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MORPHOMETRIC, MORPHOFUNCTIONAL AND PHYSIOCOCHEMICAL CHARACTERISTICS OF KATHIAWARI HORSES MAINTAINED AT MATHERAN HILL STATION

A.B. Sangale, S.T. Hande*, G.S. Khandekar, S.D. Jagadale and S.V. Bharucha
*Associate Professor and Head, Department of Livestock Production Management, Mumbai Veterinary College, Parel-400012. MAFSU (M.S.)
E-mail: drsalilhande@gmail.com (**Corresponding Author*)

Abstract: The present study was conducted on 200 Kathiawari male horses for morphometric, morphofunctional and physiocochemical characteristics. The results showed that the average body length, height at wither, chest girth, and face length similarly the average haemoglobin level and blood glucose were found significantly higher (P≤0.05) among the different age groups. However, no significant differences were observed in the average face width, ear length, ear width and cannon bone circumference. Average body index and proportionality index did not showed significant variations within the age groups. While the effect of age was significant on the load carriage index. Statistically significant differences (P≤0.05) were found in the average respiration rate and heart rate across the experimental groups. Overall, the study underscores the importance of considering age when evaluating the morphometric and physiological attributes of Kathiawari horses, particularly in relation to their performance and suitability for different tasks, such as load carriage.
Keywords: Kathiawari horses, morphometric, morphofunctional.

INTRODUCTION

India, being an agricultural country, relies heavily on livestock, which plays a vital role in uplifting the rural economy. The total number of horses and ponies in the country declined to 3.4 lakh in 2019, reflecting a 45.6% decrease from the previous census. (DAHDF 2019).

India is home to seven distinct horse breeds, with the Kathiawari breed being prevalent in the Northwestern region. In Matheran, a small hill station in Maharashtra, where vehicular traffic is restricted, horses serve as the primary mode of transport. The area has over 1,000 Kathiawari horses and ponies. These horses, known for their endurance and robust build, are closely related to the Marwari breed.

Morphometric measurements are crucial for assessing horse conformation and developing body weight estimation equations, which are essential for proper management and medication. Functional measurements, like load carriage capacity, are vital in evaluating a horse's efficiency and well-being. Additionally, physiological parameters provide insights into their health status and fitness, especially for working equids involved in endurance activities.

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To further understand equine management and welfare practices, a study was conducted to explore the morphometric and physiological characteristics of Kathiawari horses in Matheran hill station. This research aims to enhance knowledge about the breed and improve practices for their care and usage.

MATERIALS AND METHODS

Location and Environment

The study was conducted at Matheran hill station, located in the Karjat Tehsil of Raigad district, Maharashtra, India. Matheran is situated at 18.98° North latitude and 73.27° East longitude, with an elevation of 800 meters above sea level. The region experiences a tropical climate, with an average annual temperature of 25.9°C and an average relative humidity of 71.0%. The area also receives an average annual rainfall of 1,750 mm.

Experimental animals and Groups

The experiment involved 200 male Kathiawari horses, which were distributed into three different age groups: 2-4 years (Group I), 4-6 years (Group II), and 6-8 years (Group III).

Body length, height at withers, chest girth, face length face width, ear length, ear width and cannon bone circumference were manually measured.

Morphofunctional parameters were derived from the ratios between various morphometric measurements, following the methodology of Mosquera *et al*. (2020). Body index (BI) is calculated as the ratio of body length (BL) to chest girth (CG), multiplied by 100, and provides an estimate of an animal's body proportions (Mendoza *et al*., 2015). Horses were classified based on their BI as follows: horses with a BI < 86 are considered to have a short or brevilinear body, those with a BI between 86 and 88 are classified as having a medium or mesolinear body and horses with a BI > 88 are categorized as having a long or longilinear body (Rezende *et al*., 2016). Proportionality index was calculated as ratio of height at wither to body length multiplied by 100 (Sole *et al.,* 2013). Horses were judged from proportionality index as long (longer than tall, PI < 99), medium (PI: 99 –101); and tall (taller than long, PI > 101). Load carriage index was calculated as a squared chest girth divided by height at wither and multiplied by 0.95 for working equids (McManus *et al.,* 2005). This index indicates the weight (kilograms) that the animal can hold on its back while walking.

Physiological parameters that is rectal temperature (°F), respiration rate (breath/min) and heart rate (beats/min) was recorded. (Andersson and Jonasson, 1993, Reece *et al.,* 2004, Detweiler *et al.,* 1993).

To estimate blood parameters, jugular venous whole blood samples were obtained aseptically from all experimental horses using sterile vacutainers containing EDTA-2K. The samples were then transported to the laboratory on ice for analysis. Hemoglobin levels were estimated from the whole blood collected from the experimental animals using an automatic cell counter (Mindray BC-3000 Plus) through the impedance method. A jugular venous whole blood sample was obtained from experimental animals with a syringe and 18 G needle, and 0.3 µL immediately was tested with the veterinary glucometer according to the manufacturer's instructions. The glucometer evaluated utilized glucose dehydrogenase enzyme and coulometric method principles (Hackett and McCue, 2010). The data were statistically analyzed according to age group for mean, critical difference, frequency distribution, and standard error using a completely randomized design as described by Snedecor and Cochran (1998). The results from the statistical analysis were presented in the results and discussion section.

RESULTS AND DISCUSSION

The present study aimed to assess morphometric, morphofunctional, and physiological parameters in male Kathiawari horses across three different age groups (2-4, 4-6, and 6-8 years) maintained at Matheran hill station. The findings provide insights into how these parameters evolve with age and highlight significant differences in key measurements related to growth, function, and health. The results for various morphometric parameters, including average body length, height at withers, chest girth, face length, average face width, ear length, and cannon bone circumference, are presented in Tables 1.

Morphometric Parameters

The results of the study revealed that body length, height at withers, chest girth, and face length exhibited significant differences ($P \leq 0.05$) among the three age groups, with Group III (6-8 years) showing the highest values. These findings suggest that male Kathiawari horses experience considerable growth in these morphometric traits as they age, aligning with earlier studies by Gupta *et al*. (2012) and Alam *et al*. (2016), who also observed increased body measurements with age in horses.

In contrast, face width, ear length, and cannon bone circumference showed no statistically significant differences ($P \geq 0.05$) between the groups, indicating that these traits remain relatively stable as horses age. This stability is in line with studies such as Singh *et al.*, (2002) but differs from findings by Kawareti *et al*., (2017) and Pundir *et al.,* (2004), who reported no significant changes in body measurements across different age groups. These

discrepancies may be attributed to breed-specific characteristics and environmental factors.

In summary, the results of this study underscore the significance of age-related growth in certain morphometric traits of male Kathiawari horses, consistent with several previous studies. Nonetheless, some discrepancies exist, which may be attributable to breed and environmental differences.

Table 1: Average morphometric parameters of male Kathiawari horses in different age groups (cm).

Group	Age (year)	Body length (cm)	Height at withers(cm)	Chest girth (cm)	Face length (cm)	Face width (cm)	Ear length (cm)	Ear width (cm)	Cannon bone circumference (cm)
I (N=61)	2-4	150.44 ± 0.18**	148.66 ± 0.18**	165.15±0.18 **	56.25 ± 0.09**	19.22 ± 0.11	10.17 ± 0.11	7.55 ± 0.06	18.61 ± 0.08
II (N=84)	4-6	151.94 ± 0.11**	149.97 ± 0.14 **	166.61±0.13**	58.69 ± 0.10**	19.24 ± 0.08	10.31 ± 0.09	7.69 ± 0.07	18.74 ± 0.08
III (N=55)	6-8	152.39 ± 0.15**	151.23 ± 0.36 **	167.12±0.10 **	58.82 ± 0.14**	19.26 ± 0.11	10.47 ± 0.10	7.73 ± 0.08	18.86 ± 0.11

** Significant at 1% and 5% level of significance.

Morphofunctional Parameters

The average body index, proportionality index, and load carriage index of Kathiawari male horses across different age groups were analyzed, as presented in Table 2.

Body index and proportionality index were higher in Group III, though not statistically significant (P≥0.05). This suggests that the body structure remains proportionate across age groups. The findings align with those of Mosquera *et al*., (2019) and Sole *et al*., (2013), who observed similar indices in working mules and Menorca horses, respectively.

In contrast, the load carriage index increased significantly with age (P≤0.05), with Group III demonstrating the highest capacity for load-bearing. This suggests that the horses' functional ability to carry weight improves with age, consistent with the findings of Mosquera *et al*., (2020). The ability to carry loads is critical for working horses, and the increase in this index highlights the development of stronger body structures in older horses.

Table 2: Average Morphofunctional parameters of male Kathiawari horses in different age groups.

Group	Age(year)	Body index	Proportionality index	Load carriage index (Kg)
I (N=61)	2-4	91.09 ± 0.05	98.82 ± 0.06	174.29±0.17**
II (N=84)	4-6	91.19 ± 0.05	98.70 ± 0.06	175.85±0.13**
III (N=55)	6-8	91.19 ± 0.05	98.65 ± 0.04	176.49±0.09**

**Significant at 1% and 5% level of significance.

Physiological Traits

The average physiological parameters of male Kathiawari horses across different age groups were analyzed and are presented in Table 3. The rectal temperature of all age groups remained within the normal range, with no statistically significant differences (P≥0.05). However, Group I showed a slightly higher rectal temperature than Groups II and III. These findings align with previous studies by Niranjan *et al*. (2018) and Andersson and Jonasson (1993), who also recorded normal temperature ranges. The minor variations observed could be attributed to differences in environmental factors or stress levels.

The respiration rate showed a statistically significant decrease with age (P≤0.05), with Group I exhibiting the highest rate. These findings are consistent with Reece (2004), who observed that younger horses tend to have higher respiration rates. Studies by Garba *et al*., (2015) support this trend, but the results contrast with those of Niranjan *et al*., (2018) and Legha *et al*., (2018), who reported higher respiration rates in horses subjected to stress or intense physical activity.

The heart rate was also significantly higher in Group I compared to Groups II and III (P≤0.05), indicating a decrease in heart rate with age. The findings are consistent with the normal heart rate ranges for horses reported by Detweiler (1993) and further supported by Garba *et al*., (2015) and Legha *et al*., (2018). This suggests that the cardiovascular system in horses stabilizes as they mature. Age-related variations in physiological traits such as respiration and heart rates suggest important functional adaptations that could influence management and care strategies for these horses.

Table 3: Average physiological parameters of male Kathiawari horses in different age groups.

Group	**Age(year)**	**Rectal temperature(°F)**	**Respiration rate (breaths/min)**	**Heart rate (beats/min)**
I (N=61)	2-4	100.12 ± 0.09	11.00±0.25**	38.00 ± 0.26**
II (N=84)	4-6	100.06 ± 0.08	10.00 ±0.19**	34.00 ± 0.17**
III (N=55)	6-8	99.98 ± 0.10	9.00 ±0.17**	32.00 ± 0.26**

** Significant at 1% and 5% level of significance.

Blood Parameters

The average hemoglobin and blood glucose levels of male Kathiawari horses across different age groups were analyzed and are presented in Table 4. Both haemoglobin and blood glucose

levels showed significant increases (P≤0.05) with age, with Group III displaying the highest values. The results align with those of Gupta *et al*., (2002) and Naseema *et al*., (2017), who also observed higher haemoglobin and blood glucose levels in older horses. These parameters are essential indicators of overall health and physical condition, particularly in working horses. The significant increase in haemoglobin levels suggests an enhanced oxygen-carrying capacity, while elevated glucose levels may reflect changes in energy metabolism as horses age. However, contrasting results from Naseema *et al*., (2017) suggest that additional factors, such as activity levels and diet, may influence these parameters.

The significant increase in haemoglobin and blood glucose levels in older horses points to the physiological changes that occur with maturation, emphasizing the need for regular monitoring of these parameters for health management.

Table 4: Average haemoglobin and blood glucose level of male Kathiawari horses in different age groups.

Group	**Age (year)**	**Haemoglobin (gm %)**	**Blood glucose (gm/dl)**
I (N=61)	2-4	12.65 ± 0.17*	93.23 ± 0.68**
II (N=84)	4-6	13.10 ± 0.16*	96.12 ± 0.57**
III (N=55)	6-8	13.31 ± 0.21*	98.73 ± 0.64**

** Significant at 1% and 5% level of significance.

CONCLUSION

In male Kathiawari horses body and proportionality indices remain consistent across age groups, suggesting a stable body structure. The load carriage index increases significantly with age, indicating better weight-carrying ability in older horses due to a stronger body structure. Age-related physiological changes align with the functional adaptations needed for working horses. Hemoglobin and blood glucose levels increase significantly with age, highlighting improved oxygen-carrying capacity and energy metabolism in older horses. These changes indicate enhanced physical and metabolic readiness for workload as the horses mature. The findings underscore the importance of age in determining growth, functional capacity, and health parameters in male Kathiawari horses. They provide critical benchmarks for the management, training, and utilization of horses across different age groups.

REFERENCES

[1] Alam, M.P., Bhuiyan, M.S.A., and Bhuiyan, A.F.H. 2016. Morphology, morphometry and reproductive characteristics of indigenous horses in Bangladesh. *Journal of Bioscience and Agriculture Research* **11** (2): 947-954.

[2] Andersson, B.E. and Jonasson, H. 1993. Temperature regulation and environmental physiology. Dukes' Physiology of Domestic Animals, 1993, Cornell University Press, Ethaka NY,11th edn., pp.150.

[3] DAHDF. 2019. 20th Livestock Census Key Results, Department of Animal Husbandry and Dairying Ministry of Fisheries, Animal Husbandry and Dairying Government of India, New Delhi.

[4] Detweiler, D.K. 1993. In Dukes' Physiology of Domestic Animals, 11th edn (eds M.J. Swenson and W.O. Reece). Cornell University Press, Ithaca, NY.pp 343.

[5] Garba, U.M., Sackey, A.K.B., Idris, L.A., and Esievo, K.A.N. 2015. Baseline vital, haematological and serum biochemical parameters of donkeys. *Journal of Veterinary Medicine and Animal Health* **7** (3): 94-98.

[6] Gupta, A.K., Kumar, S., and Pal, Y. (2002). Biochemical, haematological and thyroid hormone profile in healthy Indian Kathiawari horses. *Asian-australasian journal of animal sciences* **15** (8): 1215-1221.

[7] Gupta, A.K., Tandon, S.N., Pal, Y., Bhardwaj, A., and Chauhan, M. 2012. Phenotypic characterization of Indian equine breeds: a comparative study. *AnimalGenetic Resources* **50**: 49-58.

[8] Hackett, E.S., and McCue, P.M. (2010). Evaluation of a veterinary glucometer for use in horses. Journal of Veterinary Internal Medicine, 24(3), 617-621.

[9] Kawareti, P.K., Nandeshwar, N.C., Salankar, A.M., Gedam, P.M., Mainde, U.P., and Ganguly, S. 2017. Morphometric characterization of horses (Equus caballus) in different age groups. *Journal of Entomology and Zoology Studies* **5** (3): 1412-1414.

[10] Legha, R.A., Kumar, V., Pai, Y., Dedar, R.K., Bala, P.A., Ravi, S.K. and Tripathi, B.N. 2018. Physiological, haematological and biochemical indices in non-descript Indian donkeys working with different pack loads in brick kilnsimulated conditions. *Int J Liv Res* **8**: 59-66.

[11] McManus, C., Falcão, R.A., Spritze, A., Costa, D., Louvandini, H., Dias, L.T., and Garcia, J.A.S. 2005. Caracterização morfológica de eqüinos da raça Campeiro. *Revista Brasileira de Zootecnia*, **34** (5): 1553-1562.

[12] Mendoza, F.J., Estepa, J.C., Gonzalez-De Cara, C.A., Aguilera-Aguilera, R., Toribio, R. E., & Perez-Ecija, A. (2015). Energy-related parameters and their association with age, gender, and morphometric measurements in healthy donkeys. *The Veterinary Journal*, **204** (2): 201-207

[13] Mosquera, J.C.V., Álvarez, J.D.C., & Jacometo, C.B. (2019). Morphofunctional characteristics of working mules in mountain areas of the Colombian Central Andes. *Acta Scientiarum. Animal Sciences*, **42** (1): e46379.

[14] Naseema, U., Vairamuthu, S., Balachandran, C. and Ravikumar, G. 2017. Haemato-Biochemical Variations In Racehorses and Breeding Horses. *Indian Vet.J* **94** (8): 12-14.

[15] Niranjan, S.K., Kataria, R.S., Sodhi, M., Bharti, V.K., Kumar, B., Garg, A. and Mukesh, M. 2018. Evaluation of physiological parameters in response to endurance exercise of Zanskar ponies adapted to high altitude of Ladakh region. *Defense Life Science Journal* **3** (2): 172-176.

[16] Pundir, R. K. 2004. Characterisation of Spiti horses of India. *Animal Genetic Resources Information*, **34**: 75-82.

[17] Pundir, R.K., Vijh, R.K., Shukla, R.N., Vyas, A.S., Bhavsar, B.K., and Nivsarkar, A. E. (1997). Characterisation of indian kathiawari horses. *AnimalGenetic Resources* **21**:71-80.

[18] Reece, W.O. 2004 Respiration in mammals. In: Dukes' Physiology of Domestic Animals, 12th edn (ed. W.O. Reece). Cornell University Press, Ithaca, NY.pp.210.

[19] Rezende, De, M.P.G., de Souza, J.C., Carneiro, P.L.S., Bozzi, R., Jardim, R.J.D., & Malhado, C.H.M. (2018). Morphofunctional diversity of equine of varied genetic compositions raised in the Pantanal biome of Brazil. *Tropical Animal Health and Production*, **50** (5):1033–1040.

[20] Singh, M.K., Yada, M., and Mehtn, N. (2002). Breed characteristics of Marwari and Kathiawari horses. *Indian Journal of Animal Sciences* **72** (4): 319-323.

[21] Snedecor, G.W. and W.G. Cochran (1998) Statistical methods, 8th edn. Affiliated East.

[22] Sole M., Gomez, M.D., Molina, A., Peña, F., and Valera, M. 2013. Analyses of conformational performance differentiation among functional breeding goals in the Menorca horse breed. *Archives Animal Breeding* **56** (1): 367-379.