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Reproductive performance and weaning success in fur-chewing chinchillas (*Chinchilla lanigera*)

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ABSTRACT

In captive chinchillas, one of the most challenging behavioral problems is the development of a stress-related abnormal repetitive behavior (ARB) known as "fur-chewing". We investigated whether there is a relationship between the severity of fur-chewing behavior and reproductive function in male and female chinchillas. Regardless of the severity of abnormal behavior, fur-chewing males did not show significant differences in seminal quality (sperm concentration, motility and viability; integrity of sperm membrane and acrosome) and the response to the process of semen collection (the number of stimuli needed to achieve ejaculation) when compared to those with normal behavior. Also, females showing normal or fur-chewing behavior presented similar reproductive performance in terms of number of litters per female per year and litter size. However, pup survival rate was lower ($p = 0.05$) in fur-chewing females than in normal females. These results seem to be consistent with data suggesting non-significant effects of ARBs on reproductive performance.

1. Introduction

Although fur-chewing behavior was initially described 40 years ago [1], it was only quite recently recognized as a stress-related behavior triggered by a variety of environmental or management factors in the captive environment. For example, such behavior has been associated with an increased adrenocortical activity (increased plasma corticosterone and adrenocortical hyperplasia) [2,3]. Recently, we described a number of factors that may contribute to the development of the abnormal behavior in domestic chinchillas (i.e., crowding, number of wood shaving changes per week, dustbathing, etc.) and hypothesized that fur-chewing behavior in the chinchilla is caused by management/environmental stress factors and/or lack of natural stimuli in the caging conditions [4]. We provided additional evidence to support this concept, and suggested that a clear female sex bias exists in the expression

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of this behavior: females that exhibited the most severe form of fur-chewing excreted elevated concentrations of urinary cortisol, which suggested that the expression of this behavior was mediated, at least in part, by physiological stress. Furthermore, those females demonstrated increased anxiety-like behavior associated with the elevated plus-maze test (e.g., decrease in the percentage of entries and time spent in open arms, increase in freezing behavior) [5].

In addition to influencing the expression of abnormal behaviors, stress and a corresponding increase in glucocorticoid production can also be associated with compromised reproductive function. Although a wealth of literature exists about the effects of glucocorticoids on reproduction [6–10], few studies have focused on the inter-relationships between abnormal repetitive behaviors and reproduction. Whether or not reproductive function is altered in fur-chewing chinchillas is still a matter of debate. Although precise information on the underlying basis of chinchilla fur-chewing is currently ambiguous, the development of this behavior in commercial farms and the related economic loss, the possible reduced welfare of affected animals and the increasing popularity of this species as pet, have all increased the public demands for more information on this pathology. Therefore, the objective of this study was to examine the reproductive function in the affected male and female chinchillas.

2. Materials and methods

2.1. *Animals, housing and management*

Sexually mature domestic chinchillas (*Chinchilla lanigera*) with proven fertility were used in this study (age range: 2–4 years). The selected animals exhibited either normal behavior or fur-chewing behavior of different intensity, categorized as follows: (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 that the animal can reach are chewed [4].

The fur-chewing animals were obtained from local commercial breeding farms where they are usually sacrificed by breeders because while some individuals may stop the behavior, the fur recovery is generally uncompleted, the pelt therefore has no economic value and the affected animals finally have to be eliminated [1,6]. Therefore, the affected animals used in the current study were collected from different farms and taken to our chinchilla breeding facility. After transportation, the animals were observed for at least one month before the study onset, and were assessed by an experienced researcher to determine the fur-chewing intensity. The animals had access to pelleted chinchilla food (Chinworld, Escobar, Buenos Aires, Argentina) and water ad libitum, as well as they received a cube of compressed alfalfa weekly. The chinchilla were exposed to ambient photoperiod and controlled temperature (20–25 °C) and were housed in individual stainless steel cages (width: 0.32 m; height: 0.30 m; length: 0.50 m) with wood shavings as substrate. Females were maintained in a polygamous breeding system, in which individual female cages have a corridor in the back allowing the male to enter any of the family females' cages when the corridor gate is open by the researcher/breeder. Males were housed individually in cages of the same size as females. A tablespoon of marble powder was added to the substrate of each cage on a regular basis so that animals could perform a "dust bath" to keep the fur dry and uncompressed. The housing, environmental and management conditions were the same as those used in commercial breeding farms. All experiments were conducted in accordance with the National Institutes of Health's Guide for the Care and Use of Laboratory Animals.

2.2. *Evaluation of reproductive function in males*

Semen quality was assessed weekly in normal ($n = 6$) and fur-chewing ($n = 18$) chinchilla males. A total of three semen samples were collected and assessed for each animal. Weekly values were then averaged to derive baseline seminal traits for each male. Semen was obtained by electroejaculation, and selected sperm parameters were assessed immediately and after 4 h of in vitro incubation to account for the overtime quality of the sample [11–16]. The examined sperm parameters included semen volume, sperm concentration, motility and viability, as well as the integrity of sperm membrane and acrosome (swollen spermatozoa and viable acrosome intact sperm, respectively) [11–16]. Due to the fact that particularly nervous animals often need more stimuli to achieve ejaculation (sometimes they do not ejaculate at all), the number of stimuli needed to achieve ejaculation and the effectiveness of the electroejaculation (number of electroejaculations per week resulted in an ejaculation/total number of electroejaculations × 100) was also recorded.

2.3. *Examination of reproductive function in females*

Fifteen chinchilla females exhibiting severe or very severe fur-chewing behavior were studied in this experiment. The females were maintained in a polygamous reproductive system and one behaviorally normal male was used for every five females. Reproductive performance for each female was evaluated over one year, allowing the male to mate with the females for the entire period (estrus and post-partum estrus), as it is usually on commercial farms. The examined reproductive parameters included: number of litters produced per female per year, litter size and weaning success (percentage of pups surviving through weaning; 60 days of age). Comparative data from behaviorally normal females were obtained from six local commercial breeding farms, which provided full reproductive databases for the preceding 5-year interval. Only females that delivered a litter during the study period were included in this comparison ($n = 1452$ females).

2.4. *Statistical analysis*

All values were expressed as mean ± SEM. Data analysis was performed using the Infostat statistical software package (Di Rienzo J.A., Casanoves F., Balzarini M.G., Gonzalez L., Tablada M., Robledo C.W. InfoStat versión 2012. Grupo InfoStat, FCA, Universidad Nacional de Córdoba, Córdoba, Argentina; URL http://www.infostat.com.ar). Modified Shapiro–Wilks