 pedometer, attached to the wrist of the left forelimb. From the measured number of steps and the travelled distance, we calculated the average length of step in meters.

2.5 Statistical analyses

Statistical programme SAS 9.3, Enterprise Guide 5.1 (SAS Institute Inc. 2011) was used for statistical processing of background data. The Analysis of Variance (ANOVA) was used to assess the effect of stage of load training and age of horses on the number of steps and step length, with testing the contrasts by means of the Scheffe test at the level of significance $p < 0.05$. The analysis was performed according to the following model equation:

$$Y_{ijkl} = \mu + LT_i + AC_j + G_k + e_{ijkl}$$

where:

Y_{ijkl} – number of steps and step length, μ – overall mean, LT_i – stage of load training ($n = 3$; stage 1; stage 2; stage 3), AC_j – age category ($n = 3$; up to 7 years; up to 14 years; over 15 years), G_k – gender ($n = 3$; stallion, mare, gelding), e_{ijkl} – random error

3   Results and discussion

Number of steps parameter reflected in statistically significant difference ($p <0.05$) between the individual stages. The most significant increase was observed between first and second stage of load, where the increase was up to 833 steps (Figure 1).

The second load stage represented a significant increase in load for the horses, as the horses were tested for 10 minutes longer in ascent, and the load levels was twice higher compared to the first stage of load. Results of measuring the third stage of load confirm that tested horses have continually adapted to the set load. This assumption is also confirmed by the measured values of "number of steps" parameter where we observed a significant decrease of steps number in third stage load and also a statistically significant difference ($p <0.05$) in length of step between individual stages of load in favour of third stage load (Figure 2). Similar conclusion was reached by Barrey et al. (2016) in terms of reducing the number of steps in the treadmill load and extending the step length, who compared the number of steps and the length of steps in horses trained on treadmill and in the riding hall with the saddled horses.

Evaluation of the movement mechanics in terms of spaciousness we recorded a slight but statistically significant ($p <0.05$) increase in all tested horses favoring the increasing degree of load. These values confirm the fact that the mechanics of horse movement are positively adjusted by systematic and regular training (Mlyneková et al., 2016). Parkes et al. (2019) in their experiment noticed that a non-linear pattern of stried length occured in two-year-old horses, which was initially stortened and the leveled off over time. At the end of the experiment, tested horses showed an extension in stride length by 0.22 m. Becero et al. (2020) state that nine horses tested on treadmill shown progress in step regularity and the reached a longer length and lower step frequency, as confirmed by our findings. In addition to the monitored external factors such as the degree of load, we also analysed the effect of gender and age on the number and length of steps. From obtained data, we can state that gender did not affect the movement mechanics, which is documented by statistically insignificant differences ($p >0.05$)
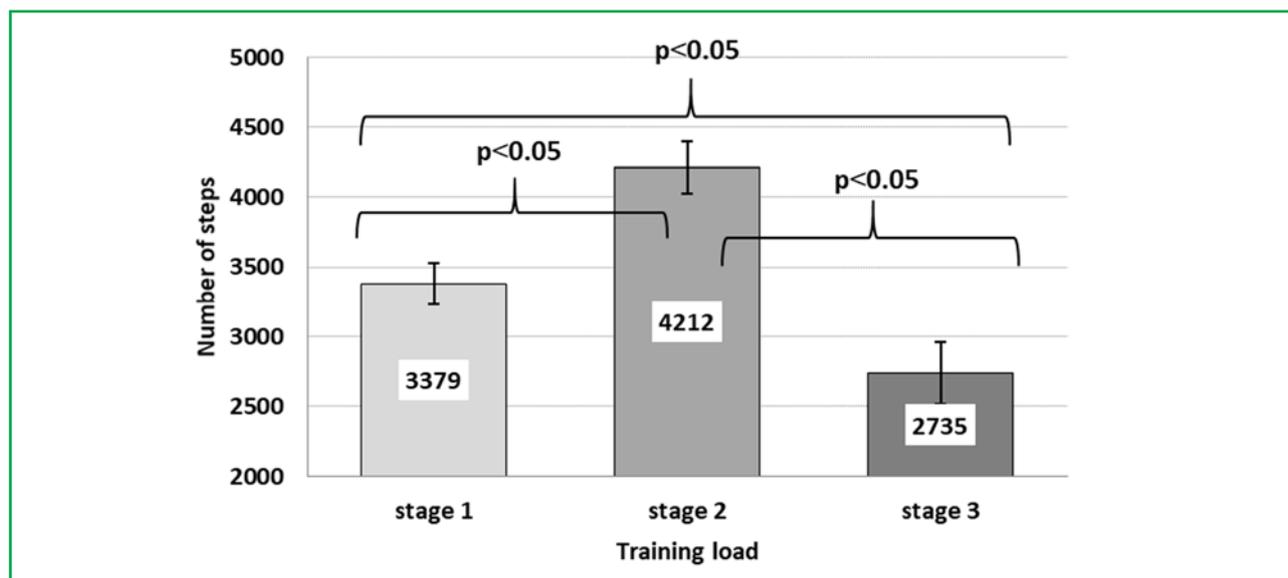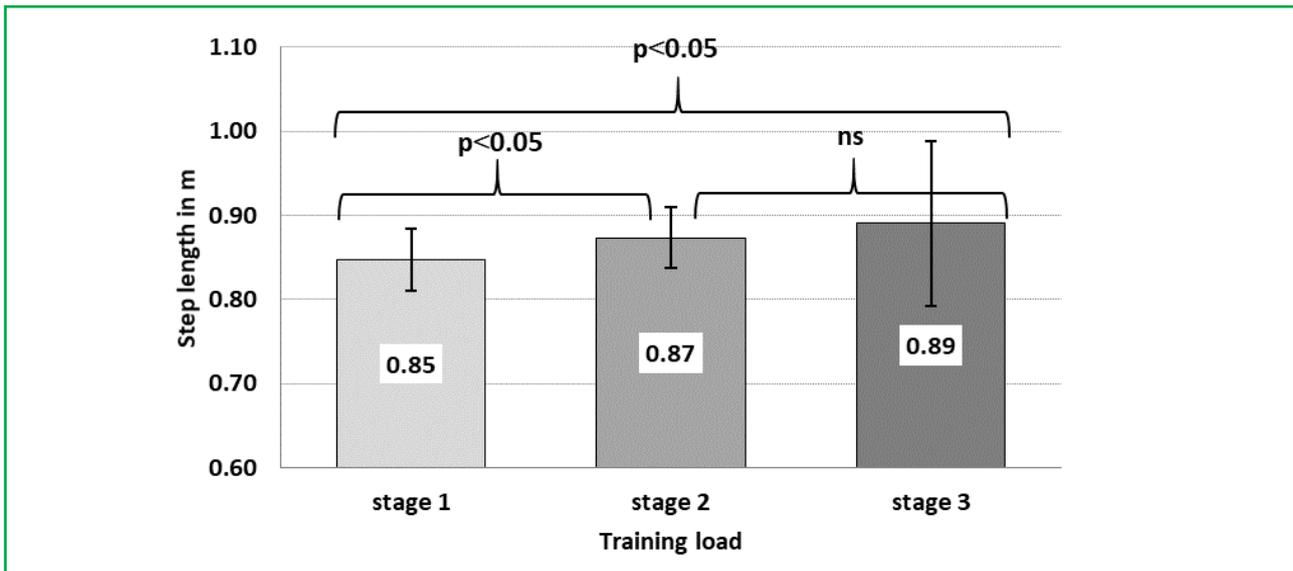

Figure 1   Analysis of number of steps during individual stages of load

Figure 2   Analysis of step length during individual stages of load

We observed a statistically significant difference (p <0.05) in number of steps between the horses aged up to 7 years (3,460 ±619) and category of horses aged up to 14 years (3,383 ±572) as we state in Figure no. 3. During analysis of the gender influence, stage of load and age on number of steps, using a linear model we calculated, that the load had most significant effect on the indicator (F = 65.07; p <0.001). Age also had effect on number of steps (F = 2.46; p <0.05). The reliability estimate reached 36.7%.
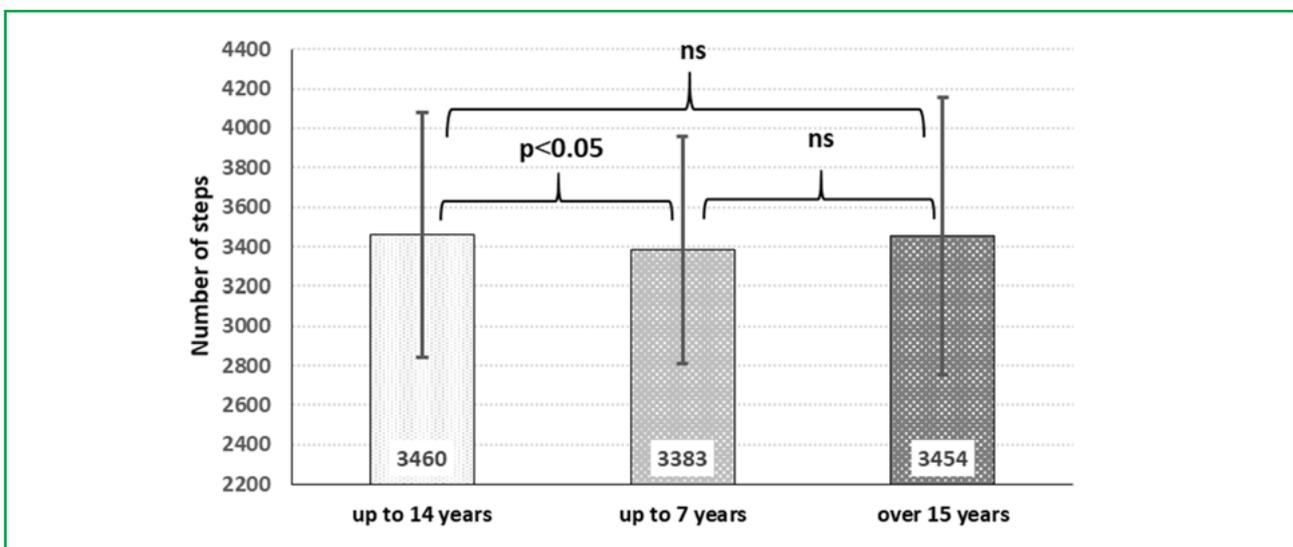
Figure 3   Number of steps comparison based on age

4   Conclusions

Gradual increase of the training load led to the economization of movement, which was manifested by the prolongation of the horse´s step, regularity of the movement and significant energy of the pelvic limbs. During a long-term training process, the organism was adapted to repeated stress. From the results obtained in the experiment, we can state that the load chosen by us represents a level that has a positive effect on the spaciousness of the horse´s movement. In order to achieve faster performance progress, it is possible to increase the training load without any major problems without compromising the welfare of the horses.

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