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## Welfare assessment at a Spanish Army Equine Breeding Centre

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### ABSTRACT

The study aimed to assess the effect of two management housing system on breeding horse welfare. An adapted version of the assessment protocol for horses was used for that purposed to this study, with the focus on the animal-based measures section. This includes individual animal scoring of good feeding, good health and appropriate behaviour. The study was conducted in a professional Equine Breeding Centre with a representative set of housing and management systems and practices used for breeding purposes in Spain. A total of 49 stallions stabled individually and 43 broodmares living loose housing in groups were subject for individual scoring. A descriptive statistic for each welfare indicator was calculated. Pearson's Chi-square test or Fisher's test were calculated between the different welfare measures and the housing system. Odds ratios were computed to quantify the association of prevalence of welfare issues with husbandry and management practices according to the type of housing. The stallions were almost two and a half times more at risk than mares to exhibit acceptance to the chin contact behavioural test. Broodmares were prone to present significant lower body condition scores (BCS). The prevalence of rubbed and broken hairs in mane and tail (OR = 4.413), gait abnormalities (OR = 5.429), skin lesions in upper and lower legs regions (OR = 2.691) was higher in stabled animals. In contrast, broodmares presented more often with general skin lesions, specifically in withers-back-barrel-girth (OR = 0.349), hindquarters (OR = 0.016) and skin irritation in lower legs (OR = 0.287). The risk factor analysis applying a multivariable logistic regression model disclosed the way that the group housing freedom system management predicted significantly the prevalence of three animal based indicators deviations: one behavioural indicator (fear to the novel object test), one feeding indicator (lower BCS) and one health indicator (harm in lower legs).

### HIGHLIGHTS

- The effect of management housing system on breeding horse welfare could be evaluated using a protocol with special focus on individual animal scoring of feeding, health and behaviour.
- The major welfare problems identified in the horses housed in individual boxes were associated with confinement and could be minimised with better management of the access to free exercise.
- The source of fear and aggression in horses living in pastures can greatly improve with intensive and correct human handling and providing sufficient feeding resources.

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## Introduction

The role of horses, like for many other domestic species, gets shaped through history by world human needs (Popescu et al. 2019). While in lower middle-income nations horses are primarily used as working animals (e.g. transport and traction), the European

horses are mainly used in the sport industry or recreational purposes (Visser et al. 2014).

Depending on how humans use horses, these animals have had to adapt onto several environmental conditions and husbandry practices. Rearing breeding horses requires serious considerations on how exactly

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the environment and horsemanship affect equine well-being and mental health (Popescu et al. 2019). Concerns with protecting animals from negative experiences such as pain, discomfort, fear and stress that can arise from inadequate housing, feeding or management (Casey 2002) should be addressed; and also facilitate their behavioural needs and maximise positive welfare effects that might increase the safety and performance level of breeding horses.

The housing system offers complex environmental conditions for the everyday living of the housed animals (Popescu et al. 2019). Around the world, stallions are housed in single stalls (stall-tying is considered as a common method). Although group housing is gaining more and more ground, especially for young horses and where stable groups are possible since the restriction of social interaction and locomotive behaviour can reduce animal welfare in this gregarious species (McBride and Hemmings 2009). In contrast, mares are kept in free housing in groups. Even where the mares are turned out alone in a flat, non-stimulating environment (Ladewig 2013), at least they have access to free movement. But, they might require intervention if best provision of resources to fulfil their species-specific needs are not met (Popescu et al. 2019).

The Spanish Army has traditionally been dedicated to the breeding and conservation of different horse breeds at the country level, covering some national demands of cryopreserved semen, fresh semen or *in situ* stallion performance across the country, thus forming a very significant element of the Spanish equine breeding sector.

There is a general lack of data about the welfare of breeding horses (Campbell and Sandøe 2015). Yet, little research is found in how different types of housing affect breeding horses (Popescu et al. 2019).

Assuring a certain level of welfare for horses requires the assessment of welfare on a standard and regular basis and, if needed, improvement of housing and management practices. The aim of this observational study was to evaluate two breeding systems at an Equine Breeding Centre and the effect of them in the welfare of breeding horses determining the risk factors on each system.

## Material and methods

This research is in full compliance with all relevant codes of experimentation and legislation.

The observational study was conducted in an Equine Breeding Centre belonging to the Spanish

Army located in the Southern of Spain (Seville) during the fall (November, 2013).

## Animals

The stallions ( $n = 49$ ) were housed in individual boxes in a main barn and the breeding mares ( $n = 43$ ) were kept in free housing in groups. The broodmares groups at the time of the welfare assessment were composed by 23 pregnant mares, and 20 non-pregnant mares, both of them living in contiguous pastures.

Stabled stallions and group housing broodmares were assessed for their welfare as well as collecting the data to characterise the housing system. The average population age was 9 years old with Spanish Purebred horse (also known as Andalusian Horse) as the predominant breed, or crossbred with English and Arabian breeds. The second main breed was English-Arabian for the stallion and Spanish-Arabian breed for the broodmares.

The purpose of the study population was breeding. However, some stallions were regularly ridden for research purposes to test the best genetically sport qualities inheritable, related to the demand of semen service of each stallion. The broodmares had an average of 20 h of free exercise; however, none of them were pursued for sport.

All the procedures handling the animals were carried out with the consent of the Spanish Army, in accordance to ethical internal guidelines.

## Reproductive and health management practices

During the breeding season (May–July), stallions get semen collections three days per week. Non-pregnant broodmares get daily reproductive examination, which is done during the morning feeding routine (concentrate ration) time when they are tethered during the breeding season. The pregnant mares are examined once a month during the gestation period, while the non-pregnant mares were examined weekly out of the breeding season. The fall was the most convenient season to carry out the study because human intervention is minimal due to the little demanding for semen, as well as most of the mares were pregnant at that time of the year.

All horses got health inspections and receive preventive treatments. The scheme consisted in a four-monthly deworming and biannual vaccination, an annual dental cheques. Stallions were shod every 6–8 weeks and the broodmares were left barefoot to

avoid injuries or group aggressions. Yet, their hoofs were checked and trimmed as necessary almost every 8 weeks.

### **Welfare assessment**

The protocol used in this study was based on the method defined in the Welfare Quality<sup>®</sup>, which includes animal-based measures (ABM, the animal itself), resource-based measures (RBM, the animal's environment or available resources) and management-based measures (management practises) that are grounded on twelve welfare criteria and four welfare principles (Blokhuys et al. 2010). The 'Assessment protocol for horses' (Wageningen UR Livestock Research 2011) was applied in this study and complemented with two behavioural tests to assess human-animal relationship, including a 'human approach test' and a 'chin contact test' as described by Burn et al. (2010).

The observational study was performed by the same observer who is a veterinarian experienced in horses (first author). The observer pre-tested the protocol with a group of horses, which were not part of the present study. The pre-test allowed optimising the animal evaluation time and recording. The majority of the ABM and RBM were recorded by direct observation of the horses and their environment in one occasion. The horses belonging to each housing system of the study were observed in the same day of the week to ensure similar environmental conditions.

### **Animal-based measures**

#### **Behavioural indicators**

The stallions were evaluated in their boxes in the early morning after feeding, with the assistance of a handler. The routine of tethering the mares individually for feeding in the barn facilities helped to perform the behavioural assessment for each animal with the assistance of a handler. The observer (first author) who performed all behavioural tests was not familiar with the animals.

Fear responses were evaluated including a novel object test using a Rubik's cube (Wageningen UR Livestock Research 2011). Animals were challenged by the object's presence. While horses were interacting, they were on a loosely lead rope, and were allowed to walk forward or turn away. Responses were scored as follows: 'curiosity-interest' (horses stretched their necks immediately or took a step forward if necessary to sniff or touch the cube), 'fear' (horses turned their

heads or bodies far away from the cube in a cautious manner or walked away from the cube) and 'neutral-indifference' (horses did not stretch their necks forward, neither stepped onwards).

In order to assess the human-animal relationship, two tests following the method of Burn et al. (2010) were carried out. The responses to the 'human approach test' were categorised as 'interest-kindness' (horses moved or turned their heads towards the observer in a friendly manner, and in addition reached out or sniffed the person); 'neutral-indifference' (the body positions were relaxed, no movements towards or away from the observer or only ear moving directed to the person without turning their heads); 'mild threat or aggressive' [horses did not make any other movement towards the observer, yet displayed threatening behaviours such as ear flattening or different threatening or aggressive movements towards the person (including any attempt to kick or bite, with the head turned towards the human person)]. The category of 'avoidance/fear' was excluded from the study. It is justified partly by the results of the pre-testing, where none of the animals responded by turning away from the observer or showing any complete fear reaction to the human presence (Søndergaard and Halekoh 2003).

Regarding the chin contact test, the observer slowly placed their hand under the animal's chin and assessing if the horse accepted or avoided the contact. The responses were classified as 'acceptation' or 'non acceptation' of human contact.

The welfare criteria called 'expression of other species-specific natural behaviours' was assessed by abnormal behaviours: crib-biting, wind sucking, weaving, box walking, head nodding, tongue playing, door kicking and wood chewing. These type of abnormalities were recorded when there was observed evidence. The observer confirmed 'crib biting' by the observation of the incisors during the teeth examination of the animals.

#### **Feeding indicators**

Given the limited number of ABM corresponding to good feeding, we considered relevant to assess and include other ABM related to other welfare principles. Together with BCS, the presence of feeding lumps (non-swallowed lumps of hay that look a bit like bird nests that are found in the stall or in the horse's paddock due to chewing problems) and dental condition (wear pattern incisors, molar hooks, teeth missing) were included in the analysis for good feeding (Supplementary Table S2).

The BCS assessment consisted in the Carol and Huntington score system (Carroll and Huntington 1988) ranged from 0 (very poor) to 5 (very fat). This system evaluated broodmares and horses separately. However after the pre-testing, none of the animals presented very poor (0) and poor (1) as well as very fat (4) scores. In consequence, those scores were merged in three score as follows: thin-moderate (2), normal (3) and fat (4).

The 'teeth condition' includes in the same indicator the wear pattern of incisors, molar hooks development, teeth missing, etc. The teeth condition is checked on each animal (with the assistance of a handler gently spread the upper and lower lips from each other) in order to look for abnormalities that possibly affect (negatively) the animal feed intake.

We considered suitable to explore feeding lumps (alteration in the skin that are indicative of having problems with feeding) as an ABM for good feeding. This indicator cannot be generally applicable in-group housing. However, in this study, broodmares were tethered daily and all animals were observed after the feeding concentrate time. This advantageous circumstance facilitated the feasibility to perform this indicator.

### **Health indicators**

The assessment of the good health was performed by a non-invasive approach through clinical examination of a total of 15 ABM. Observations were categorised as present/absent or giving a score (see [Supplementary Table S2](#)). Skin lesions/alterations were recorded as present or absent and the number of injuries per body area was also recorded. Four body areas were considered as markers (muzzle-head-neck and shoulder, withers-back-barrel and girth, hindquarters and upper and lower legs).

### **Management and RBM**

A total of eight management and RBM from the 'Assessment protocol for horses' (Wageningen UR Livestock Research 2011) were feasible to apply in this study. Their notation (i.e. access to free exercise, feeding regime, cleaning of the bedding) are briefly described in [Supplementary Table S1](#).

As part for the welfare assessment, a short questionnaire covering key aspects of the farm structure (i.e. housing) and the daily management was carried out with the animal manager.

The public and the individual safety areas and dimensions were measured, as they could indirectly cause injury risk and influence health outcomes.

The ease of movement welfare criteria was determined by measuring the area of each box and the height at the withers recorded in the Stud Books, using the relation in the equitation ( $2 \times$  height at the withers) to compare with the surface area of the inside areas of the boxes. In the pastures, the density of animals was measured (the maximum number of horses using the same area), as well as the available area to move freely and large enough for a small sprint (minimum of 5 gallops).

The thermal comfort and the comfort around resting were determined by examination of the resting areas to observe if they had sufficient dry and clean places to lie down. Bedding conditions were examined (cleaning frequency, type and amount of bedding material) and, specifically in the loose housing system in groups it was evaluated the access to shelter (including trees, bushes) in case of precipitation, wind and/or sun.

### **Statistical analysis**

Bivariate associations between housing conditions and the prevalence of ABM deviations were calculated by performing Pearson's Chi-square test or Fisher's test. The odds ratios (OR) and their respective 95% confidence intervals (95% CI) were computed to quantify the association between the housing system and the risk of welfare issues.

Indicators significantly associated with housing system ( $p \leq .25$ ) were considered candidate variables to be included in a multivariable logistic regression model. Manual model-building selection was conducted for the development of the multivariable logistic regression model. All main effects and two-way interactions terms were evaluated as potential predictors. A  $p$ -value of  $<.05$  was used as retention criteria. As a first step we compared all the possible models with just one variable by the Akaike Information Criteria (AIC) value. To the model with the lowest AIC value and one predictor, we included all the remaining covariates one by one, and compared then base on the AIC value. This process was repeated until the model with the lowest AIC was obtained. Finally, confounding was assessed by monitoring the changes in the model parameters when adding new variables. If substantial changes (i.e. higher than 20%) were observed in the regression coefficient, this was considered as indicative of confounding. The goodness of fit was evaluated by calculating the Hosmer-Lemeshow statistics (Kleinbaum et al. 2013). The confusion matrix was used to determine how correctly the model classified the housing system for each observed animal. The

potential risk factors were grouped using statistical methods traditionally put in practice in veterinary epidemiology (Robinson et al. 2010), field in which associations between measures and risk factors do not necessarily refer to causal relationships.

All statistical analysis were performed using the SPSS software package version 15.

## Results

### **ABM risk prevalence associated to the housing system (odds ratios: OR)**

Welfare issues of nine ABM, two for appropriate behaviour, three for good feeding and four for good health were linked significantly to a housing system that increased the risk of occurrence (Supplementary Table S3).

The single loose boxes system increased significantly the risk of occurrence of the following indicators: presence of feeding lumps, normal teeth (feeding), acceptance in chin contact test (behaviour) and lameness, and general skin lesions, specifically in upper and lower legs (health). In contrast, five indicators were associated to the loose housing system in groups: fear responses to novel object (behaviour), lower BCS (feeding) and harm lower legs and general skin lesions, specifically in three body areas: (withers-back-barrel-girth, hindquarters and upper and lower legs) (health).

The loose housing system in groups increased the occurrence of fear response to a novel object (OR = 0.051), while the housing systems did not affect the responses to the human approach test. Likewise, animals stabled individually allowed the chin to be touched more often than the loose housing system in groups (OR = 2.481).

The single loose boxes system was associated with some health and feeding scores: presence of feeding lumps (OR = 14.903), rubbed and broken hairs in mane and tail (OR = 4.413), normal teeth condition (OR = 2.487), and gait abnormalities (lameness, OR = 5.429). The OR data evidenced that the stable housing system increased each welfare score and issues' risk, as follows: more than double (normal teeth and absence of upper and lower legs skin lesions), more than four times (broken hairs), more than five times (lameness) and up to 14 times (presence of feeding lumps). Moreover, the loose housing system in groups was associated with deviations of ABM related with feeding and health, such as lower BCS (OR = 0.054), harm in lower legs (OR = 0.287), and injuries mainly distributed in all body areas (withers-back-barrel and

girth including genital areas) (OR = 0.349) and the hindquarters (OR = 0.313).

### **Management and RBM**

The stallions were kept in individual loose boxes of same dimensions (2.81 m wide × 2.86 m deep) with straw as bedding material. The boxes had a barrier on the door to impede placing or moving horses heads, so they only had partly possibility for providing visual horizon, and only possibilities to sniff and visual social contact. All the boxes included automatic drinkers installed (1.15 m water height) and individual cribs (1.02 m height).

The feeding regime commonly include three feeding occasions per day with concentrate (supplying concentrate plus ground oats), plus once a day forage (oat hay) just before the midday concentrate.

Stall cleaning were carried out daily. Bed is removed and replaced by fresh new bedding material. Every day the stallions got one hour of exercise in a horse walker, and some of them were also trained for sport purposes (leisure and jump).

The broodmares lived in large professional stables. Loose housing in groups had direct access to pastures (area: 15,000 m<sup>2</sup>) divided into two different groups according to their reproductive status: non-pregnant and pregnant. Animals could place the head between the barriers that split the pastures, so they had full possibilities to broaden its visual horizon as well as fully groom for social contact. Regarding comfort around resting and thermal comfort there were sufficient access and space in the shelter and share.

The broodmares groups were guided freely daily to tie-in barns for individually feeding during the morning time (4h approximately). The concentrate individual ration was given twice, at the beginning and at the end of the morning respectively, just before the time to release back to their pastures. There were not possibilities to graze, so the hay (oat and alfalfa) was provided once a day in three feeding troughs in each pasture in enough quantity (*ad libitum*) for the whole day. They also had two free water troughs for each group that were cleaned and checked every day.

### **Multivariable logistic regression analysis between housing system and ABM**

Three indicators, fear responses to novel object, low BCS and presence of harm in lower legs, representative for each welfare principle (good feeding, good

**Table 1.** Factors associated with group housing system quantified using a multivariate regression model.

Animal-based measure	B (beta)	Standard error (SE beta)	Odds ratio	95% Confidence interval	<i>p</i> Value
Intercept	0.953	0.714			
Novel object test					.023
Fear*	-3.075	1.124	0.046	0.183–2.601	.006
Indifference	-0.369	0.677	0.691	0.004–0.418	.586
Body condition score					.041
Thin moderate*	-2.682	1.141	0.068	0.007–0.640	.019
Fat	0.263	0.557	1.301	0.436–3.877	.637
Harm lower legs*	-1.337	0.527	0.263	0.093–0.738	.011

\**p* < .05.

health and appropriate behaviour) were included in the best fitting model for loose housing system in groups (see Table 1). No interactions were found between two or more of these variables. The results of this model do not suggest a lack of fit with the Hosmer and Lemeshow test ( $p = .90$ ).

The prevalence of the fear responses to the novel object test, lower scores of BCS and the harm in lower legs were associated with loose housing system in groups. The model correctly classified 37.5% of the stabled horses and 40.0% of the free housing horses, with an overall success rate of 38.1%.

## Discussion

This study provides the first step necessary for gathering data knowledge on how living conditions affect welfare in breeding horses. These results might describe significant differences due to the specific influencing factors and risk factors involved and pursued tasks which breeding horses are subjected to. However, this observational study does not cover all the factors that might affect different outcomes such as sex or age of the sample animals.

The commonly thinking that stable horses had less welfare than the ones on free housing has been supported by Giupana et al. (2017). They found the highest maximum welfare scores were obtained in the broodmares kept in extensive (mostly free housing) comparing to the stallions (kept in tied housing). Some results of this study were in line with our study like the higher prevalence of lameness in stabled horses (Giupana et al. 2017).

In this study, the housing system used for broodmares increase the risk of occurrence of some welfare issues. Our findings have had in consideration the management/resource based measures of good housing, and how the human husbandry practices could be influencing in some poor welfare states in loose housing system in groups for the interpretation: competition for the food (lower BCS), fights (harm lesions in groups), and worse human horse relationship (fear responses). In addition, it should be emphasised that

some of these ABM have high relevance for breeding horse's populations (i.e. genital skin lesions and BCS differences for stallions and broodmares).

## Prevalence of behavioural responses

The behavioural observations included in this study were used to give some insights on horse's responses to routine management practices, identifying fear or threat and how they perceived interactions with people. Fear horse responses can be caused not only by the stimulus novelty, also by negative experiences associated with the stimulus itself (Leiner and Fendt 2011). It has been suggested that animals displaying fear are often exposed to adverse handling procedures (Rousing et al. 2001). However, although fear tests have been described as predictive of perceived safety when handling a horse (Leiner and Fendt 2011), there is missing information in the robustness of the test (Forkman et al. 2007). In this study, the interpretation to the novel object test studied is multiple. Fearful reactions in the group housing population might indicate that the management has not been adequate since animal aversion can result in fearing people in general or an individual in particular (Rushen et al. 1999). Moreover, inappropriate reactions such as aggressive and temperamental behaviours could also be related to an inadequate animal handling (Grandin 2002). In contrast, the higher indifference to the novel object test in horses in single loose boxes suggest an early habituation to different causes that generate stress or novelty, leading up to situations of complete fearlessness when facing a completely new object.

The human approach test, walking beside or chin contact have been identified as appropriate to evaluate good human-animal relationship (Søndergaard and Halekoh 2003; Pritchard et al. 2005; Burn et al. 2010). The tested of the loose housing system in groups in the present study responded (most frequent) with fear aggression while horses in single loose boxes ranged from curiosity to indifference. One possible explanation for the different responses may have to do with the fact of not handling the head of

horses in painful or stressful procedures (Pritchard et al. 2005; Burn et al. 2010). Regarding the chin test, the most frequent response of acceptance in the single loose boxes system might indicate that horses did not perceive contact as a threat as reported in other studies in breeding horses (Popescu and Diugan 2017) contrasting with fear and rejection of contact in loose housing system in groups. In fact, it could also point to the desire of receiving physical contact due to the habituation of horse to a human hand feeding with different goodies, as more than a half of the horses single loose boxes showed a curious response. Therefore, the consistency cropped up between the responses of two behavioural tests consolidate that the type of housing system affected human-animal relationship.

Some characteristics of the domestic horse environment could act as potential stressors by limiting specific natural behaviours, such as feeding and locomotion restrictions, and imposing social isolation (McBride and Hemmings 2009). Environments lacking incentives and providing little or no opportunities to express natural behaviours can be responsible for the development of abnormal behaviours (Hothersall and Casey 2012) as evidenced in the present study. This is the case of stabled animals associated with suboptimal environments (Cooper and Albentosa 2005) as they are highly social animals with a strong herd preference. Contact with other peers plays an important role in equine welfare which might have represented an advantage for group housing population of the present study.

The type of housing that can allow or hinder their natural behaviour can affect the social structure of horses. Daily free movement is beneficial to the maintenance of the health. Horses who can freely move outdoors are more balanced, because they can realise their need to be on the move and gait, social and natural feeding behaviour. Daily work and training and the use of horse exercisers do not replace the need of free movement (Due 2006). These facts could have influenced the prevalence of abnormal behaviour only found in the stallions in single boxes.

### ***Prevalence of welfare issues on feeding***

An optimal body condition in horses does not always imply that the eating/grazing/foraging needs have been entirely met (Dalla Costa et al. 2014). High-energy diets do not guarantee that food restriction and eating frustration risk in stable horses could not happen. In the other side, dietary green fodder cannot

always deliver an optimal provision of the physiological needs (i.e. vitamins and minerals). This fact, although unexpected, is nevertheless in line with our study when animals living in groups and having free access to hay were found to display a higher risk of being thin. Furthermore, the poor BCS is used as an indicator of a reduced protection to body lesions condition (Henneke et al. 1983); therefore, leaner animals dispose of less natural filler or protection. The fact that more than half of the horses in single loose boxed evidenced a good BCS has been reported by others studies (Swann 2006), which describe hip point injuries attributable to horses' inadequate support surfaces (small bed, uneven surfaces) as a major hip point injury risk factors. The mentioned finding are in line with this study where the combination of mares staying outdoors overnight without resting areas and mares with (more common) lower BCS scores might result on hindquarters injury risk (OR = 0.313). Another possible explanation of a higher number of lean animals due to the lower quality pasture (during the autumn season in Southern Spain) is consistent with other studies (Ayele et al. 2006). In contrast, the broodmares had free access to a greater variety of forage and that resembles more its natural behaviour. Thus, the differences found in this study could be associated with feed competition in the loose housing in groups system. This risk factor could be decreased with different management practices such as making groups of animals attending to the BCS, or dispersing more widely the hay in several amounts, or by separating the animals of lower social rank for daily individual food ration. The season did not influence the BCS, as the animals target of this study had the same feeding management during the whole year.

The prevalence of good BCS was significantly higher in the stallions compared with the broodmares, like in other studies (Popescu and Diugan 2017). In the stallions, the proportion of concentrate in the diet is much higher, necessary for their special energy requirements for the sport, so they could be more satiated (higher presence of feeding lumps). Moreover, for stabled horses, feeding satisfaction is considered mainly a welfare issue that can be assessed by bed and crib inspection together with after lunch rest behaviour appraisal (Ninomiya et al. 2004). For this reason, we have considered the presence of food traces as a housed animal satiety estimator which exhibited the highest OR (14.903). In addition, the individual housed animal dental problems such as missing teeth or malocclusions are closely related to the ability to cope with genetic disorders and



environmental stress during growth (Parés-Casanova and Morros 2014). The prevalence of normal teeth condition in the stallions could be associated with other welfare indicators, like good BCS presented in these animals, as well as the established health management practices (dental care).

In addition, behaviour changes and feeding lump presence are found to entail housing as a risk factor. Interestingly, other studies (Visser et al. 2014) have also found that horses housed in smaller stables and daily fed with concentrates were less likely to develop an increased body condition (overweight), which agrees with our results.

### **Prevalence of health disorders**

The increased body lesions in loose housing system in groups could suggest biting or/and kicking activities which help to create and maintain long lasting dominance hierarchies (Knubben et al. 2008). Literature has reported that different herd mixtures or group composition changes may lead to increased aggressive behaviours, with a higher bite and kick related injury incidence (Knubben et al. 2008). Therefore, the presence of injuries is also indicative of poor resources, high stock density, and/or feeding competition. In this sense, Ross and Dyson (2010) concluded that aggression in herds of domestic horses rely heavily on management factors that can be reduced by management intervention.

During the wet autumn pasture, the high parasite burden causes skin irritations in the limbs that might develop more harm legs in animals with access to pasture as observed in this study. These lesions can be decrease significantly if the grasslands are mowed annually in order to reduce parasites burden (Labruna et al. 2001). In contrast, hairless patches and thickening of the skin on the mane and tail were more prevalent in horses from loose boxes. A plausible explanation of our findings is the seasonal influence and insect hypersensitivity since is the most common cause of equine pruritus (Perris 1995). Sampling representativeness across the year including summer season is needed to establish firm conclusions in this factor. In this line, some studies have been able to describe relationships between welfare and a set of different stress indicators in two seasons (Popescu and Diugan 2017).

Limb conformation abnormalities and hoof problems can cause an inappropriate gait (Ross and Dyson 2010). This situation combined with signs of neglect, defective hoof trimming and inadequate shoeing can

increase the risk of lameness. Limping, the incorrect hoof axis or pressure on heel parts besides ligament and/or tendon tensions and swellings might lead eventually to a permanent abnormal gait (Hill and Klimesh 1996). The lack of comfort around resting which also include insufficient stable dimensions are other factors and explain increased limb injury incidence in the loose boxes system. This finding has been consistent with other studies (Raabymagle and Ladewig 2006). Moreover, housing has been associated with depression and lack of response, which could result from injury and pains such as gait disturbance or back pains (Broster et al. 2009). The studies carried out by Cooper and Albentosa (2005) found evidences that back problems were strongly associated with lameness. On the other hand, according to Pritchard et al. (2005) limb problems were slightly correlated with gait disorders. Injuries, resulting from abnormal movement, increase the chance of horses of hitting their limbs which explains the association of lameness to the system of single boxes.

### **Conclusions**

The study evidence negative effects on the welfare of the animals and risk factors that are system-specific. The identification of different risk factors show opportunities to make positive changes in housing management and husbandry practices that could improve the welfare of breeding horses. The major welfare problems identified in the stallions were associated with confinement (i.e. broken-scratching hairs, lameness) and could be minimised with better management of the stallion's access to free exercise. The welfare issues recorded in mares were behaviour-related and reflected problems in the human-horse relationship. The source of fear and aggression can greatly improve with intensive and correct human handling. The other main welfare problem identified in mares (lower BCS and harm in lower legs) could be controlled by protecting lower social rank animals and providing sufficient resources. Other factors related to the individuals (i.e. age, sex) could be explored further.

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