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A survey assessment of the incidence of fur-chewing in commercial chinchilla (Chinchilla lanigera) farms

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Abstract

Chinchilla lanigera *intensive breeding programmes are affected by an abnormal repetitive behaviour called 'fur-chewing', yet the aetiology is still unknown and little scientific work has been published on this condition. Recent studies have supported the idea that fur-chewing is a stress-related behaviour. In the present study, we used a questionnaire survey in order to: 1) describe general aspects on the epidemiology of fur-chewing in Argentinian farms, and 2) identify which management and/or environmental factors within the breeding facilities may be influencing the occurrence of fur-chewing. The survey consisted of 28 questions focused on farm characteristics, environmental variables and husbandry routines, and was distributed to Argentinian chinchilla farmers. All quantitative variables were tested in a multiple logistic regression model. The mean incidence of fur-chewing was 4.32 ± 0.37% (n = 107 farms). Variables negatively related to fur-chewing were the breeder experience in the activity, the total volume of the facility, and the number of wood shaving changes per week. Positive relationships were found for space index, number of rooms in the facility and presence of different rooms for fur production and reproduction. Other tendencies suggested that farms with the presence of external sound disturbance nearby had higher incidence levels. Also, we detected a tendency towards lower numbers of affected animals with an increment in the provision of dusting baths per week. Finally, results suggested a female prevalence in the development of the behaviour.*

Keywords: *animal welfare, behaviour, chinchilla, fur-chewing, questionnaire survey, stress*

Introduction

The chinchilla, a South American hystricomorph rodent, possesses one of the most valuable pelts in the world. A hybrid of two chinchilla taxa (*Ch. lanigera* and *Ch. brevicaudata*) has been domesticated, bred and selected for fur quality, colour and growth rate (Grau 1986). However, the establishment and maintenance of intensive captive breeding programmes lead to the description of a behaviour usually called 'fur-chewing' (or 'fur-biting'). Fur-chewers will chew their own fur either constantly, or at intervals, usually at their hips and sides about half-way down the length of the hair. If the chewer is paired, they tend to chew the fur of the other chinchillas and their offspring as well (Rancher´s Handbook 1987). Although some individuals may stop the behaviour, the fur recovery is generally uncompleted and the affected animals have to be eliminated (Rancher´s Handbook 1987; Tisljar *et al* 2002).

The occurrence of this phenomenon seems to vary markedly from farm to farm: on some farms, fur-chewing is not observed at all whereas in others it affects the animal stock on a large scale (Tisljar *et al* 2002).

Fur-chewing has caused endless discussions over the years and various hypotheses have been postulated as probable causes. Yet the aetiology of the problem is still unknown, and little scientific work has been published on this animal condition. Forwarded theories are: 1) malnutrition; 2) bacteriological, mycological and parasitological causes and 3) stress caused by a variety of (environmental) causes.

One of the earliest theories was that the affected animals suffer from malnutrition and chew their fur to meet their dietary requirements. Studies were performed taking into account diverse nutritional factors such as proteins, amino acids and unsaturated fatty acids. In no case have such claims been proven to be the complete answer to fur-chewing (Rancher´s Handbook 1987). Moreover, recent works have described the absence of chewed fur in the gastrointestinal tract of affected animals (Rancher´s Handbook 1987; Tisljar *et al* 2002).

Bacteriological, mycological and parasitological examinations did not reveal significant findings. The skin under the affected body area was non-pruritic, there were no scabs around the patch of missing fur, the animal appeared to be healthy and the fur, where present, was in good condition (Tisljar *et al* 2002).

Some authors have suggested that this behaviour may be induced by inappropriate environmental conditions,

boredom, or stress (loud noises, proximity to crowded streets, visits by guests or other animals) (Mösslacher 1986; Rancher´s Handbook 1987; Merry 1990; Jenkins 1992; Tisljar *et al* 2002). Furthermore, chinchilla breeders have observed that fur-chewers have a tendency to be more 'nervous and excitable' and that sudden changes in the environment (such as shipping, changing diet, etc) may result in an increase in the proportion of affected animals (Vanjonack & Johnson 1973).

A few studies have clearly supported the hypothesis that fur-chewing is a stress-related behaviour: Vanjonack and Johnson (1973) reported an increased thyroid and adrenocortical activity (confirmed by histopathological findings) in affected animals. More recently, Tisljar *et al* (2002) corroborated the development of adrenocortical hyperplasia.

The development of this abnormal behaviour as a sign of probable poor welfare, emphasises the need to assess the adequacy of captive conditions and management strategies in chinchilla farming. However, identifying deficiencies in a captive environment that may be relevant to the development of abnormal behaviours can sometimes be extremely difficult. Mellen (1994) suggests that the use of surveys may be the most effective way of evaluating a range of housing facilities and management strategies. Furthermore, broader surveys across multiple institutions should reflect the true situation more accurately (see Mason *et al* 2007). Many researchers have successfully used this approach (Bashow *et al* 2001; Kobelt *et al* 2003; Tarou *et al* 2005).

Based on the hypothesis that fur-chewing is a stress-related behaviour triggered by a variety of environmental/management factors, we used a questionnaire survey in order to: 1) describe general aspects on the epidemiology of fur-chewing in Argentinian farms, and 2) identify which management and/or environmental factors within the breeding facilities may be influencing the occurrence of fur-chewing.

Materials and methods

Data collection and questionnaire

A complete survey was distributed to a convenient sample of Argentinian commercial chinchilla farm owners through direct mailing and publication of the questionnaire in a pre-existing, local specialised breeders web page (www.infochin.com.ar). The questionnaire was developed based on personal examination of the breeding facilities and affected animals from a focus group of chinchilla breeders, which also highlighted factors they had major concerns about. The final questionnaire consisted of 28 multiple choice questions with two to six choices or yes/no answers, focused on specific farm characteristics, environmental variables and husbandry routines including total number of animals in the farm, number of affected animals, sex of fur-chewers, management strategies on housing, cleaning and feeding, etc (see Table 1; questions 1 to 18). Some of the questions also required that the breeder indicate personal appreciations about presumed aspects of the fur-chewing behaviour (questions 19 to 28).

An introductory page was also provided with the questionnaire containing a description of the aims of the study and advising that personal and identity information would remain confidential to protect from the potential economic repercussions of being revealed as having a high percentage of fur-chewers within the breed line. Other than that, only complete sheets were included in the study.

In order to determine the possible sex differences in the development of fur-chewing, a sub-sample of selected breeders (n = 10 breeders, 7,898 animals) were personally instructed to provide the exact proportion of sexes in the farm (as well as the number of those developing the fur-chewing behaviour); this was done because several times a year, chinchilla breeders replace unproductive or aged individuals and incorporate new ones to the animal stock, but fail to keep a clear record of this constant rotation of animals and therefore it is difficult to obtain a clear response about the number of males and females bred.

Animals

Domestic *Chinchilla lanigera* (males and females aged 3 months or greater) were considered for this study. Animals in farms have access to pelleted food and water *ad libitum* and they were exposed to natural fluctuations in photoperiod and controlled temperature (20–25°C). Wood shavings were used as substrate in the cages and a spoonful of calcium carbonate or marble powder was added on a regular basis to allow the animals to perform a 'dust bath' to keep the fur dry and uncompressed.

All animals were individually housed in stainless steel cages (0.50 × 0.32 × 0.30 m; length × breadth × height), and bred in two different systems: 1) for animal production (a polygamous system of sexually mature animals [8–10 months old] is used consisting of one male for every five-six females. Female cages have a corridor in the back allowing the male to enter any of the family females cages); 2) for fur production (usually only males are used and they are housed individually. Both systems are used either in one single room or in different rooms, according to the farm space availability).

Although all animals are placed in the same sized cages (one per cage), a greater number of animals (and therefore cages) in a reduced space may result in a crowded environment (ie 10 animals m^{-3} is not the same as 30 animals in the same space). Therefore, we developed a 'space index', which is the result of dividing the total volume of the breeding facility (in m^3) by the number of animals in stock. The resulting space index for each breeding facility was then studied in relation to the percentage of fur-chewing in each farm.

Statistical analysis

Of all the questions in the survey, 14 variables generated data for quantitative statistical analysis, 10 were treated as categorical variables (those for which personal appreciations are permissible) and in 5, the responses were so variable that were not used for further statistical analysis.

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Table 1a Questionnaire survey on fur-chewing behaviour distributed to Argentinian chinchilla farmers.

Questions	Respondents' options	Rationale of the question
Section 1: Breeding facility characteristics and management practices		
1. In what year did you actively start to breed chinchillas?	–	The general experience acquired with time in breeding chinchillas is believed to be an important factor for appropriate management ie an experienced breeder will detect health, nutritional or management problems sooner. Answers were categorised as whether it was more or less than 4 years previously as this is deemed the amount of time taken to acquire the requisite skills.
2. How many animals do you breed?	–	
3. What are the dimensions of your breeding facility?	Height Length Width	Although all animals tend to be placed in cages of the same size, a large number of animals in a reduced space can lead to overcrowding, therefore we developed a'space index' (total volume in m^3 of the breeding facility/number of animals in stock) and related it the prevalence of fur-chewing on each farm.
4. Total number of rooms?	a) One b) Two c) Three d) Four or more	Some farms have all the animals located in a single, large room whilst others locate animals in a number of different rooms.
5. Different rooms designated for fur or reproduction?	a) Yes b) No	Some farms may have different rooms for animals depending whether they are destined for fur production or breeding whilst others breed all animals in one or various rooms.
6. How many rows high are animals kept?	a) Three b) Four c) Five d) Six e) Seven or more	Cages are placed in rows along the breeding facility and piled on top of each other. The greater the number of rows the more crowded the column of cages.
7. Ventilation type?	a) None b) Natural c) Roof ventilators d) Air extractors	
8. Is ambient temperature controlled	a) Yes b) No	
9. Is ambient humidity controlled?	a) Yes b) No	
10. What system of personnel management is used?	a) Permanent b) Rotative	Chinchillas are believed to be highly sensitive to the presence of unfamiliar individuals within the facility and, therefore, rotative personnel may result in undue stress to the animals.
11. What type of feedstuff is used?	a) Pelleted b) Hay c) Others	
12. How many times per week are the wood shavings changed?	a) One b) Two c) Three or more	
13. How may marble powder baths are performed per week?	a) One b) Two c) Three or more	
14. Is a radio left on all day within the breeding facility?	a) Yes b) No	Some breeders leave a radio on all day inside the farm as they believe it may mask the outside noises or make animals less susceptible to unfamiliar sounds.
15. Is there any form of constant noise or source of vibration in the proximity of the facility?	a) Yes b) No	A source of loud noises in the proximity of the farm may disturb the animals. Loud sound is known to be stressful.

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Table 1b Questionnaire survey on fur-chewing behavior distributed to Argentinian chinchilla farmers.

Questions	Respondents' options	Rationale of the question
Section 2: Fur-chewing incidence		
16. How many animals in your facility are fur-chewers at the moment?	–	
17. How many of these are males?	–	
18. How many of these are females?	–	
19. Generally on which rows do the fur-chewing animals end up being placed?	a) High b) Medium c) Lower d) Spread out	
20. To your criteria, from what approximate age is fur-chewing likely to develop?	–	
21. To your criteria, what sex develops the behaviour more often?	a) Males b) Females c) Both equally	
22. Have you noticed that breeding females show this behaviour?	a) Yes b) No c) Unsure	Many breeders maintain that breeding females show a greater tendency to demonstrate fur-chewing behaviour.
23. Have you noticed breeding females chewing on their pups' fur?	a) Yes b) No c) Unsure	
24. If this is the case do you separate the mother and pup(s)?	a) Yes b) No c) Unsure	
25. In instances where the pup has been separated does its level of affection improve?	a) Yes b) No c) Unsure	
26. Regarding the mother does affection disappear after separation?	a) Yes b) No c) Unsure	
27. Do you believe that neighbouring animals supply this affection?	a) Yes b) No c) Unsure	Some breeders maintain that fur-chewing is a behaviour that is learned or imitated by the neighbours of a fur-chewing animal.
28. In cases where an animal is affected by fur-chewing what is your approach?	a) Immediately sacrifice the animal b) Attempt to recover the animal	

To take into account possible correlations between all variables, the statistical analysis was performed using a multiple logistic regression model. Logistic regression explicitly investigates the effect of each independent variable controlling for the effects of all others; variables included in the model were those obtained from questions 1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16, 17 and 18. A backward selection procedure was used in order to obtain a reduced model. Values were expressed as mean ± SEM. All *P*-values less than 0.05 were considered statistically significant. Statistical procedures were performed with the software program Infostat (Infostat 1.1 version [2000], Grupo Infostat, National University of Córdoba, Argentina).

Results

After a detailed examination of affected animals, we considered that there are four intensity levels in fur-chewing behaviour development: 1) slight (only a few tufts of hair are chewed); 2) moderate (one of the sides or hips is extensively chewed); 3) severe (both sides of the body or hips are chewed) and 4) very severe (all the fur in regions of the body the animal can reach are chewed) (Figure 1).

Out of 145 total surveys returned, one hundred and seven were correctly completed, representing a total of 36,091 farmed chinchillas. The mean percentage of occurrence of fur-chewing in the surveyed farms was 4.32 ± 0.37% (range 0–16.7%; n = 107).

All quantitative variables were tested in a multiple logistic regression model and Table 2 contains data related to the results applying a backward selection process, including regression coefficients, Wald statistics and significance for all significant variables. Six of the 14 variables included in the model were significant ($P < 0.05$). Variables negatively

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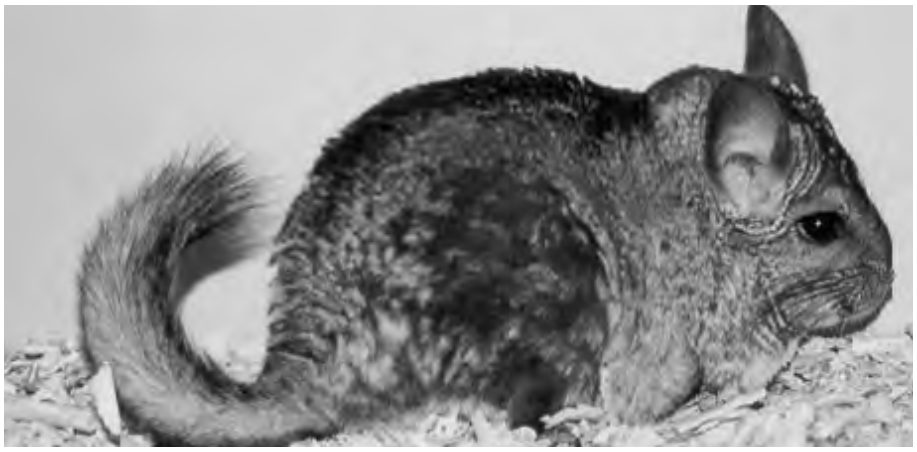
Figure 1

Domestic *Chinchilla lanigera* with differering levels of fur-chewing behaviour: a) Slight.

b) Moderate.



c) Severe.

d) Very severe.

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Table 2 Multiple logistic regression analysis of chinchilla fur-chewing behaviour related to environmental and management factors.

Variable	Coefficient	SE*	Wald-chi squared	*P*-value
Constant	–2.465409	0.169202	212.307737	< 0.0001
Breeder experience	–0.020860	0.005700	13.391949	0.0003
Total volume of the facility	–0.001341	0.000199	45.398010	< 0.0001
Space index	0.292476	0.109665	7.112896	0.0077
Number of rooms in the facility	0.216937	0.096563	5.047185	0.0247
Existence of different rooms for fur production and reproduction	0.291523	0.0076028	14.702851	0.0001
Number of wood shaving changes per week	–0.282166	0.124882	5.105118	0.0239

* Only statistically significant factors are presented.

related to fur-chewing were the breeder experience in the activity, the total volume of the facility, and the number of wood shaving changes per week. Positive relationships were found for space index, number of rooms in the facility and presence of different rooms for fur production and reproduction.

Also, there were two variables included in the multivariate model that, although not significant, showed tendencies worthy of mention: a lower percentage of fur-chewing animals was reported in farms providing more than one marble powder bath a week (one: 4.73 ± 0.6% [n = 45]; two: 4.34 ± 0.6% [n = 42]; three: 3.08 ± 0.5% [n = 20]). On the other hand, results related to the presence of a loud noise source in the proximity (ie crowded street, repair shop, barking dogs, etc) or inside the farm (ie some breeders leave a radio on all day to attenuate the outside noises), suggested that there are a higher percentage of fur-chewing animals in farms with a loud noise source nearby (5.22 ± 0.4% [n = 41] vs 3.81 ± 0.7% [n = 66]); however, leaving a radio on inside the facility did not affect the incidence of fur-chewing.

Although there is a level of variability in the responses about observations and management strategies followed by breeders towards fur-chewing behaviour, 74.4% try to recover the affected animals.

Finally, from the total number of animals reported as fur-chewers in the 107 surveys (n = 1,188), 58.7% were females. Likewise, 65.8% (n = 54) of the farms had a greater number of females afflicted with the behaviour than males (n = 28); the rest of the farms had equal numbers of affected males and females (n = 25). Furthermore 66.6% of breeders noticed that breeding females are more prone to development of the behaviour.

However, these results are based on absolute numbers; taking into account the proportion of affected males and females, the results of the sub-sample of selected breeders indicated that (n = 7,898 animals): females represented a 65.2 ± 1.3% of the total farm population whilst males a 34.8 ± 1.3% ($P = 0.001$). Although the differences did not reach statistical significance, a higher percentage of females developed the fur-chewing behaviour (4.12 ± 1.2% vs 1.7 ± 0.6%; $P = 0.08$).

Discussion

Fur-chewing is one of the most challenging behavioural problems common to captive chinchillas; it is not only responsible for considerable economic losses but is also believed to reflect a deficiency in the animals' captive environment (Rancher´s Handbook 1987).

Animal welfare has become an important standard by which animal production farms are judged by the public, and therefore efforts are being made to improve the well-being of captive chinchillas. However, recommendations regarding fur-chewing are anecdotal, and included changing the location of affected animals, spraying the chewed region with bitter tasting substances, mechanical prevention with collars, etc (Rancher´s Handbook 1987).

Therefore, this study was designed as the first phase of a larger project, to provide a description on how chinchillas are managed in Argentinian farms, what physical and social conditions are provided, and the possible relationships between behavioural problems and those factors.

Results of this survey showed that on Argentinian farms approximately 4% of the inhabitants of a breeding facility develop the disorder. This represents potentially in excess of 20,000 animals affected a year in Argentinian farms alone (the annual production has been estimated at 500,000 animals; Barletta *et al* 2004).

Few studies have described the incidence of fur-chewing in other countries; a study in Croatian farms revealed that 15–20% of the population may develop the behaviour (Tisljar *et al* 2002), while pelt-biting is observed in 3–7% of the stock in Dutch farms and in 10–30% of the American pelts exported (Rees 1962; EC 2001).

In our study 6 risk factors influencing fur-chewing development were identified, including breeder experience in the activity, total volume of the facility, space index, number of breeding rooms, allocation of different rooms for fur production and reproduction and wood shaving changes per week.

Regarding breeder experience, it is widely accepted that breeding chinchillas is a complex practice, and a breeder can only be considered experienced after a few years (3 to

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4) in the practice. The length of time spent involved in the practice of chinchilla management provides the knowledge and skills needed for quick and accurate detection of management/health problems therefore leading to individuals better prepared to avoid the potential stresses of such conditions. This possible interpretation is reinforced by the observation that most experienced breeders will not hesitate to immediately sacrifice affected animals (Ponzio personal observation 2005), hence applying better genetic selection upon the animal stock.

Most of the factors found to be significantly related to fur-chewing reflect differing aspects of crowding (ie total volume, space index, number of animals, etc). According to our results and, in contrast to what might normally be assumed, higher crowding is related to lower percentages of animals displaying the behaviour.

Rodents have been reported to demonstrate a variety of behavioural and physiological changes depending on their stocking density. In early studies, rearing in higher stocking density had been assumed to disturb the appropriate establishment of social relationships (Gregor *et al* 1970; Butler 1980; Vestal & Schnell 1986) and increase aggression (Poole & Morgan 1973) and exploratory behaviour (Syme 1973). However, some studies have reported no effect of stocking density (Greenberg 1972; McGregor & Ayling 1990; Armario *et al* 1984) or even a reverse effect (Bronson 1963; Hull *et al* 1976; Gamallo *et al* 1986). In mice, stocking density and the number of mice in the cage did not affect barbering (Garner *et al* 2004a); a similar behaviour to fur-chewing in chinchillas. Although chinchillas are reared in individual cages, they are in very close olfactory, auditory and visual contact with their neighbours and therefore the population density could be clearly perceived by the animal. In other rodents such as mice, it has been well described that the population density perceived by the animal can be much higher than merely the number of cagemates (Garner *et al* 2004a).

A possible interpretation of our results can occur when the chinchilla's social organisation in the wild, as well as certain rodent specific behaviours, are taken into account. Chinchillas live in colonies of up to 500 animals (Jimenez 1995) and it has been described that rodents are highly motivated to remain under cover (Garner *et al* 2004a). Thus, a crowded environment may provide them with a sense of protection from possible predators that, in turn, decrease the incidence of fur-chewing behaviour.

With respect to management strategies, a negative association was found with respect to the number of wood shaving changes per week. Also, although not statistically significant, we detected a tendency towards lowered numbers of affected animals relative to an increment in the number of dusting baths per week. Unlike other animals, each chinchilla fur follicle produces approximately 60 hairs (Wilcox 1950). Maintenance of fur in good condition and without humidity may be an important factor in avoiding the physical discomfort of the animals. Likewise, dustbathing has been documented in several rodents including the chinchilla, and is apparently a behavioural mechanism that is involved in the regulation of oil secretions in the pelage (Borchelt *et al* 1976; Griswold *et al* 1977; Randall 1981; Barber & Thompson 1990; Ebensperger 2000) and in social communication with conspecifics (Eisenberg 1963). In the chinchilla, dust baths may play a similar role. A study performed on Dutch farms, where chinchillas were allowed to use a sand bath during 4 hours each day, revealed that the animals spent nearly all the time possible in the sand bath (Kersten 1997); laying hens responded to dustbathing deprivation with increased corticosterone concentration and stereotypical picking (Vestergaard 1997). Therefore, providing frequent or permanent access to a dust bath may help alleviate the development of fur-chewing.

Another possible association, which could not be demonstrated with the logistic regression model, suggested that farms subjected to a degree of external sound disturbance had higher incidences of fur-chewing. The effects of noise upon captive animals and humans have been broadly characterised as stressful; indeed, noise exposure is used as model of stress (Westman &Walters 1981).

Only a few other earlier studies have highlighted the impact of stress on the development of fur-chewing in chinchillas: Vanjonack and Johnson (1973) reported an increased corticosteroid activity (confirmed by histopathological findings) in fur-chewing animals. More recently, Tisljar *et al* (2002) corroborated the development of adrenocortical hyperplasia.

Comparison of this abnormal behaviour with similar disorders described in other species might provide a better understanding of the problem. Self-plucking is described in many mammalian and avian species (Grindlinger 1991; Luescher *et al* 1991; Mason 1994; Nielsen 1996; De Jonge 1988; Hansen *et al* 1998; Mon-Fanelli *et al* 1999; Malmkvist & Hansen 2001; Wielebnowski *et al* 2002; Hierden 2003; van Meehan *et al* 2003; Garner *et al* 2004b; Honess *et al* 2005); they all share the characteristic whereby a normal behaviour is implemented in an inappropriate and repeated manner and are forms of impulsive/compulsive behaviours (Mason 1993; Mon-Fanelli *et al* 1999; Garner *et al* 2004 a,b).

Similarly, fur-chewing in the chinchilla resembles an exaggerated form of grooming in which the fur is chewed rather than simply groomed. Kraft (1994) found that the clinical signs seen in fur-chewing chinchillas are very similar to those of birds suffering from feather-picking, including the repetitive self-plucking of fur/feathers.

In general, these kinds of goal-directed repetitive abnormal behaviours where the fur/feathers are self-removed have been linked to the human obsessive-compulsive disorder (OCD) (Mon-Fanelli *et al* 1999; Garner *et al* 2004b) and trichotillomania (Bordnick *et al* 1994; Stein *et al* 1994; Garner *et al* 2004b). The latter has a strong female bias (Christenson 1995), and symptoms may worsen premenstrually or during pregnancy (Keuten *et al* 1997). In mice (Garner *et al* 2004a) and cats (Mon-Fannelli *et al* 1999) these kinds of behaviours occurs more frequently in

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females. Our results in chinchilla seem to parallel this reported sex bias.

Animal welfare implications

Given similarities in performance and aetiology with impulsive/compulsive behaviours in other species, we suggest that fur-chewing in the chinchilla may be a similar behavioural disorder, reflecting multifactorial processes in which the interaction between external (environmental) and internal (animal) factors affect its occurrence. Abnormal repetitive behaviours generally arise in barren environments; nevertheless, the specific cues that lead to the abnormal behaviour, the underlying motivational basis and the best environmental enrichments to prevent the behaviour are very species specific. In this study we were able to shed light upon some of the possible factors affecting the fur-chewing behaviour in the chinchilla, which must be taken into account in order to improve the welfare of the captive stock. According to our results, breeding farms should give special attention to factors such as breeder experience, stocking density, the cleaning of cages and dust bath provision, in order to avoid a higher occurrence of fur-chewing behaviour. Also, they may consider adding access to occupational materials or increased stimulation such as hay sticks, pieces of wood to chew and permanent dust baths.

Considering these results, future works should be focused on the elucidation of the motivational basis for the behaviour and the effects of enrichment strategies.

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