

Analysis of variables inherent to the dynamics of the practice of vaquejada to determine its influence on the result obtained in the competition

Análise de variáveis inerentes à dinâmica da prática da vaquejada para determinação de sua influência sobre o resultado obtido na competição

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Abstract

The objective of this work was to evaluate several attempts to knock down neats and to correlate the success obtained with actions performed by the horse/rider sets through an analysis of public domain videos of vaquejadas. Approximately 300 videos were considered, and the groups were evaluated according to the competition category, that is, amateur/aspirant and professional, and the animals used in the test, that is, pulling or tracking of the neat. It was found that for the pull set in the professional competition category, only the characteristics of directing the cow on the track, and the guiding behavior and positioning in the pull were significant ($p < 0.01$), while for the amateur/aspirant category, the characteristics of remaining in the pull after falling of the cattle and of the behavior at the gate had an effect ($p < 0.01$). The characteristic of remaining in the pull after the fall of the neats, in the category of professional pulling athletes, exists in greater prevalence during the competition with 85.3%, while the characteristic of directing the neat to the side of the track is performed by 87.6% of the competitors. For the set used to track the cattle, the values of the dimensions 1 and 2 were 96.56% and 3.43%, respectively, which is 99.9% of the total variance of the data based on those selected for the final result of "earn the ox". The use of multiple diversity analysis in this study of variables associated with the vaquejada set proved to be quite advantageous, and there was not much variation in the elements obtained with a greater weight in the determination of the final result.

Keywords: equine breeding; effort; pull horse; track horse.

Resumo

Objetivou-se com este trabalho avaliar por meio de análise de vídeos de domínio público de competições de vaquejadas, diversas tentativas de derrubada de rezes e correlacionar o êxito obtido com ações desempenhadas pelos conjuntos cavalo/cavaleiro. Foram considerados aproximadamente 300 vídeos, sendo os grupos avaliados quanto à categoria de competição, Amador/Aspirante e Profissional, e aos animais utilizados na prova, Puxar ou Esteirar a rês. Verificou-se que para o conjunto de puxar, da categoria profissional de competição, apenas as características de direcionamento da rês na pista, comportamento na condução e posicionamento na puxada foram significativos ($p < 0,01$), enquanto para a categoria amador/aspirante houve efeito ($p < 0,01$) para a característica de permanecer ou não na puxada após queda da rês e para o comportamento na porteira. A característica, permanecer na puxada após a queda da rês, na categoria de atletas puxadores profissionais, existe em maior prevalência em ações durante a prova com 85,3% dos casos, enquanto a característica de direcionar a rês para a lateral da pista é realizada por 87,6% dos competidores. Para o conjunto utilizado para esteirar a rês, os valores das dimensões 1 e 2 foram de 96,56% e 3,43%, respectivamente, totalizando 99,9% da variância total dos dados com base nos critérios selecionados para o resultado final de "Valeu o boi". O uso da análise de correspondência múltipla no estudo de variáveis associadas ao sucesso em competições de vaquejada mostrou-se bastante eficaz, no que tange a diminuição do universo de elementos com maior peso de determinação no resultado final obtido.

Palavras-chave: Equideocultura; esforço; cavalo de puxar; cavalo de esteira.

1. Introduction

Data analysis plays a crucial role in enhancing the productivity of any livestock operation. Every year, numerous studies are conducted in Brazil and globally for this purpose. However, in horse breeding, the primary

outcome is not meat or milk production, but rather the animal's performance in equestrian competitions. In this situation, many factors beyond those related to breeding can impact the results, due to the unique dynamics of each modality. In these scenarios, in which many variables can affect the outcome, multivariate data statistics can be used

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<https://revistas.ufg.br/vet/index>

to simultaneously analyze all these variables involved, examining and describing their covariations and relationships ⁽¹⁾.

Vaquejada, a traditional sport in Brazil, combines horses and competitive athletes. It has a significant impact on the national economy and contributes to the growth of the country's horse population, which is one of the largest in the world ^(2,3). The horses used in these competitions face high demands, as they perform intense physical activity in a short time span, including a fast start, directional changes, unexpected stops, and need to have significant physical strength during cattle felling ^(4,5).

The relationship between humans and horses plays a crucial role in affecting the horses' performance and behavior in vaquejada, a popular sport in Brazil. Despite the popularity of vaquejada, there is a lack of proper animal management practices and research on animal behavior ^(5,6,7). Understanding the sport's dynamics and all factors that contribute to the success or failure of the "search and felling of cattle" during competitions is crucial for the training of athletes. Although several studies have shown the significance of the animals' physiological and biometric aspects in the practice of vaquejada ^(8,9,5), no research has explored the impact of the human-animal relationship on the performance of the horse-rider combination and its impact on the final competition results.

Multiple correspondence analysis is a multivariate analysis technique that graphically depicts the relationships between sport categories and various factors of the human-animal relationship during competition. This method reduces the complexity of the data set by quantifying the overall association between rows and columns of a matrix and illustrating the connection between the variables ⁽¹⁰⁾. The aim of this study was to examine the essential aspects of the vaquejada practice and identify all factors linked to the horse/rider combination that contribute to success in this sport.

2. Materials and methods

This study was conducted by analyzing public domain videos of vaquejada competitions, which had been approved by the Alagoana Association of Quarter Horse Breeders (*Associação Alagoana de Criadores de Cavalo Quarto de Milha - ALQM*) and took place in the latter half of 2018. The competitions adhered to the rules and regulations set forth by the relevant sport governing bodies, ensuring the welfare of the animals involved. Over three hundred (300) fence-knocking attempts were evaluated, with seventy-nine (179) performed by amateur/aspiring competitors and one hundred and twenty-nine (129) by professional competitors.

The judges were isolated in a room equipped with the necessary tools to watch the recorded material. Their

task was to assess the efforts of felling the cattle considering various aspects, including the behavior of the competitors, the horses used for cattle pulling, and the horses used for cattle tracking. The groups were divided based on the competition category, i.e., either amateur/aspirant or professional, and the type of animal used, i.e., either for pulling or tracking the cattle.

Considering the dynamics of this equestrian sport, various factors were identified that could impact success in the competition. These factors encompass aspects related to the competitors, the horses used for cattle pulling and tracking, as well as the relationship between the horse and rider. The aim is to determine which of these factors hold greater or lesser significance in determining a positive outcome in the competition. Thus, the elements considered in the study were arranged into two categories: variables related to the behavior and actions of the horse and rider while pulling the cattle, and variables related to the behavior and actions of the horse and rider while tracking the cattle, as shown in Table 1.

The data was initially subjected to a frequency analysis to determine the number of occurrences of the events listed in Table 1. Subsequently, these values were evaluated using a chi-square test to assess their significance, and to identify which events differ from their counterparts given the binary nature of the data. Characteristics that showed a significance level of $p \leq 0.10$ were selected and further analyzed through a multivariate analysis of multiple correspondences to determine which categories for each characteristic have the most significant impact on the final result.

A multiple logistic regression competition was conducted to evaluate the performances of both professional and amateur groups of vaquejada athletes, including both pulling athletes and tracking athletes. The results of the frequency analysis were divided by group and the variables were selected using the stepwise method. The aim was to determine the factors that influence the final result of the cattle felling validation, based on the behaviors performed during the vaquejada competition. The logit transformation of probability ($p \pi(x)$) or the link logit (logistic distribution) was used, which considers:

$$\ln n = \left\{ \frac{\pi(x)}{1 - \pi(x)} \right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k.$$

The multiple logistic regression model uses k independent variables, which can be either numerical or non-numerical, to predict the likelihood of a response to the dependent variable Y . This model is expressed as:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + \varepsilon$$

Table 1. List of variables considered in the study in relation to the categories of athletes and horses being evaluated.

Pulling Horse/Rider		Tracking Horse/Rider	
Feature	Result	Feature	Result
Running position	Left	Cattle movement	Yes
	Right		No
Gets out of the saddle during pulling	Yes	Guiding position	Back
	No		Side
Remains in the pull after the cattle falls	Yes	Manages to grab cattle tail and pull it off	Yes
	No		No
Directs the cattle in the competition track	To the side	Checks the cattle after felling	Yes
	To the middle		No
Appropriate behavior at the gate	Yes	Appropriate behavior at the gate	Yes
	No		No
Participates in the cattle movement	Yes	Participates in the cattle movement	Yes
	No		No
Calm behavior while guiding	Yes	Calm behavior while guiding	Yes
	No		No
Positioning during pulling	Diagonal	Positioning during pulling	Behind the cattle
	Perpendicular		Next to the cattle

In this specific case, in which the response is a binary qualitative, a Bernoulli-type Y random variable is considered, and only two values are used: "one" which represents success at the end of the competition, with a probability (of success) π , or "zero," which stands for failure in the vaquejada competition with a probability (of failure) $1 - \pi$.

The expected value for dichotomous data can be represented as the conditional mean and is defined as $E(Y | X = x) = \pi(x)$. Then:

$$E(Y | X = x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k = \pi(x)$$

as $E(Y | X = x)$ must be between zero and one, then: $0 \leq E(Y | X = x) \leq 1$ and

$$0 \leq \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k \leq 1 \leq 1$$

In this way, the multiple logistic regression model can be expressed as $Y = E(Y | X = x) + \varepsilon$, where:

$$E(Y | X = x) = \pi(x) = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k}}$$

The odds of one event occurring over another is called the odds ratio (OR) and is given by:

$$OR_j = \frac{\text{Odds}_{(j+1)}}{\text{Odds}_{(j)}} = e^{\beta_j}, j = 1, 2, 3, \dots, n$$

All analyses were performed using the Statistical Analysis System SAS version 9.0.

3. Results

Table 2 and Figure 1 indicate that for the pulling set in the professional competition category, only three characteristics had a significant impact: directing of the cattle

on the track, behavior while guiding, and positioning during pulling ($p < 0.10$). Meanwhile, in the amateur/aspiring category, two additional characteristics were found to be statistically significant: remaining in the pull after the cattle falls and the behavior at the gate ($p < 0.10$).

A second action that showed a statistically significant difference was the animal's pulling behavior while guiding the bull along the track, in terms of whether it was calm or distressed ($p = 0.063$). Concerning the position of the drafting horse during the action of overthrowing the cattle, for the professional category competitors ($p = 0.051$), they performed the movement perpendicular to it in 65.3% of the positive outcomes for the competitor.

An analysis of the data from amateur or aspiring pulling athletes reveals a pattern of similar behaviors as observed for professional pulling athletes. Specifically, 79.9% of these athletes do not stay in the pulling position after the cattle falls, 78.8% direct the cattle to the side of the track, and 91.6% of the pulling athletes in this category participate in moving the cattle on the track.

Considering the actions that showed statistically significant differences for pulling athletes in this category, the variable of how long the pull was maintained on the cattle after felling was identified ($p = 0.048$) with a prevalence of not performing this action in 74.2% of the analyzed presentations that resulted in a positive outcome for the competitor. The second variable with a statistically significant difference in the amateur/aspiring pulling category was guiding the cattle to the side of the track ($p = 0.082$), which was a contributing factor to the success of 83% of the analyzed presentations that had a positive result. This significance was also observed for the professional pulling category. The variable dealing with the appropriate behavior of the pulling horse at the exit gate of the chute at the beginning of each performance analyzed was significant ($p = 0.078$) for the pulling athletes in this category, but not for the professionals.

Table 2. Comparison between variables evaluated for the professional (Prof) and amateur/aspirant (AM/AS) categories according to a positive or negative result of “*Valeu o Boi* – the ox was knocked down” for the group of pulling in vaquejada

Feature	Feature Category	Professional category			Amateur/Aspirant category			
		No	(%)	p-value	No	(%)	p-value	
Running position	VB	Left	31	41.3	0.236	52	55.9	0.208
		Right	44	58.7		41	44.1	
	NVB	Left	28	48.2		56	65.1	
		Right	26	51.8		30	34.8	
Gets out of the saddle during pulling	VB	Yes	43	57.3	0.391	36	38.7	0.306
		No	32	42.7		57	61.3	
	NVB	Yes	35	64.8		27	31.4	
		No	19	35.2		59	68.6	
Remains in the pull after the cattle falls	VB	Yes	14	18,7	0.136	24	25.8	0.048
		No	61	81,3		69	74.2	
	NVB	Yes	5	9,3		12	13.9	
		No	49	90,7		74	86.1	
Directs the cattle in the competition track	VB	to the side	69	92	0.073	78	83.9	0.082
		to the middle	6	8		15	16.1	
	NVB	to the side	44	81.5		63	73.3	
		to the middle	10	18.5		23	26.7	
Appropriate behavior at the gate	VB	Yes	41	54.7	0.346	59	63.4	0.078
		No	34	45.3		34	36.5	
	NVB	Yes	34	62.9		65	75.6	
		No	20	37.1		21	24.4	
Participates in the cattle movement	VB	Yes	66	88	0.621	87	93.5	0.332
		No	9	12		6	6.5	
	NVB	Yes	49	90.7		77	89.5	
		No	5	9.3		9	10.5	
Calm behavior while guiding	VB	Yes	51	68	0.063	55	59.1	0.250
		No	24	32		38	40.9	
	NVB	Yes	28	51.8		58	67.4	
		No	26	48.2		28	32.6	
Positioning during pulling	VB	Diagonal	26	34.7	0,051	36	38.7	0.009
		Perpendicular	49	65.3		57	61.3	
	NVB	Diagonal	28	51.8		50	58.1	
		Perpendicular	26	48.2		36	41.9	

VB – *Valeu o Boi* – The ox was knocked down; NVB – *Não Valeu o Boi* - The ox was not knocked down.

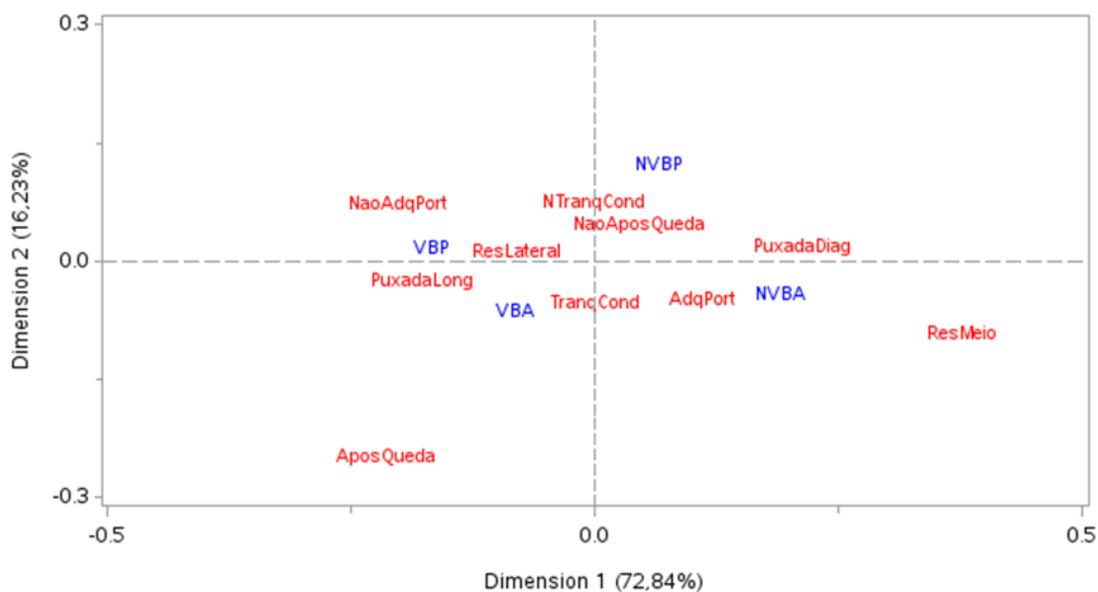


Figure 1. Representation of the correspondence analysis in a two-dimensional plane of the categories of the significant characteristics of the different groups: *Valeu o Boi* Professional Category (VBP), *Não Valeu o Boi* Professional Category (NVBP); *Valeu o Boi* Amateur/Aspirant Category (VBA) and *Não Valeu o Boi* Professional Category (NVBA).

Regarding the positioning of the drafting horse during the task of knocking out the cattle for competitors in the amateur/aspiring category ($p=0.009$), there is a prevalence of 61.3% executing it in a maneuver perpendicular to it in the performances that resulted in a positive outcome for the competitor. This is similar to what was observed for professional category competitors. Through correspondence analysis, two dimensions (dimensions 1 and 2) were identified, which explained 72.84% and 16.23% of the total data variance, respectively, amounting to 89.1% of the total variance based on the criteria selected for the "Valeu o Boi" end result (Figure 1). This results in a lack of explanation for only 10.9%.

After analyzing Table 3 and Figure 2, it has been observed that in contrast to the horse/pull rider sets, the horse/track rider sets have clear preferences and tendencies

with regards to nearly all variables that are directly associated with them. The only exception is the variable related to the involvement or lack thereof of these sets in the movement of the cattle, which showed similar proportions for both "yes" and "no" answers regardless of the category being considered and the end result obtained. The correspondence analysis allowed the discovery of two dimensions, (dimensions 1 and 2). These dimensions accounted for 96.56% and 3.43% of the total variance of the data, respectively, and together they explained a total of 99.9% of the variance. This is based on the criteria selected for the final outcome of "Valeu o Boi" (Figure 2). This result shows that the analysis was successful in capturing all variation in the data, making the results presented more reliable.

Table 3. Comparison of variables evaluated between the professional (Prof) and amateur/aspirant (AM/AS) categories according to a positive or negative result of "Valeu o Boi" for the tracking group in vaquejada

Feature	Feature Category	Professional category			Amateur/Aspirant category			
		No	(%)	p-value	No	(%)	p-value	
Cattle movement	VB	Yes	39	52	0.282	43	46.2	0.151
		No	36	48		50	53.8	
	NVB	Yes	22	42.3		33	35.9	
		No	30	57.6		59	64.1	
Guiding Position	VB	Back	16	21.1	0.599	6	6.45	0.984
		Side	60	78.9		87	93.5	
	NVB	Back	9	17.3		6	6.5	
		Side	43	82.7		86	93.5	
Manages to grab cattle tail and pull it off	VB	Yes	66	86.8	0.722	80	86.0	0.309
		No	10	13.2		13	14.0	
	NVB	Yes	44	84.6		74	80.43	
		No	8	15.4		18	19.57	
Checks the cattle after felling	VB	Yes	69	90.8	<.0001	89	95.7	<.0001
		No	7	9.2		4	4.3	
	NVB	Yes	27	51.9		47	51.1	
		No	25	48.1		45	48.1	
Appropriate behavior at the gate	VB	Yes	65	85.5	0.016	83	89.3	0.185
		No	11	14.5		10	10.7	
	NVB	Yes	51	98.1		87	94.6	
		No	1	1.92		5	5.43	
Participates in the cattle movement	VB	Yes	37	48.7	0.354	41	44.1	0.323
		No	39	51.3		52	55.9	
	NVB	Yes	21	40.4		34	37.0	
		No	31	59.6		58	63.0	
Calm behavior while guiding	VB	Yes	68	89.5	0.345	87	93.5	0.195
		No	8	10.5		6	6.45	
	NVB	Yes	49	94.2		81	88.0	
		No	3	5.77		11	12.0	
Positioning during pulling	VB	Behind the cattle	12	15.8	0.716	7	7.5	0.771
		Next to the cattle	64	84.2		86	92.5	
	NVB	Behind the cattle	7	13.5		8	8.7	
		Next to the cattle	45	86.5		84	91.3	
Immediate departure after opening of the gate	VB	Yes	35	46.1	0.386	51	54.8	0.198
		No	41	53.9		42	45.2	
	NVB	Yes	28	53.8		59	64.1	
		No	24	46.2		33	35.9	
Behavior while guiding	VB	Easy	68	89.5	0.054	78	83.9	0.542
		Makes it difficult	8	10.5		15	16.1	
	NVB	Easy	40	76.9		74	80.4	
		makes it difficult	12	23.1		18	19.6	

VB – Valeu o Boi – The ox was knocked down; NVB – Não Valeu o Boi - The ox was not knocked down.

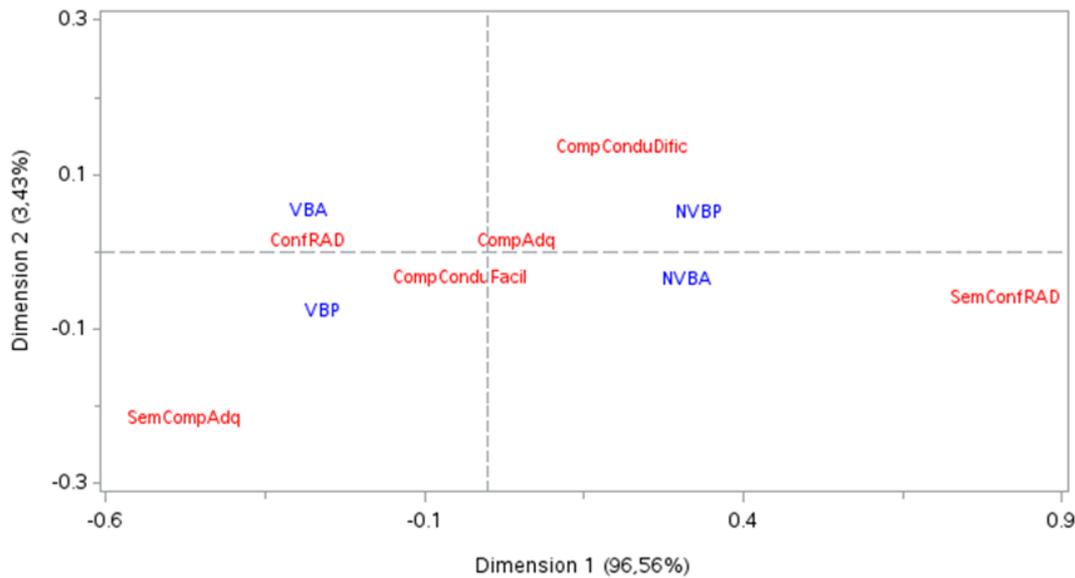


Figure 2. Representation of the correspondence analysis in a two-dimensional plane of the categories of the significant characteristics of the different groups: *Valeu o Boi* Professional Category (VBP), *Não Valeu o Boi* Professional Category (NVBP); *Valeu o Boi* Amateur/Aspirant Category (VBA) and *Não Valeu o Boi* Professional Category (NVBA).

For VBP, success in the vaquejadas competitions is significantly related ($p < 0.001$) to three factors: the act of staying or not staying in the pull after the fall, the direction of the pull, and the confirmation or not of the cattle after the takedown. The logistic models obtained for successful outcomes (*Valeu o Boi*), considering the variables studied for vaquejada competitions in the professional (1) amateur/aspirant (2) categories, for both pulling and tracking sets, were:

$$(1) VBP = P(Y = 1) = \frac{e^{-1,4095 - 1,6871APQ - 1,0183PX + 2,5681CRAD}}{1 + e^{-1,4095 - 1,6871APQ - 1,0183PX + 2,5681CRAD}}$$

$$(2) VBA = P(Y = 1) = \frac{e^{0,7341 - 0,8684PX - 1,2119CA - 1,8081CT}}{1 + e^{0,7341 - 0,8684PX - 1,2119CA - 1,8081CT}}$$

where VBP: professional *Valeu o Boi*, VBA: amateur/aspiring *Valeu o Boi*, APQ: remains in the pull after the fall (1=yes 0=no), PX: pull direction (1=diagonal 0=perpendicular), CRAD: confirmation of the cattle after felling (1=yes 0=no), CAP: appropriate behavior at the gate (1=no, 0=yes), CTC: calm behavior when guiding (1=no, 0=yes).

In the VBP logistic regression model, Somers'D, Goodman-Kruskal Gamma and Kendall's Tau-a indices were observed with values equal to 0.54, 0.68 and 0.27, respectively. As for VBA, the indices were equal to 0.34,

0.50 and 0.17, respectively, demonstrating an average to good predictive capability.

4. Discussion

It has been observed that among professional pulling athletes, certain behaviors are more common regardless of their success in pulling down cattle. One such behavior is not remaining in the pull after the animal has fallen, which was observed in 85.3% of all cases. Another behavior is directing the animal to the side of the lane, which was performed by 87.6% of the competitors. The third behavior is participating in moving the cattle along with the tracking rider, which was performed by 89.1% of professional pulling athletes in the 129 presentations analyzed. Regarding actions that have statistically significant differences in this category being analyzed, the practice of directing the cattle to the side of the track ($p = 0.073$) takes place during the guidance towards the designated felling area. This is done to increase the lateral displacement area of the horse used to pull the cattle and enhance its ability to provide a guiding force against the cattle's displacement, thereby increasing the chances of successful felling.

The vaquejada competition track has specific

measurements, with a minimum distance of 100 meters from the chute exit gate to the first signaling lane of the cattle felling area. This requires the rider to have control over their horse, as those who display calmness have a reduced chance of causing the cattle to prematurely move away from the scoring area. The results support this, as 68% of the presentations analyzed had riders with calm guidance, resulting in a satisfactory outcome for the competitor.

To succeed in overthrowing the cattle in a competition, it is crucial for the rider to abruptly move the horse away from the cattle in the designated scoring area of the track. If the horse moves diagonally along the path it was following, there is a prolonged delay for the rider until application of the maximum pulling force on the tail guard of the cattle, which increases the risk of it falling outside the scoring area. In contrast, a perpendicular movement by the horse accelerates the moment of traction and increases the chances of the cattle falling within the designated location.

It is worth mentioning that continuing to pull the cattle even after it has been knocked down is not a required action and does not result in any score bonuses for the competitor. Some use this action as a demonstration of their skill, but it can increase the risk of musculoskeletal injuries for both cowboys and their horses. Results of this study show that this practice should be discouraged among competitors as it offers no competitive advantages while increasing the risk of harm in competitions.

Professional competitors, due to their greater experience and skill, are able to correct any initial misbehavior of their horses during the presentation, thereby minimizing its impact on the final result. In contrast, this was not observed for amateur or aspiring pulling riders, for which a positive correlation was found for 63.4% of the successful presentations in this category.

The multivariate analysis in the study produces graphs that visually display the variables of interest and any deviations from the assumption of independence. These graphs reveal potential relationships and the way they occur, positioning the variables based on their association and similarity⁽¹⁰⁾. This is demonstrated through the correlation of the variables to the success or failure in overthrowing the cattle in the competitive categories analyzed. It was observed that the key factors for a successful performance were keeping the cattle in the center of the track and executing the pull at a diagonal angle. Conversely, the opposite characteristics showed a greater correlation with failure in the competitions. Additionally, remaining calm while guiding was found to be particularly crucial for the amateur/aspirant group in cases of negative results. The results of the multivariate analysis indicate that all selected characteristics had a significant impact on the final result. This method of

analysis is particularly valuable in situations in which many factors can influence the result, as not all of these have the same level of impact on the result⁽¹¹⁾.

The development of a horse is not solely determined by genetic factors. Environmental components, such as nutrition, health, and training, also play a significant role in shaping its performance⁽¹²⁾. The findings presented herein can serve as a useful reference for both coaches and competitors. Coaches can use this information to focus on the variables that have been shown to have a significant impact on the athlete's performance, while competitors can use it to decide the focus of their training and in the evaluation of which horses to ride.

As seen in Table 3, in the professional category, significant statistical differences were observed in the aspects of checking the cattle after felling, behavior at the gate, and the guiding behavior of the cattle. The role of the horse/rider set during the competition is to provide support to the pulling horse/rider through various actions. In this sport, the objective is to score by dropping the cattle within a designated area on the track. The act of checking the cattle after it has been felled, carried out by the tracking rider, is crucial ($p < 0.0001$) as it ensures that the cattle does not leave the designated area, thereby avoiding the associated loss of points.

Good behavior of a tracking horse at the chute exit gate ($p = 0.016$) improves the likelihood of a successful start in the race. This helps to prevent the cattle from becoming frightened and prevents it from deviating from the desired path along the side of the track. As previously shown in Table 2, the drafting horse's behavior significantly impacts the final result. Additionally, the third key characteristic that shows a significant difference in outcome for horse-rider combinations in the professional category - the behavior of the cattle during guidance ($p = 0.054$) - also contributes to the increased difficulty in guiding the cattle across the competition track. While the behavior pattern of cattle is a major factor that affects this variable, this is also closely linked to the actions of the tracking set. Correction of this behavior is primarily the responsibility of the set. In the amateur/aspirant category, only the variable of the tracking rider checking the cattle after felling ($p < 0.0001$) showed a statistically significant difference for positive results. This highlights the importance of coaches and competitors giving special attention to this aspect, as it also had significance in the professional category.

It is evident that an absence of confirmation of the cattle after it has been knocked down (SemConFRAD) and challenging guiding behavior are not conducive to a positive outcome, in both the amateur/aspirant and professional categories. Therefore, it can be concluded that when these two characteristics are present during a vaquejada competition, the result is likely to be

unfavorable for the "Valeu o Boi" metric. In contrast, the presence of confirmation of the cattle (ConfRAD) and an easy guiding behavior (CompCondFácil) are more closely associated with positive outcomes in both categories, showing a stronger correlation with positive results. It is intriguing to observe the complementarity between a multivariate and univariate statistical analysis in a study like this. As demonstrated in Figure 2, data from 10 variables and 2 competition categories were condensed into 2 factors that greatly influence the results, approaching 100%. One of these key factors is the act of examining the bull after it has been brought down, which is directly impacted by the training of the horse and the rider's guiding. Although the other relevant variable identified is related to the cattle's behavior, which may make it difficult for the riders to control it, the possibility of adjustments to this process along the racecourse is largely in the hands of the tracking rider, thus signaling to both trainers who prepare the animals and to the riders the importance of the horse/rider tracking combination in this process.

According to the results of a logistic regression analysis, the probability of an athlete achieving a positive outcome in a vaquejada competition decreases by more than 1.5 times (-1.6871) when they remain in the pull after a fall. These results are consistent with previous findings, suggesting that this technique is not conducive to positive results in either the professional or amateur/aspirant categories. An athlete who performs the pull in a diagonal direction (1) has a 36.1% chance of obtaining a positive result in a vaquejada competition (OR PX = 0.361), compared with those who perform the pull in a perpendicular direction, who have a 63.9% chance. The act of checking on the cattle after they have fallen, carried out by the horse and rider on the track, increases the likelihood of success in the competition by more than 2.5 times (2.5681), compared with instances in which this action is not performed.

For VBA, the odds ratio for inappropriate behavior of athletes at the gate is 0.298, meaning that when the odds ratio is equal to 1, there is a 30% chance of the result being positive in comparison to negative. In contrast, when the behavior is not calm while guiding, the odds ratio (OR CTC) is 0.164, meaning that the chances of the result being positive in comparison to negative is only 16%. Another significant factor that impacts the final result in the amateur/aspirant category is the direction of the pull, which increases the chances of failure by 42% and decreases the chances by almost one time (-0.8684) when compared with pulling in the opposite direction. The results of the logistic regression models for VBP and VBA reveal that the estimated models have a good predictive power. The model for VBP has a higher ability to predict success or failure in the competition, which could be due to the experience that professional athletes

have gained from their training in the sport. The model for VBA, in contrast, has medium to good predictive capability, as expected, given the limited experience of the participants.

5. Conclusion

Multiple correspondence analysis was used in this study to examine the variables associated with success in vaquejada competitions. The results show that this method was highly effective in reducing the number of elements that had the greatest impact on the outcome of the competition. The findings of this study can be used by coaches and competitors in vaquejada as a guide for focusing on certain actions during competitions that increase their chances of success.

Declaration of conflict of interest

The authors declare that there is no conflict of interest

Author contributions

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