



Standardized Body Size Indexes of 10 Canine Breeds Vulnerable to Intervertebral Disc Disease

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Abstract The intervertebral disc is a crucial structure located between each vertebral body, except C1 and C2 and the fused sacral vertebrae, which provides cushioning and stability. However, sometimes these discs may bulge or extrude, causing painful conditions and various neurological problems such as ataxia, paresis, motor or sensorimotor paralysis. As a result, dogs affected by intervertebral disc disease (IVDD) can suffer a significant decrease in their quality of life. The main objective of this study was to provide comprehensive data on the body size of several IVDD-susceptible dog breeds commonly bred in South Korea, which could help develop supportive devices for IVDD patients. Using standardized measurements, the study aimed to design appropriate support tools, taking into account the mobility challenges faced by IVDD patients. The findings provide valuable data to improve the quality of life of patients with IVDD. In addition, it may lay the foundation for research to establish the correlation between body size and IVDD through future research.

Key words body size, chondrodystrophic breeds, intervertebral disc disease, nonchondrodystrophic breeds.

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Received November 21, 2023 / Revised December 27, 2023 / Accepted January 19, 2024



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Introduction

The intervertebral disc is a vital cushioning and stabilizing structure located between all vertebral bodies except the atlas and axis (C1 and C2) and the fused sacral vertebrae (1). In some cases, these structures may protrude or extrude, resulting in pain and various neurological manifestations, such as ataxia, paresis, motor paralysis or sensorimotor paralysis (4). For dogs with thoracolumbar spinal cord disease, a modified Frankel score is often used to rank patients from zero to five, based on severity of symptoms. In this classification system, grade 5 is defined by a normal gait accompanied by paraspinal hyperesthesia. Ambulatory paraparesis is observed from grade 4 onward, and nonambulatory paraparesis from grade 3 onward. In addition, nociception serves as a criterion, and grade 2 indicates paraplegia with intact nociception. Grade 1 denotes paraplegia with absence of superficial pain, while grade 0 means paraplegia without profound pain perception (2,10,11,13).

Despite significant advances in veterinary neurosurgery, imaging techniques and therapeutic options for intervertebral disc disease (IVDD), the likelihood of recovery of neurological symptoms remains less than 50% in cases of profound loss of pain perception (modified Frankel score grade 0), regardless of medical or surgical treatments (1,3,9,15). The prognosis worsens extremely with prolonged loss of profound pain perception, underscoring the need for early treatment and management of IVDD (8,14). Although the prognosis varies depending on the management approach, with surgical intervention showing the best results, other methods such as medical treatment, mainly anti-inflammatory measures, and supportive slings are also feasible (9,13,14). In cases where patients with paralysis do not improve after surgery, significant mobility discomfort can affect the owner's quality of life. Consequently, adjunctive treatment options, such as medication, harnesses and wheeled carts, become crucial, improving the quality of life for both patients and their owners.

Therefore, the present study aims to document comprehensive data on the dimensions of various body parts in canine breeds predisposed to IVDD as well as those commonly bred in the Republic of Korea. These standardized measurements are also expected to help design supportive interventions for IVDD patients, such as wheelchairs and harnesses.

Materials and Methods

Animals

Subject selection for this study was based on previous research on IVDD (15,17). The study included 10 breeds of dogs, including several chondrodystrophic breeds, such as

the Dachshund, Pekingese, Shih-Tsu, Beagle, American Cocker Spaniel, Miniature Poodle and Chihuahua. In addition, nonchondrodystrophic but common breeds in the Republic of Korea such as the Pomeranian, Yorkshire Terrier and Maltese were also included. In each breed, dogs were fully adult, over 1 year of age, and scored from 4 to 7 on body condition score (each $n = 5$).

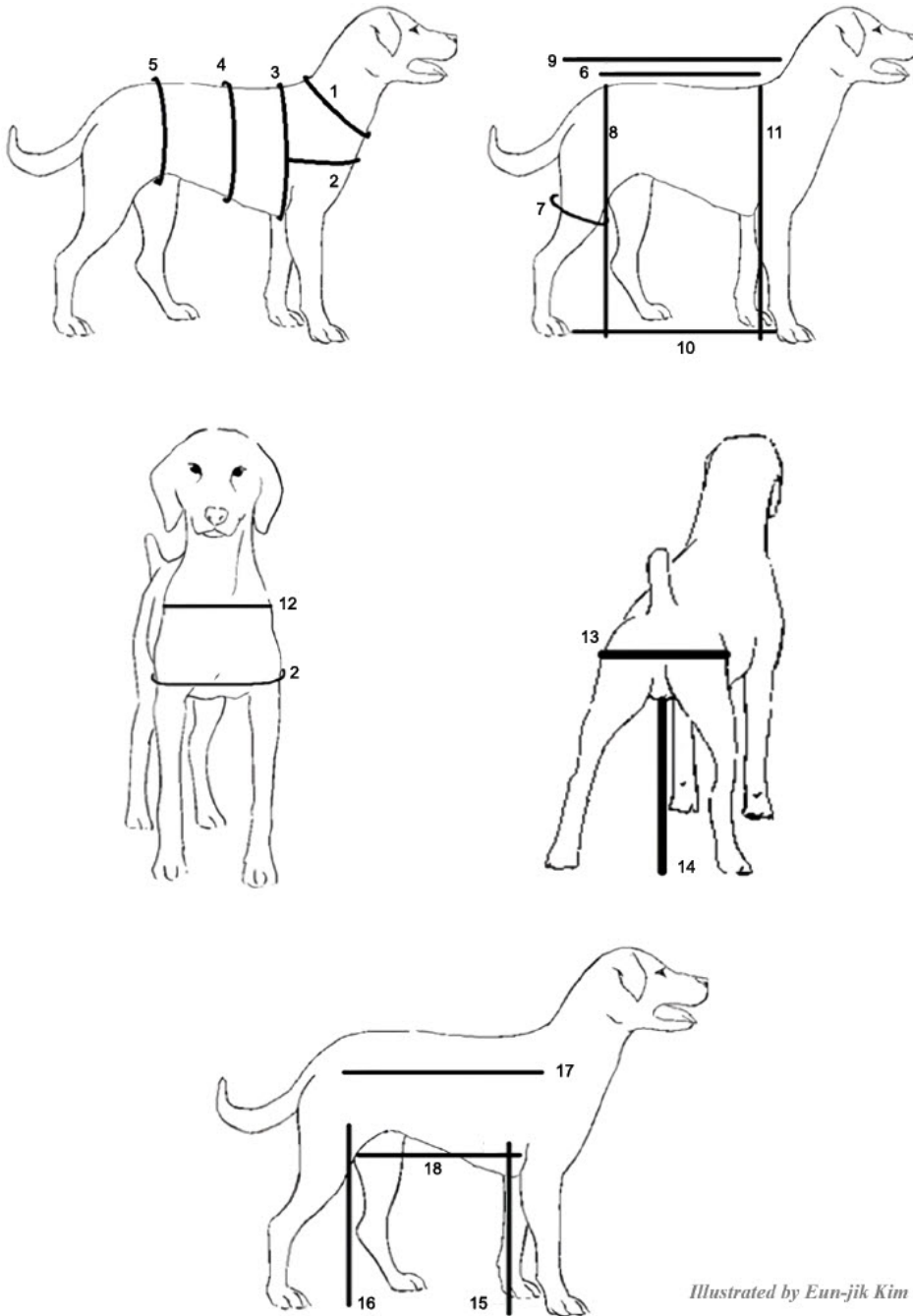
Data collection and processing

Measurements were taken of body weight and eighteen different body parts of the subjects (Fig. 1, Table 1). To minimize measurement errors, a single veterinarian performed all measurements on each subject. The mean and standard deviation were then calculated for each parameter, including body weight and body index.

Results

First, for Dachshund, the mean body weight was 7.40 ± 0.84 kg. The neck circumference measured 31.2 ± 1.63 cm, and the length from the center of the dogs' chest around to the back of the girth line was 28.2 ± 1.33 cm. The mean girth circumference was 46.1 ± 2.42 cm, and the chest circumference at the level of the 13th rib was 45.2 ± 2.93 cm. The circumference of the abdomen at the level of the iliac wing measured 40.4 ± 1.62 cm. The length from the most dorsal point of the shoulder blade to the iliac wing was 30.8 ± 2.71 cm. The circumference of the hind limb at the middle of the femur was 21.0 ± 2.77 cm. The rear height from the top of the hip to the floor measured 21.9 ± 1.43 cm. The distance from the shoulder blade to the starting point of the tail was 36.3 ± 1.17 cm. Additionally, the length between the front paw to the hind paw was 25.0 ± 4.56 cm. The front height from the top of the shoulder to the floor standardly measured 22.3 ± 2.93 cm. The width of shoulders straight across measured 15.2 ± 0.98 cm, and the width of the hip straight across was 15.1 ± 1.28 cm. The height of the groin from the floor was 10.6 ± 1.24 cm. The lengths of the front leg and rear leg were also measured, with the former measuring 10.7 ± 2.89 cm and the latter measuring 15.6 ± 2.06 cm. Additionally, the distance between the mid-point of the shoulders to the mid-point of the hip was 29.2 ± 2.93 cm. Finally, the length of the abdomen measured 22.0 ± 2.10 cm (Table 2, Table 3).

Secondly, Shih-Tzu's are the third breed to be examined. The mean body weight is 4.92 ± 0.72 kg. The neck circumference measures 26.6 ± 4.08 cm, and the length from the center of the dogs' chest around to the back of the girth line is 22.8 ± 1.60 cm. The mean girth circumference is 38.5 ± 4.60 cm, and the chest circumference at the level of the 13th



Illustrated by Eun-jik Kim

Fig. 1. A simplified diagram showing the indexes used in this study.

rib is 39.1 ± 3.53 cm. Additionally, the circumference of the abdomen at the level of the iliac wing was 32.9 ± 3.29 cm. The length from the most dorsal point of the shoulder blade to the iliac wing was 22.2 ± 2.31 cm, and the circumference of the hind limb at the middle of the femur was 16.9 ± 0.92 cm. Rear height from the top of the hip to the floor was 27.8 ± 4.26 cm. The measurements from the shoulder blade to the starting point of the tail were 32.0 ± 0.89 cm. Addi-

tionally, the length between the front paw to the hind paw was 25.2 ± 4.17 cm. The front height from the top of the shoulder to the floor is standardly 28.2 ± 4.66 cm. Next, the width of the shoulders straight across measures 13.8 ± 1.75 cm, and the width of the hip straight across measures 12.6 ± 1.75 cm. The height of the groin from the floor measures 15.2 ± 2.23 cm. The measurements of both front and hind legs were also taken, with the front leg measuring $16.2 \pm$

Table 1. The indexes measured in this study

Number	Indexes
1	Circumference of the neck
2	The center of the dog's chest around to back of line 3
3	Circumference of the girth
4	Circumference of the chest at the level of 13th rib
5	Circumference of the abdomen at the level of iliac wing
6	Top back shoulder blade bone to the iliac wing
7	Circumference of the hind limb at the middle of femur
8	Rear height from top of hip to floor
9	From shoulder blade to the start of the tail
10	Between the front paw to the hind paw
11	Front height from top of shoulder to floor
12	Width of shoulders straight across
13	Width of hip straight across
14	Groin to the floor
15	Height of front leg
16	Height of rear leg
17	Mid-point of shoulders to mid-point of hip
18	Length of abdomen

2.04 cm and the hind leg measuring 19.7 ± 2.86 cm. The distance between the mid-point of the shoulders to the mid-point of the hip measures 24.6 ± 2.94 cm. Finally, the length of the abdomen is 18.2 ± 2.40 cm (Tables 2, 3).

According to the American Kennel Club, poodles are divided into four groups: standard, medium, miniature, and toy. In this study, only miniature poodles from 25 cm to 38 cm at the highest point of the shoulders, were examined. For poodles, the mean body weight was 7.85 ± 0.94 kg. The neck circumference measured 28.6 ± 4.13 cm, and the length from the center of the dogs' chest around to the back of the girth line was 27.6 ± 3.61 cm. The mean girth circumference was 44.9 ± 4.41 cm, and the chest circumference at the level of the 13th rib was 46.0 ± 3.03 cm. Additionally, the circumference of the abdomen at the level of the iliac wing was 43.7 ± 5.58 cm. The length from the most dorsal point of the shoulder blade to the iliac wing was 27.2 ± 3.19 cm, and the circumference of the hind limb at the middle of the femur was 25.5 ± 11.87 cm. Rear height from the top of the hip to the floor was 31.8 ± 2.79 cm. The distance from the shoulder blade to the starting point of the tail measured 37.8 ± 2.56 cm. Also, the length between the front paw to the hind paw was 28.0 ± 2.97 cm. The front height from the top of the shoulder to the floor was standardly 31.6 ± 2.24 cm. Proceeding to additional measurements, the width of the shoulders straight across was 15.6 ± 2.42 cm, and the width of the hip straight across was 14.8 ± 1.29 cm. The height of the groin from the floor measured 19.0 ± 3.08 cm. The front leg and rear leg were also

Table 2. The body weight of 10 breeds

Breed	Body weight (kg)	
	Mean	SD*
Chondrodystrophic		
Dachshund	7.40	0.84
Pekingese	6.28	1.04
Shih-Tzu	4.92	0.72
Beagle	8.52	0.40
American Cocker Spaniel	7.97	0.35
Miniature Poodle	7.85	0.94
Chihuahua	3.15	0.83
Non-Chondrodystrophic		
Pomeranian	2.56	0.71
Yorkshire Terrier	2.60	0.35
Maltese	3.08	0.96

*SD, standard deviation.

measured, with the front leg measuring 19.9 ± 2.69 cm, and the rear leg measuring 24.8 ± 3.37 cm. The distance between the mid-point of the shoulders to the mid-point of the hip measured 28.6 ± 2.65 cm. Finally, the length of the abdomen was 22.6 ± 3.26 cm (Tables 2, 3).

In addition, the weight and body size of other chondrodystrophic breeds have been measured and are documented in Table 2 and Table 3.

The breeds mentioned above belong to the small chondrodystrophic breeds. In contrast, the breeds to be treated are not chondrodystrophic; however, they are often reported with IVDD due to their popularity in Korea. To begin with, Pomeranians had a mean body weight of 2.56 ± 0.71 kg. The neck circumference measured 21.1 ± 4.05 cm, and the length from the center of the dogs' chest around to the back of the girth line was 18.8 ± 3.54 cm. The mean girth circumference was 31.0 ± 3.29 cm, and the chest circumference at the level of the 13th rib was 28.7 ± 1.33 cm. Additionally, the circumference of the abdomen at the level of the iliac wing was 26.8 ± 2.56 cm. The length of the most dorsal point of the shoulder blade to the iliac wing was 21.9 ± 3.53 cm, and the circumference of the hind limb at the middle of the femur was 13.7 ± 4.28 cm. Rear height from the top of the hip to the floor measured 24.7 ± 3.16 cm. From the shoulder blade to the starting point of the tail was 26.4 ± 3.26 cm. Also, the length between the front paw to the hind paw was 16.7 ± 2.75 cm. The front height from the top of the shoulder to the floor was standardly 26.2 ± 3.60 cm. Next, the width of shoulders straight across was 10.7 ± 1.66 cm, and the width of the hip straight across was 10.3 ± 1.72 cm. The height of the groin from the floor was 15.5 ± 2.79 cm. The length of the front

Table 3. The measured sizes of chondrodystrophic breeds

Number (cm)	Dachshund		Pekingese		Shih-Tzu		Beagle		American Cocker Spaniel		Miniature Poodle		Chihuahua	
	Mean	SD*	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	31.2	1.63	27.4	4.27	26.6	4.08	31.2	2.16	30.4	0.49	28.6	4.13	25.2	1.72
2	28.2	1.33	24.0	2.19	22.8	1.60	27.1	1.02	29.0	3.03	27.6	3.61	20.6	1.85
3	46.1	2.42	42.0	3.03	38.5	4.60	47.1	1.02	54.4	7.00	44.9	4.41	34.3	3.54
4	45.2	2.93	41.5	2.57	39.1	3.53	47.8	2.25	50.8	4.17	46.0	3.03	33.9	3.88
5	40.4	1.62	35.6	0.80	32.9	3.29	40.9	0.73	39.6	1.36	43.7	5.58	30.3	4.77
6	30.8	2.71	24.2	1.60	22.2	2.32	29.3	5.13	28.9	1.02	27.2	3.19	19.4	1.85
7	21.0	2.77	19.0	1.41	16.9	0.92	22.4	1.74	26.1	1.80	25.5	11.87	18.0	3.69
8	21.9	1.43	24.5	1.79	27.8	4.26	38.4	1.16	35.6	2.44	31.8	2.79	21.2	2.14
9	36.3	1.17	31.5	2.10	32.0	0.89	38.6	1.50	39.8	1.60	37.8	2.56	25.8	1.94
10	25.0	4.56	22.7	1.60	25.2	4.17	32.0	5.73	32.8	1.17	28.0	2.97	19.4	2.87
11	22.3	2.93	24.2	1.33	28.2	4.66	43.2	3.97	36.0	3.62	31.6	2.24	21.9	2.91
12	15.2	0.98	14.0	1.10	13.8	1.75	14.6	0.37	16.1	1.62	15.6	2.42	10.9	1.11
13	15.1	1.28	12.5	0.84	12.6	1.02	13.8	1.50	15.4	1.62	14.8	1.29	11.3	1.33
14	10.6	1.24	12.9	2.62	15.2	2.23	22.9	2.31	20.6	2.06	19.0	3.08	12.4	0.80
15	10.7	2.89	14.1	1.62	16.2	2.04	24.8	1.44	22.8	3.76	19.9	2.69	13.4	1.77
16	15.6	2.06	19.3	2.82	19.7	2.86	28.7	1.12	28.4	1.62	24.8	3.37	16.5	1.95
17	29.2	2.93	25.0	0.63	24.6	2.94	32.6	2.85	29.0	2.00	28.6	2.65	21.2	2.48
18	22.0	2.10	18.9	2.15	18.2	2.40	22.4	1.36	23.2	2.32	22.6	3.26	13.6	2.06

*SD, standard deviation; 1, circumference of the neck; 2, the center of the dog's chest around to back of line 3; 3, circumference of the girth; 4, circumference of the chest at the level of 13th rib; 5, circumference of the abdomen at the level of iliac wing; 6, top back shoulder blade bone to the iliac wing; 7, circumference of the hind limb at the middle of femur; 8, rear height from top of hip to floor; 9, from shoulder blade to the start of the tail; 10, between the front paw to the hind paw; 11, front height from top of shoulder to floor; 12, width of shoulders straight across; 13, width of hip straight across; 14, groin to the floor; 15, height of front leg; 16, height of rear leg; 17, mid-point of shoulders to mid-point of hip; 18, length of abdomen.

leg and rear leg was also measured, and the former was 16.6 ± 2.94 cm, and the latter was 20.2 ± 4.62 cm. The length between the midpoint of the shoulders to the midpoint of the hip was 17.8 ± 3.31 cm. Finally, the length of the abdomen was 13.1 ± 1.80 cm (Tables 2, 4).

Continuing with the nonchondrodystrophic breeds, Yorkshire Terriers are the second breed to be examined. They had a mean body weight of 2.60 ± 0.35 kg. The circumference of the neck measured 20.8 ± 1.6 cm, and the length from the center of the dogs' chest around to the back of the girth line was 18.0 ± 0.55 cm. The mean girth circumference was 29.5 ± 2.14 cm, and the chest circumference at the level of the 13th rib was 34.4 ± 1.53 cm. Additionally, the circumference of the abdomen at the level of the iliac wing was 30.8 ± 2.79 cm. The measurement from the most dorsal point of the shoulder blade to the iliac wing was 18.7 ± 1.91 cm, and the circumference of the hind limb at the middle of the femur was 15.2 ± 2.14 cm. Rear height from the top of the hip to the floor was 21.3 ± 1.78 cm. The length between the shoulder blade and the starting point of the tail was 28.6 ± 3.65 cm. Additionally, the length between the front paw to the hind paw was 18.6 ± 1.96 cm. The front height from the top of the shoulder to the floor measured a standard 22.1

± 2.65 cm. Next, the width of the shoulders straight across was 11.3 ± 1.40 cm, and the width of the hip straight across was 12.2 ± 2.04 cm. The height of the groin from the floor was 12.5 ± 1.00 cm. The length of the front leg and rear leg was also measured, with the front leg measuring 13.3 ± 1.29 cm and the rear leg measuring 16.7 ± 1.54 cm. The length between the mid-point of the shoulders to the mid-point of the hip was 19.90 ± 1.2 cm. Finally, the abdomen measured 14.0 ± 1.10 cm (Tables 2, 4).

Finally, for Maltese dogs, the mean body weight was 3.08 ± 0.96 kg. The neck circumference measures 19.3 ± 4.19 cm, and the length from the center of the dogs' chest around to the back of the girth line was 16.6 ± 2.08 cm. The mean girth circumference was 29.9 ± 3.61 cm, and the chest circumference at the level of the 13th rib was 30.4 ± 5.04 cm. Additionally, the circumference of the abdomen at the level of the iliac wing was 26.8 ± 5.95 cm. The length from the most dorsal point of the shoulder blade to the iliac wing was 20.1 ± 3.38 cm, and the circumference of the hind limb at the middle of the femur was 13.8 ± 2.77 cm. Rear height from the top of the hip to the floor was 22.7 ± 1.94 cm, and from the shoulder blade to the starting point of the tail was 27.8 ± 3.76 cm. Furthermore, the length between the front paw and hind paw

Table 4. The measured sizes of non-chondrodystrophic breeds

Number (cm)	Pomeranian		Yorkshire Terrier		Maltese	
	Mean	SD*	Mean	SD	Mean	SD
1	21.1	4.05	20.8	1.60	19.3	4.19
2	18.8	3.54	18.0	0.55	16.6	2.08
3	31.0	3.29	29.5	2.14	29.9	3.61
4	28.7	1.33	34.4	1.53	30.4	5.04
5	26.8	2.56	30.8	2.79	26.8	5.95
6	21.9	3.53	18.7	1.91	20.1	3.38
7	13.7	4.28	15.2	2.14	13.8	2.77
8	24.7	3.16	21.3	1.78	22.7	1.94
9	26.4	3.26	28.6	3.65	27.8	3.76
10	16.7	2.75	18.6	1.96	19.6	4.45
11	26.2	3.60	22.1	2.65	22.9	1.50
12	10.7	1.66	11.3	1.40	10.9	1.71
13	10.3	1.72	12.2	2.04	10.5	2.97
14	15.5	2.79	12.5	1.00	14.0	2.21
15	16.6	2.94	13.3	1.29	15.5	1.48
16	20.2	4.62	16.7	1.54	18.1	2.06
17	17.8	3.31	19.9	1.20	20.9	2.63
18	13.1	1.80	14.0	1.10	14.7	2.38

*SD, standard deviation; 1, circumference of the neck; 2, the center of the dog's chest around to back of line 3; 3, circumference of the girth; 4, circumference of the chest at the level of 13th rib; 5, circumference of the abdomen at the level of iliac wing; 6, top back shoulder blade bone to the iliac wing; 7, circumference of the hind.

was measured, and it is 19.6 ± 4.45 cm. The front height from the top of the shoulder to the floor was found to be standardly 22.9 ± 1.50 cm. Next, we measured the width of shoulders straight across, which was 10.9 ± 1.71 cm, and the width of hip straight across, which was 10.5 ± 2.97 cm. The height of the groin from the floor was recorded as 14.0 ± 2.21 cm. The length of the front leg and rear leg was also measured, with the former measuring 15.5 ± 1.48 cm, and the latter measuring 18.1 ± 2.06 cm. The length between the mid-point of the shoulders to the mid-point of the hip was found to be 20.9 ± 2.63 cm. Finally, the length of the abdomen was measured to be 14.7 ± 2.38 cm (Tables 2, 4).

Discussion

The aim of this study is to provide essential information on the standard measurement and average body sizes derived from various canine breeds susceptible to IVDD, allowing the development of supportive devices. These measurements are essential for designing wheel carts for paraplegic patients or harnesses for cervical, thoracic and lumbar spinal disorders to strengthen muscles before or after IVDD surgery. Ensuring the suitability and lasting comfort of these devices is critical

to avoid injuries caused by improper fit. However, because custom options can often be expensive, they are potentially out of reach for some pet owners. In contrast, prefabricated or ready-to-use devices based on standardized sizes for each canine breed can reduce costs and improve accessibility.

In epidemiological studies of IVDD, chondrodystrophic and other small breeds show the highest risk. In particular, Dachshunds, Poodles and Beagles account for a significant proportion of IVDD cases (6). In the study of 8,117 cases, dachshunds showed a markedly 10-fold greater susceptibility to IVDD compared to all other breeds combined, while Shih-Tzus and Pekingese demonstrated a nearly 4-fold greater susceptibility to IVDD than all other breeds (15). In addition, another study reported that Dachshunds, American Cocker Spaniels, Pekingese, and Beagles accounted for 60%, 7%, 5%, and 3% of all IVDD cases, respectively (5). Therefore, these IVDD-susceptible breeds are commonly referred to as chondrodystrophic breeds (16).

The subject of this study covers not only several chondrodystrophic breeds, but also nonsusceptible breeds. Among the latter, Yorkshire Terriers, Maltese and Pomeranian dogs are commonly bred in the Republic of Korea, making them common breeds in veterinary practice. Therefore, although these breeds are not susceptible to IVDD, they are relatively well documented (7). In contrast, although several large or giant breeds, such as German Shepherds, Labrador Retrievers, and Doberman Pinschers, were known to be frequently affected by IVDD (12), they were excluded from the present investigation because of their rarity in the veterinary setting in the Republic of Korea.

Correlations between each body size and IVDD incidence rate were not analyzed in the present study. This point is considered a limitation of the document. However, previous reports indicate that a shorter spinal length from T1 to S1 and a shorter distance from the calcaneal tubercle to the mid-point of the patellar tendon may predispose to intervertebral disc herniation. Alternatively, in affected dogs, longer spinal length, greater height at the withers and smaller pelvic girth could cause more severe myelopathy (10). These findings provide an opportunity for further research to uncover possible etiological factors using the data obtained. Although the standardized sizes may not correlate directly with IVDD and body sizes, the results of the present study are valuable for designing supportive devices for IVDD-affected canines, especially those belonging to the 10 breeds studied. Consideration of various indexes from the present study allows the development of appropriate support instruments for IVDD patients, both before and after surgery. Another limitation of the study is the small number of dogs per breed included,

which may result in substantial variations in body measurements due to individual differences such as weight and body condition score. This suggests the need for more research focused on differentiation within the breed population based on body weight and body condition score. This type of research can provide detailed weight-based body indexes within a specific breed, which will aid in the accurate design of appropriate assistive devices for individual canine bodies.

Finally, standing positions are favored for measurements, as they provide greater accuracy for many categories, such as the length of each leg. However, clinicians should be aware that patients requiring such measures, wheeled carts or customized slings, are likely to be partially or totally paralyzed and unable to assume a standing position.

In conclusion, this study aimed to provide comprehensive data on the body size of several IVDD-susceptible dog breeds commonly bred in the Republic of Korea. The goal is to support the development of devices for IVDD patients, ultimately improving their quality of life and providing cost-effective solutions for their care needs. Standardized sizes play a crucial role in the design of appropriate assistive devices for patients with IVDD who face mobility problems. The data from this study can be a valuable resource for veterinary professionals and researchers working in IVDD management. Although this study did not analyze correlations between body sizes and the incidence of IVDD, the existing literature highlights potential factors influencing the disease. In addition, this research can serve as a foundational study to understand the correlation between body sizes and the occurrence of IVDD.

Conflicts of Interest

The authors have no conflicting interests.

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