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The Welfare of Young Polish Konik Horses Subjected to Agricultural Workload

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Every year a new group of young Polish Konik colts are separated from the forest herds to be trained in the stable breeding system. The aim of this study was to evaluate how the young Polish Konik horses who had been born in a forest reserve adapt to and tolerate draft work. Two groups of 6 horses each were studied: (a) 3- to 4-year-old colts and (b) 7- to 13-year-old stallions. An effort response was estimated by heart rate (HR) registration and biochemical analysis of hematocrit; blood lactic acid (LA) level; and plasma concentration of glucose, triacylglycerols, uric acid, total protein, and cortisol as well as the activity of creatine kinase and lactate dehydrogenase. The mean HR workload response was significantly higher in the group of colts than in the adult stallions: 141 ± 19.3 bpm versus 124 ± 14.4 bpm, respectively. Blood LA level determined after effort was also significantly higher in colts than in stallions: 2.17 ± 0.42 and 1.40 ± 0.16 mmol/l, respectively. The increases in HR and blood LA levels in the colts were higher than in adult stallions, but such increases did not exceed the values characteristic for young working horses. Therefore, the Polish Konik colts evaluated in this study, and new colts who will be separated from the forest herds and brought to the stables in the future, can be subjected to the same work routine that has been used historically because it is not beyond their capabilities.

Keywords: effort test, harrow, heart rate, lactic acid, Polish Konik
The Polish Konik is a native horse breed. This breed is a direct descendant of the wild Tarpan horse breed, which became extinct in about the eighteenth century (Jeziorski, Jaworski, & Górecka, 1999; Komosa & Purzyć, 2009). The native Polish Konik is included in a unique breeding system that is part of the forest reserve conservation program. Herds of wild Konik horses are bred in nature reserves or national parks in Poland. They are very well adapted to the outdoors (Jaworski, 2007). Polish Konik horses are characterized by good fertility, and as a result, the risk of overpopulation is great. Too many nonhuman animals in a limited area cause many problems like food deficiency during winter or frequent fights between young stallions. For this reason, some horses, especially colts, are separated every year and transferred to the stable breeding system. The goal of the system is to domesticate the horses and then use them as saddle or draft horses. After an initial light draft training, young colts are used in agricultural work. This work is classifiable as a moderate workload (Meyer & Coenen, 2003). In reality though, young horses had not been receiving proper training and they had been worked irregularly (authors’ own observations). Such treatment means that the physical and mental preparation of young horses for moderate–heavy, monotonous, and prolonged work could be insufficient. It is not known to what extent this routine influenced the horses’ health and welfare.

To judge or make evaluations of the working horses’ welfare is still considered a difficult task (Burn, Pritchard, & Whay, 2009). Moreover, young horses are very sensitive to exercise overload (Kędzierski, Kowalik, & Janczarek, 2007). Because physical effort can modify a horse’s physiologic metabolism, the use of biochemical tests is recommended. Physical effort can induce some changes in the level of many biochemical parameters, including plasma total protein, enzymes, and hormones or blood-borne energetic substrates and their metabolites (Kędzierski, Bergero, & Assenza, 2009; Kędzierski et al., 2007). In general, the value of these changes is proportional to the level of fatigue a horse is experiencing. The usual practice is to measure the blood lactic acid level (LA) and heart rate (HR) in exercised horses to estimate the state of their condition (Evans, Harris, & Snow, 1993; Gramkow & Evans, 2006; Persson, 1997). An overload of work or work in an unknown environment can be stressful for horses. Exposing a horse to situations involving mental stress also leads to an increase in HR (Janczarek & Kędzierski, 2011b; Jansen et al., 2009; Rietmann et al., 2004; Stewart, Foster, & Waas, 2003; Waran & Cuddeford, 1995).

On the other hand, horses of different breeds can show various physiological or biochemical reactions to the same types of exercise or energy deficiency states (Janczarek & Kędzierski, 2011a; Kędzierski et al., 2009; Kędzierski, Kapica, Kolstrung, & Pluta, 2008; Pritchard, Burn, Barr, & Whay, 2009). Gender-related variations can be found as well (Janczarek & Kędzierski, 2011a; Persson, 1997).

The aim of this study was to evaluate how young, forest-reserve-born Polish Konik horses tolerate the typical agricultural workload when their workload
training was insufficient. The horses were paired with adult horse companions from the same breeding stable. Each young horse and his adult companion harrowed the field as a team. The horses were examined while they were working as a team in the field.

**MATERIALS AND METHODS**

This study was part of a larger project designed to investigate how stress caused by the training process affects horses. The study was conducted according to European Community regulations concerning the protection of experimental animals and in accordance with the rules of the Ethic Review Committee for Animal Experiments of the University of Life Sciences in Lublin, Poland. The authors of this work do not have a personal or financial relationship with other people or organizations that could influence the content of the article.

**Animals**

Twelve Polish Konik horses were divided into two groups according to their age: 6 colts who were 3 to 4 years old (mean 3.3 ± 0.45) and 6 stallions who were 7 to 13 years old (mean 10.5 ± 2.49). All 12 of the horses used in this study were brought to one of the auxiliary farms of a national park in Poland. The horses were 2 years old when they were separated from the forest herds and brought to an auxiliary farm. All horses had been domesticated and conditioned to work in draft pairs. The domestication process and the initial training for draft work were performed according to the traditional method for breaking in draft horses. After the horses were used to the harness equipment, the young horses were harnessed in pairs with older, experienced horse companions. The aim of this routine was to keep the young horses composed and to encourage them to learn through example and imitation.

Prior to the study, 3- to 4-year-old colts had only been trained to pull light carts on the farm. They were still inexperienced in such agricultural work as harrowing, which requires strength for pulling and endurance for continuous work. The old stallions had at least 4 years of experience in this kind of work. All of the horses from both studied groups were kept in one stable, in one-horse tie stalls. They were fed the same diet and cared for in a manner typical for working horses. For the 6 months prior to the experiment, they were under the care of three familiar persons. These caretakers were adult men with long-term experience caring for horses. Before the study, all the horses had worked irregularly. Their work on the farm consisted of pulling light carts for no more than 2 hr per day.
Effort Test

The experiment was done in the spring. The study lasted for 1 day. The day of the study was the 1st day of agricultural work for the horses after their winter rest. The effort test was the draft work of harrowing a field. This kind of work was a novelty for the 3- to 4-year-old colts. The amount of time the horses worked was decided by the farm manager. The task of the researchers was only to observe and study the animals. None of the horses had clinical symptoms of any health problems. Traditional harrows were used to do the farmwork. The field consisted of sandy soil. The force necessary to pull the harrows was measured by a dynamometer and was about 95 kgf. The horses were harnessed in teams. Each team was made up of 1 colt and 1 adult stallion. The horses walked while working for about 150 min. They had two 5-min rest periods after every 45 min of work. Three draft teams worked in the morning and the other three started in the afternoon. All studied pairs of horses were examined in comparable weather conditions. The weather conditions were estimated using the psychrometrical method. On the day of the study, the temperature was 15°C, relative humidity was 61 to 76%, cloudiness was medium, and wind velocity was 2.5 to 4.0 m/s. There were no interruptions, for example, the appearance of a strange object, that could cause a change in a horse’s reaction. An effort response was estimated by biochemical analysis and HR registration.

Biochemical Analysis

Two blood samples were collected from the jugular vein of each horse via a venipuncture. Blood was taken (a) at rest, before leaving the stable, and (b) at the end of the effort test. Two test tubes containing dipotassium EDTA were used for each blood drawing: one tube was used for LA and hematocrit (Ht) determination, and the second tube was used for the determination of the other parameters in plasma. For plasma separation, the tubes were centrifuged within 30 min, and plasma samples were stored at 4°C.

The blood LA concentration was determined immediately in the field via Dr. Lange’s enzymatic cuvette test (Hach Lange GMBH, Berlin, Germany). The other parameters were determined in the laboratories in the 3 days following the blood sample collections. The levels of glucose (Glc), triacylglycerols (TG), uric acid (UA) and total protein, and activity of creatine kinase (CK) and lactate dehydrogenase (LDH) were determined using biochemical diagnostic kits (Cormay, Lublin, Poland). The levels of Glc, TG, and UA were expressed as mmol/L. Total protein concentration was expressed as g/L and enzymes’ activity as U/L. The plasma cortisol level was measured using the ELISA Immunoassay kit (DRG, Marburg, Germany) and expressed as ng/ml.
HR Measures

The HR was measured at rest and during and after the work effort. Before the horses started their work sessions, an elastic belt with a transmitter for telemetric HR registration (POLAR Accurex Plus, OY ELECTRO, Kempele, Finland) was put around the girth of each horse. After activation of the telemetric set, the horses were left alone in the stalls for about 5 min to achieve the HR resting values. Then, the horses were moved from their stalls and harnessed to small carts. After reaching the field, the horses were harnessed to the harrows. HR was continuously measured at 1-min intervals until 10 min after the work activity ended. To identify the beginning and the end of each action (resting or pulling the harrows), the person conducting the tests had to press the lap button of the telemeter, which helped identify the area of analysis. The data were downloaded from the transmitter to a computer using the Polar OY interface. The Polar Precision Performance software program (Polar Precision Performance™ Portrainer 5 program, Kempele, Finland) was used to analyze the HR data.

Statistical Analysis

The results are presented as $M \pm SD$. Prior to the statistical analysis of HR, a mean HR score per min (bpm) was calculated. For each horse, the following three HR measures were used: (a) at rest, (b) HR measured during the whole work activity with the exception of the two rest periods, and (c) HR scores registered 10 min after the end of the work activity. The data were analyzed using multifactor analysis of variance (ANOVA) and the Tukey test (GraphPad Software, Inc.) The type of activity (rest vs. work), group of horses, and interactions were considered (type of activity $\times$ age-related group). The statistical significance was accepted at the level of $p < .05$. The correlation coefficient was also calculated to compare the obtained results and the ages of the studied horses.

RESULTS

The authors’ observations indicated that adult stallions pulled the harrows evenly and easily. On the contrary, the young colts did not work in an equal fashion. They started too quickly and too fast, pulling in jerks. Then, after about 15 min of work, they were less active at pulling and fell one step behind their adult companions. After the end of work, all the horses were sweaty at a level defined as wet water, according to the coat moisture scale described by Pritchard, Burn, Barr, and Whay (2008).

$M \pm SD$s for measured blood parameters are shown in Table 1. The effort test induced a statistically significant increase in blood LA level in both studied
TABLE 1  
Levels of Blood Parameters in Polish Konik Colts and Stallions During Effort Test (*M* ± *SD*)

<table>
<thead>
<tr>
<th>Blond Parameters</th>
<th>Colts (n = 6)</th>
<th>Stallions (n = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At Rest</td>
<td>After Effort</td>
</tr>
<tr>
<td>LA (mmol/L)</td>
<td>0.75 ± 0.11(^a)</td>
<td>2.17 ± 0.42(^b)</td>
</tr>
<tr>
<td>Ht (%)</td>
<td>34.8 ± 0.96(^a)</td>
<td>42.6 ± 3.26(^b)</td>
</tr>
<tr>
<td>Glc (mmol/L)</td>
<td>6.73 ± 1.58</td>
<td>5.70 ± 0.88</td>
</tr>
<tr>
<td>TG (mmol/L)</td>
<td>0.28 ± 0.08</td>
<td>0.66 ± 0.16</td>
</tr>
<tr>
<td>UA (mmol/L)</td>
<td>0.014 ± 0.013</td>
<td>0.041 ± 0.032</td>
</tr>
<tr>
<td>Total plasma protein (g/L)</td>
<td>71.6 ± 0.21</td>
<td>83.0 ± 1.10</td>
</tr>
<tr>
<td>LDH (U/L)</td>
<td>634 ± 50.5(^a)</td>
<td>785 ± 37.0(^b)</td>
</tr>
<tr>
<td>CK (U/L)</td>
<td>62.1 ± 52.7</td>
<td>101 ± 89.0</td>
</tr>
<tr>
<td>Cortisol (ng/ml)</td>
<td>153 ± 71.4</td>
<td>314 ± 168</td>
</tr>
</tbody>
</table>

Note. LA = lactic acid; Ht = hematocrit; Glc = glucose; TG = triacylglycerols; UA = uric acid; LDH = lactate dehydrogenase; CK = creatine kinase.

\(^a\),\(^b\),\(^c\) Means in rows with different superscripts differ significantly at *p* ≤ .05 according to the Tukey *t* test.
WELFARE OF POLISH KONIK COLTS SUBJECTED TO DRAFT

TABLE 2
Heart Rates in Polish Konik Horses During the Effort Test (M ± SD)

<table>
<thead>
<tr>
<th>Heart Rate (bpm)</th>
<th>At Rest</th>
<th>During Effort</th>
<th>10 min After End of Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colts 3–4 years old</td>
<td>53.4 ± 7.18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>141 ± 19.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>66.5 ± 5.10&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Stallions 7–13 years old</td>
<td>42.2 ± 3.62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>124 ± 14.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>58.6 ± 5.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup> Means with different superscripts differ significantly at p ≤ .05 according to the Tukey t test.

DISCUSSION

Among the many biochemical parameters determined in the blood, only the measurement of LA is used in practice to evaluate the fitness of exercised horses (Lindner, 2000). The LA is a parameter often employed for gauging the intensity of the exercise and training level or exhaustion of horses (Guhl, Lindner, & Von Wittke, 1996; Hinchcliff et al., 2002). A properly managed training program leads to lowered blood LA concentrations at a given level of exercise intensity (Hinchcliff et al., 2002). In this study, the blood LA level was used as an indicator of the relative intensity of exercise. Thus, it can be ascertained that the effort the horses were submitted to was relatively more intensive for colts than for stallions. A similar, slight increase in blood LA concentration was also observed in draft horses studied by Pérez, Recabarren, Mora, et al. (1992) and Pérez, Recabarren, Valdes, and Hetz (1992).

All of the blood parameters measured at rest fell into the normal range (Krumrych, Wiśniewski, & Danek, 1993). The stated posteffort increase in Ht, total plasma protein concentration, and LDH activity were typical for exercised
horses. Generally, hematological values increase with splenic contraction, which takes place in conditions of increased workload (Kędzierski & Podolak, 2002). The total plasma protein increases after exercise as a result of blood dehydration because water flows from the bloodstream to an extravascular space. These changes can be offset through conditioning (Hinchcliff et al., 2002). Increases in plasma LDH and CK activity also result from physical activity and were observed in previous studies of racehorses (Harris, Marlin, & Gray, 1998; Kędzierski & Bergero, 2006) after endurance rides (Barton, Williamson, Jacks, & Norton, 2003; Marlin et al., 2002) and participating in competitive jumping events (Balogh, Gaal, Ribiczeyne, & Petri, 2001). The postexercise increase in plasma enzyme activity correlates positively with the duration and intensity of exercise (Barton et al., 2003; Harris et al., 1998; Marlin et al., 2002). On the other hand, this increase can be offset through proper training (Harris et al., 1998).

The changes in the other determined biochemical parameters did not reach the level of statistical significance, probably because of the small number of animals and the high SDs. The individual variability explains the high SD of estimation of some data and decreases the possibility of noticing statistically significant differences. The slight increases or decreases recorded for the mean values after the performed effort test represent a low metabolic engagement in this kind of workload. In exercised horses, the changes in plasma Glc, TG, UA, and cortisol levels reflect the intensity of exercise (Castejón, Trigo, Muñoz, & Riber, 2006; Kędzierski & Podolak, 2002; Lassourd et al., 1996; Malinowski, Betros, Flora, Kearns, & McKeever, 2002; Pösö, Viljanen-Tarifa, Soveri, & Oksanen, 1989). For example, a rise in plasma Glc concentration was recorded after short-time, intensive exercise, whereas a decrease was noted after endurance effort (Kędzierski & Bergero, 2006; Marlin et al., 2002). Plasma TG concentration also increased during exercise and this increase was positively correlated with the intensity of effort (Kędzierski & Bergero, 2006; Pösö et al., 1989). This increase of TG is specific for the exercising horse; it was not observed in rodents or human beings (Pösö et al., 1989). Intense exercise also led to adenine nucleotide degradation, and therefore, the level of plasma UA is a good marker of muscle adenosine triphosphate loss (Castejón et al., 2006). An increase in plasma cortisol concentration is also characteristic for exercising horses (Desmecht, Linden, Amory, Art, & Lekeux, 1996). Hypercortisolaemia was noted just after the end of different exercise tests (Desmecht et al., 1996; Malinowski et al., 2006). The plasma cortisol response, however, appeared to be connected with the duration of exercise (Nagata et al., 1999). Both horse age and training reduced the plasma cortisol response to acute exercise tests (Malinowski et al., 2006; Marc, Parvizi, Ellendorff, Kallweit, & Elsaesser, 2000). In the horses studied here, the measured blood parameters, with the exception of LA and LDH, did not show any age-related variations in the response to effort.
On the other hand, HR measured during the effort test was highly negatively correlated with the age of studied horses and was higher in the group of colts than in the stallions. HR increases in horses undergoing any kind of work task (Aguirre & Orihuela, 2000; Evans et al., 1993; Persson, 1997). The HR increase reflects the relative intensity of the exercise (Evans et al., 1993; Persson, 1997), which indicates that the effort applied in this study was more intensive for young colts than for adult Konik horses. This corresponds with the results of the blood LA levels that were found.

The results of the HR measurements of working horses obtained in this study were generally similar to those obtained earlier during the draft trial in Polish Konik horses (Jezierski, 1993). Physical activity is an important factor that increases HR, but this parameter also depends on emotional factors. For example, Jezierski and Górecka (1999, 2000) reported that social isolation in a stable caused a significant increase in adult horse HR. Just before the start of a competition, HR in racehorses also increased as a result of the psychogenic response to stress (Reynolds et al., 1993). In warm-blood horses, the saddling and harnessing alone or just handling before training stimulated the sympathoadrenal axis and HR increase (Janczarek & Kędzierski, 2011a; Kędzierski & Janczarek, 2009; Podolak, Kędzierski, & Bergero, 2006). Moreover, in a stressful situation, the presence of the horse handler or a calm companion decreased the HR in horses (Christensen, Malmkvist, Nielsen, & Keeling, 2008; Górecka, Bakuniak, Chruszczewski, & Jezierski, 2007). The HR registered at rest in the studied colts was 53 bpm. This is considerably above the normal range, which is 28 to 40 bpm. Therefore, the heightened HR in the colts at rest can potentially be the result of a mental load combined with the anticipation of doing work. However, the differences in the HR scores obtained during work in colts and stallions can be explained differently.

In this study, the colts were habituated to work in a harness by completing pulling tasks and other lighter workloads. The novelty for the colts was only in the need to do prolonged work with a medium workload that was heavier than what they were previously used to. Aguirre and Orihuela (2000) showed that HR measured in same-age horses working in the plow harness did not depend on a horse’s work experience. Moreover, Polish Konik horses seem to be generally relatively resistant to stress, according to the results other HR analyses. For example, potentially stressful treatments such as cleaning the hooves of Konik horses maintained in nature reserves were not significantly stress inducing (Kapron, Pluta, Bocian, & Słomiany, 1996). Therefore, the more probable explanation for higher HR in working colts compared with stallions was the effort that was relatively more intense for the younger horses.

HR measured after exercise can also be used as an indicator of horse performance (Evans et al., 1993). In this study, though, any statistically important differences were found between the analyzed groups of horses. The physical
CONCLUSION

In conclusion, the study showed that the work in harnesses was relatively more intensive for young Konik colts than for the adult Konik stallions. Nonetheless, the intensity of their work effort did not exceed the physiological ability of young horses to do the work. The increase in HR and blood LA levels found for working Polish Konik colts was typical for this type of physical activity, and it was similar to the data given by other researchers. These results show that the studied Polish Konik colts and the new colts can be subjected to the same work routine as had been previously used because such a routine is not beyond their capabilities.

REFERENCES


