The Classification of Body Measurement on Syrian Hamster (*Mesocricetus auratus*) Based on Factor Analysis and Principal Component Analysis

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Abstract

Mesocritus (M.) auratus (Syrian hamster) is not only used a laboratory animal especially in medical research, but also is looked after as a pet animal. Genetic information can be obtained by studying body morphometry of Syrian hamster, and quantitative characteristics can be useful for conservation and breeding development. Body size characteristics of Syrian hamster is becoming the focus of this study. It is, therefore, this study is conducted to classify Syrian hamster into large, medium and small body sizes on the basis of factor analysis (FA) and principal component analysis (PCA). Hotelling T2-statistic showed differences in linear measurement of body surface between male and female Syrian hamsters (P<0.01). Results of FA showed that variable affecting the body size of male M. auratus in this study was body length; however, it did not influence the body size of female significantly. Body length in male hamsters, therefore, can be used as a reference in a selection program based on body size measurements that are not directly related to body weight. Body length is also found as discriminatory variable for body size, and the chest width was the discriminatory variable for body shape for both male and female. The distribution of colors that occur in each body size class indicated that M. auratus still has a variety in coat colors. Results of clustered diagram show that the crowd in body shape of male is greatly different from that of female Syrian hamsters. Classification the male and female Syrian hamster can be performed based on the value of first factor scores (SF-1) for practical purposes, as well as the body size. Both male and female Syrian hamster can be classified into large, medium and small groups, and each hamster individual data have SF-1 score and it own body score. It is concluded that classification of body size in M. auratus based on factor analysis and principal component analysis showed the same results.

Keywords: body measurement, classification, factor analysis, Mesocricetus auratus, principal component analysis

Introduction

Mesocricetus (*M*.) *auratus* (Syrian hamster) was the first species which was used as a laboratory animal at a university in Jerrusalem in 1930 (Hafez, 1970). Sanders and Sandadura (1992) reported that *M. auratus* was the appropriate laboratory animal for studying the effect of boiled coffee on hypercholesterolemia. Bornhop *et al*. (2003) also used *M. auratus* in observing Luminescent Lanthanide Chelate Contrast Agents for detecting early - stage malignant lesions in Syrian hamster cheek pouch. Most of *M. auratus* had been used as laboratory animals in medical research, nowadays, the animals are becoming popular as pet animal, and it had been used as pet animals in England since 1880 (Grzimek, 1975).

Genetic information can be obtained by studying body morphometry of *M. auratus*. Characteristics in body size and shape of *M. auratus* is determined through Principal Component Analysis (PCA); Factor Analysis (FA) is used to determine factors for classifying body size on the basis of relations between body size varibles which are independent each other (Gaspersz, 1992). The last analysis can be viewed as an expansion analysis of PCA. The original variables can be used as a factor if total variability was approximately 80 - 90% (Gaspersz, 1992).

Quantitative characteristics can be useful for conservation and breeding development. Body size of *M. auratus* is included in medium size (Henwood, 2007), but the hobbyist like hamster with small size; as a result, body sizes of *M. auratus* is becoming the focus of this study. Therefore, this study is conducted to classify *M. auratus* into large, medium and small body sizes. Classification through FA and PCA (Gaspersz, 1992) was carried out on the basis of linear sizes of body surfaces which include body length (X_1), chest width (X_2), pelvic width (X_3) and wrist circumference of front arm or front leg (X_4).

Materials and Methods

The experiment was conducted in the Laboratory of Animal Genetics, Department of Animal Production and Technology, Faculty of Animal Science, Bogor Agricultural University, Bogor. Syrian hamsters used in this experiment were 58 heads (24 males and 34 females) at the mature body age. Other materials used were vernier caliper and thread for measuring linear variables of body surface. Hotelling T^2-statistic was used to compare linear measurements of body surface between males and females with the formula suggested by Gaspersz (1992). If the results reject H_0 hypothesis, the two average values of linear variables of body for were different and the test were continued with FA (Factor Analysis) and PCA (Principal Component Analysis). The FA used was calculated on the basis of formula suggested by Gaspersz (1992) as follows : $X_p = c_{p1} F_1 + c_{p2} F_2 + \ldots + c_{pm} F_m + \epsilon_p$ with description: X_p = random variables; c_{ij} = parameters reflecting the importance of

j^{th} factor in composition from i^{th} respons; in FA was known as weighting (loading) from i^{th} respons at the same factor of j^{th}; F_j= the same factor of j^{th}; ϵ_p= error from i^{th} respons, in FA was known as i^{th} specific factor which was random; i= 1, 2, 3,4 (p= 4); j= 1, 2, 3, 4 (m= 4); p= numbers of variables measured. Factor score (SF) was calculated using formula of Gaspersz (1992) as follows: $SF= C' K^{-1} (X_j - X)$; j= 1, 2, . . , n; with description: SF= matrix for factor score (descendant from covariance); C'= matrix for weighting factor (descendant from covarian); K^{-1}= invers from covarian matrix K; X_j= vector for observation of j^{th} individu; X= vector average value from variable X; n= sample size. Classification based on body measurements (small, medium and big or large) was conducted using formula recommended by Gaspersz (1992) which were: large group if SF > SF + sSFs, medium group if SF – sSF < SF < SF + sSF, small group if SF < SF – sSF, with description: SF= factor score, SF= average of factor score, sSF= standard deviation of factor score. Principle Component Analysis (PCA) by Gaspersz(1992), equation model for body parts were: $Yp= a_1pX_1 + a_2pX_2 + a_3pX_3 + a_4pX_4$; with description: Yp= p^{th} principle component (p= 1, 2, 3, 4); X_1= body length, X_2= chest girth, X_3= pelvic width, X_4= wrist-circumference. Classification on the basis of body linear size that was observed (small, medium and large) was conducted using Garpersz (1992) formula large group: if $y_{h1} > y_1 + s_{y1}$; medium group: if $y_1 - s_{y1} < y_{h1} < y_1 + s_{y1}$ and small group if $y_{h1} < y_1 - s_{y1}$. Data was processed using statistical software of Minitab.

Results and Discussion

Table 1 demonstrates descriptive statistics for body linear size variables of Syrian hamster. T^2-Hotteling statistic showed that there were differences in body linear sizes between male and female Syrian hamster ($P<0.01$). These differences were also observed by Fox *et al*. (1984). The highest body linear size variables influencing body sizes of male and female hamsters was obtained on the basis of communality at Factor Analysis.

Tabel 1. Average and standard deviation for body linear sizes of male and female Syrian hamster (*Mesocricetus auratus*) (cm)

Sex	Body length	Chest girth	Pelvic width	Wrist circumference
♂	9.45±0.70 (7.41%)[1] (n=24)[2]	1.87±0.15 (8.02%)[1] (n=24)[2]	1.12±0.09 (8.04%)[1] (n=24)[2]	1.54±0.14(9.1%)[1] (n=24)[2]
♀	9.22±0.55 (5.97%)[1] (n=34)[2]	1.88±0.22(11.7%)[1] (n=34)[2]	1.10±0.12 (10.91%)[1] (n=34)[2]	1.69±0.09 (5.33%)[1] (n=34)[2]

[1] (%)= coefficient of variance; [2] n= sample numbers.

Table 2 showed the communality (proportion of variability of each variable origin) in body linear size variables of Syrian hamster. The results demonstrated that the body length (X_1) was expressed as a factor F1 of body size in males. Variable affecting the body size of male Syrian hamster in this study was body length (X_1). This variable had a value of 0.70 which was the primary factor affecting the body size of male significantly. According to Pontoh (2007), a weighting factor value closing to +1 or -1 can be used as primary factor. Body length of male Syrian hamster showed a positive relationship between the closeness of the body length and the F1-factor. The higher the body length then the body size will be greater in male. The results demonstrated that the body length (X_1) was expressed as a factor F1 of body size in females. Weighting factor of body length (X_1) on the F1 factor had the greatest value, ie. -0.55. According to Hair, Jr. *et al.* (1998), the weighting factor was greater than ± 0.50, but was not greater than ± 0.55; so the statistical value of the weighting factor has no effect. The results stated that body length was the main factor determining body - size in males, but not in females.

Body length in male, therefore, can be used as a reference in a selection program based on body size measurements that are not directly related to body weight. Linear size of the body in Syrian hamster observed was associated with the condition of the body skeleton.

Table 2. Factor weighting (correlation between original variable with factor), Eigen value (λ), total variance (%), cumulative variance (%) and body size communality score of male & female Syrian hamster (*Mesocricetus auratus*)

Variables measured (Male)	Factor				Communality score
	F1	F2	F3	F4	
Body length (X1)	0.70	-0.01	-0.00	-0.01	0.49
Chest girth (X2)	-0.01	-0.13	0.08	-0.01	0.02
Pelvic width (X3)	0.04	-0.05	-0.03	0.06	0.01
Wrist circumference (X4)	-0.05	-0.09	-0.10	-0.03	0.02
Eigen value (λ)	0.50	0.03	0.01	0.00	0.54
Total variance (%)	91.1	5	3	0.9	100
Variables measured (Female)	F1	F2	F3	F4	
Body length (X1)	-0.55	-0.04	0.01	-0.01	0.31
Chest girth (X2)	0.15	-0.16	0.04	-0.01	0.05
Pelvic width (X3)	0.01	-0.08	-0.09	0.00	0.01
Wrist circumference (X4)	-0.02	-0.01	0.00	0.08	0.01
Eigen value (λ)	0.33	0.03	0.01	0.01	0.38
Total variance (%)	87	8.6	2.5	1.9	100

F1= 1st factor, F2= 2nd factor, F3= 3rd factor, F4= 4th factor

Table 3. Body size and shape equations with the total diversity and Eigen values in the Syrian hamsters (*Mesocricetus auratus*) male and female

Sex	Equation	Total Diversity	Eigen Value
Male	Size = $X_1 - 0.02X_2 + 0.06X_3 - 0.07X_4$	91.1%	0.50
	Shape = $0.04X_1 + 0.80X_2 + 0.28X_3 + 0.53X_4$	5.0%	0.03
Female	Size = $0.96X_1 - 0.26X_2 - 0.01X_3 + 0.04X_4$	87.0%	0.33
	Shape = $0.24X_1 + 0.86X_2 + 0.44X_3 + 0.06X_4$	8.6%	0.03

X_1= body length, X_2= chest width, X_3= pelvic width, X_4= wrist circumference

Discriminatory variable for body sizes of male and female Syrian hamster were body length (X_1) based on the highest Eigen value on body size equation (Table 3). Everitt and Dunn (1998) stated that the first principal component represents the overall size of the body must explain the total variability between 50%-95%. The first principal component is the body size. Discriminatory variable for body shape of male and female Syrian hamster were chest width (X_2). Everitt and Dunn (1998) stated that the second principal component represents the overall body shape, must explain the total diversity of at least 1%.

Classification the male Syrian hamster can be performed based on the value of first factor scores (SF-1) in Table 2; can be divided into large group with SF-1 $\geq$ 1.01 (five heads), medium group with SF-1 -1.01 to + 1.01 (13 heads) and small group with SF-1 $\leq$ -1.01 (six heads). Classification the female Syrian hamster can be performed based on the value of first factor scores (SF-1) that can be divided into large group with SF-1 $\geq$ 1.06 (five heads), medium group with SF-1 -0.94 to + 1.06 (13 heads) and small group with SF-1 $\leq$ -0.94 (six heads).

Classification based on the score of body size based on Table 3 demonstrates that male with a score value $\geq$ 10.03 (five heads) is for large group, a score value 8.63 to 10.03 (13 heads) is for medium group and a score value $\leq$ 8.63 (six heads) is for small group. The classification for the females results in the score value > 9.02 (five heads) for the large group, the score value : 7.88 to 9.02 (23 heads) for the medium group and the score value $\leq$ 7.88 (six heads) for the small group. Distribution of Agouti Non Golden (ANG), Agouti Golden (AG), and Non Agouti (NA) in each group of Syrian hamster indicated that the coat color was not related to body size.

Conclusion

Variable that affects the body size of male M. auratus in this study was body length; however, it did not influence the body size of female significantly. Body length was found as well as discriminatory variable for body size of male and female. Discriminatory variable for body shape of male and female M. auratus were

chest width. The distribution of colors that occur in each body size class indicated that M. auratus still has a variety in coat colors. Classification of body size in M. auratus based on factor analysis and principal component analysis showed the same results.

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