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Goniometric measurement of the hind limb standing (zero) joint angles of Nigerian local dogs

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Abstract

Goniometry is a low-cost, user-friendly and widely available technique used by veterinarians to determine joint range of motion (ROM). Studies providing breed-specific reference ranges for goniometric measurements are scarce, and there is a lack of information regarding the hind limb joint angles in Nigerian local dogs (NLDs). The study was conducted on 20 apparently healthy NLDs (10 males and 10 females), aged between 1 and 8 years, and weighing between 15 and 25 kg. Measurements of the hip, stifle, and tarsal joints were taken in a normal standing (zero) position using a universal goniometer. The static and movable arms of the goniometer were positioned according to established anatomical landmarks. The hip joint angle in the male and female dogs was 70.2° ± 1.48 and 71° ± 7.43, respectively, with no significant difference between them ($P > 0.05$). The stifle joint angle in the male and female dogs was 47.0° ± 5.09 and 46.4° ± 6.09, respectively, with no significant difference between them ($P > 0.05$). However, the tarsal joint angle in the male and female dogs was 48.6° ± 6.99 and 41.4° ± 7.72, respectively, with a significant difference between them ($P < 0.05$). These findings suggest that there might be sex-specific variations in the anatomy of the tarsal joint in NLDs. These findings contribute to a better understanding of the normal anatomical variation in NLDs and may have implications for veterinary orthopaedic practice and breed standards.

Keywords: Goniometry, Hind limb, Joint angles, Nigerian local dogs, Tarsal joint

Introduction

The Nigerian local dogs are a breed native to Nigeria. They are long-headed (dolichocephalic), long-legged, semi-erect-eared, long-snouted, and elongated, slender-bodied domesticated dogs (Awah & Nottidge, 1998). They are omnivorous in nature and are somehow more resistant to certain haemoparasitic

diseases such as canine babesiosis and trypanosomosis, which constantly affect exotic breeds, hence their high level of domestication in Nigeria (Olayemi *et al.,* 2009; Igado, 2011). Typically, an adult Nigerian local dog weighs between 15 and 25kg (Olayemi *et al.,* 2009) and has not been classified or recognised as a breed (Bukar-Kolo *et al*., 2016).

Goniometry is the measurement of angles, particularly those formed by joints in an animal or human. These angles may be measured in a standing position or in flexion or extension (Jaegger *et al*., 2002; Ates *et al.,* 2011; Thomovsky *et al.,* 2016; Formenton *et al*., 2019). Goniometric measurement is a noninvasive and objective method to quantify the range of motion in the joints (Taboadela*,* 2007; Norkin & White, 2016). This measurement may be used for diagnostic purposes, in physiotherapy assessment and management, in surgical or clinical treatment evaluations, and in research (Taboadela*,* 2007; Hesbach, 2007; Norkin & White, 2016; Formenton *et al*., 2019). The universal goniometer, which may be plastic or metallic, is one of the most often used devices to measure joint angles (Jaegger *et al*., 2002; Thomas *et al*., 2006; Hesbach, 2007; Norkin & White, 2016). The anatomical reference points are used to align the arms of the goniometer; the stationary arm is positioned at the proximal reference points, and the movable arm is positioned at the distal reference points (Hesbach, 2007). In a study conducted by Jaegger *et al.* (2002), they concluded that no significant differences were detected in the goniometric measurements of the joint between sedated and awake dogs (Jaegger *et al.,* 2002). However, there may be variations when the goniometric values are compared between species, as well as in comparisons between breeds within the same species (Hesbach, 2007; Thomas *et al*., 2006). Thus, it is necessary to determine the goniometric measurement values for specific species and breeds.

Plate I: Nigerian local dog on normal standing position

The accuracy and reproducibility of goniometry in humans have been documented, and various goniometric methods have been compared (Dent *et al*., 2020; Canever *et al.,* 2025; Quintero-Diaz *et al.,* 2025). Goniometry is used extensively by orthopaedic surgeons and physical therapists in human medicine to quantify baseline limits of joint motion, to aid decisions on appropriate therapeutic interventions, and to document the effectiveness of these interventions (Enwemeka, 1986; Moseley & Adams*,* 1991; Schulte *et al.,* 1993; Barker *et al.,* 1999). Goniometry has been similarly used in canine orthopaedics to assess treatment efficacy for problems involving the carpal (Marcellin-Little *et al.,* 1998), elbow (Huibregtse *et al*., 1994), stifle (Johnson *et al.,* 1997), and hip joints (Marcellin-Little *et al.,* 1999). In Nigerian local dog, however, goniometry has not been validated, and to the best of our knowledge, there is limited information regarding goniometric methods and reference values in this breed. This study set out to determine the normal standing (zero) joint angle of the hip, stifle, and tarsal joints in healthy, non-sedated male and female Nigerian local dogs using goniometry. It was therefore hypothesised that there was no significant difference in the hindlimb joint angles between male and female Nigerian local dogs.

Materials and Methods

Source of animals

Forty-two Nigerian local dogs presented to the Small Animal Clinic of the Veterinary Teaching Hospital, Ahmadu Bello University, Zaria were recruited for the study. Owners were fully informed of the study protocol and provided consent. Breed, sex, age, and weight of each dog were collected.

Inclusion criteria

Adult male and female Nigerian local dogs (Plate I), aged between 1 and 8 years, with body condition scores ranging from 4 to 6 on a 1-to-9 scale (Mawby *et al*., 2004) were used. Owners were interrogated about their previous history of orthopaedic problems or trauma. Distance gait examination and assessment at the walk and trot were carried out to detect lameness and joint abnormalities; these were followed by close inspection in the standard standing anatomical position for musculoskeletal changes or asymmetries,

Table 1: Anatomical landmarks for the placement of the goniometer on the hind limb joints

S/N	Joints	Goniometer		
		Static arm	Vertex	Mobile arm
1	Hip	Iliac spine	Greater trochanter	Femoral longitudinal axis
2	Stifle	Femoral longitudinal axis	Lateral epicondyle of the femur	Lateral malleolus
3	Tarsus	Longitudinal axis of the tibia	Space between the talus and calcaneus	V metatarsus lateral axis

Source: Formenton *et al*. (2019))

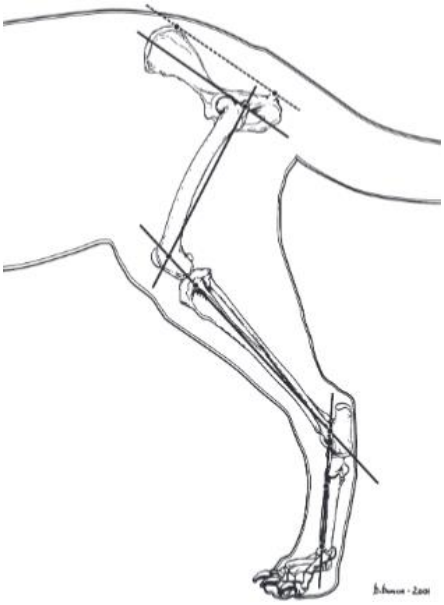

Figure 1: Anatomical landmarks for the placement of the goniometer on the hind limb joints
Source: Jaegger *et al.* (2002)

joint palpation in the full range of motion for signs of pain, crepitus, or instability. Dogs with a moderate level of physical activity, neither sedentary nor overly active (to prevent activity levels from influencing joint angle measurements), were used since the dogs were not sedated before goniometric measurements

Exclusion criteria

Exclusion criteria (EC) were defined to ensure the selection of dogs with no apparent musculoskeletal dysfunctions that might interfere with goniometric assessment, as follows: Nigerian local-mixed dogs, dogs with a history of joint disorders (e.g., arthritis, hip dysplasia) or previous injuries that might affect joint structures, dogs younger than 1 year (puppies) or older than 8 years, overweight or underweight dogs,

dogs with extreme aggression or nervousness and pregnant female dogs were all excluded.

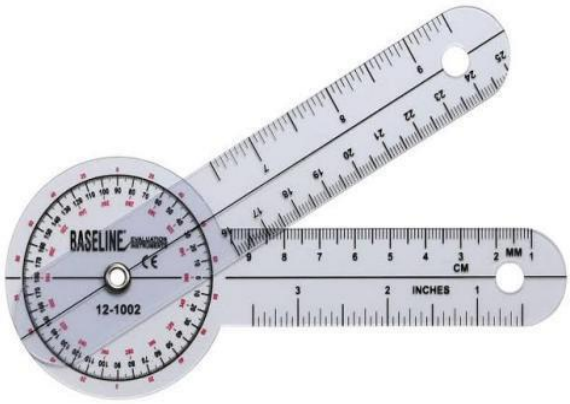

Plate II: Universal (plastic) goniometer

Materials

Materials used included a plastic 25 cm (12 inch), 0° to 360° system universal goniometer (HiRes 360 Degree Head - 12 inch Arms, FEI Enterprise, New York, US) with two-degree increments (Plate II), examination table, record book, pen, and laptop.

Goniometry measurement

Goniometric assessment was performed with the dogs standing in their normal anatomical standing position on the examination table, and they were manually restrained with their owner's assistance with nosedation. The goniometer was placed at the hip, stifle, and tarsal joint by the examiner using the landmarks for each joint as shown in Table 1 and Figure 1. Three repetitions were made for each joint.

Data analysis

Data obtained from goniometry joint angles of the hip, stifle, and tarsal joints of both male and female dogs were expressed as mean ± standard deviation of mean (mean ± SD) and analysed using a t-test in Microsoft Excel. A p-value of <0.05 was considered significant.

Results

Forty-two Nigerian local dogs were evaluated, and out of these, twenty dogs (10 males and 10 females)

Table 2: Mean **±** standard deviation of hip, knee and tarsal standing joint goniometry measurement in male and female Nigerian local dogs

Sex	Hip joint	Knee joint	Tarsal joint
Male	70.2° **±** 1.48	47.0° **±** 5.09	48.6° **±** 6.99
Female	71.0° **±** 7.43	46.4° **±** 6.09	41.4° **±** 7.72
P-Value	0.74	0.97	0.02

which met the inclusion criteria were subjected to the standing goniometry measurement. The median age was 2.8 years (range 1 to 8 years), and the median weight was 21 kg (range 15 to 25 kg). The standing hip joint angle in the male and female dogs was 70.2° ± 1.48 and 71° ± 7.43, respectively (Table 2). The standing stifle joint angle in the male and female dogs was 47.0° ± 5.09 and 46.4° ± 6.09, respectively (Table 2), while the standing tarsal joint angle in the males and female dogs was 48.6° ± 6.99 and 41.4° ± 7.72, respectively (Table 2). The hip and the stifle joints showed no significant difference between the males and the females (P-values 0.74 and 0.97, respectively), while the tarsal joints showed a significant difference between the males and females (P-value 0.02), as shown in Table 2.

Discussion

This study relied on the use of a simple universal plastic goniometer to assess the normal standing (zero) angle of the hip, knee and tarsal joints of Nigerian local dogs and to see if there is sex variation in these joint angles. We chose to evaluate Nigerian local dogs because there is currently limited research specifically examining the joint goniometry of this breed.

The dogs use for the study were selected with stringent exclusion factors; Nigerian local dogs younger than 1 year (puppies) or older than 8 years were not included to avoid age-related changes in joint structure or mobility (Mondino *et al*., 2023; Abdalsada *et al.,* 2025), female dogs that were pregnant were also excluded, as pregnancy may affect joint flexibility and weight distribution. In addition, dogs with extreme aggression or nervousness that could make accurate measurement of the joints difficult were not used. This was because the dogs were not put under sedation as the dogs were required to remain in their standard standing anatomical position before and during the goniometric measurements.

The standing hip joint angles in both sexes did not differ significantly.

This suggests that pelvic limb conformation is largely similar between male and female dogs and exhibit similar patterns of movement and function in both male and female dogs (Abdalsada *et al.,* 2025). Possible reasons could be that there is similar pelvic morphology between sexes in this breed, unlike some larger standard breeds, where males may have broader hips. The hip joint angle in standing dogs is highly influenced by overall body posture, which appears consistent across sexes in this population (Bukar-Kolo *et al.,* 2016). Also, indigenous dogs often undergo minimal artificial selection, resulting in limited sexual dimorphism in pelvic structure (Nganvongpanit *et al.,* 2017). This finding is consistent with studies in other medium-sized dog breeds where sex often does not significantly affect hip extension values (Ates *et al.,* 2011; Humphries *et al.,* 2020).

Similarly, the mean standing stifle angles of the male and female dogs also showed no significant statistical difference. This likely indicates a comparable femoral-tibial alignment in both sexes, similar levels of muscle tone and limb loading patterns in the standing posture. The stifle joint's functional role in stabilising the hind limb during stance is uniform across sexes, thus producing similar joint angles (Al-Juhaishin & Khalil, 2023). The closeness of the standard deviation values further suggests that the stifle joint conformation is fairly consistent within this breed.

In contrast, the tarsal joint angle showed a significant difference between sexes which implies that the male dogs have more extended tarsal joints, while females maintained a more flexed standing posture. This may indicate functional or structural dimorphism, possibly related to greater body weight in males, causing more extension at the tarsal to support weight (Nganvongpanit *et al.,* 2017). The tarsal joint is crucial for propulsion and weight-bearing, so even minor differences can have biomechanical implications.

Similar goniometric hind limb standing joint angle studies in dogs of the Nigerian local breed are lacking to the best of our knowledge. Therefore, no comparison could be made with this present study. Interestingly, to the best of our knowledge, there are very few goniometric studies focused on standing (zero) position joint angles in other breeds of dog too. Majority of studies conducted on joint angles are centred around joint range of motion (ROM), maximum joint flexion and maximum joint extension of the hind limb.

In one of the few reports (Mann *et al*., 1988), the goniometric measurement of the canine pelvic limb

of 13 normal mixed-breed dogs were they evaluated. Their findings differ significantly from what was reported in the present study. They recorded normal values of 108° for the hip, 142° for the stifle and 140° for the hock joint. Unfortunately, sexual variations were not captured in the study. However, the findings in this study were comparable to the findings of Ates *et al.* (2011) in their study of the angular values of the joints of Kangal dogs for the hind limbs using the technique of goniometry for comparison between the sexes. The mean angular values of zero position in the male and female dogs reported were: 62.12º ± 3.37 and 69.8º ± 5.20 (hip), 39.12º ± 3.76 and 42.6º ± 2.56 (stifle), and 26.75º ± 2.7 and 26.1º ± 3.05 (tarsal), respectively. They recorded no statistical difference between the sexes for all the joints.

In their study, the full extension angles of 181º±7, 172º±8 and 188º±7 for the hip, stifle and tarsal joint, respectively, and flexion angles of 58º±10, 58º±8 and 40º±6 for the hip, stifle and tarsal joint, respectively. However, they made no report of the standing (zero) angle of the breed. They concluded that their findings were similar to those reported in Rottweilers (hip flexion) (Mendonça, 2009) and Dachshunds (hip, stifle, and tarsal flexion) (Thomovsky *et al.,* 2016).

In a similar study by Jaegger *et al.* (2002), where they evaluated the reliability of goniometry in Labrador Retrievers, they reported extension angles of 162º±3, 162º±3, 164º±2, and flexion angles of 50º±2, 42º±2, 39º±2 for hip, stifle, and tarsal joints, respectively.

The location and placement of the goniometer on the landmarks were particularly easy in the present study. The Nigerian local dog is a long-legged, medium-sized dog with mild pelvic limb muscle mass, which made landmark palpation and placement of the flat goniometer easy (Bukar-Kolo *et al.,* 2016). This was a major challenge in the study conducted by Thomovsky *et al.* (2016) in the goniometric study evaluating hip, stifle and tarsal flexion angles in Dachshunds. They asserted that the pelvic limb muscle mass made landmarks for goniometer placement particularly difficult to palpate, as well as the chunky, curvy limbs of Daschunds, which hindered the placement of a flat goniometer.

The findings in this present study suggest that while sex does not significantly affect the angulation of the hip and knee joints, it does have a measurable impact on the tarsal joint. This implies that any studies, clinical treatments, rehabilitation or surgeries related to the tarsal joint may need to take sex into account when evaluating joint function in the Nigerian local dogs.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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