Horses

Fitness in horses after carriage driving competitions: individual prediction of fitness to compete.

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Background

Predicting an individual prognosis is common in human medicine, e.g. APGAR score, breast cancer risk or scores for cardiovascular events. While veterinary medicine commonly deals with herds, in some cases individual predictions could be useful. Drivers from carriage driving competitions objected to the invasiveness of measuring rectal temperature (RT). RT is measured as proxy for fitness to compete. A carriage driving competition comprises three parts, of which the marathon, the most demanding part, comes second. The regulations state that horses are fit to compete if RT after the finish of the marathon does not exceed 40°C, to prevent denaturation of proteins and subsequent muscle or metabolic problems.

Aim

This study aims to replace RT measurements by designing a prediction model to predict the RT at the finish of the obstacle course based on non-invasive measurements.
This prediction model, predicting the risk of exceeding RT limits potentially dangerous to the animal, could replace the very invasive and disliked RT measurements at the finish, limiting the burden on drivers as well as animals.

Methods

Data on physiology (heart rate (HR), RT, color, location in the team and horse/pony) and environment (ambient temperature, humidity, difficulty of the course) were available for 1042 records from 278 horses and ponies over 7 competition days (Fig. 1). The multilevel model, adjusting for repeated measurements and equality of teams, was fitted using manual backwards selection, removing predictors for RT>40°C with p<0.15. Calibration of the models was assessed by plotting the predicted probabilities against their observed probabilities. Shrinkage was adopted to improve calibration by using the slope of the calibration plot as shrinkage factor. The discrimination of the models was assessed using the area under the curve (AUC) of a receiver operating curve (ROC). The prediction score was based on the coefficients of the predictors in the model.

Results:

Predictors used to calculate the score were: ambient temperature, humidity >60%, horse (as opposed to pony), harnessed at the back, and HR all measured at the finish (Table 1). After shrinkage of the estimates to avoid overfitting (shrinkage factor=1.4), calibration of the score was good. In addition, the area under the curve of the ROC was 0.95 (Fig. 2), indicating good discrimination as well.

Three score categories were formed (Table 2). Animals with low scores, <110 points, were not at risk for exceeding the maximum RT at the finish. Animals with moderate scores, 110-130 points, were at a 9% risk of exceeding the maximum allowed RT. Finally animals with high scores, >130, were at 47% risk of exceeding the maximum limit. The high risk category contained 79% of animals exceeding the RT limit at the finish.
All of these recuperated after extra time to cool and extra rest (30min.) under supervision of a veterinarian. The remaining 21% of horses at risk fall in the moderate category and might also benefit from extra rest.

Score	Risk category	Risk
<110 points	Low	0.0
110-130 points	Medium	0.09
>130 points	High	0.47

Table 2 Risk categories

Example

At a competition with ambient temperature 15°C and humidity 80%, baseline risk for pony singles, pairs and at the back of a four-in-hand would be (15*2)+10+11=51 points. For horses baseline risk would be slightly higher at 63 points, while for leading horses in a four-in-hand the risk would be decreased by 11 points. Added to this would be their HR at the finish. Consider a single horse in th is competition finishing with a HR of 60 beats/min. Baseline risk was (15*2)+10+11+12=63 points, added to a HR of 60 would be 123 points; the 'medium risk' category. If this same horse would have finished with a heart rate of 76 beats/min, he would have been in the 'high risk' category and would have extra rest.
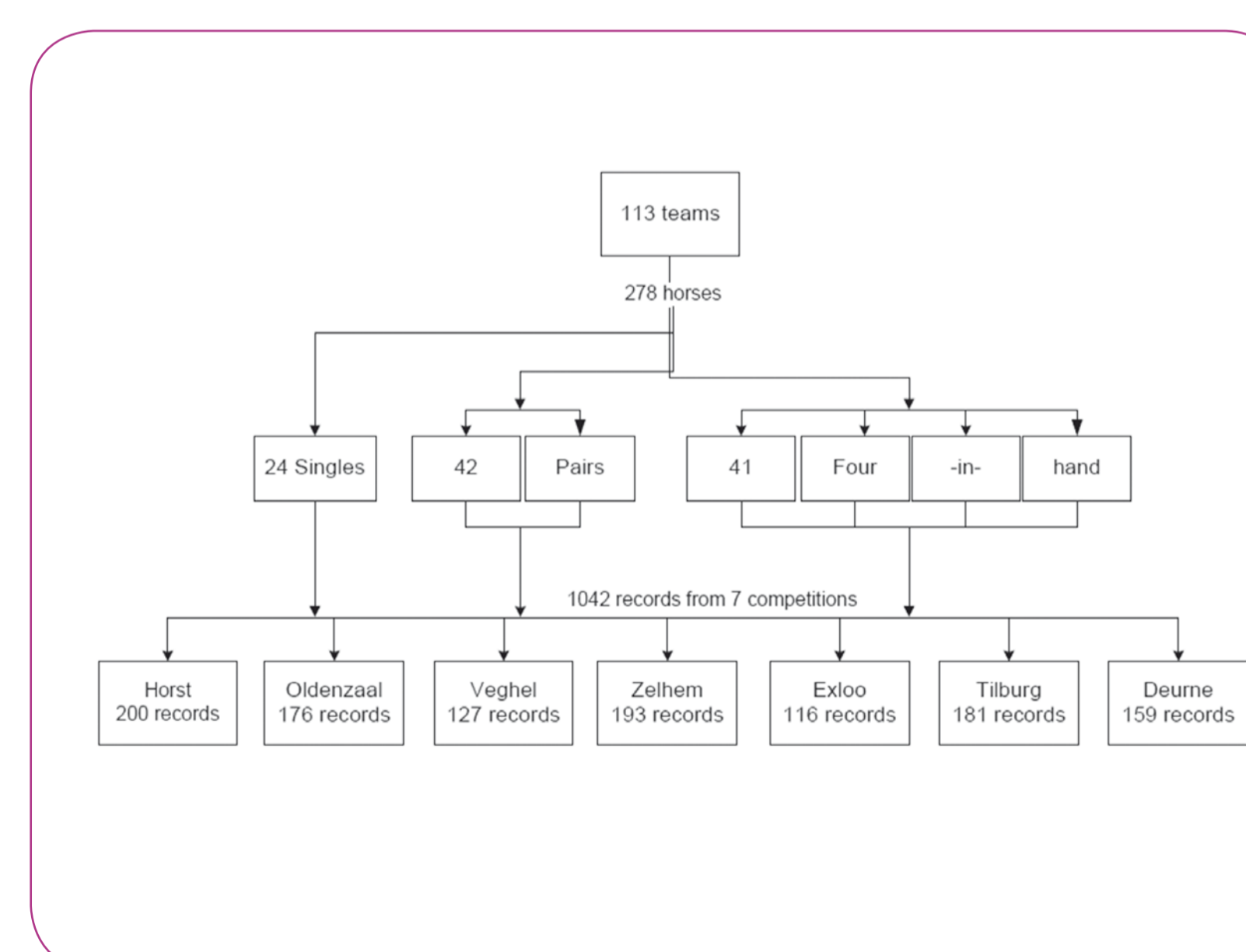

Photo: Aart van de kamp competing in the marathon.

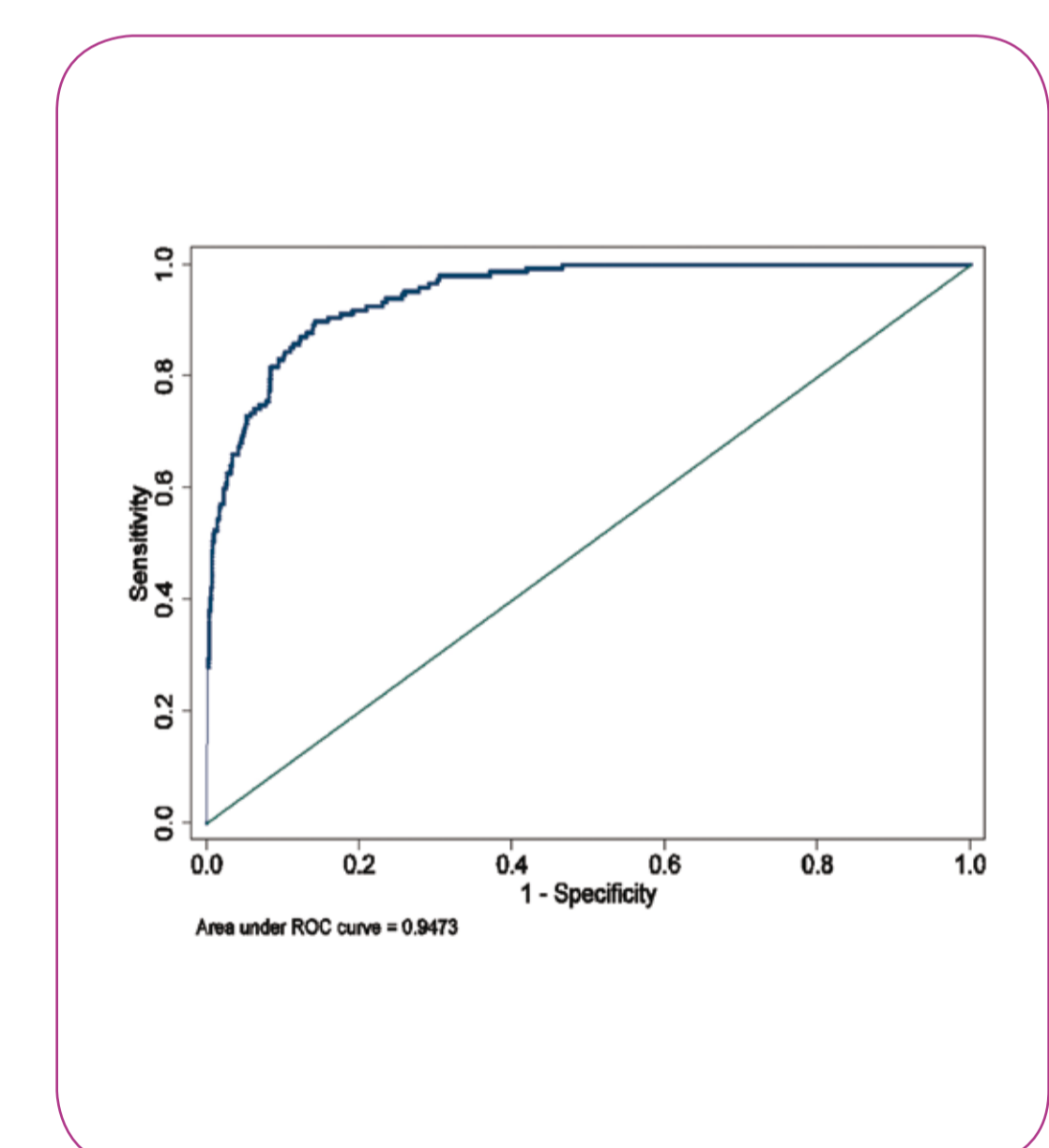
Fig. 1 Hierarchy of the data.

Fig. 2 ROC curve

Parameter	coefficient (95% CI)	Shrunk coefficient	Score
Ambient temperature (°C)	0.24 (0.17 -0.32)	0.2	2
Humidity>60%	1.4 (0.83 -1.9)	1.0	10
Horse	1.6(0.88 -2.4)	1.2	12
Harnessed at the back	1.5(0.67 -2.4)	1.1	11
HR at the finish obstacle course	0.11(0.09 -0.15)	0.1	1

Table 1 Predictors of RT at the finish, estimates and scores.

Conclusion

This prediction model, predicting the risk of exceeding RT limits potentially dangerous to the animal, could replace the very invasive and disliked RT measurements at the finish, limiting the burden on drivers as well as animals. At the finish only the four risk components need to measured and the risk score can be calculated. Subsequently, 72% of horses can be cleared, while only 28% will need further rest and examination by a veterinarian. Especially horses at the back of the team, competing in humidity >60% seem to be at high risk of overheating. Officials could advise drivers to cool and provide extra rest for horses located at the back of a team.