WORKLOAD IN EVENTING HORSES IN NEW ZEALAND

RESEARCH INTERNSHIP

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INHOUDSOPGAVE

ABSTRACT

Eventing is a sport where the horse's fitness is tested to the limit, especially at elite level. In order to get a horse fit, management and training should be accurate. Training prepares the equine athlete to compete effectively and safely. In addition, it has been shown that good fitness decreases injury chances. However, the knowledge about accurate training and management of eventing horses is minimal. The aim of this study was to gain more knowledge about management, training strategy and workload of New Zealand eventing competition horses.
The hypothesis of this study was that heart rate reflects the workload of eventing horses. Another hypothesis was that the management regime of eventing horses competing at a higher level (≥CNC105) was better structured compared to eventing horses trained at a lower level (<CNC105).
Five horses were selected. Heart rate was recorded during various training moments. A survey was developed in order to obtain more knowledge about management and training of the horses.
Results showed a significant relation (P=0.023) in cross country between average heart rate in zone 4 compared to the relative workload from the whole cross country. Furthermore, a significant difference (P=0.035) was found for the minutes spent per dressage training session. Horses competing at CNC<105 level spent more minutes per dressage training session than horses competing at CNC≥105 level. Our study showed that relative workload could be a good indicator of training intensity in eventing horses. In addition, no difference was found in training and management regime by horses competing at a higher level eventing compared to a lower level.
We conclude that relative workload could be a good indicator for training intensity. However, more research is necessary to obtain more knowledge about current practices in training eventing horses and the effects thereof to further improve the training strategies for eventing competition horses in an evidence-based way.

INTRODUCTION

Eventing is rapidly growing as a popular sport in the Netherlands. In addition, eventing is a sport where the horse's fitness is tested to the limit, especially at the highest level. Eventing competition horses need peak power and endurance capacity to perform at their maximum at three-day events. They need endurance capacity to gallop at a high speed in the cross country for 5 – 10 minutes, but in order to gain a final sprint to finish inside the time they need peak power. Hence the aerobic and anaerobic capacities need to be well-trained. In addition, peak power is also necessary for the show jumping and dressage test. In order to get your horse fit your management and training should be accurate.

However, the knowledge about the accurate training and management of eventing horses is minimal. Across all equestrian disciplines, lameness and musculoskeletal injury belong to the major reasons for the loss of horses *(Rogers et al., 2012).* Training prepares the equine athlete to compete effectively and safely. It induces the physiological adaptations necessary to perform with minimal risk of injury *(Hinchcliff, 2008). Munsters et al (2013)* did show that during the preparation for the European championships (EC) 45% of the horses were withdrawn, even before they could participate at the EC, because of locomotor injuries.

Internationally it appears that most sport horses are trained for circa 45 minutes per day with limited variation in training protocol (*Walters et al., 2008; Lönnell et al., 2013*). Overall, there seem to be large differences in training methods. The management of elite horses is different regarding to horses that compete at national level. *Walters et al (2008)* showed indeed a difference in training and management practices in non- elite and elite horses. In addition, they found that dressage horses in that study were stabled for 64- 91% of the time with no difference between elite and non- elite horses. Limitation of movement, a consequence of spending a lot of time in a stable, is detrimental to the development of musculoskeletal tissues (*Barneveld et al., 1999*). In contrast to Western Europe, the horses in New Zealand are managed in a pastoral environment. This could have an impact on the frequency and volume of exercise received *(Verhaar et al., 2014; Dijkstra et al., 2016)*. Next to that, the horses in New Zealand are mostly thoroughbreds and the horses in Europe are mostly warmblood horses. To my knowledge, it is unknown if the different breeds are also trained differently.

New Zealand is a well-known country in the equestrian eventing sport, currently two New Zeeland elite eventing riders are placed in the top ten in the World Ranking *(Fei.org., 2018).* During this research local eventing riders in the Manawatu region in New Zealand will be followed and their training methods will be compared for their eventing competition horses.

The aim of this study was to gain more knowledge about management, training strategy and workload of New Zealand eventing competition horses. Workload is a measure that is frequently used to determine the intensity of a training session *(Munsters et al., 2013; Dekker et al., 2007; Rogers et al., 2007; Harris et al., 2007)*. To quantify the intensity of a training session the relative workload can be calculated *(Dekker et al 2007; Munsters et al 2013).*

The hypothesis of this study was that heart rate reflects the workload of eventing horses. Another hypothesis was that the management regime of eventing horses competing at a higher level (≥CNC105) would be better structured compared to eventing horses that are trained at a lower level (<CNC105).

METHODS

SAMPLE SET

In this study five horses ridden by 2 different riders were recruited in the Manawatu region in New Zealand. Horses 1 to 3 were ridden by rider A and horses 4 and 5 were ridden by rider B. Horses were a convenience sample, depending on the willingness of the rider to participate in the research. The level of training was divided into a national level (<CNC105) and an international level (>CNC105). Horses competing at international level were horse 1, 4 and 5, whereas horse 2 and 3 competed at national level. Details of the horses are shown in *Table 1.*

	Horse 1	Horse 2	Horse 3	Horse 4	Horse 5
Age	8	6	5	9	7
Sex	Gelding	Gelding	Gelding	Mere	Gelding
Breed	Warmblood	Thoroughbred	Warmblood	Thoroughbred	Thoroughbred
Previous level	CCI 2*	CNC 105	None	CNC 1*	CNC 1*
Current level	CNC 2*	CNC 105	CNC 105	CNC 2*	CNC 1*

TABLE 1. OVERVIEW OF THE HORSES USED FOR THIS STUDY.

The horses were at the start of their eventing season. At the beginning of our study the horses were exercised approximately 5 days a week. All horses were housed in individual stables bedded with straw. They had unlimited access to water and were fed 5 times a day.

The 2 riders that participated in the study were all female; they were 36 and 21 years old.

STUDY DESIGN

Dressage training was performed in a sand arena. Fitness tests have been carried out on the beach or on farm roads. The cross country course took place on a grass surface.

Table 2 gives the heart rate zones used in the study in beats per minute (bpm).

Zone	Heart rate (bpm)
1	< 140
2	140 – 160
3	161 - 170
4	171 - 195
5	≥ 196

TABLE 2. OVERVIEW OF THE HEART RATE ZONES USED IN THIS STUDY.

Results from each training session were compared with the results of the same type of training sessions from the other horses. In addition, results were compared at an individual level. Furthermore, cross country results were compared with the horses from the same level.

QUESTIONNAIRE

Next to the follow up of these 5 eventing horses a questionnaire was developed. This questionnaire was developed in order to obtain more knowledge about management and training of the horses. The data were collected by way of an online survey via a national social media platform for eventers in New Zealand. Riders who were followed in this study also completed this survey. The survey consisted of 23 questions in 3 categories covering rider information, horse information and management.

Riders who filled in the survey were all female (N=17) with an average age of 21.8 years (±8.2).

The majority of horses were geldings (53%), average age was 10 years (±5.4). Most horses were a combination of breeds (47%). In addition, 89% were a mix with thoroughbreds, followed by thoroughbreds (41%) and warmbloods (12%). Fifty-seven (57) percent of the thoroughbreds raced before they started their eventing career. Looking at the current level of competition 59% competed below CNC105 level (lower level), 41% of the horses competed at CNC105 or a higher level (higher level). See for an overview *figure 1.*

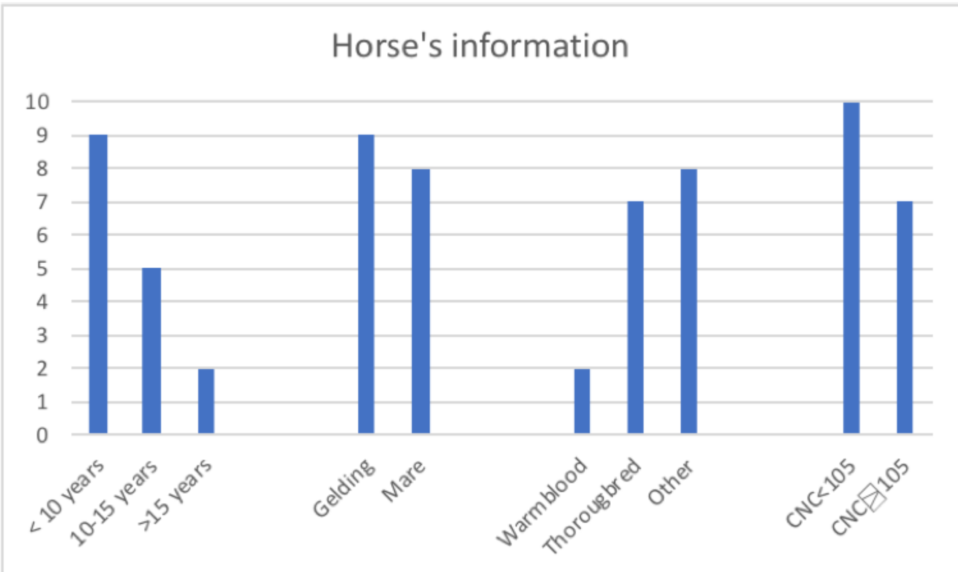

FIGURE 1. OVERVIEW OF THE INFORMATION OF THE HORSES OF THE RIDERS THAT PARTICIPATED IN THE SURVEY.

HEART RATE MONITORING

Heart rate (bpm) was recorded using the Polar equine V800 HR watch with an internal GPS and the H7 HR sensor electrode base set. The Polar equine electrodes were firmly attached in the correct position to the horse. The electrodes and the skin of the horse needed to be wet before placing the electrodes. One of the electrodes was attached at the left side underneath the girth, the other at the right side between the saddle panel and the withers.

During a period of six weeks (September-October) as many trainings sessions as possible were recorded. In addition, one cross country competition was recorded; all horses rode this cross-country course on the same day.

To determine the fitness level of the horses the criteria as given in table 3 were used. These criteria are recommended by the Polar equine system and are based on an article by *Bitschnau et al., (2010)*. The table relates the heart rate to zones of fitness.

Sport Zone	Benefits	Recommended for	Heart rate	How
5 MAXIMUM 90-100%	Increases maximum sprinting capacity and tunes the neuromuscular system	Enhancing anaerobic capacity; only for well-preconditioned horses	Maximal heart rate	Fast trot/gallop - short sprints of up to 2 minutes after an appropriate warm-up in zones 1-3
4 HARD 80-90%	Builds up high-speed endurance (stamina)	Developing anaerobic power for horses that compete at intensities eliciting lactate accumulation or at maximal intensities	Thoroughbreds and standardbreds around 200 bpm, eventing horses around 190 bpm, endurance horses and warmbloods around 180 bpm	Fast trot/gallop - up to 4-6 intervals of short durations of 2-3 minutes; the shorter the interval, the higher the intensity; appropriate warm-up in zones 1-3 and sufficient recovery between intervals are very important
3 MODERATE 70-80%	Enhances aerobic power	Mainly aerobic moderate training, an essential part of training independent of the equestrian discipline or breed of horse	Thoroughbreds and standardbreds between 160-190 bpm, eventing horses between 160-170 bpm, endurance horses and warmbloods between 150-160 bpm	Canter - may consist of intervals followed by recovery periods; trotting in this zone is especially effective for improving endurance, blood circulatory capacity of the heart and skeletal muscles
2 LIGHT 60-70%	Improves basic endurance, increases the metabolism and strengthens the body so that the horse can tolerate higher intensity training	Aerobic endurance training, an essential part of training independent of the equestrian discipline or breed of horse	Thoroughbreds, standardbreds and eventing horses up to about 160 bpm, endurance horses and warmbloods up to about 150 bpm	Walk, trot and slow canter - training of 40-80 minutes duration
1 VERY LIGHT 30-60%	Improves overall health and promotes active recovery	Recovery training, rehabilitation, warm-up and active recovery from more strenuous training sessions, an essential part of training independent of the equestrian discipline or breed of horse	All breeds and disciplines up to about 140 beats per minute (bpm)	Walk and trot - recovery training for a total of 40-80 minutes duration or an initial warm-up followed by an active recovery exercise of about 30 minutes

TABLE 3. HEART RATE ZONES OF THE EQUINE ATHLETE ACCORDING TO POLAR (BITSCHNAU ET AL., 2010).

DATA PROCESSING AND STATISTICAL ANALYSIS

Before processing, all HR data was visually checked for artefacts. All mean values were calculated through the use of the whole data set of each training session. If possible, all data are presented as means ± standard deviation (SD).

Descriptive statistics via SPSS v22 was used to explore the data. All data was processed with Microsoft Excel v16. In addition, descriptive statistics and independent T-tests and Fishers' exact tests were used by SPSS v22. Explorative plots and other graphics were made via Microsoft Excel v16. The level of significance was set at P<0.05 in all statistical analyses.

RELATIVE WORKLOAD

Relative workload was determined by dividing the average heart rate per training session by the maximum heart rate. The maximum heart rate was estimated by deduction of the horse's age from 220 *(Dekker et al., 2007).*

RESULTS

The aim of this study was to obtain insight in the management and training regimes of New Zeeland eventing riders. We hypothesized that heart rate would reflect the workload of eventing horses. Next to that, we hypothesized that the management regime of eventing horses that compete at a higher level (>CNC105) would be better structured compared to eventing horses trained at a lower level (<CNC105).

All horses were evaluated for any recent illness or lameness at the beginning of the study. The horses were in good condition and all horses completed this study. However, we had to exclude the cross country test of horse 4 because of problems with the polar system. Due to practical limitations no data was obtained from show jumping. For the same reason there are no data on two fitness tests.

DOES HEART RATE REFLECT WORKLOAD?

The Pearson test showed a significant relation (n= 4, p = 0.023) in cross country between average heart rate in zone 4 compared to the relative workload of the whole cross country. No significance results were found in dressage training.

To obtain more insight in training load we compared the bouts in each fitness training to the whole relative workload of that training. No significance results were found.

DRESSAGE TRAINING

	Horse 1	Horse 2	Horse 3	Horse 4	Horse 5
Total time (min:sec)	62:27	14:19	51:09	90:09	39:31
Distance covered (m)	7017	1623	6654	10994	6590
HRmax (bpm)	224	182	198	209	231
Mean speed (m/s) ± SD	2.67 ± 0.87	2.96 ± 1.24	2.58 ± 1.20	2.45 ± 1.06	3.26 ± 1.02
Relative workload	0.58	0.57	0.56	0.54	0.52
% time zone 1	73.78	71.86	65.23	68.54	73.74
% time zone 2	13.52	22.91	13.23	13.48	9.78
% time zone 3	4.43	4.53	10.23	6.47	5.40
% time zone 4	7.20	0.70	11.01	10.50	8.68
% time zone 5	1.07	0	0.29	1.01	2.40

TABLE 4. DESCRIPTIVE STATISTICS OF ALL DRESSAGE TRAININGS. THE DATA CONSIST OF 2 TRAININGS OF EACH HORSE EXCEPT FOR HORSE 2. IN ADDITION, HORSE 2 HAD ONLY ONE DRESSAGE TRAINING.

Maximum HR during dressage training was higher than expected. *Table 4* shows that horses spend a % time in zone 4 and 5 during aerobic training. However, *Table 4* also shows that dressage training is mainly in heart rate zones one and two. In addition, the mean speed is low. Next to that we see that the average relative workload during dressage training is 0.55.

	Horse 1	Horse 2	Horse 5
Total time (min:sec)	63:57	70:34	17:27
Distance covered (m)	14923	13024	4465
HRmax (bpm)	180	212	214
Mean speed (m/s) ± SD	3.89 ± 2.90	3.08 ± 2.12	4.41 ± 2.05
Relative workload	0.53	0.54	0.65
% time zone 1	74.88	77.92	55.63
% time zone 2	14.36	7.16	18.03
% time zone 3	3.07	3.68	8.30
% time zone 4	7.69	9.43	16.70
% time zone 5	0	1.82	1.33

TABLE 5. DESCRIPTIVE STATISTICS OF FITNESS TRAINING. TWO HORSES WERE EXCLUDED DUE TO PRACTICAL LIMITATIONS.

According to the relative workload those fitness trainings seemed to be not so hard. Average relative workload is 0.57. *Table 5* shows that the horses spent more time during the fitness training in heart rate zone 4 compared to dressage training. In addition, mean speed and distance covered are higher.

Below in *table 6* the fitness training is shown divided in bouts. Horse 1 was the only horse that participated in bout 4. In addition, this horse is the horse with the highest competition level.

	Bout 1	Recovery	Bout 2	Recovery	Bout 3	Recovery	Bout 4	Total *Fitness training*
Horse 1								
Mean Speed (m/s)	6.17	2.24	7.03	1.74	7.19	1.65	9.54	3.89
Time (min:s)	04:24	09:30	05:16	20:48	04:38	07:14	03:29	63:57
Relative workload	0.59	0.41	0.66	0.42	0.69	0.43	0.81	0.53
Horse 2								
Mean speed (m/s)	6.16	2.28	6.99	1.75	7.05			3.08
Time (min:s)	04:25	09:29	05:16	20:46	04:39			70:34
Relative workload	0.69	0.63	0.71	0.39	0.54			0.54

Horse 5								
Mean Speed (m/s)	7.37	4.38	7.21	4.17	7.20			4.41
Time (min:s)	01:34	2:30	01:30	3:00	01:23			17:27
Relative workload	0.76	0.58	0.68	0.67	0.69			0.65

TABLE 6. DESCRIPTIVE STATICS OF FITNESS TRAINING BOUTS. RECOVERY BOUTS HAVE BEEN ADDED.

In *table 6* we see that the total mean relative workload from the fitness training is lower compared to the relative workload of the bouts.

CROSS COUNTRY COMPETITION

During the cross country competition all horses are mainly in zone 4. The relative workload is high. In addition, average relative workload is 0.87. Next to that it is shown that during cross country those horses mainly gallop around zone 4 and 5 compared with fitness and dressage training.

	Horse 1	Horse 2	Horse 3	Horse 5
Total time (min:s)	06:31	08:01	06:11	06:00
Distance covered (m)	3203.2	2837.5	2614.4	2274.5
HRmax (bpm)	205	206	202	204
Mean speed (m/s) ± SD	8 .46 ± 1.83	6.13 ± 1.69	7.24 ± 1.05	8.82 ± 0.99
Relative workload	0.90	0.82	0.86	0.88
% time zone 1	3.83	4.56	2.69	3.05
% time zone 2	2.30	11.41	2.42	5.82
% time zone 3	1.79	14.11	3.76	6.93
% time zone 4	78.83	64.94	86.56	69.53
% time zone 5	13.52	4.98	4.57	14.68

TABLE 7. DESCRIPTIVE STATISTICS OF THE CROSS COUNTRY DURING A COMPETITION. THIS DATA IS PURELY THE CROSS COUNTRY, WARMING UP AND COOLING DOWN ARE EXCLUDED. ONE HORSE IS EXCLUDED BECAUSE THE POLAR ELECTRODE SLIPPED OF.

Table 7 shows descriptive statistics during cross country competition. As shown, horse 2 has a longer cross country competition duration compared with horse 3. In addition, they compete at the same level. However, horse 2 had 2 refusals during the competition.

TRAINING AND MANAGEMENT REGIME CNC<105 COMPARED WITH CNC≥105

No difference was found between the number of training sessions per week spent on dressage (Mean=2.53 ± 0.72) or show jumping (Mean=1.35 ± 0.49) between horses competing at a lower or higher level.

A significant difference was found (p-value = 0.035) for the minutes spent per dressage training session. *Figure 2* shows that all riders that participate ≥ CNC105 train around 30- 45 minutes each dressage training. In addition, there is a difference between horses competing <CNC105 level and those competing at higher level. Horses competing <CNC105 level spent more minutes per training session for dressage than horses competing ≥ CNC105 level.

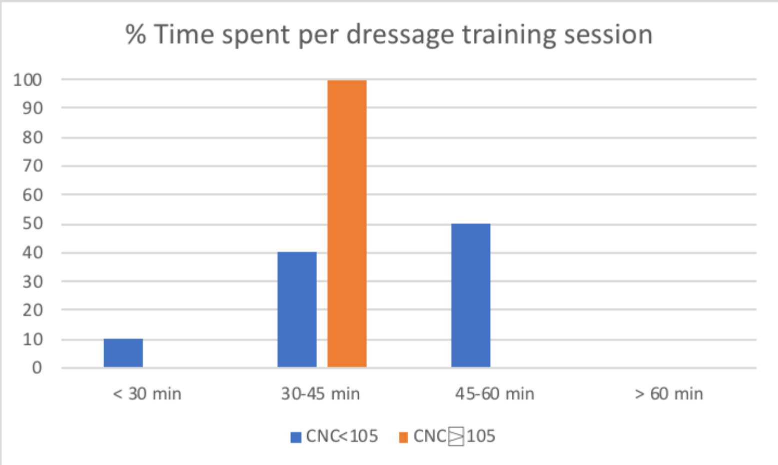

FIGURE 2. AN OVERVIEW OF MINUTES SPEND ON DRESSAGE TRAINING.

No significant difference (p-value = 0.124) was found for minutes spent per show jumping session.

When asked if the rider kept a daily training record 53% answered positive. Most riders identify the first eventing start of the season as the baseline for designing their training program (65%). Twenty-nine percent of the horses were trained for dressage and show jumping during the winter, so they only needed to start with fitness training. Six percent of the respondents brought in the horses each year at a similar time after an X number of months off.
The majority of the horses (60%) were <10 weeks in training prior the first eventing competition of the season, followed by 20 % 10-15 weeks in training and 20 % were year- round in training.
When asked if they used long slow distance (LSD) in their training program 76% responded positive. Most riders used LSD once a week (62%) in their program, followed by 2 (15%), 3 (15%) and 4 (8%) times a week. Duration was respectively 30-45 minutes, 45-60 minutes, >60 minutes and <30 minutes (38.5%; 38.5%; 15%; 8%).

Remarkably, the riders who participated in our field study had the same training regime for their national and their international horses. The only difference was that during fitness training rider A would do one bout less with the horses being trained for national level. Both riders used interval training for their fitness sessions and measured the fitness training ‘on their own feeling’.
The other riders that participated in the survey gave almost the same answers as is shown in *figure 3.*

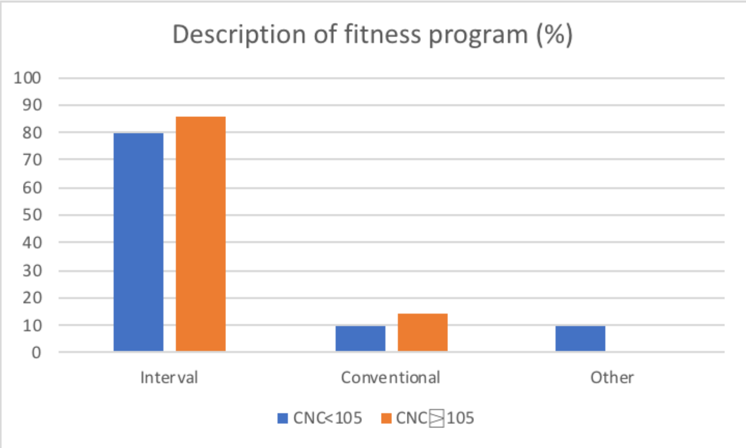

FIGURE3. DESCRIPTION OF FITNESS PROGRAMM SHOWN IN PERCENTAGES.

Most riders described their fitness training program as an interval program (76%). In addition, conventional training was used by 12% and "other" was answered by 12%. Respondents who answered with "other" indicated that they decided when and what kind of fitness training they wanted to use on their horse dependent on how the horse 'was feeling'. As expected, most riders designed their training program based on their own ideas (40%). Thirty-three percent used 'other' ways (33%) to get information followed by their instructor (13%), scientific articles (7%) and the internet (7%).
Another remarkable observation that is shown in *figure 4* was that most riders measured fitness training 'on their own feeling' (56%), followed by the respiration rate of the horse 31(%) and heart rate monitor (13%). Lactate level was used by none of them.

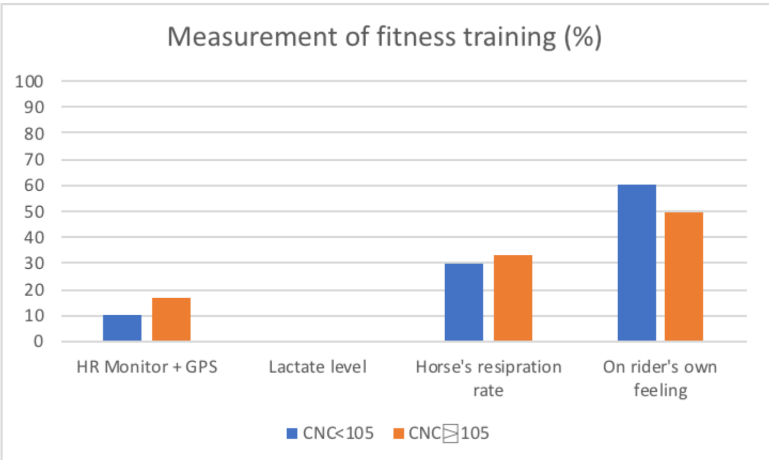

FIGURE4. OVERVIEW OF THE METHODS USED FOR MEASURING FITNESS TRANING.

The average times a week horses went out for hacking was 2.18. When horses were trained in an arena 57% used a mixture of sand and rubber as footing, 21% used a sand footing, 14% used a grass footing and 7% used a mixture of sand and fibre as footing.

When assessing how the horses were kept, most horses were kept in a paddock 24 hours a day (71%) versus a combination of 12 hours stable and 12 hours paddock (29%).

DISCUSSION

Our results show that heart rate reflects the workload when the equine athlete is around submaximal intensity. This study shows that dressage and fitness tests have lower workloads. In the fitness test, it appears that the average relative workload is nearly equal to the average dressage relative workload. This suggests that the intensity of fitness training is comparable with the intensity of dressage training.

The outcome of the questionnaire was that horses competing at lower level spent more minutes on dressage training compared to horses competing at a higher level.
When asked if riders kept a daily training record slightly more than half of the respondents confirmed this question positive. All riders, independent of competition level, used a fitness program. The design of the training program was mostly based on the riders' point of view instead of input from professionals with expertise in training and exercise physiology.

IS FITNESS TRAINING JUST AS HARD AS DRESSAGE TRAINING?

Dressage training is mainly around a heart rate range of 70 – 160 bpm. In addition, dressage training is mainly aerobic. Heart rate can be influenced by stress in those lower heart rates zones (*Williams et al., 2008; Marlin & Nankervis., 2002*). Our study demonstrates high maximum heart rates during dressage training. This could indicate that the horses were sensitive for some kind of stress during the measured dressage exercise. Relative workload is calculated based on mean and maximum heart rate values. Due to those higher heart rates the relative workload could disown the real value of the relative workload. *Table 6* shows that during the fitness tests the recovery bouts are long. In addition, during those recovery bouts the mean speed and heart rate is low. This indicates that the horse can recover during the recovery bouts. To provoke a training stimulus recovery bouts are necessary. However, they are not supposed to be this long. There needs to be a balance between recovery and stimuli in order to provoke muscle adaptation. With the current training design, the horse will not receive a real training stimulus due to this combination of recovery and training bouts. Therefore we indicate that those long recovery bouts, with low heart rates, influence the relative workload of the fitness training, leading to a lower relative workload.
As mentioned before, the general workload for fitness training is almost equal to that in dressage training. This suggests that the intensity of those training sessions is almost equal. However relative workload is purely based on heart rate. Duration of time spent in each heart rate zone is an important parameter for determining workload (*Boressen et al., 2008*). In addition, as is observed in *table 5* the time spent in zones 1 and 2 is larger compared to the time spent in zones 3 and 4 in fitness training. This suggests that the relative workload could indeed reflect the intensity of the measured fitness tests.

CAN WE USE RELATIVE WORKLOAD AS A RELIABLE MEASURE OF INTENSITY?

Above we suggest that the relative workload could indeed reflect the intensity of the training. However, we presume that it is important to measure more data. Heart rate alone is sensitive to stress, excitement, dehydration, temperature and pain (*Marlin & Nankervis, 2002*). Problems with attaching heart rate monitors occur. Most frequently a girth that is too loose or a heart rate electrode that is not wet enough, to have proper contact for conduction, lead to unusable data. Unfortunately due to those problems some of this data was lost in the current study.

In the Netherlands standardized exercise field tests (SET) are used to obtain more knowledge about the fitness of a horse. Monitoring fitness of eventing horses showed predictive values for prospective injuries *(Munsters et al., 2013*). None of the horses used in this study were ever measured with heart rate monitors before. Each rider assumed that they trained the horses correctly and sufficiently based on their own feeling. The 2 riders that participated at CCI2* level did not participate once in a SET. In addition, they did not monitor anything except following their 'own feeling'. During the study both horses were without injuries. However, within a year both horses were withdrawn from competition because of injuries.

Our study shows that the relative workload during cross country competition is high compared to fitness and dressage training. This indicates that all horses were undertrained for the cross country competition. *Serrano et al (2002*) found similar results. They also suggested that training intensity was lower compared with cross country competition intensity. Therefore, in our study, all 5 equine athletes were probably at a higher risk for an injury.

In the field, lactate measurement is often used to determine the fitness of the horse (*Munsters et al., 2013; Bitschnau et al., 2010)*. A practical constraint is that it is expensive and impractical to use over a long-term period. However, obtaining more knowledge of fitness using a heart monitor is relatively easy. Heart rate monitoring with GPS provides information you can use as outcome parameters for internal and external loads.

In humans workload can be described as internal and external load. Internal load measures the psychological and physiological experience by an athlete. We acknowledge that psychological measurements are difficult in horses. However, physiological experience we can measure. An internal load is the response to the external load. External loads describe the amount of work that was performed by an athlete. Part of the internal load, particularly the psychological experience, are subjective. However, the accumulation of lactate and heart rate monitoring are parameters to determine internal load. External loads could for example be the frequency or the amount of training, the distance covered, speed and time. A combination of those internal and external loads by determining the workload could be the key to success. In addition, we need to simplify the measures to make it easy to use in the field (*Muijka., 2017; Windt & Gabett., 2017; Drew et al., 2016*). Another interesting ratio is discussed in an article by *Sanders et al (2018).* This study uses heart rate, power output and Rate of Perceived Exertion (RPE) to determine a ratio of intensity and load.

However, we need to consider that those articles are about humans. The equine athlete cannot give their RPE for example. At the same time, we should use the knowledge that already was gathered in human exercise physiology to expand the knowledge in equine exercise physiology. To our knowledge, not much is known about internal and external loads in the equestrian sport. Hence, we suggest that further research is necessary to obtain more knowledge.

On top of that, we need to keep in mind that most sports horses are lost due to musculoskeletal injuries (*Rogers., 2012; Munsters et al., 2013*). All loads that are used to determine workload should also consider the load that is received by tendons. Ultrasound Tissue Characterization (UTC) is a method that could be applied to monitor the load received by the tendons. In addition, it is possible to detect subtle changes in the tendon before they tear up (*Docking., 2012*).

TRAINING AND MANAGEMENT REGIME

Our sample is believed to be representative of the eventing riders population in New Zealand since the platform used to spread the survey was a national platform for eventing riders. In addition, the response rate is unknown since it was distributed via a social media network and it is not known how many people received the invitation for the survey. However, it is quite possible that the response rate was low for a national platform but may be higher than reported as riders may ride 2 or more horses and the response rate was calculated per combination (rider and horse). Furthermore, only riders who participated in eventing competitions filled in the questionnaire.

There doesn't seem to be much discrepancy between the management of horses trained at a lower level versus horses trained at a higher level. A surprising outcome was that horses competing at a lower level were trained more frequently and the duration per dressage session was longer. A limitation of this survey was that it is unknown what motivates the riders to train their horses this way. Conclusion is that eventing competition horses at a higher level are not necessarily subjected to a stricter training program.

When comparing surveys from rider A and rider B, differences were found in the amounts of dressage training and hacking. The reason behind this was simple, according to Rider A she focused more on dressage since she herself found dressage more difficult. Rider B went hacking out most times of the week because she thought it was better for her horse and felt her horse didn't need a lot of dressage training.
Noteworthy is that Rider A spent one bout less during fitness training with her horses competing at national level compared with horses competing at international level. The reason behind this was that she felt horses competing at national level wouldn't need as much fitness training as horses trained at international level. None of the riders ever got professional feedback about their training programs. Basically, their own feeling was their training guideline.

AEROBIC AND ANAEROBIC TRAINING

Finally, we want to note that to our knowledge most horses were trained particularly aerobically. However as mentioned in our introduction, it is important for eventing horses that they are also trained anaerobically. Therefore, it is important that trainers and riders gain more knowledge about training. When we demand maximum challenges during competition of our horses we need to train them correctly. Our study took place in New Zeeland. However, we expect this kind of results in the Netherlands too in the population of riders that do not already participate in SETs and train with help of an exercise physiologist.

LIMITATIONS OF THE STUDY

The main limitation of this study is especially the small number of riders that participated. Hence, the study might be underpowered to identify differences between groups. Furthermore, during the first weeks of the study the heart rate monitor had technical issues. Therefore we needed to order a new one which took some time.

CONCLUSION

Our results show that heart rate reflects the workload when the equine athlete is training around submaximal intensity. This study shows that dressage and fitness tests have lower workloads. In the fitness test, it appears that the average relative workload is nearly equal to the average dressage relative workload. This suggests that the intensity of fitness training is comparable with the intensity of dressage training. Our study shows that the relative workload during cross country is high compared to fitness and dressage training. In conclusion, we found that heart rate could indeed reflect the workload of eventing horses. However, we need to say that to make the method more accurate more research is necessary. Relative workload is a reliable measure.

The management and training regime of eventing horses competing at a higher level was not necessarily better structured compared to eventing horses competing at a lower level. Moreover, management and training regime were not structured at all. Most riders that participated in our survey stated that they use their own feeling instead of some data-based method.

Thanks to this study we gained more knowledge on how eventing riders train and manage their horses. More research is necessary to generate a simple and efficient tool by which riders know how they should train. We suggest that a combination of internal and external loads could be the key to success. On top of that, riders should be made more aware of the risk of not training appropriately. In the equine world it is common to make decisions about training and management program based on a rider's feeling only. However, based on this study it seems that this method is not sufficient to prepare a horse for a cross country competition. National and international federations should create more awareness about this topic among riders. Relative workload could be a good tool to help instructors and riders deal with the question: "How to train my horse appropriately?"

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APPENDIX

SURVEY: WORKLOAD IN EVENTING HORSES

Q1: Riders information

Name:

Age:

Gender:

Email:

Q2: Horse's information

Name

Age:

Sex:

Q3: Best description of breed:

- Thoroughbred
- Sport horse
- Stationbred
- Warmblood
- Other (please specify)

Q4: If thoroughbred, has your horse raced before?

- Yes
- No

Q5: What is the current level of your horse?

- CNC65
- CNC80
- CNC95
- CNC105
- CNC1*
- CNC2*
- CNC3*

Q6: How many times a week do you work your horse on flatwork?

1	2	3	4	5	6	7

Q7: What is the average time you spent on flatwork schooling per training session?

- Less than 30 minutes
- Between 30 and 45 minutes
- Between 45 and 60 minutes
- More than 60 minutes

Q8: How many times a week do you work on show jumping with your horse?

1	2	3

Q9: What is the average time you spend on a school jumping session?

- Less than 30 minutes
- Between 30 and 45 minutes
- Between 45 and 60 minutes
- More than 60 minutes

Q10: How many times a week do you hack out?

- 1
- 2
- 3
- 4 or more then 4 times

Q11:Do you use an arena for schooling at home, if yes what is the surface of the arena made off?

- Yes, please specify
- No

Q12: What is the best description management when your horse is in training?

- Paddock 24 hours a day
- Combination of stable and paddock (12 hours/12hours)
- Always stabled
- Other (please specify)

Q13: Do you use a daily diary, recording your training program?

- Yes
- No

Q14: What is the best description for your training competition program for your chosen horse?

- I identify the first eventing start and work back from there
- I only need to start with fitness training because I trained them for dressage and show jumping through winter
- I always bring in the horses at a similar time each year after a X amount of months (fill amounts of months in at the comments) and build a program around how the horse is
- Other (please specify)

Q15: Prior to the first eventing start of this season, for how many weeks was the horse in work?

- Open question

Q16: If we broke down the training program in 3 stages from the time the horse first started working this season until the first eventing start, approximately how many weeks have you spent doing the following:

- Stage 1: Initially doing only long slow distance conditioning work
- Stage 2: Some fitness work and the introduction of schooling
- Stage 3: Some fitness work but mostly schooling as started some competitions (show jumping and dressage)

Q17: Do you use LSD in your training program? If not you can skip this question.

- Yes
- No

Q18: How many times a week do you use LSD?

1	2	3	4	5

Q19: What is the duration of your LSD training every time you do LSD?

- Less than 30 minutes
- Between 30 and 45 minutes
- Between 45 and 60 minutes
- More than 60 minutes

Q20: What is the description of your fitness training program?

- Fartlek (speed play)
- Interval (series of low-to-high intensity workout)
- Conventional
- Other (please specify)

Q21: When the eventing season has started, how does a typical week look like for your horse?

Flatwork	Show jumping	Cross country	Hacking out	Lounging	Fitness training

Q22: How do you measure your fitness training?

- HR monitor + GPS
- Lactate level
- Respiration rate (blowing etc)
- On my own feeling

Q23: When you're constructing your training program, where do you get your information from? Who guides constructing the training program?

- My instructor
- Scientific articles
- Internet
- Own ideas
- Other (please specify)