

Short Communication

Hair Phosphorus Concentration is Age-Dependent in Adult Cats

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Abstract

We measured mineral concentrations in hair of adult cats to gather information about their changes with age. Forty-seven cats aged one to twelve years were classified into three age groups (adolescence, adulthood, and middle scene) depending on their development and physical functions. Cats were kept individually in cages indoors in the same environmental conditions. They were randomly fed one of ten ordinary cat foods commercially sold in Japan. The amount of cat food provided was based on the body weight. Hair samples were collected from the neck by using a razor. The levels of Mg, P, K, Ca, Fe, Mn, Cu, Zn, Se, and Mo in the hair were detected by ICP-MS. A significant positive correlation was observed in adult cats between hair phosphorus concentration and age ($r = 0.453$, $n = 47$, $P < 0.01$). The hair P concentration of cats in middle scene was significantly higher (mean = 6.54, SD = 1.72, $n = 12$) than those of the other two age groups (mean = 4.67, SD = 1.44, $n = 12$, for cats in adolescence and mean = 5.01, SD = 1.62, $n = 23$, for cats in adulthood; both $P < 0.05$). Thus, the P concentration in hair changed with the age of adult cats.

ABBREVIATIONS

ICP-MS: Inductively Coupled Plasma Mass Spectrometry; SD: Standard Deviation

INTRODUCTION

To examine mineral metabolism, generally feces and urine of animals are collected using metabolism cages. However, confining animals to a small cage with a wire-mesh base carries the risk of injury to feet and legs as well as psychological stress. In order to overcome these problems related to animal welfare, alternative methods such as modified litter boxes have been studied [1]. On the other hand, if concentrations of minerals in hair are useful indicators of mineral excretion, their measurement is non-invasive for the animals and relatively easier to collect than feces and urine. Therefore, we measured mineral concentrations in hair of adult cats fed a variety of ordinary cat foods to obtain information about their changes with age.

MATERIALS AND METHODS

Twenty-nine male and 18 female mongrel cats aged one to twelve years were examined. They were classified into three age groups depending on their development and physical functions: adolescence from 1 to 2 years old ($n = 12$), adulthood from 3 to 7 years old ($n = 23$), and middle scene from 8 to 12 years old ($n = 12$). This division of age was based on the correspondence between a cat's chronological age and the age of a human in reference to the six periods of age in humans: infancy from 0 to 4 years old, childhood from 5 to 14 years old, adolescence from 15

to 24 years old, adulthood from 25 to 44 years old, middle scene from 45 to 64 years old, and advanced age from 65 years old [2]. The body weights of cats in each age group were comparable (adolescence: 3.6 ± 0.4 kg, adulthood: 3.7 ± 0.4 kg, middle scene: 3.4 ± 0.2 kg).

Cats were kept individually in two-level wire cages (width 450 × depth 600 × height 700 mm) indoors. They were reared under the same environmental conditions (light 12 h from 7.00 and dark 12 h from 19.00; room temperature: $23 \pm 2^\circ\text{C}$). In the morning (9.00–12.00 hours), they were provided with one of ten randomly chosen ordinary cat foods commercially sold in Japan. The amount of cat food provided was based on the body weight. They could access water freely. All rearing management and experiments were conducted in accordance with approval from the Experimental Animal Welfare Committee of Kitayama Labes Co., Ltd.

Hair samples (approximately 0.5 g) were collected from the neck by using a razor to cut the hair as close to the skin as possible. Hair samples were wiped with ethanol and washed with hot (50°C) distilled water, and then dried. Each dried sample (0.1 g) was placed in a capped tube containing 8 mL 60% nitric acid and micro waved (Speed wave two; Bergh of Products + Instruments) for 20 min ($250\text{ W}, 180^\circ\text{C} \times 5$ minutes; $400\text{ W}, 180^\circ\text{C} \times 5$ minutes; $500\text{ W}, 180^\circ\text{C} \times 5$ minutes) including the cooling-down period of 5 min. Finally, dissolved samples were diluted 500-fold or 5500-fold with distilled water and subjected to inductively coupled plasma mass spectrometry (ICP-MS: ICPM-8500; Shimadzu Corp.). In this study, concentrations of 10 minerals (Mg, P, K, Ca, Fe, Mn, Cu, Zn,

Se, and Mo) in hair were measured. Pearson correlations were performed to determine the relationship between hair mineral concentration and age. For multiple age group comparisons, the Tukey-Kramer test was applied when one-way ANOVA indicated differences among the groups.

RESULTS AND DISCUSSION

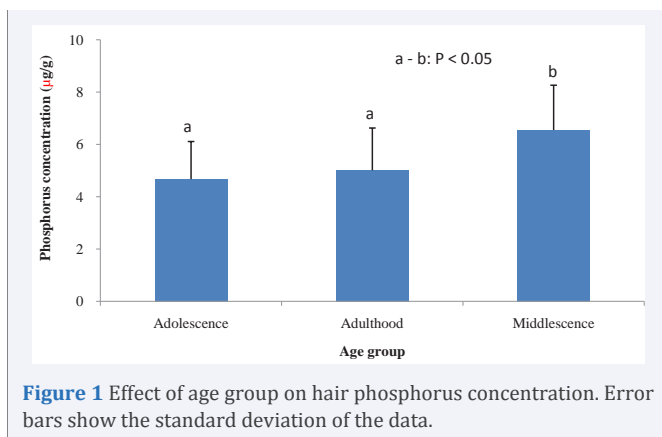
A significant positive correlation was observed in adult cats between hair phosphorus concentration and age ($r = 0.453$, $n = 47$, $P < 0.01$) (Table 1). The hair P concentration of cats in middlescence was significantly higher (mean = 6.54, SD = 1.72, $n = 12$) than that of the other two age groups (mean = 4.67, SD = 1.44, $n = 12$, for cats in adolescence and mean = 5.01, SD = 1.62; $n = 23$, for cats in adulthood; both $P < 0.05$) (Figure 1). The concentrations of other minerals in hair did not show significant correlations with age and differences between age groups (Table 1).

The results indicate that the concentration of only

Table 1: Pearson correlations in hair mineral concentrations of cats by age.

Mineral	Correlation (r)	Significance
Mg	-0.151	0.310
P	0.453	0.001
K	-0.195	0.188
Ca	-0.143	0.339
Mn	-0.011	0.941
Fe	-0.186	0.209
Cu	0.258	0.080
Zn	-0.054	0.719
Se	-0.095	0.527
Mo	0.144	0.334

n = 47



phosphorus among the ten minerals examined changed in hair of adult cats with age. Urolithiasis, which is composed of struvite, a magnesium-ammonium-phosphate complex ($MgNH_4PO_4 \cdot 6H_2O$), is a common problem in cats over one year old [3]. Although Mg and Ca may also be important etiological components of urethral plugs [4], the change of P concentration in hair with age observed in this study might reflect the extent of blockage of the urethra by struvite in middle-aged cats.

Even in cats kept indoors, the rate of hair growth varies according to season [5]. Thus, hair growth and replacement cycle should be considered when measuring mineral concentrations in the hair of cats. In addition, a difference in mineral concentration according to the location of the hair on the body should be considered.

CONCLUSION

Hair phosphorus concentration of cats in middle scene was significantly higher than cats in adolescence and in adulthood.

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Conflict of Interest

The authors of this paper have no financial or personal relationship with other people or organizations that could inappropriately influence or bias the context of the paper.

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