

Relationship between the shoulder height and the neck girth of Sri Lankan domesticated elephants (*Elephas maximus maximus*)

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Abstract

The aim of this study was to examine whether a relationship exists between the neck girth and the height measured at the shoulder of Sri Lankan elephants (*Elephas maximus maximus*), as proposed for the Burmese timber elephants (*Elephas maximus birmanicus*) by Gale (1974). The study was conducted between 1 st April 1993 and 1 st April 1994 in 13 administrative districts of Sri Lanka using 140 domesticated elephants (72 male and 68 female elephants). The results show a significant correlation between the shoulder height and the neck girth of elephants (irrespective of gender) ($r=0.4323$, $p=0.001$) when considered separately. Linear regression equations for each was $Y=-9.89+1.0253 \times X$, $P=0.001$, $Y=-28.46+1.11 \times X$, $p=0.001$, and $Y=78.29+0.6310 \times X$, $P=0.001$ respectively. (Y =Shoulder height, X , = Neck girth). Further the shoulder height is almost equal to the neck girth in males. However, this was not so for the females.

1. Introduction

According to Gale (1974), the girth of the neck of the Burmese timber elephants (*Elephas maximus birmanicus*) is almost equal to the height measured at the shoulder. However, this relationship was not based on scientific data but appears to be based on his personal observations. The purpose of this study was to determine scientifically whether such a relationship proposed for the Burmese elephants also occurs in the Sri Lankan elephant (*Elephas maximus maximus*). This was studied using domesticated animals.

2. Materials and methods

This study was carried out during the period of 1993 April to 1994 April. The sample consisted of 140 domesticated elephants of which 72 were males and 68 were females, ranging in age from 3 to 75 years. These elephants were from 13 (out of the 24) administrative districts in the country [nine in wet zone (Galle, Matara, Colombo, Gampaha, Kalutara, Ratnapura, Kegalle, Nuwara Eliya, Kandy), three in intermediate zone (Kurunegala, Matale, Monaragala) and one in dry zone (Anuradapura)].

The measurements of shoulder height and neck girth were made on the methodology described by Wemmer & Krishnamurthy (1992). The shoulder height was determined using a height caliper made according to Schmidt (1986). In taking the shoulder height measurements, the elephants were made to stand on flat ground and the sliding arm of the calliper was brought to rest against the highest point of the shoulder and the height measurement on the vertical pole was marked. The neck girth was measured at the center of the neck using a surveyor's tape (Sword fish brand, China).

When doing this the tape was kept taut to take up the slack skin hanging from the neck. In carrying out these measurements the mahout's assistance was sought.

Measurements were taken either at the elephant's working sites when they were brought to participate in peraheras (the Nawam perahera, the Bellanwila perahera, the Kandy perahera, the Aluthnuwar dewale perahera and the Kelaniya Duruthu perahera) or at owners' residence and temples.

The ages of the elephants were obtained from their respective mahouts or owners. Elephants were age classed according to the criteria used by Daniel et al (1987); calves (0-1 year); juveniles (1-5 years); sub-adults (5-15 years); and adults (15 < years).

The data are represented as mean \pm SEM. Statistical comparisons were made using Student's t-test, Pearson correlation and Standard linear regression. The values of the $p < 0.005$ were regarded as significant.

3. Results

Of the 140 elephants in the study 72 were males and 68 were females. Out of the 72 male elephants four (6%) were juveniles, eight (11%) were sub adults and 60 (83%) were adults. There were no infants found among males. Out of the 68 female elephants four (6%) were sub adults and 64 (94%) were adults. There were no juveniles and infants among females. The overall mean age of elephants was 37.4 ± 1.4 years (range 3-75 years, mode; 45 years, median; 42 years).

The mean shoulder height of all elephants was 234.5 ± 0.26 cm (range: 147.3-302.2 cm, mode; 228.6 cm). The mean shoulder height of males was 239.6 ± 3.9 cm (range: 147.3-302.2 cm, mode; 248.92 cm) while that of females was 228.9 ± 2.1 cm (range; 165.1-264.2 cm, mode; 228.6 cm). The mean shoulder height of males was significantly higher (Student's t-test; $t = -2.34$, $p = 0.019$, $d.f = 138$) than the mean shoulder height of females.

The mean neck girth of all elephants was 230.1 ± 3.1 cm (range; 121.9-332.7 cm, mode: 218.4 cm) The mean neck girth of males was 237.0 ± 5.1 cm (range; 121.9-332.7 cm, mode; 218.44 cm) while that of females was 222.7 ± 3.1 cm (range; 154-279.4 cm, mode; 220.98 cm). The mean neck girth of males was significantly higher (Student's t-test; $t = -2.35$, $p = 0.019$, $d.f = 138$) higher than the mean neck girth of females.

No significant difference was found between the shoulder height and the neck girth of the male elephants (Student's t-test (paired); $p = 0.5384$). However, there is a significant difference found between the shoulder height and the neck girth of the female elephants (Student's t-test (paired); $p = 0.038$). A significant correlation was evident between the shoulder height and the neck girth of males (Pearson correlation $r = 0.827$, $p = 0.001$, $d.f = 70$) and females (Pearson correlation $r = 0.4323$, $p = 0.001$, $d.f = 66$) and when the results

of two sexes were pooled (Pearson correlation; $r=0.7652, p=$, $n=140$) (Figures 1,2 and 3). Linear regression equation for each was $Y=-28.46+1.11x X$, $p=0.001, d.f =70$, $Y=78.29+ 0.6310x X$, $p= 0.001$, $d f=66$ and $Y=-9.89+1.0253x X$, $p=0.001$, $d.f=138$ respectively.

Correlation was also found between the shoulder height and neck girth of the adult males (Pearson correlation; $r= 0.5518$, $p=0.001$, $n=60$) and females (Pearson correlation; $r=0.3385$, $p=0.001$, $n =64$) and for the two sexes were pooled (Pearson correlation; $r= 0.6019, p=0.001, n=124$). Linear regression equation for each was $Y=32.66+0.8733x X$, $p=0.001, d.f=58$, $Y=114.223+0.48207xX$ and $Y=34.899+0.8436x X$ respectively. However, the relationship between shoulder height and the neck girth of other classes (calves, juveniles, sub adults) could not be evaluate since the group sizes were small.

Figure 1: Relationship between shoulder height and neck girth of elephants

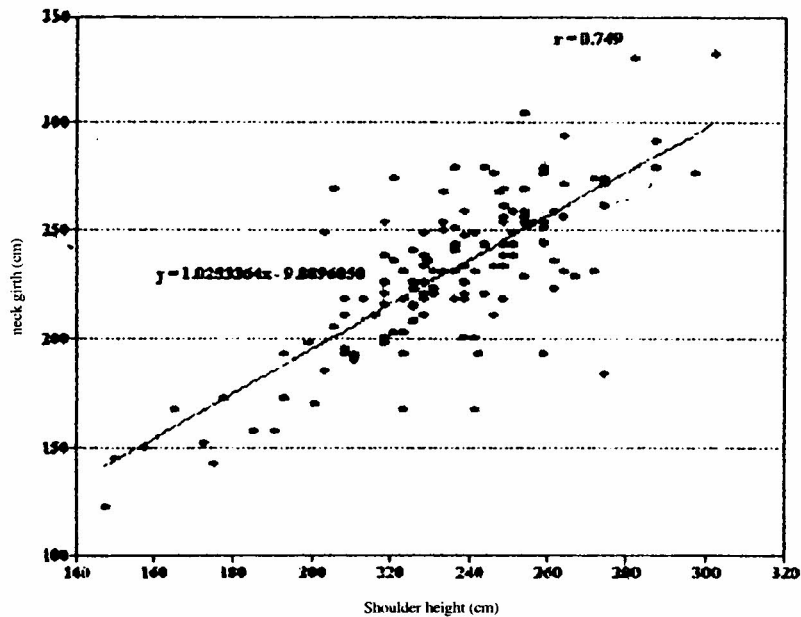


Figure 2: Relationship between shoulder height and neck girth of male elephants

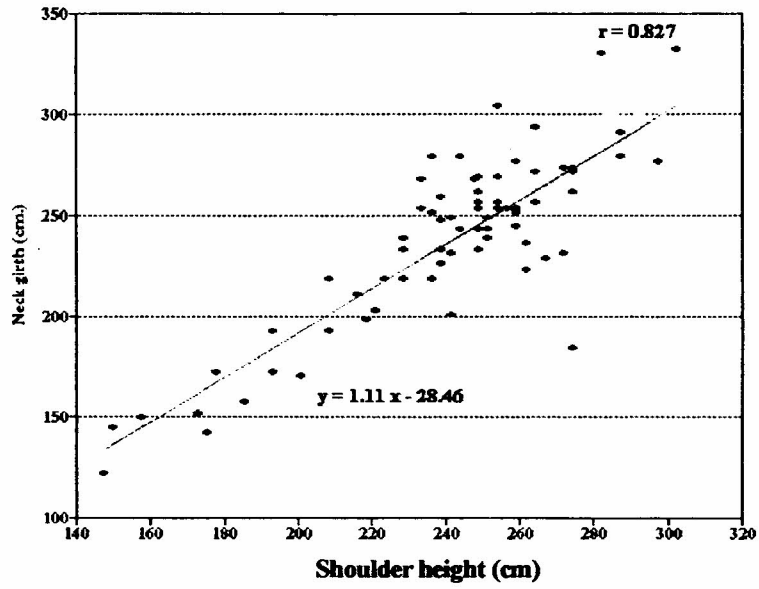
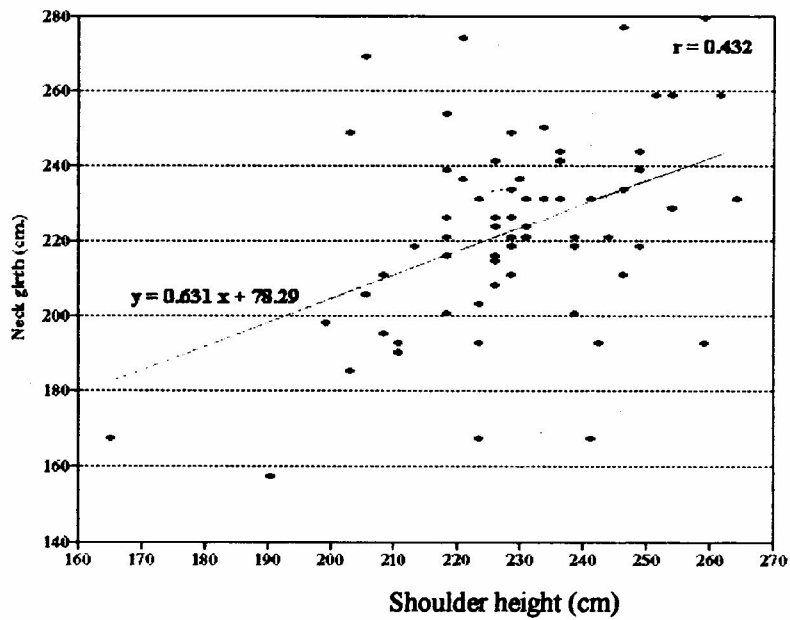


Figure 3: Relationship between shoulder height and neck girth of male elephants



4. Discussion

Relationships between the shoulder height and circumference of the forefoot (Bongoso *et al.*, 1981), shoulder height and body weight, chest girth and body weight (Kurt & Nettasinghe, 1968), shoulder height and age (Kurt, 1969, Ilangakoon, 1993) shoulder height and age, shoulder height and thorax circumference, shoulder height and circumference of fore foot (Kurt & Kumarasinghe, 1998) have been described for Sri Lankan elephants previously. Based on Hundley, Reuther and Kurt & Nettasinghe's data, McKay (1973) has conducted a growth curve for Sri Lanka elephants. However, the present study is the first to evaluate the relationship between the shoulder height and the neck girth of Sri Lankan elephants (*Elephas maximus maximus*) using a large number of domesticated animals.

The results clearly show that the correlation exists between the shoulder height and the neck girth of both male and female Sri Lankan elephants. This correlation was powerful in the case of males ($r=0.827, p=0.001, d.f=70$), and moderate in the case of females ($r=0.4323, p=0.001, d.f=66$). The results also show that the neck girth of males (juveniles, sub adults, adults) elephants are almost equal to the height measured at the shoulder heights. On the other hand, this does not hold true for female elephants. Thus, Gale's statement that the girth of the neck of Burmese timber elephants (*Elephas bimarnicas*) is almost equal to the height measured at the shoulder appears not applicable to female domesticated Sri Lankan elephants, but becomes applicable only to males. This difference could be a sub-species variation (Ratnasooriya & Fernando, 1992) or could be due to some unknown factor which hinders the normal growth of female Sri Lankan elephants in domesticated condition. It even may be possible that the neck girth is not equal to shoulder height in female Burmese elephants too, as is evident in our study, since Gale (1974) has not actually made any measurements of their shoulder height and neck girths in proposing his statement.

The accurate measurement of shoulder height of elephants is difficult without an apparatus as used in this study and by others (Kurt and Nettasinghe, 1969). This study shows a positive relationship between shoulder height and neck girth of elephants. Thus, it is now possible to evaluate the shoulder height of elephants, with a higher accuracy without using an apparatus, but by simply measuring their neck girth irrespective of their

gender. This can be done using regression equations obtained in this study: for males $Y = 28.46 + 1.11x X$, and for females $Y = 78.29 + 0.6310x X$ and for both sexes $Y = -9.89 + 1.0253 x X$. Measurements of the neck girth can be made accurately even by using a rope or a tape. Further, it may now be possible to estimate the body weight of domesticated Sri Lankan elephants, by measuring the neck girth as there is a relationship between the shoulder height and the body weight of domesticated elephants (Kurt & Nettasinghe, 1969). Elephants used in this study were in good condition when assessed by the body condition index (Godagama *et al*, 1998) described by Wemmer *et.al* (1996). Therefore, it remains to be seen whether the relationship obtained in this study is applicable to unhealthy or sick elephants.

In conclusion, this study shows that a relationship exists between the shoulder height & neck girth of domesticated Sri Lankan elephants & for male elephant the neck girth & shoulder height are approximately equal. This is a novel finding, in our opinion, which has valuable practical implications.

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6. References

- Bongso, T.A., Perera, B.M.A.O. and Motha, M.X.J. (1981). Estimation of shoulder height from fore-foot circumference in the Asian elephants (*Elephas maximus maximus*). *Ceylon J. Sci. (Bio. Sci.)*, **14**, 79-82.
- Daniel, M.S. Sivaganeson, N. and Kumar, S.R. (1991). Study of the ecology of some endangered species of wild life and their habitat. The Asian elephant (Report October 85 to September 87) Bombay Natural History Society, India.
- Gale, U.(1974). *Burmese Timber Elephant*. Trade corporation, Rangoon, (Burma).
- Godagama, W.K. Wemmer C., Ratnasooriya, W.D. (1998). The body condition of Sri Lankan domesticated elephants (*Elephas maximus maximus*) *Cey.J. Sci. (Bio. Sci.)* **26**,1-6.

Ilangakoon, A. (1993). A preliminary study of the Captive elephants in Sri Lanka. *Gajah*, **11**,29-42.

Kurt, F. and Nettasinghe, A.P.W. (1968). Body weigh o the Ceylon elephant (*Elephas maximus maximus*). *Ceylon Vet. J.*, 16,24-26).

Kurt, F. (1969). Some observation on Ceylon elephants. *Loris.*, **11(5)**, 238-243.

Kurt, F. and Kumarasinghe. C. (1998). Remarks on body growth and phenotypes in Asian elephant (*Elephas maximus maximus*) *Acta Theriologica*, Suppl. 5: 135-153.

McKay, G.M. (1973). Behavior and ecology of the Asiatic elephant in South Eastern Ceylon. *Smithsonian contribution. Zool.*, **125**, 1-113.

Ratnasooriya, W.D. and Fernando, S.B.U.(1992). Pattern of toe nail distribution of Sri Lanka elephant, *Elephas maximus maximus*. *Med. Sci. Res*, **20**,221-222.

Schmidt, M(1986). Elephants (Proboscidea) In:Fowler, M.E. (Ed.) Zoo and wild animal Medicine.pp33-34, W.D. Saunders Company (Philadelphia)

Wemmer,C. and Krishnamurthy, V.(1992). Methods in taking standerd measurements of live domestic elephants In: Silas, E.G., Krishnan Nair, M., Nirmalan, G. (Eds.) The Asian Elephants, Ecology, Biology, diseases, conservation and management.pp 34-37. Kerala Agricultural University.

Wemmer, C.Krishanamurthy, V., Shrestha, S., Hayek. L.A., and Nanjappa, K.A., (1996). A body condition index for live Asian Elephants (*Elephas maximus*) (Unpublished manuscript).