Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

The Effect of Age and Sex on The Range of Motion (Rom) in Pshder Dogs

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Abstract

RANGE of Motion (ROM) is an important parameter in evaluating joint flexibility and musculoskeletal health in animals and humans. This study investigates the effect of age and sex on ROM in Pshdar dogs to identifying the potential differences across various joints. A total of 120 Pshdar dogs were categorized based on sex (male and female) and age groups (1–2 years, 3–4 years, 5–6 years, and >7 years). ROM was measured for six major joints: shoulder, elbow, carpal, hip, stifle, and tarsal joints. although the results indicated that the sex factor was not affect significantly on ROM ($p \geq 0.05$), males were exhibited a higher ROM values in some joints. For age, the results were significantly influenced across all joints ($p \leq 0.05$), in particular in older dogs that displaying a greater flexibility than younger ones. However, the interaction between age and sex was not significant, suggesting that age is the primary determinant of ROM. This study demonstrates that ROM in Pshdar dogs increases with age, while sex differences are minimal; suggesting that age-related musculoskeletal adaptations contribute to increased joint flexibility over time. Future studies should consider additional factors such as activity level, genetics, and health conditions to further understand ROM variations in this breed.

Keywords: age, joint flexibility, musculoskeletal adaptation, Pshdar dogs, Range of Motion

Introduction

Understanding the musculoskeletal response to age and sex is crucial for veterinary research, particularly in case of Labradors and Pshdars, both working and companion breeds [1]. The relationship between age and range of motion (ROM) is complex. Some researchers suggesting that aging may be associated with normal changes in performance of well-understood musculoskeletal adaptations over time; while, others suggested that the sedentary or overweight dogs may experience a reduction in muscle tone, strength, and joint stability [2]. Inconsistent findings have emerged from studies on variations in musculoskeletal function between the sexes, despite numerous mammalian species being examined. Some researchers argued that male dogs have greater ROM, attributing this to higher muscle mass and differences in their joint structures [3]. Others have linked ROM and joint mobility with the levels of certain hormones such as estrogen and other female sex hormones [4], which are believed to make the ligaments and tendons of female dogs more genetically and hormonally elastic, leading to greater joint mobility and inspectable ROM [5]. Despite reports showing that ROM differs by sex in some breeds, the findings are not universal across all breeds. Some studies have even found no significant differences in ROM between male and female canines, suggesting that factors like genetics, training, and lifestyle have a much bigger influence on joint flexibility than sex does [6]. Given the inconsistency in the reports reviewed, the Pshdar breed merits further investigation to better

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(Received 12 April 2025, accepted 12 June 2025)
DOI: 10.21608/ejvs.2025.372843.2777

understand whether or not sex influences ROM, especially in an "inflexible" breed like the Pshdar. Biochemical markers and hematologic parameters can offer insights into the health of the musculoskeletal system and the function of joints. Age and sex have been shown to affect dogs' and other animals hematologic and serum biochemical analyses [7], which are often reflected in the types of inflammatory and oxidative stress markers that are used in medicine to gauge the musculoskeletal health of canine patients [8]. Markers that veterinarians look for include IL-6 and CRP levels, which are associated with joint diseases and degenerative changes that can affect a dog's range of motion over time. Certain breeds have also been shown to express age-related differences in serum biochemical studies, particularly with respect to creatinine and cystatin C levels [9]. Grasping the significance of the hematologic and biochemical profiles of Pshdar dogs vis-à-vis their ROM could yield valuable insights about their health, particularly their musculoskeletal health. Mobility impairment is a liability that haunts any breed, and understanding risk factors for that liability could help mitigate it. This study aims to determine how age and sex affect the ROM in canine joints, specifically in Pshdar dogs, while advancing our understanding of the state of flexibility in joint structures.

Material and Methods

Animals and study design

A total of 120 clinically healthy Pshdar dogs were included in the study. The dogs were categorized equally into four age groups; Group 1 (1–2 years), Group 2 (3–4 years), Group 3 (5–6 years), and Group 4 (>7 years). Additionally, the dogs were divided equally based on their sex into males and females. Inclusion and Exclusion Criteria were taken as follow:

Inclusion Criteria:

- Healthy Pshdar dogs with no history of orthopedic disorders or musculoskeletal injuries.
- Dogs that had undergone regular veterinary checkups and exhibited normal mobility.
- Dogs within the defined age groups.

Exclusion Criteria:

- Dogs with a history of trauma, fractures, or surgical procedures affecting joint mobility.
- Dogs diagnosed with hip dysplasia, osteoarthritis, or any degenerative joint disease.
- Dogs receiving medications or supplements that could influence joint function.

ROM testing

The ROM was measured in **six** major joints of each dog using a standard goniometer, a widely used instrument in veterinary orthopedic assessments. The joints assessed included: Shoulder Joint, Elbow Joint, Carpal Joint, Hip Joint, Stifle Joint, Tarsal Joint.

Procedure for ROM Measurement was as follow: The dog was placed in standing and relaxed position to ensure consistent baseline joint positioning. Each joint was passively extended and flexed to its maximum range, with measurements taken three times per joint. The goniometer was aligned with the anatomical landmarks of each joint to ensure accuracy. The mean ROM for each joint was recorded based on three repeated measurements. All measurements were performed by a trained veterinarian to minimize inter-observer variability and ensure accuracy in data collection.

Statistical analysis

The collected data were statistically analyzed using SPSS (Version 26) and GraphPad Prism (Version 9) to determine the effects of age, sex, and their interaction on ROM. Differences between values were considered significant at $p<0.05$.

Results

The ROM differences between male and female Pshdar dogs indicated that while there are slight variations in joint flexibility between the sexes, none of these differences are statistically significant ($p\geq0.05$). Males exhibited marginally higher ROM values in the shoulder, elbow, and hip joints, while females had slightly greater ROM in the stifle and tarsal joints. However, these differences remain within the margin of error and do not indicate a sex-dependent influence on ROM (Table 1).

Also, the findings confirmed that ROM values are relatively similar between the sexes, supporting the conclusion that sex does not play a major role in determining joint flexibility in Pshdar dogs (Figure 1). The ROM variations among different age groups shows a significant increase in ROM with age for most joints (Table 2). Younger dogs (Group 1) were exhibited the lowest ROM values, particularly in shoulder, elbow, and hip joints; whereas, older dogs (Groups 3 and 4) demonstrated increased joint flexibility. The statistical analysis confirmed that age significantly influences ROM, with ($p\leq0.05$) for several joints, including the shoulder and elbow. This

trend is further highlighted in Figure 2, which provides a line graph depicting ROM changes across age groups for both males and females. The figure clearly illustrates a consistent upward trend in ROM with increasing age, confirming that older dogs generally possess greater joint flexibility than younger ones.

The combined effect of age and sex on ROM was appeared statistically without significant interactions between these factors were observed, the results suggest that males consistently exhibited slightly higher ROM across all age groups. This trend was particularly notable in the shoulder and elbow joints, where older male dogs displayed greater ROM than their female counterparts (Table 3).

The interaction between age and sex is further visualized in Figure 3**,** a heatmap showing ROM variations across different age groups and sexes. The figure demonstrates that although ROM increases with age in both males and females, there are minor sex-based differences in specific joints. However, these variations are not statistically significant, indicating that age is the primary determinant of ROM rather than sex. To further explore the age-related changes in ROM for males and females separately, Table 4 provides a detailed breakdown of ROM values across age groups for each sex.

The data confirm that ROM increases with age in both males and females, with the most pronounced differences observed in the shoulder, elbow, and carpal joints. Comparing the sexes within each age group, males in Group 4 consistently displayed slightly higher ROM than females in the same age category. However, the differences remain minor and do not indicate a substantial sex-dependent effect on ROM. To assess the significance of the observed ROM differences, an ANOVA test was conducted, and the results are summarized in Table 4**.** The analysis confirmed that age has a statistically significant effect on ROM for most joints ($p \leq 0.05$), whereas sex does not show a significant impact. Furthermore, the interaction between age and sex was not statistically significant for any joint, reinforcing the conclusion that age is the dominant factor influencing ROM in Pshdar dogs.

Discussion

The study examined the impact of age and sex on the range of motion (ROM) in Pshdar dogs across six major joints: shoulder, elbow, carpal, hip, stifle, and tarsal. The results revealed that age significantly affects ROM, with older dogs exhibiting greater joint flexibility than younger ones [10, 11, 12]. However, sex showed no statistically significant effect on ROM. The interaction between age and sex was also not significant, indicating that age is the primary determinant of joint mobility in this breed. Pshdar dogs' ROM was influenced by a key factor: age. When comparing older dogs (Groups 3 and 4) with younger dogs (Group 1), the former group had higher joint mobility, particularly in specific joints such as the shoulder, elbow, and carpal. The findings could have various implications for the average dog owner, suggesting that with age, a dog's ROM will increase, which could have various implications for our understanding of canine anatomy. The study suggests that increased ROM in older dogs could be an early indicator of joint instability or degeneration, particularly in high-impact joints such as the hip and stifle [13, 14]. Several studies have suggested that aging may lead to changes in the composition of joint cartilage and synovial fluid, which could contribute to increased joint movement but also predispose older dogs to conditions like osteoarthritis [11, 12, 13]. Further investigation is needed to determine whether these changes are purely adaptive or if they represent the early onset of joint degeneration in older Pshdar dogs. Sex did not have a statistically significant impact on ROM in Pshdar dogs, as demonstrated in Table 1 and Figure 1. Although males exhibited slightly higher ROM values in certain joints, these differences were not substantial enough to suggest a sex-related effect on joint flexibility. This finding aligns with previous research, which has shown that sex-based ROM variations in dogs are generally minimal and often breed-dependent [11, 15]. One possible explanation for the lack of sex-based differences in ROM is that Pshdar dogs may not exhibit the same muscle mass and joint structure variations seen in other breeds, such as German Shepherds or Labrador Retrievers, where sex-based ROM differences have been observed [11, 15]. Additionally, hormonal influences, particularly testosterone in males and estrogen in females, have been suggested to affect ligament elasticity and joint stability, but their impact on ROM remains inconclusive in canines [13, 15]. The interaction between age and sex was not statistically significant, suggesting that age-related changes in ROM occur similarly in both sexes, further reinforcing the conclusion that age is the primary factor influencing joint flexibility in Pshdar dogs. The study reveals a significant decline in joint flexibility with age in Pshdar dogs, indicating that they are more likely to be inflexible and that less ROM is normal. Veterinarians should consider

individual differences in joint flexibility when designing rehabilitation programs or physical therapy regimens for dogs that have sustained injuries. Older dogs may benefit more from "strength skills" that increase the stability and serendipitous safety of their joints [14, 16]. The results stress the importance of longitudinal investigations on joint range of motion (ROM) and joint well-being in an insufficiently studied breed like the Pshdar dog. Future studies could adopt various methodologies to enrich the observed outcomes, such as performing kinematic analyses, conducting biomechanical assessments, or evaluating serum biomarkers [12, 17, 18]. The study provides robust evidence that age is the overriding factor affecting ROM in Pshdar dogs. Older dogs display greater, and in some cases, unexpected flexibility, even when considering a "dogs learn as they live" factor. The increased movement seen in older dogs may be a byproduct of them having had more time to "work out" their joints [11, 17]. Further research should probe the reasons for these changes at the level of cells and tissues involved, biomechanically and biochemically, with inflammatory markers and the type and amount of metabolic changes that occur when joints experience excessively high or low levels of ROM [12, 13, 14]. This research drives better veterinary diagnostics, rehab protocols, and musculoskeletal health management for Pshdar dogs, contributing to their breed-specific health.

Conclusion

This study gives robust evidence that age is the overriding factor affecting ROM in Pshdar dogs. Older dogs display a much greater, and in some cases, unexpected flexibility. Even when one considers a "dogs learn as they live" factor, so that the increased movement seen in older dogs may be a byproduct of them having had more time to "work out" their joints, the data on sex suggest that ROM in old male and female Pshdar dogs is remarkably and similarly enhanced.

Attributing the increase in ROM with advancing years to natural musculoskeletal adaptations or to early signs of joint instability could be the onset of serious musculoskeletal issues, necessitating a closer look. Further studies must probe the reasons for these changes at the level of the cells and tissues involved, biomechanically and biochemically, with inflammatory markers as well as the type and amount of metabolic changes that occur when joints experience excessively high or low levels of ROM.

This research drives better veterinary diagnostics, rehab protocols, and musculoskeletal health management for Pshdar dogs, contributing to their breed-specific health. By studying just and unjust flexibility, in the context of normal aging, we expect to find age-linked trends in joint flexibility across the dog population that—given the distinctive form and common health history of our breed—should yield meaningful insights into the health of Pshdar dogs.

Acknowledgments

The authors would like to express their sincere gratitude to the College of veterinary medicine, University of Sulaimani, for providing the facilities and resources necessary to conduct this research. We also extend our thanks to the technical staff at the Department of Anatomy and Histopathology for their invaluable assistance. My special thanks for all dog owners in Sulaymaniyah province for sharing their dogs' samples. Additionally, we appreciate the insightful feedback from the anonymous reviewers, which greatly improved the quality of this manuscript.

Funding statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was conducted using internal resources provided by the College of Veterinary medicine, University of Sulaimani.

Declaration of Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The study was conducted with the sole aim of advancing scientific knowledge in the field of canine morphology specially Pshder dog and does not reflect any commercial interests or biases

Ethics approve

Ethical approval was obtained from the ethical committee of the College of Veterinary Medicine, Sulaimani University, Iraq (Approval No. VET53673 on date 24/12/2024).

TABLE 1. Effect of Sex on Range of Motion (ROM).

Traits	Male		Female		Sig.
	Mean ± SE	CV	Mean ± SE	CV	
ShJ	101.35±2.28 a	17.67	98.30±2.47 a	16.04	0.299
EJ	119.31±2.29 a	14.55	117.57±2.48 a	15.76	0.390
CJ	127.20±3.37 a	18.73	126.30±3.65 a	20.10	0.825
HJ	76.79±1.62 a	16.27	73.35±1.76 a	16.53	0.146
SJ	107.09±2.79 a	19.33	107.87±3.02 a	19.69	0.944
TJ	118.92±5.05 a	30.72	119.25±5.48 a	29.38	0.860

ShJ= Shoulder Joint, EJ= Elbow Joint, CJ= Carpal Joint, HJ= Hip Joint, SJ= Stifle Joint, TJ= Tarsal Joint.

TABLE 2. Effect of Age on Range of Motion (ROM).

Traits	Group 1		Group 2		Group 3		Group 4	
	Mean ± SE	CV	Mean ± SE	CV	Mean ± SE	CV	Mean ± SE	CV
ShJ	90.42±2.46 b	19.77	109.54±2.93 a	12.97	103.43±3.81 a	11.97	105.95±3.99 a	8.60
EJ	107.10±2.47 b	19.55	128.08±2.94 a	6.38	124.83±3.82 a	6.09	126.27±3.98 a	7.81
CJ	114.22±3.64 b	28.54	136.18±4.33 a	6.03	134.46±5.64 a	6.26	136.29± 5.90 a	7.61
HJ	68.66±1.75 b	20.84	83.17±2.08 a	9.93	77.58±2.71 a	9.85	77.32±2.84 a	7.84
SJ	95.15±3.01 b	26.79	116.11±3.58 a	9.37	115.67±4.57 a	9.19	116.23±4.89 a	7.99
TJ	101.99±5.46 b	46.39	133.18±6.50 a	5.75	132.93±8.46 a	5.42	124.91±8.84 a	24.72

ShJ= Sholder Joint, EJ= Elbow Joint, CJ= Carpal Joint, HJ= Hip Joint, SJ= Stifle Joint, TJ= Tarsal Joint. The groups are based on age categories (1: 1-2 years, 2: 3-4 years, 3: 5-6 years, 4: 7+ years).

TABLE 3. Age-Based Differences in ROM for Each Sex

Traits	Male (Age Group 1)	Male (Age Group 2)	Male (Age Group 3)	Male (Age Group 4)	Female (Age Group 1)	Female (Age Group 2)	Female (Age Group 3)	Female (Age Group 4)
ShJ	90.50±2.67	110.20±3.05	104.58±3.92	105.50±4.12	87.78±3.12	108.03±3.90	101.34±4.11	103.67±4.00
EJ	107.80±2.68	128.56±3.33	124.40±4.08	125.10±4.10	102.60±4.25	126.60±4.45	121.00±4.76	124.80±5.22
CJ	115.50±3.80	135.50±4.05	132.12±5.20	134.00±5.30	105.10±4.60	133.80±5.10	128.88±5.95	134.50±6.10
HJ	71.00±2.40	82.00±2.60	77.40±3.80	78.00±3.90	63.80±2.90	82.90±3.70	76.50±3.60	75.00±3.80
SJ	98.30±3.00	115.20±3.50	116.40±4.20	114.90±4.50	89.50±3.90	118.40±4.00	114.90±4.80	116.20±5.00
TJ	106.30±5.10	132.90±6.00	131.00±7.00	130.30±7.30	93.80±6.10	131.00±6.50	130.00±7.00	128.20±7.50

ShJ= Sholder Joint, EJ= Elbow Joint, CJ= Carpal Joint, HJ= Hip Joint, SJ= Stifle Joint, TJ= Tarsal Joint. The groups are based on age categories (1: 1-2 years, 2: 3-4 years, 3: 5-6 years, 4: 7+ years).

TABLE 4. Analysis of Variance (ANOVA) for Joint Flexibility Based on Age and Sex.

Trait	p-value for Age	p-value for Sex	p-value for Age*Sex Interaction
ShJ	0.001	0.145	0.350
EJ	0.020	0.210	0.455
CJ	0.005	0.301	0.388
HJ	0.031	0.415	0.390
SJ	0.002	0.220	0.435
TJ	0.010	0.325	0.467

ShJ= Sholder Joint, EJ= Elbow Joint, CJ= Carpal Joint, HJ= Hip Joint, SJ= Stifle Joint, TJ= Tarsal Joint

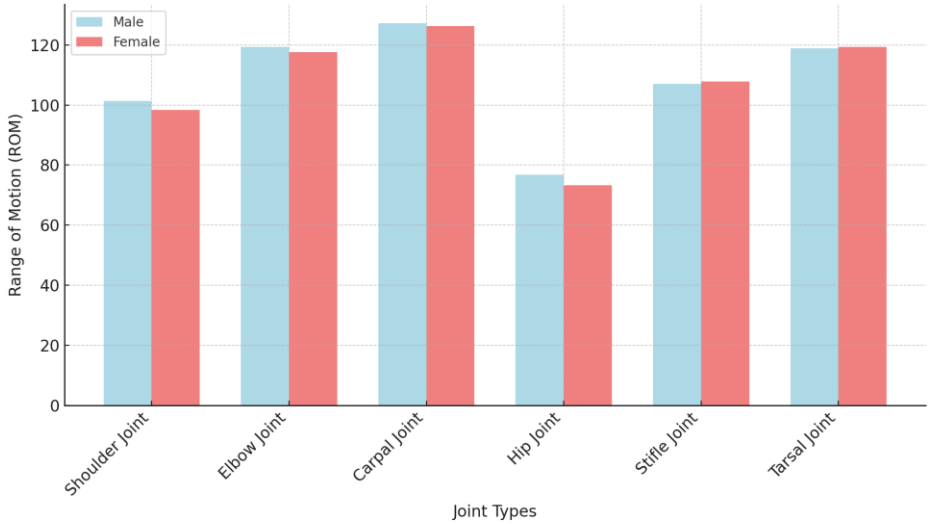

Fig. 1. Bar graph showing the comparison of ROM between males and females across all joints. The data reveal that, while there are minor variations between sexes, the differences in ROM were not statistically significant. This figure provides a visual comparison of the overall ROM between male and female Pshdar dogs for each joint.

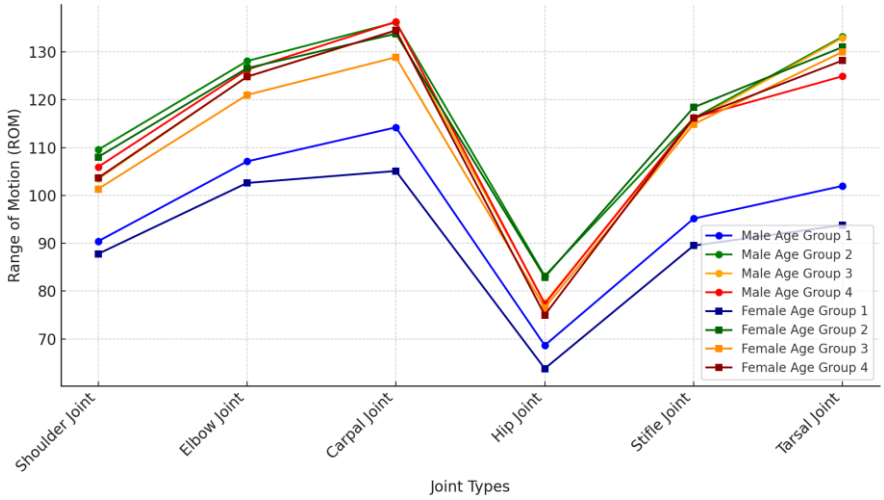

Fig. 2.Line graph illustrating ROM trends by age and sex for each joint. The graph clearly demonstrates that ROM increases with age for both males and females across all joints, with older dogs (Groups 3 and 4) showing higher ROM compared to younger dogs (Group 1). Males consistently show slightly higher ROM than females, but the trend is similar across both sexes.

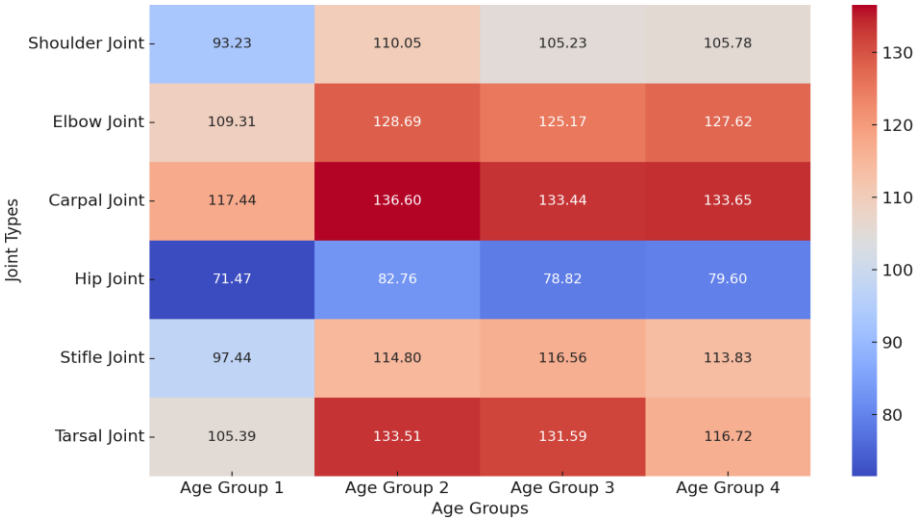

Fig. 3. Heatmap showing the interaction between age groups and sex for ROM in each joint. The heatmap clearly indicates that ROM varies with both age and sex, although the interaction between the two factors is not significant. The increase in ROM with age is evident in both males and females across all joints.

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تأثير العمر والجنس على النطاق الحركي في كلاب البشدر

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الملخص

يُعد نطاق الحركة (ROM) من المعايير المهمة في تقييم مرونة المفاصل وصحة الجهاز العضلي الهيكلي لدى الحيوانات والبشر. تهدف هذه الدراسة إلى التحقيق في تأثير العمر والجنس على نطاق الحركة في كلاب البشدر، من أجل تحديد الفروقات المحتملة في المفاصل المختلفة. تم تصنيف ما مجموعه ١٢٠ كلبًا من فصيلة البشدر حسب الجنس (ذكور وإناث) ومجموعات عمرية (١–٢ سنة، ٣–٤ سنوات، ٥–٦ سنوات، وأكثر من ٧ سنوات). تم قياس نطاق الحركة في ستة مفاصل رئيسية: الكتف، الكوع، الرسغ، الورك، الركبة، والكاحل. على الرغم من أن النتائج أشارت إلى أن عامل الجنس لم يكن له تأثير معنوي على نطاق الحركة($p\geq0.05$) ، إلا أن الذكور أظهروا قيمًا أعلى في بعض المفاصل. أما فيما يتعلق بالعمر، فقد تأثرت جميع المفاصل بشكل كبير($p\leq0.05$) ، لا سيما في الكلاب الأكبر سنًا التي أظهرت مرونة أكبر مقارنةً بالأصغر سنًا. ومع ذلك، لم تكن هناك دلالة معنوية للتفاعل بين العمر والجنس، مما يشير إلى أن العمر هو العامل الأساسي المحدد لنطاق الحركة. تُظهر هذه الدراسة أن نطاق الحركة في كلاب البشدر يزداد مع التقدم في العمر، بينما تكون الفروقات بين الجنسين ضئيلة؛ مما يشير إلى أن التكيفات العضلية الهيكلية المرتبطة بالعمر تسهم في زيادة مرونة المفاصل بمرور الوقت. وينبغي أن تأخذ الدراسات المستقبلية في الاعتبار عوامل إضافية مثل مستوى النشاط، العوامل الوراثية، والحالة الصحية لفهم أفضل لاختلافات نطاق الحركة في هذه السلالة.

الكلمات المفتاحية: العمر، مرونة المفاصل، التكيف العضلي الهيكلي، كلاب بشدار، نطاق الحرك.