Niger. J. Physiol. Sci. 31(June 2016) 077-081
www.njps.com.ng

Niger. J. Physiol. Sci.

# Evaluation of Body Mass Index and Plasma Lipid Profile in Boerboel Dogs

* Ajadi Rasheed Adetola, Ashogbon Rashidat Oluwatobiloba, Adeniyi Abisola Abosede

*Department of Veterinary Medicine and Surgery, Federal University of Agriculture, Abeokuta, Nigeria*

Summary: This study evaluated the body mass index (BMI) and plasma lipid profile in Boerboel dogs. Body weights (BW), height (H) at shoulder and waist circumference (WC) were obtained from fifty-three Boerboels to determine the BMI while, body condition score (BCS) was determined subjectively. Also 5mls of blood was obtained from the dogs for determination of total cholesterol (TC), triglycerides (TRIG), low density lipoproteins (LDL) and high density lipoproteins (HDL). Data were presented as means ± standard deviation and results were compared using analysis of variance. Relationship between BW, H and WC was determined using regression analysis. Value was accepted significant at $p < 0.05$. There were no significant differences ($P > 0.05$) in BW, WC, BMI and GAS between male and female Boerboels, however, H was significantly ($P < 0.05$) higher in male (62.0 ± 1.6 cm) than female Boerboels (57.0 ± 1.5 cm). BMI and HDL were significantly ($P < 0.05$) lower in Boerboels <23 months (112.4 ± 2.8 Kg/m$^2$; 36.0 ± 2.4mg/dl) compared with those 24 – 47 months (133.4 ± 1.8Kg/m$^2$; 40.1 ± 2.2mg/dl) and >48 months (137.9 ± 1.6kg/m$^2$; 45.8 ± 2.6mg/dl) respectively. However, there were no significant differences ($P > 0.05$) in TC, TRIG, HDL and LDL between Boerboels with BCS > 5 compared to those with BCS < 5. BMI linearly increased with decreasing H and WC in Boerboel dogs. It was concluded that BMI did not differ between sexes of Boerboel but differ between age categories.

**Keywords:** Body mass index, Lipid profile, obesity, osteoarthritis, Boerboel



**Address for correspondence:* ade_vsr@hotmail.com Telephone: 234-703-380-0326, 234-802-257-2535

*Manuscript Accepted: June, 2016*

## INTRODUCTION

The Boerboel is a big, strong and intelligent working dog. It is well balanced with good muscle development and buoyant in movement. The dog is impressive and imposing. Boerboel are believed to have originated from South African and was thought to be a crossbreed between Bullmastiff and local South African dog breeds like Bullenbijter. Boerboels are generally known for their good health. However, Boerboels can suffer from hip or elbow dysplasia, cervical spondylomyelopathy, vaginal hyperplasia, ectropion, and entropion (Gray, 2003).

Vascular diseases and cardiovascular risk factors are high amongst people with osteoarthritis (Plumb and Aspden, 2004). Emerging evidence suggests that osteoarthritis may share similar risk factors with cardiovascular diseases (Conaghan *et al.*, 2005). Hypercholesterolemia and hypertriglyceridemia, the risk factors for cardiovascular disease, have been related to risk of osteoarthritis and its progression (Findlay, 2007). It has been reported that humans with osteoarthritis had altered lipid profiles characterized by increased concentration of total cholesterol (Borman *et al.*, 1999). It was demonstrated that serum cholesterol and triglyceride levels were associated with incidence of bone marrow lesions in humans (Davies-Tuck *et al.*, 2009). On the contrary, there were no associations between the progression of experimental knee osteoarthritis and plasma lipid profile of dogs (Alam *et al*., 2006; Ajadi *et al.*, 2012).

Obesity is an escalating global health problem both in humans and domestic animals. It is a very important risk factor in the development of musculoskeletal diseases. The incidence of obesity in dogs and cats has been estimated to be between 20 and 40%, and there is an increasing trend in the incidence of obesity in the pet population (McGreevy *et al.*, 2005). The clinical problem of obesity in animals lies in the fact that it is frequently associated with several metabolic abnormalities such as dyslipidemia, insulin resistance and the development of orthopaedic disorders such as osteoarthritis and intervertebral disc disease (German, 2006). Therefore, early recognition of the pathophysiology of obesity with its metabolic alterations and correlates is essential in its control in large breed of dogs.

It has been shown that apart from food intake, sex hormones plays an important role in weight gain (Kanchuk *et al.*, 2003). For instance, gonadectomised dogs have been shown to have greater risk of growing obese compared with intact dog (German, 2006). In humans, post-menopausal women are at greater risks of developing osteoarthritis (OA) compared with men of the same age due to low secretion of oestrogen (Srikanth *et al.,* 2005). In spite of the recorded high prevalence of obesity in pet population and the implication of obesity in the pathophysiology of a number of health disorders among pet population, very little is known about the prevalence of obesity amongst Boerboel population in Nigeria.

In humans, the National Institute of Health developed a body mass index (BMI) which measures body fat based on height and weight (Tobias *et al.*, 2014). These indexes are considered the most accurate assessment of body condition available. However, no such index exists for dogs, so it is exceedingly difficult to objectively evaluate dogs' body condition. A visual nine-step chart was developed for subjective assessment of the body condition system (BCS) in dogs (Laflamme, 1997). However, this body condition scoring (BCS) system fails to take into account the wide range of sizes among dogs of a particular breed hence leading to inaccurate judging of the body condition. The method of estimating body mass index (BMI) in humans is currently being evaluated for its accuracy in dogs by comparing the results with body condition scoring system. Till now there is no record of the plasma lipid profile in Boerboel dogs in spite of their high risk for obesity and musculoskeletal diseases. This study compared the accuracy of the body mass index system in Boerboel dogs using the methods described in humans. It also determined the prevalence of obesity among Boerboel population and evaluated the association between body mass index and plasma lipid profile.

## MATERIALS AND METHODS

Fifty three client-owned Boerboel dogs of both sexes were used. The dogs were adjudged to be in good health condition based on physical examination findings and complete blood profile. Informed owner's consents were obtained and documented. Also, the diet histories of the dogs were noted. The breed, sex and age of the dogs were also noted. In addition, information on whether the dogs have been neutered or not were obtained.

Body weights (BW) of the dogs were obtained with bathroom scale, while height (H) at shoulder and the waist circumference (WC) were determined using a meter rule. These indices were used to determine the body mass index (BMI). The BMI was calculated as the ratio of the body weight (Kg) to the square of the height (m) i.e. BMI= BW (Kg)/$H^2$ ($m^2$). In addition, the body condition score (BCS) was determined subjectively using a scale from 1-9 as described by Laflamme *et al.,* 1999.

About10 mls of blood was obtained from the cephalic vein of the dogs into lithium heparin bottle for the determination of total cholesterol (TC), triglycerides (TRIG), low density lipoproteins (LDL) and high density lipoproteins (HDL) and were determined using Randox Laboratory kit reagents as described by Akpanabiatu *et al.*, 2005.

***Statistical Analysis***

Data were presented as means ± standard deviation (SD) and results were compared using analysis of variance (ANOVA), while relationship between BW, H and WC was determined using regression analysis. P value was accepted significant at values less or equal to 0.05

## RESULTS

The fifty-three Boerboel dogs used in this study comprised of twenty-six (26) males and twenty-seven (27) females. Using the body condition scoring (BCS) twenty (20) of the dogs were classified as obese giving an obesity prevalence of thirty-eight per cent (38%).

There were no significant differences (P > 0.05) in body weight, waist circumference and body mass index between the male and female dogs (Table 1). However, the height at shoulder was significantly (P < 0.05) higher in the male dogs than the female dogs. Similarly, there were no significant (P > 0.05) differences in the plasma concentration of triglycerides, total cholesterol, low density lipoprotein and high density lipoprotein (Table 2).

The body weight, waist circumference and height at shoulder did not differ significantly between the three age categories (Table 3). However, the body mass index was significantly (P < 0.05) lower in dogs under the 0 – 23 months age category when compared with other age categories. Similarly, the high density lipoprotein was significantly (P < 0.05) lower in dogs under the 0 – 23 months age category (Table 4).

**Table 1:** Effect of sex on body weight, height at shoulder, waist circumference, body mass index and gait assessment score of dogs

| Sex | BW (Kg) | H (cm) | WC (cm) | BMI (Kg/$m^2$) |
|---|---|---|---|---|
| Male N=26 | 46.5±0.9 | 62.0±1.6* | 76.5 ±2.4 | 127.4 ± 7.4 |
| Female N-27 | 45.4±1.8 | 57.0±1.5* | 74.0±2.8 | 127.2 ± 5.6 |

**N**: Number of dogs, **BW**: Body weight, **H**: Height to the shoulder, **BMI**: Body mass index, **WC**: Waist circumference * P = 0.026

**Table 2:** Effect of sex on plasma triglycerides, total plasma cholesterol, low density lipoproteins and high density lipoproteins

| Sex | TRIG (mg/dl) | TC (mg/dl) | LDL (mg/dl) | HDL (mg/dl) |
|---|---|---|---|---|
| Male N=26 | 94.3±7.9 | 159.9 ± 9.8 | 101.4 ± 8.0 | 42.8 ± 2.6 |
| Female N-27 | 96.4±5.7 | 159.9 ± 7.8 | 101.2 ± 6.4 | 38.5 ± 2.5 |

**N:** Number of dogs **TRIG**: Plasma triglycerides**, TC**: Total plasma cholesterol, **HDL**: High density lipoproteins**, LDL**: Low density lipoproteins

**Table 3:** Effect of Age categories on body weight, height at shoulder, waist circumference, body mass index and gait assessment score of dogs

| Age categories | BW (Kg) | H (cm) | WC (cm) | BMI (Kg/m$^2$) |
|---|---|---|---|---|
| 0–23 months | 47.1±1.5 | 64.0±1.9 | 75.1± 1.8 | 112.4 ± 2.8* |
| 24-47 months | 44.7±1.7 | 57.7±1.2 | 75.2± 1.5 | 133.4 ± 1.8* |
| > 47 months | 45.8±1.4 | 57.9±1.6 | 76.8± 1.9 | 137.9 ± 1.6* |

**N**: Number of dogs, **BW**: Body weight, **H**: Height to the shoulder,**BMI**: Body mass index, **WC**: Waist circumference, ***:** P = 0.003

**Table 4:** Effect of age categories on plasma triglycerides, total plasma cholesterol, low density lipoproteins and high density lipoproteins

| Age categories | TRIG (mg/dl) | TC (mg/dl) | LDL (mg/dl) | HDL (mg/dl) |
|---|---|---|---|---|
| 0–23 months | 91.1 ±6.7 | 155.7±8.3 | 102.1± 7.4 | 36.0 ± 2.4* |
| 24-47 months | 93.2 ± 7.8 | 162.2±7.9 | 101.9 ± 7.8 | 40.1 ± 2.2* |
| > 47 months | 103.9±5.9 | 164.2±6.9 | 101.3 ± 8.2 | 45.8 ± 2.6* |

**N:** Number of dogs **TRIG**: Plasma triglycerides**, TC**: Total plasma cholesterol, **HDL**: High density lipoproteins**, LDL**: Low density lipoproteins ***:** P = 0.02

**Table 5:** Effect of body condition scores on plasma triglycerides, total plasma cholesterol, low density lipoproteins and high density lipoproteins

| Obesity Status | TRIG (mg/dl) | TC (mg/dl) | LDL (mg/dl) | HDL (mg/dl) |
|---|---|---|---|---|
| Non-obese N=33 | 95.1 ± 7.2 | 161.7 ± 7.5 | 103.7 ± 6.3 | 40.9 ± 2.5 |
| Obese N=20 | 95.9 ± 6.8 | 157.1 ± 8.4 | 97.2 ± 5.7 | 40.2 ± 2.3 |

**N:** Number of dogs **TRIG**: Plasma triglycerides**, TC**: Total plasma cholesterol, **HDL**: High density lipoproteins**, LDL**: Low density lipoproteins

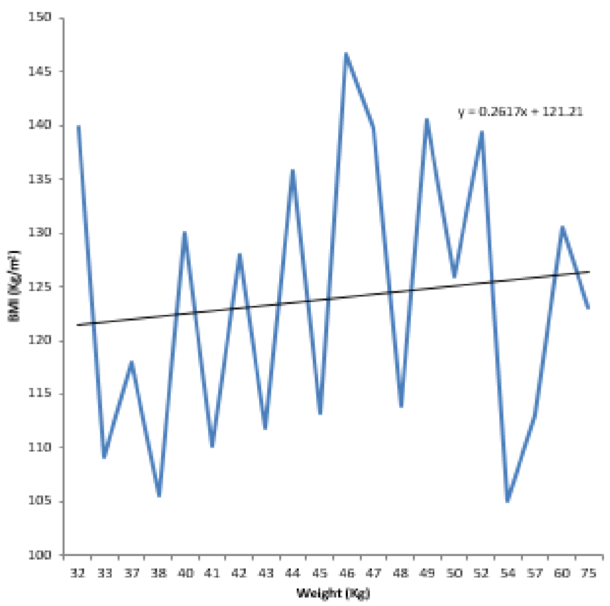


**Fig. 1:** Changes in BMI with increasing body weight

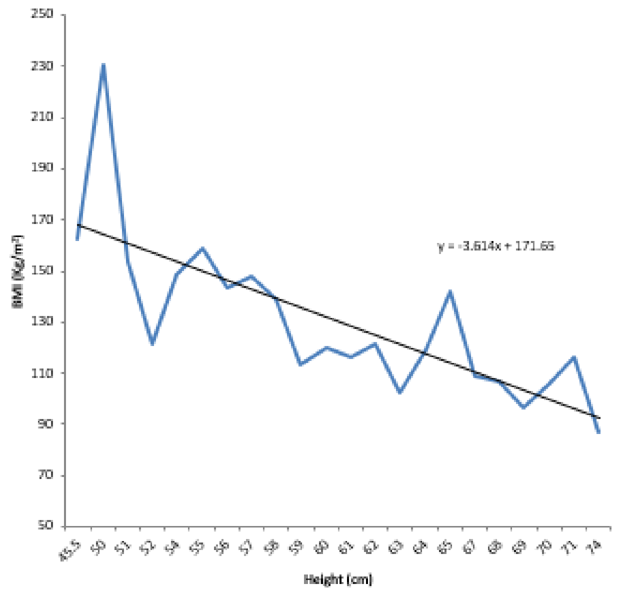


**Fig. 2:** Changes in BMI with decreasing height at shoulder

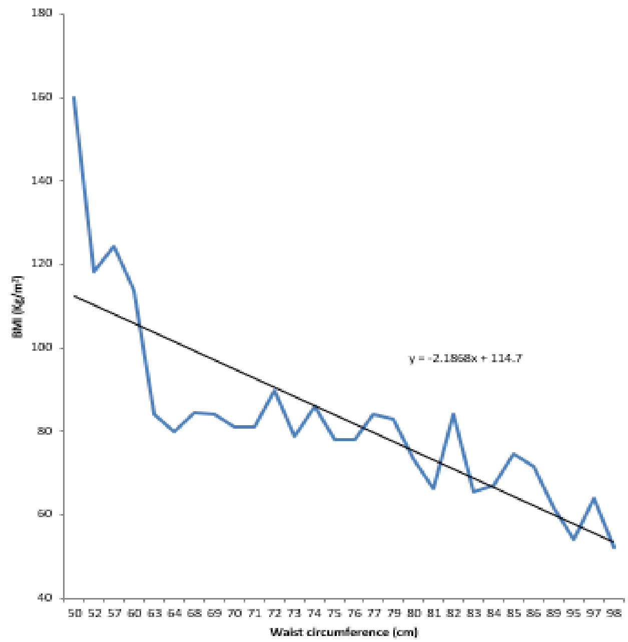


**Fig. 3:** Changes in BMI with decreasing waist circumference

There were no significant differences in the plasma concentrations of total plasma triglycerides, total cholesterol, low density lipoprotein and high density lipoprotein between dogs with BCS greater than 5 compared to those with BCS less than 5 (Table 5). The body mass index tended not to change with increasing body weight (Fig. 1) but linearly increased with decreasing height at shoulder (Fig. 2) and waist circumference (Fig. 3) in the Boerboel dogs.

## DISCUSSION

The body mass index system in humans is universally applicable for all ages and both sexes. However there is no such index for dogs, making it difficult to objectively evaluate the body conditions score (Vogel, 2004). In this study, an attempt was made to estimate the body mass index in dogs using the system established for Humans. The aim was to see if the method established in humans can be used in dogs to determine the body condition. The result of this study showed that the estimated body mass index did not differ between the sexes of dogs but differ significantly between the different age categories of the Boerboel dogs. This finding implied that the method of estimating body mass index in humans can be used to objectively determine the obesity status of Boerboel dogs instead of the body condition scoring (BCS) method.

The result of this study also showed that the body mass index tended not to change with body weight but increased with decreasing height of the dogs. This finding implied that the height of the Boerboel dogs is a major determinant of whether they will be classified as obese or not. This is similar to the findings in humans (Tobias *et al.*, 2014).

Currently, dogs body condition is subjectively evaluated using the body condition score system (Vogel, 2004). This technique is reported to be difficult for dogs' owners to use because it leads to inaccurate judgment of the dogs' body conditions by their owners. This has necessitated the need to develop a technique which is more objective and is dependent on the weight and height of the dog. In this study, the body condition system chart developed by Laflamme and others (Laflamme, 2006) was used to classify the dogs as obese or non- obese. Thirty-eight per cent of the Boerboel dogs in this study were classified as moderately obese. This result is within the reported prevalence of obesity in dogs in general (McGreevy *et al.*, 2005).

Lipid and lipoprotein alterations have been reported in dogs with obesity (Jeusette *et al.*, 2005; Riveria *et al.*, 2011). These included significant increases in total plasma cholesterol and triglycerides concentrations (Jeusette *et al.*, 2005). In this study, the plasma concentrations of triglycerides and high density lipoproteins did not differ between the different sexes of dogs, but the plasma fractions of the high density lipoproteins increased with increasing age. However, there was no significant difference in the plasma lipid profile between Boerboel dogs with BCS less than 5 and those with BCS of 5 and above. The lack of significant difference in the plasma lipid profile between dogs with BCS less than 5 and those with BCS of 5 and above may be as a result of the closeness in the body condition scores and the BMI of the dogs. This implies that the body condition score system might not be a good index of obesity in the Boerboel dogs.

In conclusion, the body mass index did not differ between the sexes of the dogs but differ between the different age categories of the Boerboel dogs suggesting that it might be a useful quantitative assessment of body condition status. However, there is no significant difference in the lipid profile between the different body condition statuses of dogs evaluated probably due to the age of the dogs and closeness in their body condition scores. This is the first study evaluating the plasma lipid profile in Boerboel dogs and relating it to the body condition to assess the risk of obesity.

It is thus recommended that the current technique of BMI determination in humans can be used to quantitatively evaluate the body condition status and predict the risk of obesity in Boerboel dogs. However, it is yet to be determined, the different BMI ranges for each body condition status in Boerboel dogs. It is also recommended that continual evaluation of the plasma lipid profile in large breed dogs be done routinely to determine the risk of the development of cardiovascular and musculoskeletal diseases.

## REFERENCES


Ajadi, R. A., Otesile, E. B., Kasali, O. B. (2012). Short term changes in lipid profile following experimental osteoarthritis in dogs. Bulgarian Journal of Veterinary Medicine 15(3): 166-171

Akpanabiatu, M. I., Umoh, I. B., Udosen, E. O., Udoh, A. E., Edet, E. E. (2005). Rat serum electrolytes, lipid profile and cardiovascular activity on *Nauclea latifolia* leaf extract administration. Indian Journal of Clinical Biochemistry 20(2): 29-34.

Borman, P., Seckin, U., Yucel, M**.** (1999). Dyslipidemia in patients with rheumatoid arthritis and osteoarthritis. Physical Medicine, 2:5-9

Conaghan, P. G., Vanharanta, H., Dieppe, P. A. (2005). Is progressive osteoarthritis an atheromatous vascular disease? Annals of Rheumatic Diseases 64**:**1539-1541

Davies-Tuck, M. L., Hanna, F., Davis, S. R., Bell, R. J., Davison, S. L., Wluka, A. E., Adams, J. and Cicuttini, F. M. (2009). Total cholesterol and triglycerides are associated with the development of new bone marrow lesions in asymptomatic middle-age women- a prospective cohort study. Arthritis Research & Therapy 11(6): 1-7

Findlay, D. M. (2007). Vascular pathology and osteoarthritis. Rheumatology 46:1763-8

German, A. J. (2006). The growing problem of obesity in dogs and cats. Journal of Nutrition 136:1940S-1946S

Gray, M. J., Kirberger, R. M., Spotswood, T. C. (2003). Cervical spondylomyelopathy (wobbler syndrome) in the Boerboel. Journal of South African Veterinary Association 74(4): 104-110

Jeusette, I. C., Lhoest, E. T., Istasse, L. P., Diez, M. O**.** (2005). Influence of obesity on plasma lipid and lipoprotein concentrations in dogs. American Journal of Veterinary Research 66: 81–86

Kanchuk, M. L., Backus R.C. and Calvert, C.C. (2003). Weight gain in gonadectomised normal and lipoprotein lipase-deficient male domestic cats result from increased food intake and not decreased energy expenditure. Journal of Nutrition 133:1866–74.

Laflamme, D. P. (1997). Development and validation of a body condition score system for dogs: a clinical tool. Canine Practice 22:10–5

Laflamme, D. P. (2006). Understanding and managing obesity in dogs and cats. Veterinary Clinics of North America Small Animal Practice 36: 1283-1295

McGreevy, PD, Thomson, PC, Pride, C, Fawcett, A, Grassi, T, Jones, B. (2005). Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. Veterinary Record 156: 695–702

Plumb, M. S. and Aspden, R. M. (2004). High levels of fats and (N-6) fatty acids in cancellous bone in osteoarthritis. Lipids in Health and Disease 3(12): 1476- 1511

Riveria, N. L., Felix, P. A., Ferreira, F. M., Fisher da Silva, A. V., Maiorka, A. (2011). Body measurements and serum lipid profile of overweight adult dogs fed diet containing conjugated linoleic acid. Cienca Rural 41(11): 2020-2025

Srikanth, V.K., Fryer, J.L., Zhai, G., Winzenberg, T.M., Hosmer, D. and Jones, G. (2005). A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis & Cartilage13(9), 769-781

Tobias, D. K., Pan, A., Jackson, C. L., O'Reilly, E. J. and Ding, E. L. (2014). Body mass index and mortality and adults with incident type -2- diabetes. New England Journal of Medicine 370: 233-244.

Vogel, C. (2004). Developing a breed specific body mass index: A cooperative project. Perspective Pp 4