EVALUATION OF PHYSICAL ACTIVITY AND ENERGY REQUIREMENTS IN TROTTING HORSES USING GPS TECHNIQUE DURING OUTDOOR TRAINING

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EXERCISE REQUIREMENTS

- Additive approach (maintenance + exercise) used by most common systems (INRA and NRC)
- Exercise requirements -> length and intensity of effort
- Difficult measurement of intensity in outdoor (studies mostly carried out on treadmill)
- Estimates of energy expenditure during exercise mainly by oxygen consumption (Coenen, 2008; Ellis, 2008; Eaton, 1995) from heart rate or speed measured in standardized condition of slope and ground
GLOBAL POSITIONING SYSTEM - GPS

GPS allow estimates of:

- Position
- Distance
- Time
- Speed
- Slope of ground

(Outdoors activities)
AIM

Use of GPS as suitable method for the evaluation of both physical activity and energy requirements in trotting horse during outdoor training
EXPERIMENTAL SITE

“GINA BIASUZZI” STABLE
MIRANO (VENICE)-ITALY
30 Standardbred horses:
- 20 males
- 10 females

Three age classes:
- 2 years
- 3 years
- ≥ 4 years

5 weeks of study
Animals fed individually grass hay (2 times daily and a mixture of cereals (three times: early morning, noon and middle afternoon) containing 60% whole oats, 30% cracked barley, and 10% flaked corn

The amount of feeding changed daily according to the programmed physical activity

Residuals were weighed daily to obtain actual feed intake
At the beginning and at the end of the experiment

- BW: with a specific scale based on electronic system during footrest
- BCS: French system consisting of a 6 points scale (from 0 to 5; (Martin-Rosset, 1990) by a skilled operator
Interval training
- Slow run (“Treno”)
- Fast run (“Prova”) twice a week

Two different race tracks
- Oval (1000 m)
- Straight (800 m)

7 GPS: 1 trainer 6 handlers
GPS RECORDINGS
TRACK & TRACES BY GPS
EXAMPLE OF A SINGLE RUN RECORDED
Garmin Training Center®

- 687 total records (runs)
- 30 horses
- 5 weeks

<table>
<thead>
<tr>
<th>Horse</th>
<th>Date</th>
<th>Total time (s)</th>
<th>Total Distance (m)</th>
<th>Mean speed (km/h)</th>
<th>Max speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armbro</td>
<td>23/02/2009</td>
<td>1480</td>
<td>7182</td>
<td>17.47</td>
<td>27.0</td>
</tr>
</tbody>
</table>
Estimation of VO$_2$ by equation proposed by Coenen (2008):

\[ \Sigma VO_2 = (-0.438 + 5.47 \times x + 1.12 \times x^2 + 0.065 \times x^3 + 2.03 \times z) \times BW \]

where:
- \[ \Sigma VO_2 = \text{ml/min} \]
- \[ x = \text{speed (m/sec)} \]
- \[ z = \text{slope (0 in this study)} \]
- \[ BW = \text{Body Weight (kg)} \]

1 ml of O$_2$ is equivalent to 20.1 J (Kleiber, 1961)

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<th>Mean Speed (km/h)</th>
<th>Max Speed (km/h)</th>
<th>Energy Expenditure (MJ)</th>
<th>Energy Expenditure (MCal)</th>
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<td>16.9</td>
<td>4.03</td>
</tr>
</tbody>
</table>
Requirements of DE (NRC, 2007)

for the maintenance:
\[ \text{DEm} = 0.0363 \times \text{BW} \]

Total (maintenance + very intensive exercise):
\[ \text{DEt} = (0.0363 \times \text{BW}) \times 1.9 \]
Hierarchical linear model for repeated measurements using PROC MIXED of SAS (SAS, 2004)

\[ y_{ijklm} = \mu + A_i + S_j + AS_{ij} + H_{k:ij} + D_{ijkl} + e_{ijklm} \]

Where:

- \( y_{ijklm} \) = single observation
- \( \mu \) = overall mean
- \( A_i \) = fixed effect of age class (i=1: 2 years; i=2: 3 years; i=3: ≥ 4 years)
- \( S_j \) = fixed effect of sex (j=1, male; j=2, female)
- \( AS_{ij} \) = Interaction between \( A_i \) and \( S_j \)
- \( H_{k:ij} \) = random effect of horse within \( AS_{ij} \) \( \sim N(0, \sigma^2_h) \)
- \( D_{ijkl} \) = fixed effect of day
- \( e_{ijklm} \) = random residual error term \( \sim N(0, \sigma^2_e) \)
BODY WEIGHT & BCS

**BW**

- Males
- Females

**BCS**

- 2 years
- 3 years
- ≥4 years
### ANOVA ON PHYSICAL ACTIVITY

<table>
<thead>
<tr>
<th>Training variable</th>
<th>Age (A)</th>
<th>Sex (S)</th>
<th>A x S</th>
<th>Days</th>
<th>RSE</th>
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</thead>
<tbody>
<tr>
<td>Total Time (s)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Total Distance (m)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Mean speed (km/h)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Max speed (km/h)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>8.63</td>
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</tbody>
</table>

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<th>Mean</th>
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<tr>
<td>Total Time (s)</td>
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<tr>
<td>Total Distance (m)</td>
<td>7800</td>
</tr>
<tr>
<td>Mean speed (km/h)</td>
<td>18.0</td>
</tr>
<tr>
<td>Max speed (km/h)</td>
<td>31.0</td>
</tr>
</tbody>
</table>
ENERGY ALLOWANCES VS. REQUIREMENTS

The graph illustrates the differences between energy allowances and requirements for boys and girls, categorized by age groups (2, 3, and ≥4 years old) and two sets of standards: GPS and NRC. For each age group, the graph shows the difference in calories (MCal) as a function of gender. The data points indicate that there is a significant difference in energy allowances and requirements, with girls generally requiring lower energy intake compared to boys, especially in the 2-year age group for both GPS and NRC standards.
GPS is a simple and not too expensive tool to evaluate actual physical activity in standardbred horses.

It allows a great amount of information and a possible greater personalization of activity.

At present, not useful tool to estimate energy requirements due to exercise.

Need of specific equations aimed to estimate energy expenditure and optimize diets on the basis of actual individual exercise.