*Supplementary Data for*

# Application of the Two-Dimensional Entropy Measures in the Infrared Thermography-Based Detection of Rider:Horse Bodyweight Ratio in Horseback Riding

**Małgorzata Domino [1,*], Marta Borowska [2], Łukasz Zdrojkowski [1], Tomasz Jasiński [1], Urszula Sikorska [3], Michał Skibniewski [4] and Małgorzata Maśko [3,*]**

[1] Department of Large Animal Diseases and Clinic, Institute of Veterinary Medicine, Warsaw University of Life Sciences, 02-787 Warsaw, Poland

[2] Institute of Biomedical Engineering, Faculty of Mechanical Engineering, Białystok University of Technology, 15-351 Bialystok, Poland

[3] Department of Animal Breeding, Institute of Animal Science, Warsaw University of Life Sciences, 02-787 Warsaw, Poland

[4] Department of Morphological Sciences, Institute of Veterinary Medicine, Warsaw University of Life Sciences, 02-776 Warsaw, Poland

* Correspondence: malgorzata_domino@sggw.edu.pl (M.D.); malgorzata_masko@sggw.edu.pl (M.M.)

**Table S1.** Details of horses and riders participating in the study. Riders represented the light (L), moderate (M), and heavy (H) riders groups.

| Rider groups | Horse | | | | Horse | | | | Rider | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sign | BW | High | SW | Sign | BW | High | SW | Sign | BW | High | BMI |
| L | **1** | 585 | 166 | 4.1 | **7** | 560 | 162 | 4.2 | **A** | 58 | 159 | 22.9 |
| | **2** | 550 | 154 | 4.5 | **8** | 545 | 157 | 4.2 | **B** | 60 | 160 | 23.4 |
| M | **3** | 580 | 158 | 4.2 | **9** | 570 | 158 | 4.4 | **C** | 77 | 172 | 26.0 |
| | **4** | 575 | 164 | 4.5 | **10** | 580 | 162 | 4.4 | **D** | 75 | 164 | 27.9 |
| H | **5** | 560 | 160 | 4.1 | **11** | 565 | 160 | 4.2 | **E** | 91 | 172 | 30.8 |
| | **6** | 550 | 156 | 4.4 | **12** | 580 | 166 | 4.2 | **F** | 92 | 174 | 30.4 |

SW- saddle's weight [kg]; BW- bodyweight [kg]; height [cm]; BMI- body mass index [kg/m$^2$].

**Table S2.** Details of the rider:horse bodyweight ratio of pairs participating in the study. Riders represented the light (L), moderate (M), and heavy (H) riders groups.

| Rider groups | Horse/ Rider | Rider: Horse Bodyweight Ratio | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| L | **A** | 10.6 | 11.4 | 10.7 | 10.9 | 11.1 | 11.3 | 11.1 | 11.4 | 10.9 | 10.8 | 11.0 | 10.7 |
| | **B** | 11.0 | 11.7 | 11.1 | 11.2 | 11.4 | 11.7 | 11.5 | 11.8 | 11.3 | 11.1 | 11.4 | 11.1 |
| M | **C** | 13.9 | 14.8 | 14.0 | 14.2 | 14.5 | 14.8 | 14.5 | 14.9 | 14.3 | 14.0 | 14.4 | 14.0 |
| | **D** | 13.5 | 14.5 | 13.7 | 13.8 | 14.1 | 14.4 | 14.1 | 14.5 | 13.9 | 13.7 | 14.0 | 13.7 |
| H | **E** | 16.3 | 17.4 | 16.4 | 16.6 | 17.0 | 17.3 | 17.0 | 17.5 | 16.7 | 16.4 | 16.8 | 16.4 |
| | **F** | 16.4 | 17.5 | 16.6 | 16.8 | 17.2 | 17.5 | 17.2 | 17.7 | 16.9 | 16.6 | 17.0 | 16.6 |

Horse - from 1 to 12; Rider - from A to F.

**Table S3.** The withers area (ROI 1)**.** Values (mean ± SD) of entropy measures for grayscale images in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | 1.14±0.39 | 1.77±0.45 | 1.20±0.04 | 7.01±0.51 | 0.93±0.06 |
| L | post-ex | 1.06±0.25 | 1.63±0.29 | 1.19±0.04 | 7.00±0.41 | 0.93±0.04 |
| | p | 0.500 | 0.262 | 0.509 | 0.622 | 0.812 |
| | pre-ex | 1.04±0.41 | 1.71±0.50 | 1.20±0.03 | 7.08±0.51 | 0.92±0.05 |
| M | post-ex | 1.21±0.38 | 1.83±0.45 | 1.20±0.04 | 7.18±0.37 | 0.92±0.03 |
| | p | 0.065 | 0.375 | 0.877 | 0.318 | > 0.999 |
| | pre-ex | 1.20±0.33 | 1.92±0.43 | 1.21±0.02 | 7.23±0.36 | 0.93±0.05 |
| H | post-ex | 1.22±0.43 | 1.78±0.49 | 1.21±0.03 | 7.22±0.45 | 0.94±0.03 |
| | p | 0.822 | 0.170 | 0.375 | 0.923 | 0.855 |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S4.** The thoracic spine area (ROI 2)**.** Values (mean ± SD) of entropy measures for grayscale images in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **0.84±0.33** | **1.46±0.35** | **1.15±0.06** | 6.80±0.54 | **0.95±0.04** |
| L | post-ex | **1.21±0.35** | **1.75±0.41** | **1.19±0.03** | 6.96±0.43 | **0.93±0.04** |
| | p | **0.001** | **0.016** | **0.001** | 0.164 | **0.046** |
| | pre-ex | **0.81±0.33** | **1.41±0.40** | 1.15±0.05 | 6.82±0.47 | 0.94±0.04 |
| M | post-ex | **1.10±0.40** | **1.61±0.35** | 1.18±0.05 | 6.87±0.57 | 0.93±0.04 |
| | p | **0.003** | **0.049** | 0.051 | 0.944 | 0.114 |
| | pre-ex | 1.07±0.48 | 1.67±0.41 | 1.18±0.04 | 7.03±0.43 | 0.92±0.06 |
| H | post-ex | 1.17±0.47 | 1.72±0.51 | 1.17±0.08 | 6.92±0.93 | 0.90±0.08 |
| | p | 0.456 | 0.838 | 0.456 | > 0.999 | 0.143 |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S5.** The withers area (ROI 1)**.** Values (mean ± SD) of entropy measures for red color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | 0.61±0.35 | 1.38±0.60 | 1.17±0.05 | **7.25±0.39** | **0.83±0.15** |
| L | post-ex | 0.94±0.74 | 1.15±0.29 | 1.19±0.04 | **6.57±0.47** | **0.50±0.14** |
| | p | 0.089 | 0.218 | 0.345 | **< 0.0001** | **< 0.0001** |
| | pre-ex | 0.55±0.31 | **1.34±0.58** | 1.17±0.05 | **7.34±0.42** | **0.85±0.14** |
| M | post-ex | 0.55±0.42 | **0.99±0.24** | 1.19±0.04 | **6.87±0.68** | **0.59±0.21** |
| | p | 0.584 | **0.020** | 0.152 | **0.005** | **< 0.0001** |
| | pre-ex | 0.54±0.27 | **1.39±0.50** | **1.15±0.04** | **7.45±0.35** | **0.90±0.09** |
| H | post-ex | 0.59±0.31 | **1.14±0.27** | **1.22±0.08** | **7.11±0.55** | **0.64±0.23** |
| | p | 0.550 | **0.034** | **< 0.0001** | **0.007** | **< 0.0001** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S6.** The thoracic spine area (ROI 2)**.** Values (mean ± SD) of entropy measures red color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **0.82±0.83** | **0.91±0.37** | **1.13±0.06** | **6.05±0.69** | **0.81±0.14** |
| L | post-ex | **1.98±1.60** | **1.52±0.32** | **1.18±0.04** | **6.34±0.71** | **0.63±0.14** |
| | p | **0.001** | **< 0.0001** | **0.004** | **0.037** | **0.0001** |
| | pre-ex | **0.61±0.69** | **0.84±0.36** | **1.13±0.06** | **6.18±0.60** | **0.82±0.14** |
| M | post-ex | **1.16±0.89** | **1.42±0.36** | **1.17±0.06** | **6.68±0.93** | **0.66±0.14** |
| | p | **0.001** | **< 0.0001** | **0.033** | **0.025** | **0.0001** |
| | pre-ex | **0.56±0.67** | **0.86±0.30** | 1.15±0.06 | **6.36±0.76** | **0.87±0.12** |
| H | post-ex | **1.11±1.08** | **1.41±0.40** | 1.18±0.05 | **6.91±0.99** | **0.67±0.19** |
| | p | **0.003** | **< 0.0001** | 0.160 | **0.018** | **0.002** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S7.** The withers area (ROI 1)**.** Values (mean ± SD) of entropy measures for green color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **1.13±0.49** | 2.22±0.61 | **1.16±0.04** | **7.45±0.26** | **0.88±0.07** |
| L | post-ex | **0.89±0.29** | 1.96±0.45 | **1.14±0.03** | **7.71±0.25** | **0.98±0.02** |
| | p | **0.038** | 0.106 | **0.025** | **0.0002** | **< 0.0001** |
| | pre-ex | **1.05±0.32** | 2.16±0.46 | **1.17±0.04** | **7.52±0.25** | **0.88±0.08** |
| M | post-ex | **0.82±0.25** | 1.96±0.47 | **1.15±0.03** | **7.74±0.19** | **0.97±0.02** |
| | p | **0.004** | 0.065 | **0.039** | **0.0004** | **< 0.0001** |
| | pre-ex | 1.06±0.43 | 2.13±0.59 | **1.17±0.04** | **7.48±0.27** | **0.85±0.06** |
| H | post-ex | 0.93±0.34 | 2.06±0.54 | **1.14±0.02** | **7.76±0.33** | **0.97±0.03** |
| | p | 0.240 | 0.650 | **0.0008** | **0.003** | **< 0.0001** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S8.** The thoracic spine area (ROI 2)**.** Values (mean ± SD) of entropy measures green color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **0.73±0.32** | **1.79±0.54** | 1.12±0.04 | **7.28±0.46** | **0.92±0.05** |
| L | post-ex | **1.45±0.41** | **2.86±0.61** | 1.10±0.04 | **7.69±0.22** | **0.85±0.07** |
| | p | **< 0.0001** | **< 0.0001** | 0.088 | **0.0007** | **0.0004** |
| | pre-ex | **0.76±0.35** | **1.84±0.68** | 1.13±0.04 | **7.38±0.39** | **0.95±0.05** |
| M | post-ex | **1.07±0.41** | **2.23±0.63** | 1.13±0.05 | **7.70±0.34** | **0.89±0.07** |
| | p | **0.008** | **0.044** | 0.793 | **0.004** | **0.004** |
| | pre-ex | 0.91±0.45 | 2.07±0.62 | 1.12±0.05 | **7.10±0.53** | **0.97±0.03** |
| H | post-ex | 1.12±0.63 | 2.27±0.99 | 1.13±0.04 | **7.71±0.53** | **0.92±0.06** |
| | p | 0.303 | 0.812 | 0.353 | **0.0002** | **0.0002** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S9.** The withers area (ROI 1)**.** Values (mean ± SD) of entropy measures for blue color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **1.09±0.71** | **1.71±0.51** | 1.19±0.03 | **7.77±0.22** | **0.86±0.09** |
| L | post-ex | **1.54±0.45** | **2.41±0.43** | 1.18±0.02 | **7.02±0.26** | **0.72±0.11** |
| | p | **0.013** | **< 0.0001** | 0.050 | **< 0.0001** | **0.021** |
| | pre-ex | **0.83±0.40** | **1.51±0.41** | **1.20±0.02** | **7.65±0.28** | **0.87±0.08** |
| M | post-ex | **1.17±0.41** | **2.04±0.45** | **1.18±0.02** | **7.21±0.35** | **0.80±0.11** |
| | p | **0.007** | **< 0.0001** | **0.045** | **< 0.0001** | **< 0.0001** |
| | pre-ex | **0.70±0.31** | **1.43±0.30** | 1.19±0.03 | **7.65±0.33** | **0.89±0.09** |
| H | post-ex | **1.10±0.35** | **1.96±0.40** | 1.19±0.02 | **7.37±0.35** | **0.84±0.09** |
| | p | **0.0003** | **< 0.0001** | 0.288 | **0.010** | **0.032** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.

**Table S10.** The thoracic spine area (ROI 2)**.** Values (mean ± SD) of entropy measures blue color component in light (L), moderate (M), and heavy (H) groups. The pre-exercise (pre-ex) and post exercise (post-ex) data series were compared. When features differed significantly ($p < 0.05$) for all three groups (L, M, H), the values were marked in bold.

| Groups | | SampEn | FuzzEn | PermEn | DispEn | DistEn |
|---|---|---|---|---|---|---|
| | pre-ex | **1.33±0.52** | **2.08±0.44** | 1.18±0.04 | **7.89±0.20** | **0.84±0.09** |
| L | post-ex | **1.78±0.49** | **2.34±0.49** | 1.19±0.02 | **7.45±0.30** | **0.71±0.11** |
| | p | **< 0.0001** | **0.004** | 0.327 | **< 0.0001** | **< 0.0001** |
| | pre-ex | 1.18±0.46 | 1.97±0.41 | 1.19±0.02 | **7.82±0.13** | **0.86±0.07** |
| M | post-ex | 1.39±0.49 | 2.04±0.46 | 1.19±0.04 | **7.57±0.26** | **0.77±0.11** |
| | p | 0.128 | 0.527 | 0.812 | **0.0001** | **0.0008** |
| | pre-ex | 1.26±0.50 | 2.03±0.46 | 1.19±0.03 | **7.84±0.12** | **0.85±0.08** |
| H | post-ex | 1.38±0.80 | 1.97±0.65 | 1.19±0.02 | **7.66±0.27** | **0.81±0.07** |
| | p | 0.790 | 0.591 | 0.931 | **0.016** | **0.026** |

ROI - regions of interest. SampEn - two-dimensional sample entropy, FuzzEn - two-dimensional fuzzy entropy, PermEn - two-dimensional permutation entropy, DispEn - two-dimensional dispersion entropy, DistEn - two-dimensional distribution entropy. p - the level of marginal significance; SD - standard deviation.