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THESIS

EPIDEMIOLOGY AND PAIN ASSESSMENT OF DOGS WITH JOINT DISEASES VISITED KASETSART VETERINARY TEACHING HOSPITAL

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A Thesis Submitted in Partial Fulfillment of
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The study was divided into two parts, a retrospective case-control study and a case-control study. The objectives of the first study were to study epidemiology of joint disease in dogs visited Suvarnnachad therapeutic swimming pool at Kasetsart Veterinary Teaching Hospital in 2007, and to evaluate risk factors associated with hip joint diseases including age, sex, breed, size, and body weight.

The first study included 447 dogs. A case group consisted of 149 dogs with hip joint disorders; whereas 298 dogs without neuromuscular diseases, and joint diseases visited the hospital in the same period represented a control group. Risk factors were analyzed with multivariate logistic regression analysis. The results indicated that joint diseases was the most common problem affected 60% of dogs visited the pool in 2007. Of those dogs, hip joint was the most affected which accounted for 83% of 179 dogs with joint diseases. Furthermore, the study found that body weight, retriever breed, non-retriever purebred, and large-sized dog were risk factors for hip joint diseases in dogs. Odds ratios and 95% confidence intervals (CI) were 1.08 (95% CI, 1.05 to 1.11) for body weight, 4.16 (95% CI, 1.38 to 12.52) for retriever breed, 2.31 (95% CI, 1.15 to 4.67) for non-retriever purebred, and 2.81 (95% CI, 1.22 to 6.49) for large-sized dog.

The second study aimed to evaluate validity of 4 questionnaires including Helsinki chronic pain index (HCPI), Bioarth functional evaluation scale (BFES), orthopedic examination grading system (OEGS), and gait analysis (GA) that is a part of canine orthopedic rehabilitation evaluation form. These questionnaires intended to distinguish dogs with and without hip disorders (case and control group). Also, correlations among scores from each method as well as between owner scores and a veterinarian scores were assessed. Each group consisted of 20 dogs. Owners were asked to complete only HCPI and BFES form. But, a veterinarian, who evaluated all dogs, had to complete all. Data were analyzed using nonparametric analyses. The results showed that there were significant differences between scores of two groups ($p<.01$). Additionally, high correlations among scores from all questionnaires were found ($r = 0.70$ to 0.88, $p<.01$). Correlations between owner scores and veterinarian scores for HCPI ($r = 0.88$, $p<.01$) and BFES ($r = 0.79$, $p<.01$) were detected as well.

Overweight condition should be controlled to prevent dogs from hip joint diseases. Additionally, questionnaires are suitable methods for evaluating lame dogs, and can be used interchangeably by veterinarians and owners.

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Thitiwan Patanasatienkul

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LIST OF ABBREVIATIONS

BCS	=	body condition score
BFES	=	Bioarth functional evaluation scale
CI	=	confidence interval
cm	=	centimeter
GA	=	gait analysis
HCPI	=	Helsinki chronic pain index
IQR	=	interquartile range
KU-VTH	=	Kasetsart Veterinary Teaching Hospital
mm	=	millimeter
NRS	=	numerical rating scale
NSAID	=	non-steroidal anti-inflammatory drug
OEGS	=	Orthopedic examination grading system
r	=	correlation coefficient
ROM	=	range of motion
SD	=	standard deviation
SE	=	standard error
VAS	=	visual analogue scale

EPIDEMIOLOGY AND PAIN ASSESSMENT OF DOGS WITH JOINT DISEASES VISITED KASETSART VETERINARY TEACHING HOSPITAL

INTRODUCTION

Number of dogs visited Kasetsart Veterinary Teaching Hospital (KU-VTH) with lameness problem has increased. Osteoarthritis is one of the common causes of lameness. It is a chronic disease with clinical signs of pain, joint stiffness, decreased range of motion (ROM), and difficulties in standing up. Risk factors of joint diseases in dogs are rarely described and results are controversial among studies (Popovitch *et al.*, 1995; Ohlerth *et al.*, 1998; Smith *et al.*, 2001; Rettenmaier *et al.*, 2002). Hence, evaluation for risk factors of these diseases should be performed to prevent dogs from the problem.

Although surgery is a method to correct the disease such as hip dysplasia, this method is frequently avoided. This is due to unacceptable risk of the dogs being anesthetized prior to the operation and owners attitudes toward pain during and after the procedure (Vaisanen *et al.*, 2008). Moreover, it is not the best way to overcome the disease in some situation. Conservative treatment is an alternative choice for joint disease. Both veterinarians and dog owners preferred this method to surgery. Treatments include medication and rehabilitation with the goals to reduce pain, increase joint ROM, and improve quality of life. Pain is usually alleviated by medication such as corticosteroids and non-steroidal anti-inflammatory drugs (NSAID). ROM is increased by means of rehabilitation. When pain is relieved and ROM is increased, the dog will be able to perform normal activities. That shows improving quality of life.

Rehabilitation is often used in combination with medication. It includes passive ROM, standing on a ball, hydrotherapy, and etc. Passive ROM is performed to increase joint ROM. Standing on a ball is done with an aim to strengthen the limb

by increasing force on the affected legs. Moreover, hydrotherapy is a therapeutic exercise of which the dog is put to swim in the water by itself or with some facilitating equipment.

His Majesty the King granted a budget to KU-VTH to build a therapeutic swimming pool and named it “Suvarnnachad”. This pool has opened officially since the 6th of May 2005. The king gave an advice on building the swimming pool and also permitted to use his pool as a prototype. All dogs assigned to use this pool must be examined by a veterinarian beforehand. Most of them have lameness problem and overweight problem. Since the swimming pool has been opened, there was no information about the dogs that have used the pool. It should be described how effective the pool is and whether it served all ill dogs in order to improve this alternative treatment.

Whether the dog is well responded to the treatment is unknown without an evaluation. As a result, pain assessment is necessary to cope with joint disease. There are several methods to evaluate pain and lameness in dogs including goniometer and force plate gait analysis. Goniometer is used to measure ROM of the treated joint. While, force plate gait analysis is used to measure how the animal bears weight on each limb. This method is known to be gold standard test. Additionally, questionnaire is another approach to evaluate lame dogs. Several questionnaires were developed including Helsinki chronic pain index (HCPI), Bioarth functional evaluation scale (BFES), orthopedic examination grading system (OEGS), functional stifle scale, and hip score. However, validity and reliability of these questionnaires are rarely mentioned. These tools should be assessed prior to be applied in veterinary practice. Additionally, if the questionnaire can be evaluated effectively by owners, the efficiency of treatment evaluation should be increased.

OBJECTIVES

1. To study descriptive epidemiology of dogs with joint diseases

2. To evaluate risk factors of hip joint diseases including age, sex, breed, size, and body weight compared with non-joint diseased dogs

3. To evaluate validity of four questionnaires for assessing pain and lameness in dogs with hip disorders including HCPI, BFES, OEGS, and Gait analysis (GA), a part of canine orthopedic rehabilitation evaluation form

4. To assess correlations among scores from these four questionnaires

5. To assess correlations between scores assessed by owner and scores assessed by veterinarian in each questionnaire

LITERATURE REVIEW

1. Joint

1.1. Joint diseases

Joint consists of bone, cartilage, ligaments, tendons, and joint capsule. Its functions are permitting movement and supporting the body. Joint diseases occur when any part of joint is damaged, and so the joint loses its function. Clinical signs include pain, joint stiffness, and lameness. Joints of a dog include atlanto-occipital joint, shoulder joint, elbow joint, carpal joint, sacroiliac joint, hip joint or coxofemoral joint, stifle joint, and tarsal joint (Evans and deLahunta, 1996). Olsewski *et al* (1983) studied joint abnormalities in 92 dogs. Of those dogs, 71% had hip joint involvement, 38% had shoulder joint involvement, 22% had stifle joint involvement, and 40% had multiple joints involvement. There are plenty of orthopedic problems that occur in hip area of dogs. Those include hip dysplasia, Legg-Calve-Perthes disease, fractures, hip luxation, and muscle injuries. These diseases involve inflammation and frequently lead to osteoarthritis (Schrader, 1995; Levine *et al.*, 2004). A study of Power *et al.* (2005) found that the prevalence of hindlimb lameness caused by cranial cruciate ligament rupture was 32% among dogs with lameness previously attributed to hip dysplasia. The affected sides of joint were 29% left side, 28% right side, and 43% bilateral. In addition, there are several studies related to hindlimb lameness, particularly hip joint diseases (Paster *et al.*, 2005; Smith *et al.*, 2006; Edge-Hughes, 2007; Szabo *et al.*, 2007; Voss *et al.*, 2007; Witsberger *et al.*, 2007; Zhu *et al.*, 2008; Katic *et al.*, 2009).

1.2. Risk factors of hip joint disorders

A hospital-based study of Rettenmaier *et al.* in 2002 showed that prevalence of canine hip dysplasia was 19.7% in purebreds and 17.7% in crossbreeds. The numbers were not differed between the two breeds. Also, disease similarly

distributed between male and female dogs (Lust, 1993; Rettenmaier *et al.*, 2002). Most dogs had a problem of degenerative joint disease according to radiographic findings (Fries and Remedios, 1995; Rettenmaier *et al.*, 2002). Body weight is found to be a factor associated with joint disease in many studies (Smith *et al.*, 2001; Mayhew *et al.*, 2002; Sallander *et al.*, 2006; Smith *et al.*, 2006). Weight control tends to reduce disease severity and disease incidence in dogs (Kealy *et al.*, 1992; Impellizeri *et al.*, 2000). Moreover, age (Ohlerth *et al.*, 1998; Mayhew *et al.*, 2002; van Hagen *et al.*, 2005) and distraction index (Popovitch *et al.*, 1995; Smith *et al.*, 1995) were shown as risk factors for canine hip dysplasia. Environmental factor such as floor type is associated with hip dysplasia in dogs as disease is more likely to occur in dogs kept on slippery floor (van Hagen *et al.*, 2005). Additionally, nutrition is an environmental factor influencing canine hip dysplasia development. It does not directly cause the disease but it accelerates the occurrence in dog with genetic predisposing (Wilhelmi, 1993; Fries and Remedios, 1995; Sallander *et al.*, 2006). Genetic also plays an important role on hip joint disease (Ohlerth *et al.*, 1998; van Hagen *et al.*, 2005; Hays *et al.*, 2007; Zhu *et al.*, 2008).

2. Pain assessment

Pain is an unpleasant condition related to tissue damage for both human and animals. After one exposes to a pain stimulus, pain is developed. Then, the individual reacts for pain as called pain recognition (Debbie, 2006). Pain assessment is divided into two methods, subjective measurement and objective measurement. The objective one is preferable (Hesbach, 2007), but it is sometimes difficult to perform. This study will mainly focus on pain associated with lameness in dogs.

2.1. Subjective measurement

This kind of measurement depends on an evaluator's experience. There are various methods classified as subjective measurement. The following techniques are some methods used currently in veterinary practice.

2.1.1. Visual analogue scale (VAS) is commonly used in both veterinary and human medicine (Impellizeri *et al.*, 2000; Lipscomb *et al.*, 2002; Dierick *et al.*, 2004; Mejjad *et al.*, 2004; Wohlrab *et al.*, 2004; Wacker *et al.*, 2005; Corr and Brown, 2007; Moreau *et al.*, 2007). It consists of a 100 mm in length. One end represents "no pain at all" or "no lameness at all", whereas the other represents "worst possible pain" or "could not be more lame". However, it has been said that the VAS is influenced by observer abilities, visual and motor coordination. The errors can be up to 7 mm as a result of reducing evaluator ability to precisely mark the line (Debbie, 2006).

2.1.2. Numerical rating scale (NRS) is a compromised scale modified from VAS. It has been used to evaluate analgesic efficacy of a drug (Bergmann et al., 2007). The scale ranges from 0 to 10, or 0 to 100. Where 0 denotes "no pain", and 10 or 100 denotes "worst possible pain". Quinn et al. (2007) claimed that NRS might not suit for evaluating lame dog unless lameness is severe, however.

2.1.3. Questionnaire is a useful tool to evaluate lameness in dogs. It contains several questions related to dog activities and behaviors. Number of questions depend on ability of a questionnaire to extract the right information from the responder (Debbie, 2006). Various questionnaires have been designed. For examples; Helsinki chronic pain index (HCPI) contains 11 questions and has total score of 44 points (Hielm-Bjorkman, 2007); Bioarth functional evaluation scale (BFES) contains 12 variables including 8 questions for functional limitation, 3 questions related to range of movement, and 1 question about muscle atrophy (Ramon et al., 2006). Total score of BFES is added up to 31 points. Furthermore, orthopedic examination grading system was developed by Vijarnsorn in 2004. The form comprises of 4 questions related to locomotor ability, weight bearing, joint mobility, and pain with total score of 22 points. Additionally, canine orthopedic rehabilitation evaluation form (Levine and Adamson, 2004) is a form used to evaluate patient who undertake physical therapy. Gait analysis is a part of the form, used to assess orthopedic lameness problem. The scales include degree of lameness at stance, walk, and trot phase with total score of 12 points.

2.2. Objective measurement

This kind of measurement is more reliable than the subjective one, as it does not rely on observer's judgment of the patient. In contrast, it needs equipment to measure and comes up with a quantifiable outcome. Objective measurement increases its importance in veterinary practice, especially in research scheme.

2.2.1. Kinetic gait analysis is a method measuring ground reaction forces with force plate or platform. It can measure outcomes as many times as needed with good reliability (Bockstahler et al., 2007a). Also, it is set as a gold standard for gait analysis (Hesbach, 2007; Quinn et al., 2007). A study of Voss et al. (2007) came up with 90% sensitivity and 100% specificity for assessing hindlimb lameness in dog at trot. However, this method requires standardized procedures, calibration, and the high-priced equipment. Therefore, it is uncommonly used by practitioners (Hesbach, 2007).

2.2.2. Kinematic gait analysis is a powerful tool to study a dog in motion. Measurement is performed with two- or three-dimensional computer-assisted videography with or without infrared cameras and reflective markers so as to record pattern of gait (Hesbach, 2007). It measures flexion and extension angles of joints, parameters of stride such as stride length (Millis, 2004). Kinematic gait analysis is not often used by clinicians. However, it has been used in various research schemes (Colborne et al., 2006; Bockstahler et al., 2007b; Burton et al., 2008).

2.2.3. Joint function is described by joint range of motion (ROM). ROM is obtained by goniometer. It measures angles of maximum flexion and extension (Millis, 2004). Additionally, it is used to monitor progression of patient's impairment and to evaluate effectiveness of treatment (Wang et al., 2007).

2.2.4. Muscle mass is measured with calibrated tape measure or girthometer. Muscle mass can also be estimated with diagnostic ultrasound, magnetic resonance imaging, computed tomography, and dual energy x-ray absorptiometry.

However, it is not worthwhile using those tools. Tape measure is used more often since it is easier to do. Thigh circumference is used for estimating quadriceps and hamstring muscle mass. It is recommended that a thigh should be measured at 70% of the length of femur in lateral recumbent dog with a neutral coxofemoral and stifle position (Millis, 2004).

3. Joint disease management

The goals of treating joint diseases are to manage pain, to maintain function and range of motion, and to regain normal activities. Disease management includes surgical treatment, medication, and rehabilitation.

3.1. Surgical treatment

Surgery is a good method of dealing with joint diseases in dogs. The method depends on which joint is affected. Some diseases are treated by repairing the joint, while the others require replacement of joint. Although this is a good way to correct the problem, it is often avoided because of risk of the dog being anesthetized prior to the operation, and owners attitudes for pain during and after the procedure (Vaisanen *et al.*, 2008).

3.2. Medications

Medication is given when dogs do not undergo surgery. Also, they can be combined with surgical method. The main purpose of medication is to reduce pain. Pain is managed by corticosteroids and non-steroidal inflammatory drugs (NSAIDs). NSAID is an anti-inflammatory drug that used for managing pain, particularly in advance cases with osteoarthritis. There are lots of NSAIDs introducing in veterinary practice including carprofen, meloxicam, tepoxalin, ketoprofen, tolfenamic acid, phenylbutazone, cinchophen, vedoprofen, and deracoxib (Debbie, 2006). Among those NSAIDs for veterinary use, carprofen is the most common one. Additionally, joint supplements might be applied. Those include glucosamine, chondroitin sulfate,

omega-3 fatty acid, and vitamin C. These supplements are believed to have effect of chondroprotectant (Beale, 2004).

3.3. Rehabilitation

Veterinary physical rehabilitation is a science of treatment to alleviate impairment of animals. It's often applied in combination with medications and as a post-operative treatment. A veterinary rehabilitation team consists of a veterinarian, physical therapist, veterinary technician, and owner (Millis and Levine, 1997). Rehabilitation process comprises of the following courses (Anderson *et al.*, 2004). First, assessing level of function and dysfunction of patient should be performed. Next, organizing and interpreting the assessment is done in order to identify factors outside normal limits follows by, establishment of short- and long-term goals. Then treatment plan is developed. Progress of the plan is reassessed afterward, and will be adjusted as needed. Examples of rehabilitation include the following methods.

3.3.1. Therapeutic exercise is performed to encourage the use of limbs with a minimum of expense and equipment needed (Doyle, 2004). This type of rehabilitation includes assisted standing exercise, proprioceptive training, and dynamic ambulation activities. Assisted standing exercise is performed when an animal cannot support its own body. Several activities can be used such as body sling, maximal assisted standing, active assisted standing, active assisted standing with carts and slings, active assisted standing using exercise rolls, and standby assisted standing. Proprioceptive training is for the dog that is able to stand independently and safely. The training aims to improve balance of the animal. Such training includes weight-shifting, manual unloading of one limb during stance, balance board, and exercise balls and rolls. In order to initiate the dog for a walk, dynamic ambulation activities are performed. Assisted devices such as walking slings, towels, and canine carts are used with a dog that is unable to walk independently. If the dog can walk independently, other techniques may be applied including 1) leash walking; inclines and declines 2) standing or walking on foam rubber, mattresses, air mattresses3) stair climbing 4) treadmill walking 5) dancing and wheelbarrowing 6) jogging 7) sit-to-

stand exercises 8) down-to stand exercises 9) cavaletti rails 10) walking in tall grass, sand, or snow 11) pole weaving 12) tunnels 13) pulling or carrying weight 14) controlled ball playing (Hamilton et al., 2004).

3.3.2. Manual therapy is a technique of touch with aims to reduce tissue stress, induce relaxation, increase joint ROM, and reduce soft tissue inflammation (Saunders et al., 2005). This technique is mainly based on mobilization and manipulation of joints and associated soft tissue. It is indicated for pain and loss of motion which is caused by neuromusculoskeletal dysfunction. A study by Hoeksma et al. (2004) found that manual therapy could improve pain, hip function, and range of motion in hip osteoarthritic patients.

3.3.3. ROM and stretching exercise are methods of motion of joint improvement. They are used in either post-operated patient or patient with chronic disease. Stretching exercise is used to improve joint flexibility and extensibility of muscles, and tendons surrounding the joints. Difference between stretching and manual therapy is that stretching places a low load on the tissues for a specific amount of time to help elongate them. While, manual therapy applied the force in an oscillatory manner (Saunders et al., 2005). ROM exercise is performed to regain normal joint angle. It can be passive and active depended on severity of joint dysfunction.

3.3.4. Hydrotherapy becomes popular modality for rehabilitation among human and animals as numbers of research studies in this area have rises (Wang et al., 2007). Two forces associated with water are gravity and buoyancy. Gravity is the downward force, whereas buoyancy is the upward force. It is controlled by water depth. The buoyant force increases as water gets deeper. Hydrotherapy is a technique that uses water properties to treat patients with neuromusculoskeletal disorders. It provides the ability of joint movement which is not available on the ground. Moreover, it has been incorporated in weight control program for dogs.

MATERIALS AND METHODS

Materials

1. Medical records of dogs visited KU-VTH in 2007
2. Questionnaires
   2.1. Helsinki chronic pain index
   2.2. Bioarth functional evaluation scale
   2.3. Orthopedic examination grading system
   2.4. Gait analysis, a part of canine orthopedic rehabilitation evaluation
3. Goniometer

Methods

This study was divided into 2 parts, retrospective case-control study, and case-control study. The former was designed to achieve the first and second objective, while the latter served the rest.

1. Study I: Retrospective case-control study

1.1. Animals

Dogs that visited Suvarnnachad therapeutic swimming pool at KU-VTH during 1st January 2007 to 31st December 2007 were included in the study. All dogs with hip joint disorders were classified as a case group, whereas dogs with no history of joint disorders and neuromuscular disorders were described as a control group. The controls were selected by systematic random sampling procedure from dogs visited KU-VTH in the same year. Every 100th dogs were selected. Dogs assigned for hydrotherapy were also excluded from control group to assure normal joint dogs. A case to control ratio of 1:2 was used.

1.2. Data Collection

Medical records were reviewed. Data related to dog characteristics (sex, breed, age at first time of diagnosis, and body weight), type of disease (joint disorders, neurological disorders, musculoskeletal disorders, other diseases, combination of the above-mentioned), affected joint, side of affected joint, and objective of treatment (conservative or post-operative) were collected. For control group, only data related to dog characteristics were obtained.

1.3. Data analysis

Data were collected and manipulated in an Excel® spreadsheet (Microsoft Corporation., 2003) and analyzed using commercial statistical software, SAS® 8.2 (SAS Institute Inc., 2001). Golden retriever and Labrador retriever were described as retriever dog. Other breeds were non-retriever dog and mixed-breed dog. Moreover, Dog breeds were arbitrarily organized into three sizes; small, medium, and large (Table 1).

Descriptive statistic was performed for all variables. Additionally, risk factors for hip joint diseases were evaluated with logistic regression analysis. These analyzed factors included age, breed (retriever breed, non-retriever purebred, and mixed breed), sex, size, and body weight. Univariate logistic regression was performed for all possible risk factors. Variables with p-value of greater than 0.2 were left out. The rest were included in multivariate logistic model. Stepwise backward elimination procedure was performed to obtain a final model. Each variable that was least significant, or showed the greatest p-value, was dropped out. Then the rest were recalculated until significant model was achieved. The model was considered statistical significance at p-value of less than 0.05.

Table 1 Dog size classification

Small	Medium	Large
Chihuahua	American Cocker Spaniel	Affenpinscher
French Bulldog	American Pitbull	Bernese Mountain
Jack Russell Terrier	Bangkaew	Bull Mastiff
Maltese	Basset Hound	Chow Chow
Miniature Pinscher	Beagle	Collie
Pekingese	Bulldog	Dalmatian
Pomeranian	Bull Terrier	Doberman
Poodle-miniature	Dachshund	Fila Brasileiro
Pug	Finnish Spitz	German Shepherd
Shih-Tzu	German Hound	Golden Retriever
Tenerife	Mixed	Labrador Retriever
Yorkshire Terrier	Schnauzer	Old English Sheepdog
	Thai Ridgeback	Rottweiler
		Saint Bernard
		Siberian Husky

2. Study II: Case-control study

2.1. Animals

Twenty dogs with hip disorders visited KU-VTH during 1st August 2008 to 31st October 2008 were selected as a case group. The other 20 clinically normal dogs visit KU-VTH in the same period were selected as a control group. Dogs with multiple joint disorders were excluded from the study. The control group excluded dogs with history of joint disorders. These controls must have shown no clinical signs of lameness and were healthy (i.e., dogs visited KU-VTH for annual health check or for vaccination) in order to meet the criteria.

2.2. Data Collection

All dogs were examined by the same trained veterinarian throughout the study. The collected data included age, breed, sex, body weight, 1-5 scale body condition score (BCS) (Millis, 2004), and disease status. Then the owners were asked to complete two questionnaires, HCPI and BFES. Both were translated into Thai and had been tested for content validity by an expert opinion. After that, the veterinarian performed an examination using the same questionnaires and also assessed the dogs with OEGS, and GA. For the BFES, ROM from both left and right hips were measured by goniometer. OEGS scale was inverted from the original scale to ease in analytical procedure. After inverting, OEGS score would follow the same trend as other scores.

2.3. Data analysis

Data were collected and manipulated in an Excel® spreadsheet (Microsoft Corporation., 2003) and analyzed by commercial statistical software, SAS® 8.2 (SAS Institute Inc., 2001). Dog breeds were arbitrarily classified into two categories, large and non-large breed. Dogs listed in non-large breed were Bangkaew, Beagle, Cocker, Crossbreed, Fox Terrier, Miniature Pinscher, Poodle, Samoyed, Shi-Tzu, and Yorkshire Terrier, whereas large breed dogs included Golden Retriever, Great Dane, Rottweiler, Siberian Husky, and Saint Bernard. Some obtained scores from the questionnaires were missing, therefore standardized scores were calculated. In order to standardize obtained scores, these scores were transformed into percentages by dividing the total answered score by possible full score, multiplying by 100.

$$\text{Standardized score} = \frac{\textit{total answered score}}{\textit{possible full score}} \times 100$$

The possible full score for each dog depended on number of questions answered by an evaluator. For example, if an evaluator answered eight questions out of ten, total answered score would be sum score of eight obtained items, while

possible full score would be the total maximum scores from the eight questions. Data were tested for normality assumption by Shapiro-Wilk test to determine whether parametric analyses should be used. As normalities were not presented, nonparametric analyses were used. Descriptive statistic was performed for age, breed, sex, body weight, and BCS. Statistical analyses to compare dog characteristics were used to show whether there were statistical differences between case and control group. As difference was not observed, effect adjustment was not performed in analyzing procedure. Differences of scores for each questionnaire between the two groups were assessed by Mann-Whitney U test. Correlations among scores of all scoring systems and between owner scores and veterinarian scores were determined by Spearman's rank correlation method. Additionally, mean scores for each question were assessed to find differences between cases and controls. These differences were tested by Mann-Whitney U test. P-value of equal or less than 0.05 was considered statistical significance.

RESULTS AND DISCUSSION

Results

1. Study I: Retrospective case-control study

1.1. Descriptive epidemiology

There were 297 dogs assigned for hydrotherapy at Suvarnnachad therapeutic swimming pool in 2007. Those dogs included 179 (60.27%) dogs with joint disorders, 53 (17.85%) dogs with neurological disorders, 28 (9.43%) dogs with musculoskeletal disorders, 33 (11.11%) dogs with other problems, and 4 (1.35%) dogs with combination of the above-mentioned problems. 40.74% of the dogs were female and 59.26% were male. There were 15.49% small dogs, 30.64% medium dogs, and 53.87% large dogs. Percentages of sex and dog size for each problem were shown in table 2. Age and body weight of dogs classified by problems were shown in table 3 and 4. Average age of dogs receiving hydrotherapy in 2007 was 4.70 (SD 3.49) years, average body weight was 22.42 (SD 13.28) kilograms. Of the 297 dogs visited the pool, 71.48% of these dogs were assigned for hydrotherapy as a conservative treatment, and 28.52% used the pool for post-operative treatment.

Mean age of the joint disordered dogs was 4.44 (SD 3.38) years (Table 3), whereas mean body weight was 23.97 (SD 13.39) kilograms (Table 4). In 179 dogs with joint disorders; 149 (83.24%) of the dogs were affected at hip joint, 21 (11.73%) of the dogs were affected at stifle joint, 2 (1.12%) of the dogs were affected at hock joint, 1 (0.56%) of the dogs was affected at elbow joint, and 6 (3.35%) of the dogs were affected at multiple joints. For dogs with hip joint disorders, 77 (52.74%) of them were bilateral affected, 41 (28.08%) dogs were right-side affected, and 28 (19.18%) dogs were left-side affected. Three dogs had no records of side affected.

1.2. Univariate logistic regression analysis

A total of 447 dogs were included in the risk factors analysis. 149 dogs were in case group and 298 were in control group. Age and body weight of case dogs and control dogs were described in table 5. Percentages of sex, breed, and dog size were shown in table 6.

1.2.1. Age -- Case dogs had average age of 4.19 (SD 3.37) years (median, 3.94; interquartile range, 5.23; range, 0.33 to 18.04 years). Average age of control dogs was 3.81 (SD 3.95) years (median, 2.00; interquartile range, 5.59; range, 0.003 to 17.00 years). Age was not a significant risk factor of hip joint disorders from this study.

1.2.2. Body weight -- Case dogs had average body weight of 25.15 (SD 13.26) kilograms (median, 24.00; interquartile range, 18.40; range, 2.00 to 57.00 kilograms). Average body weight of control dogs was 10.40 (SD 9.50) years (median, 6.50; interquartile range, 13.60; range, 0.28 to 40.90 kilograms). Every increase of 1 kilogram in body weight, the odds of hip joint disorders in dogs increased 1.11 times (Table 6).

1.2.3. Sex – Sex of dog was not detected as significant risk factor associated with hip joint disorders from this study (Table 6).

1.2.4. Breed -- Breeds were divided into three categories; mixed breed, retriever, and non-retriever. Mixed breed was set as reference category. Odds of hip joint disorders were 23 times higher in retriever breed compared with the mixed-breed dogs. Moreover, it was 2 times more in non-retriever purebred compared to the mixed-breed dogs (Table 6).

1.2.5. Size – Odds of hip joint disorders were 22 times higher in large-sized dogs compared with the small-sized dogs, whereas frequency of the disease in medium-size dogs was not different from the small size (Table 6).

1.3. Multivariate logistic regression analysis

Body weight, sex, breed, and size factors were included in the initial multivariate analysis model. Factors existing in final model were body weight, retriever breed, non-retriever purebred, and large-sized dog (Table 7). All factors were identified as potential risk factors. Every increase of 10 kilograms in body weight, the odds of hip joint disorders in dogs increased 2.2 times (95% confidence interval: 1.7 to 2.9). Hip disorders were 4.2 times more likely to occur among retriever dogs than among mixed-breed dogs in the study population. Moreover, odds of disease in non-retriever dogs were 2.3 times more than odds in mixed-breed dogs. For dog size, disease occurrence was 2.8 times more likely to occur among large-sized dogs than among the small ones. However, odds ratio for medium-sized dogs did not significantly differ from 1.

Table 2 Percentages of dogs visited Suvarnnachad therapeutic swimming pool in 2007 classified by problem, sex, and size

Problem	Sex		Size		
	Female	Male	Large	Medium	Small
Joint disorder	70 (23.57%)	109 (36.70%)	110 (37.04%)	44 (14.81%)	25 (8.42%)
Neurological disorder	20 (6.73%)	33 (11.11%)	19 (6.40%)	23 (7.74%)	11 (3.70%)
Musculoskeletal disorder	13 (4.38%)	15 (5.05%)	10 (3.37%)	12 (4.04%)	6 (2.02%)
Combination	2 (0.67%)	2 (0.67%)	3 (1.01%)	0 (0.00%)	1 (0.34%)
Other	16 (5.39%)	17 (5.72%)	18 (6.06%)	12 (4.04%)	3 (1.01%)
Overall	121 (40.74%)	176 (59.26%)	160 (53.87%)	91 (30.64%)	46 (15.49%)

Table 3 Means, standard deviation (SD), medians, interquatile ranges, minimum, and maximum values for age (years) of dogs visited Suvarnnachad therapeutic swimming pool in 2007

Problem	Mean	SD	Median	Interquartile range	Minimum	Maximum
Joint disorder	4.44	3.38	4.55	5.27	0.33	18.04
Neurological disorder	6.45	3.98	6.12	6.37	0.41	15.32
Musculoskeletal disorder	3.13	2.53	2.32	4.58	0.32	8.14
Combination	6.52	1.92	5.89	2.77	5.09	9.20
Other	4.34	3.02	3.56	5.29	0.35	10.01
Overall	4.70	3.49	4.71	5.62	0.32	18.04

Table 4 Means, standard deviation (SD), medians, interquatile ranges, minimum, and maximum values for body weight (kilograms) of dogs visited Suvarnnachad therapeutic swimming pool in 2007

Problem	Mean	SD	Median	Interquartile range	Minimum	Maximum
Joint disorder	23.97	13.39	23.00	19.96	2.00	57.00
Neurological disorder	20.66	12.87	17.05	21.03	1.48	44.10
Musculoskeletal disorder	14.82	11.07	11.72	17.26	1.70	37.00
Combination	32.01	14.35	36.05	18.28	11.45	44.50
Other	21.32	12.18	22.70	22.18	3.92	40.00
Overall	22.42	13.28	21.00	21.45	1.48	57.00

Table 5 Means, standard deviation (SD), medians, interquartile ranges, minimum, and maximum values for age and body weight of 149 case dogs with hip joint disorders compared with 298 control dogs

Variable	Group	Mean	SD	Median	Interquartile range	Minimum	Maximum
Age	Case	4.19	3.37	3.94	5.23	0.33	18.04
(years)	Control	3.81	3.95	2.00	5.59	0.003	17.00
Body weight	Case	25.15	13.26	24.00	18.40	2.00	57.00
(kilograms)	Control	10.40	9.50	6.50	13.60	0.28	40.90

Table 6 Parameter estimates, standard error (SE), odds ratios (OR), 95% confidence intervals (CI), and p-values for dogs characteristics of 149 case dogs with hip joint disorders compared with 298 control dogs

Variable	Number of case	Number of control	Parameter Estimate (β)	SE	OR	95% CI	p-value
Age	-	-	0.03	0.03	1.03	(0.98, 1.08)	0.32
Body weight	-	-	0.11	0.01	1.11	(1.09, 1.14)	<.01
Sex							
- male	94 (63.09%)	161 (54.03%)	0.38	0.21	1.45	(0.97, 2.18)	0.07
- female	55 (36.91%)	137 (45.97%)	-	-	1	reference	
Breed							
- retriever	64 (42.95%)	16 (5.37%)	3.14	0.37	23.16	(7.29, 24.16)	<.01
- non-retriever purebred	66 (44.30%)	66 (57.72%)	0.80	0.29	2.22	(1.26, 3.90)	<.01
- mixed	19 (12.75%)	110 (36.91%)	-	-	1	reference	-
Size							
- large	100 (67.11%)	34 (11.41%)	3.09	0.32	22.06	(11.78, 41.30)	<.01
- medium	31 (20.81%)	129 (43.29%)	0.59	0.32	1.80	(0.96, 3.38)	0.07
- small	18 (12.08%)	135 (45.30%)	-	-	1	reference	-

Table 7 Parameter estimates, standard error (SE), odds ratios (OR), and 95% confidence intervals (CI) from multivariate analysis of all risk factors using backward elimination logistic regression

Variable	Parameter estimate (β)	SE	OR	95% CI
Body weight	0.08	0.01	1.08	(1.05, 1.11)
Breed				
- retriever	1.43	0.56	4.16	(1.38, 12.52)
- non-retriever purebred	0.84	0.36	2.31	(1.15, 4.67)
- mixed	-	-	1	reference
Size				
- large	1.04	0.43	2.81	(1.22, 6.49)
- medium	0.80	0.49	2.22	(0.85, 5.79)
- small	-	-	1	reference

2. Study II: Case-control study

Case group included 6 (30%) non-large breed dogs, and 14 (70%) large breed. Control group included 8 (40%) non-large breed dogs and 12 (60%) large breed. There were 7 (35%) females and 13 (65%) males in case group and control group. Both groups showed no difference in age, body weight, and BCS (Table 8). Likewise, there was no difference in breed ($\chi^2_{1, 40} = 0.44$, p-value = 0.51) and sex ($\chi^2_{1, 40} = 0.00$, p = 1.0) between two groups.

Standardized scores of each questionnaire from case group were significantly different from those of control group (Table 9). Moreover, there were strong correlations among scores from all questionnaires (Table 10). These correlations ranged from 0.70 to 0.88. Scores determined by veterinarian were strongly correlated with owner scores for both HCPI and BFES.

Table 8 Means, standard deviation (SD), medians, interquartile ranges (IQR), minimum, and maximum values for age, body weight, and body condition score (BCS) of 20 case dogs and 20 control dogs

Variable	Group	Mean	SD	Median	IQR	Minimum	Maximum
Age	Case	4.62	3.11	4.75	4.52	0.42	11.00
(years)	Control	3.46	3.02	3.00	4.09	0.50	12.00
Body weight	Case	29.25	13.77	32.25	16.20	3.00	62.00
(kilograms)	Control	21.18	13.70	19.13	25.88	4.00	44.20
BCS	Case	3.63	0.58	4.00	1.00	3.00	5.00
(in 5 scales)	Control	3.40	0.58	3.00	1.00	3.00	5.00

Table 9 Means, standard deviation (SD), and p-values of scores from four questionnaires of case group (n=20) compared with control group (n=20)

Questionnaire	Case group		Control group		p-value
	Mean	SD	Mean	SD	
HCPI by veterinarian	27.64	18.94	5.91	9.41	<.01
HCPI by owner	30.57	20.44	9.93	9.02	<.01
BFES by veterinarian	36.62	16.18	5.39	10.36	<.01
BFES by owner	30.25	25.98	4.00	9.40	<.01
OEGS*	25.83	13.88	5.56	3.12	<.01
GA*	31.25	29.60	1.25	3.05	<.01

Note: * Data were only obtained from veterinarian.

The data were also analyzed for each question in each questionnaire. Table 11 showed mean scores of HCPI form assessed by veterinarian. Mean scores of question number 4, 5, 7, 8, and 9 were significantly different between case and control group. Mean scores of question number 1, 2, 3, 10, and 11 were not available. On the other hand, owners were able to answer all questions in HCPI form. Mean scores of HCPI assessed by owners were shown in table 12. Mean scores of question number 4 to 11 were significantly different between the two groups. Unlike, those of question number 1, 2, and 3 in case group were not different from the control group.

Table 10 Correlation coefficient (r) among scores from four questionnaires evaluated by a veterinarian (vet) and owners (n=40)

Questionnaire	HCPI by vet	HCPI by owner	BFES by vet	BFES by owner	OEGS**	GA**
HCPI by vet	1.00	0.88*	0.79*	0.82*	0.73*	0.77*
HCPI by owner	-	1.00	0.70*	0.72*	0.71*	0.72*
BFES by vet	-	-	1.00	0.79*	0.79*	0.87*
BFES by owner	-	-	-	1.00	0.76*	0.82*
OEGS**	-	-	-	-	1.00	0.88*
GA**	-	-	-	-	-	1.00

Note: * indicated p-value of <.01.

** Data were only obtained from veterinarian.

Table 11 The number of questionnaires (N), means, standard deviation (SD), and p-values of veterinarian score from HCPI of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
HCPI 1	-	-	-	-	-	-	N/A
HCPI 2	-	-	-	-	-	-	N/A
HCPI 3	-	-	-	-	-	-	N/A
HCPI 4	20	0.70	0.57	20	0.15	0.49	<.01
HCPI 5	17	0.88	0.70	18	0.17	0.51	<.01
HCPI 6	5	0.20	0.45	8	0.13	0.35	0.82
HCPI 7	12	2.00	1.48	18	0.50	0.62	<.01
HCPI 8	20	1.15	0.99	20	0.10	0.31	<.01
HCPI 9	20	1.55	1.19	20	0.20	0.52	<.01
HCPI 10	-	-	-	-	-	-	N/A
HCPI 11	-	-	-	-	-	-	N/A

Note: N/A denoted not available.

- denoted 100% missing.

Table 12 The number of questionnaires (N), means, standard deviation (SD), and p-values of owner score from HCPI of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
HCPI 1	20	1.25	0.91	20	0.80	0.62	0.10
HCPI 2	20	0.70	0.98	20	0.45	0.76	0.33
HCPI 3	20	0.15	0.49	20	0.15	0.37	0.71
HCPI 4	20	0.70	0.73	20	0.20	0.41	0.02
HCPI 5	20	0.95	0.83	20	0.35	0.67	0.02
HCPI 6	20	1.70	1.53	20	0.45	1.10	<.01
HCPI 7	20	1.70	1.53	20	0.70	1.13	0.03
HCPI 8	20	1.10	1.25	20	0.35	0.49	0.04
HCPI 9	20	1.90	1.21	20	0.50	0.76	<.01
HCPI 10	20	1.85	1.63	20	0.25	0.64	<.01
HCPI 11	20	1.45	1.43	20	0.10	0.31	<.01

Mean scores of BFES form assessed by a veterinarian and by owners were demonstrated in table 13 and 14, respectively. Data from veterinarian scores were not available in question number 3 and 4. Likewise, owners were not able to answer question number 9 to 12 in BFES form. Mean veterinarian scores of case group were significantly different from control group for all questions with available data except question number 10. Moreover, mean owner scores between the two groups were different for all answered questions.

Mean scores of OEGS form between case and control group were different for all questions (Table 15). Likewise, mean scores of GA form were different between the two groups (Table 16).

Table 13 The number of questionnaires (N), means, standard deviation (SD), and p-values of veterinarian score from BFES of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
BFES 1	20	1.10	0.85	20	0.10	0.31	<.01
BFES 2	19	0.89	0.88	20	0.10	0.31	<.01
BFES 3	-	-	-	-	-	-	N/A
BFES 4	-	-	-	-	-	-	N/A
BFES 5	20	0.75	0.64	20	0.10	0.45	<.01
BFES 6	19	0.63	0.60	18	0.00	0.00	<.01
BFES 7	17	0.65	0.61	17	0.12	0.33	<.01
BFES 8	15	0.93	0.70	17	0.12	0.33	<.01
BFES 9	20	1.80	0.62	20	0.00	0.00	<.01
BFES 10	20	0.10	0.31	20	0.00	0.00	0.17
BFES 11	20	3.00	1.34	20	0.95	1.50	<.01
BFES 12	20	0.70	0.73	20	0.00	0.00	<.01

Note: N/A denoted not available.

- denoted 100% missing.

Table 14 The number of questionnaires (N), means, standard deviation (SD), and p-values of owner score from BFES of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
BFES 1	20	0.80	1.06	20	0.00	0.00	<.01
BFES 2	20	1.00	0.92	20	0.20	0.62	<.01
BFES 3	20	0.60	0.88	20	0.00	0.00	<.01
BFES 4	20	0.85	1.14	20	0.10	0.31	0.01
BFES 5	20	0.70	0.80	20	0.05	0.22	<.01
BFES 6	20	0.75	0.79	20	0.15	0.49	<.01
BFES 7	20	0.55	0.69	20	0.05	0.22	<.01
BFES 8	20	0.80	0.83	20	0.25	0.64	0.02
BFES 9	-	-	-	-	-	-	N/A
BFES 10	-	-	-	-	-	-	N/A
BFES 11	-	-	-	-	-	-	N/A
BFES 12	-	-	-	-	-	-	N/A

Note: N/A denoted not available.

- denoted 100% missing.

Table 15 The number of questionnaires (N), means, standard deviation (SD), and p-values of score from OEGS of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
OEGS 1	20	1.20	0.83	20	0.20	0.41	<.01
OEGS 2	20	1.05	0.88	20	0.00	0.00	<.01
OEGS 3	20	1.30	0.86	20	0.80	0.41	0.04
OEGS 4	20	1.10	0.85	20	0.00	0.00	<.01

Table 16 The number of questionnaires (N), means, standard deviation (SD), and p-values of score from GA of case group compared with control group

Question	Case			Control			p-value
	N	Mean	SD	N	Mean	SD	
GA 1	20	1.40	0.94	20	0.10	0.31	<.01
GA 2	20	1.20	1.36	20	0.05	0.22	<.01
GA 3	20	1.15	1.39	20	0.00	0.00	<.01

Discussion

1. Study I: Retrospective case-control study

Our study found that the most common problem in dogs receiving hydrotherapy in 2007 was joint disorders which accounted for 60% of the dogs. For those dogs, hip joints were the most affected. Of all dogs assigned for hydrotherapy, 71% were not treated with operation. They used the pool as conservative treatment. Moreover, risk factors of hip joint disorders found in this study were body weight, retriever breed, non-retriever purebred, and large-sized dog. The most important one was retriever breed with odds ratio of 4.2 compared with the mixed-breed dogs.

The results agreed with a study that hip joint was the most affected joint (Olsewski *et al.*, 1983). Furthermore, results of this study agreed with previous studies that body weight was a significant risk factor for hip joint disease (Smith *et al.*, 2001; Sallander *et al.*, 2006). As found in our study that body weight when adjusted for breed and dog size would increase odds of hip disorders in dogs by 8% for every 1 kilogram increase in body weight. Thus, higher risk dog should undergo weight control program to prevent them from obesity. Since obese dog may have higher risk of hip joint disease. Moreover, odds of disease in large-sized dogs when adjusted for breed and body weight were 2.8 times greater than the small ones. This result was in accordance with other studies that large breed showed higher incidence than the smaller ones (Priester and Mulvihill, 1972; Popovitch *et al.*, 1995; Smith *et al.*, 1995).

A study showed non-significant result of hip disease occurrences between mixed-breed and purebred dog (Rettenmaier *et al.*, 2002). In contrast to our results that both retriever and non-retriever purebred were found to be significant risk factors of hip joint disease with odds ratios of 4.2 and 2.3, respectively. Age was not significantly associated with hip joint disease unlike result from previous studies (Ohlerth *et al.*, 1998; Mayhew *et al.*, 2002; van Hagen *et al.*, 2005). The possible explanation for this finding may be due to age in our study was treated as a continuous variable, whereas others were treated as a categorical variable. When we treated age as a categorical variable (0 to 2, 2 to 4, 4 to 7, 7 to 10, and greater than 10 years), we found that age of 2 to 4 years was significantly associated with hip joint disorders with odds ratio of 2.66 (95% CI, 1.59 to 4.43). The study of van Hagen *et al.* (2005) found that dogs with age of greater than 5 years were 1.8 times as likely to develop canine hip dysplasia. We also reanalyzed our data by categorizing age with the cut-off value of 5 years. Finally, we came up with significant odds ratio of 1.76 (95% CI, 1.17 to 2.64). This result agreed with the study of van Hagen *et al.* in 2005. According to age of case and control dogs visited KU-VTH, both groups had higher age than what normally found in other animal clinics. It implied that dogs visited the animal hospital were old-aged dogs, thus we did not find difference of age between the two groups.

The study indicated that purebred dogs visited KU-VTH had higher risk of hip joint disorders, especially hip dysplasia. It could be possible that ineffective selective breeding or inbreeding were accounted for the problem, since it was an inherited disease (Fries and Remedios, 1995). This implied that the defect gene lingered on several litters of dogs in Thailand. Therefore, joint health should be examined prior to breeding in order to reduce disease incidence.

Because of disadvantage of retrospective study, many factors were not studied. Our study was performed using data from the medical records. Most of them had no information about floor type, diet, exercise, etc. Therefore, we could not study the environmental factors which were mentioned to be other risk factors for hip joint disease (Fries and Remedios, 1995; van Hagen *et al.*, 2005). Cohort study may be a better approach to study these factors.

Although breed and dog size were known to be risk factors for hip joint disease, they sometimes were difficult to avoid. In addition to good selective breeding and weight control, it may be necessary to do more research on treatment, especially rehabilitation. Since this method is a non-invasive way to improve clinical signs of joint diseases and it is suitable for elderly dogs. Also, it can be used either for conservative or post-operative treatment. Moreover, many gaps in the knowledge of this alternative treatment are waiting for the exploration.

2. Study II: Case-control study

Our study found that these 4 questionnaires had good validity to differentiate dogs with hip disorders from clinically normal dogs. HCPI and BFES forms could be used interchangeably by veterinarian and by owner. Since it was a hospital-based study, the sampling population might not be the best representative. However, most dogs with severe hip disorders were often brought to hospital, thus it would be considered as an appropriate approach. On the other hand, normal dogs were not often brought to hospital compared with dogs with disease, but only the healthy dogs were included in the study to achieve the true normal.

The results showed no significant difference between case and control group for neither body weight nor BCS. This was due to the initial attempt to match these factors to control their possible effects on the evaluated scores. However, matching technique was not performed in all dogs due to time limitation in data collection process.

All the studied questionnaires were able to distinguish dogs with hip disorders from the clinically normal ones. Moreover, correlations among the four questionnaires appeared to be strong. Therefore, these methods could be used to evaluate lameness in dogs interchangeably. However, assessment should be done by means of the same questionnaire in order to compare pre- to post-treatment scores. Likewise, scores assessed by a veterinarian were highly associated with scores assessed by owners. The result was in accordance with previous study (Pollard *et al.*, 2006). This suggested that these questionnaires, HCPI and BFES could be used by veterinarians and owners exchangeably. According to variation of scores among these 4 questionnaires, OEGS is recommended for veterinarians and HCPI is recommended for owners.

Although these 4 questionnaires were valid for assessing dogs with hip disorders, they produced some missing values. A suggestion for further study is to evaluate each question from these questionnaires to develop a new complete questionnaire. This questionnaire will be easily performed either by owners or by veterinarians. It should reduce missing answers because of too specific questions. Questions related to activities of dogs were mostly missed including stair climbing, and willingness to play. The dogs did not perform those activities for some reasons, so the questions could not be answered. Moreover, high repeatability should be obtained. The score from new developed questionnaire should be highly differentiated between dogs with and without lameness. This will improve diagnosis and treatment evaluation in veterinary practice for management of lameness in dogs.

CONCLUSION AND RECOMMENDATION

Conclusion

From the results and discussion of these two studies, the conclusion can be drawn as the following:

The most common problem among dogs visited Suvarnnachad therapeutic swimming pool in 2007 was joint diseases which accounted for 60% of the dogs. The other problems were neurological disorders (18%), musculoskeletal diseases (9%), other problems (11%), and combination of the above-mentioned problems (1%). Hip joints were commonly affected among dogs with joint disorders. Furthermore, dogs were assigned to use the pool mostly for conservative treatment.

Risk factors for hip joint diseases found from our study included body weight, retriever breed, non-retriever purebred, and large-sized dog. Retriever breed was the most important factor with odds ratio of 4.2 compared with mixed-breed dog.

Four questionnaires including; HCPI, BFES, OEGS, and GA, were valid to use for evaluating lameness in dogs with hip disorders. They were able to distinguish dogs with hip joint disorders from clinically normal dogs.

Scores from the four questionnaires were highly associated. Therefore, they can be used interchangeably. Additionally, strong correlations between scores assessed by a veterinarian and by owners were found for HCPI and BFES forms. With these forms, dogs can be evaluated by a veterinarian and an owner interchangeably.

Recommendation

The study of risk factor needs good data collection. Retrospective study with medical records review may not be appropriated to get specific data. Either questionnaire or cohort study will improve this weak point. Animal hospital is a good place to gather information, if data are easy to access. Therefore, management of information system should be used for collecting medical records. Many studies will be able to take place afterward.

Questionnaire is a good choice for assessing pain in dogs but it needs to be short and easy to answer. The questions should not be too specific to get all answers. Questions related to activities of dogs such as willingness to play and willingness to climb up the stairs are sometimes difficult to answer. Therefore, new questionnaire development also needs to concern about that point.

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APPENDICES

Appendix A

Questionnaires

Helsinki chronic pain index

Tick only one answer that best describes your dog during the preceding week

1. Rate your dog's mood

very alert	alert	neither alert, nor indifferent	indifferent	very indifferent
□ 0	□ 1	□ 2	□ 3	□ 4

2. Rate your dog's willingness to participate in play

very willingly	willingly	reluctantly	very reluctantly	does not at all
□ 0	□ 1	□ 2	□ 3	□ 4

3. Rate your dog's vocalization (audible complaining, such as whining or crying out)

never	hardly ever	sometimes	often	very often
□ 0	□ 1	□ 2	□ 3	□ 4

4. Rate your dog's willingness to walk

very willingly	willingly	reluctantly	very reluctantly	does not walk at all
□ 0	□ 1	□ 2	□ 3	□ 4

5. Rate your dog's willingness to trot

very willingly	willingly	reluctantly	very reluctantly	does not trot at all
□ 0	□ 1	□ 2	□ 3	□ 4

6. Rate your dog's willingness to gallop

very willingly	willingly	reluctantly	very reluctantly	does not gallop at all
□ 0	□ 1	□ 2	□ 3	□ 4

7. Rate your dog's willingness to jump (eg. into car, onto sofa…)

very willingly	willingly	reluctantly	very reluctantly	does not jump at all
□ 0	□ 1	□ 2	□ 3	□ 4

8. Rate your dog's ease in lying down

with great ease	easily	neither easily, nor difficulty	with difficulty	with great difficulty
□ 0	□ 1	□ 2	□ 3	□ 4

9. Rate your dog's ease in rising from a lying position

with great ease	easily	neither easily, nor difficulty	with difficulty	with great difficulty
□ 0	□ 1	□ 2	□ 3	□ 4

10. Rate your dog's ease of movement after a long rest

never difficult	hardly ever difficult	sometimes difficult	often difficult	very often/always difficult
□ 0	□ 1	□ 2	□ 3	□ 4

11. Rate your dog's ease of movement after major activity or heavy exercise

never difficult	hardly ever difficult	sometimes difficult	often difficult	very often/always difficult
□ 0	□ 1	□ 2	□ 3	□ 4

Source: Hielm-Bjorkman (2007)

Helsinki chronic pain index (Translated into Thai)

เลือกข้อที่ตรงกับเหตุการณ์ที่เกิดขึ้นในช่วงสัปดาห์ที่ผ่านมาเพียงข้อเดียว

1. อารมณ์ของสุนัข

ร่าเริงมาก	ร่าเริง	ไม่ร่าเริงแต่ไม่ซึม	เฉื่อย/ซึม	เฉื่อย/ซึมมาก
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

2. ความเต็มใจในการวิ่งเล่น

เต็มใจมาก	เต็มใจ	ลังเล ไม่ค่อยอยากเล่น	ไม่อยากเล่นอย่างมาก	ไม่ยอมเล่นเลย
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

3. การส่งเสียงร้องครวญครางแสดงความเจ็บปวด

ไม่ส่งเสียงเลย	แทบจะไม่เคยได้ยิน	ได้ยินบ้าง	ได้ยินบ่อยๆ	ได้ยินบ่อยมาก
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

4. ความเต็มใจในการเดิน

เต็มใจมาก	เต็มใจ	ลังเล ไม่ค่อยอยากเดิน	ไม่อยากเดินอย่างมาก	ไม่ยอมเดินเลย
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

5. ความเต็มใจในการวิ่งเหยาะๆ

เต็มใจมาก	เต็มใจ	ลังเล ไม่ค่อยอยากวิ่ง	ไม่อยากวิ่งอย่างมาก	ไม่ยอมวิ่งเลย
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

6. ความเต็มใจในการวิ่งเร็วๆ

เต็มใจมาก	เต็มใจ	ลังเล ไม่ค่อยอยากวิ่ง	ไม่อยากวิ่งอย่างมาก	ไม่ยอมวิ่งเลย
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

7. ความเต็มใจในการกระโดด (ขึ้นรถ/โซฟา)

เต็มใจมาก	เต็มใจ	ลังเล ไม่ค่อยอยากกระโดด	ไม่อยากกระโดดอย่างมาก	ไม่ยอมกระโดดเลย
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

8. ความลำบากในการลงไปนอน (จากท่ายืน)

ง่ายมาก	ง่าย	ไม่ยาก แต่ไม่ง่าย	ค่อนข้างลำบาก	ลำบากมาก
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

9. ความลำบากในการลุกขึ้นจากท่านอน

ง่ายมาก	ง่าย	ไม่ยาก แต่ไม่ง่าย	ค่อนข้างลำบาก	ลำบากมาก
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

10. ความลำบากในการขยับตัวหลังจากนอนนานๆ (เช่น หลังตื่นนอน)

ไม่ลำบากเลย	แทบไม่พบความลำบาก	มีความลำบากบ้าง	มีความลำบากอยู่บ่อยๆ	ลำบากทุกครั้ง/เกือบทุกครั้ง
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

11. ความลำบากในการขยับตัวหลังจากออกกำลังกายอย่างหนัก

ไม่ลำบากเลย	แทบไม่พบความลำบาก	มีความลำบากบ้าง	มีความลำบากอยู่บ่อยๆ	ลำบากทุกครั้ง/เกือบทุกครั้ง
☐ 0	☐ 1	☐ 2	☐ 3	☐ 4

Bioarth functional evaluation scale

Quantify the changes of posture, lameness, and behavior when the dog performs the following activities.

1. Changes standing still
   (0) Standing normally
   (1) Leaning on one side
   (2) Rising the tip of its paw
   (3) Non weight bearing on that limb
2. Changes standing up
   (0) Standing normally
   (1) Adopting different positions when standing up
   (2) Difficulty to rise
   (3) Does not stand up
3. Lameness at the beginning of exercise
   (0) No lameness present
   (1) The lameness disappears when the dog moves (up to 10 minutes)
   (2) The lameness does not disappear
4. Lameness after warm-up (10 minutes)
   (0) No lameness present
   (1) Mild lameness
   (2) Severe lameness
   (3) Continuous non-weight-bearing lameness
5. Lameness during the walk
   (0) It can walk without difficulties.
   (1) It often stops while going for a walk.
   (2) It does not want to go for a walk.
6. Lameness while running and playing
   (0) It can run and play without difficulties.
   (1) It runs and plays with difficulties or it gets tired easily
   (2) It runs with lots of difficulties under a stimulus.
   (3) It neither runs nor plays under any stimulus.
7. Going up the steps
   (0) It goes up without difficulties.
   (1) It goes up 16 steps (a flight) with difficulty.
   (2) It goes up 1 or 2 steps either a kerb, with difficulty.
   (3) It does not go up the steps.
8. Small jumps 40-50 cm
   (0) It gets on the sofa or on the car without difficulties.
   (1) It gets on the sofa or on the car with difficulty.
   (2) It neither gets on the sofa or on the car.
9. Manual mobilization produces
   (0) No pain and no crepitation
   (1) There is pain on the last stages.
   (2) There is pain and/or crepitation during the process.
   (3) It cannot be carried out or there is severe pain and crepitation.
10. ROM in flexion
    (0) Total flexion 50-60º
    (1) Mild limitation <80º
    (2) Severe limitation >80º
11. ROM in extension
    (0) Total extension 160-170º
    (1) Mild limitation >150º
    (2) Severe limitation <150º
12. Muscular atrophy
    (0) There is no muscular atrophy.
    (1) Mild atrophy
    (2) Severe atrophy

Source: Ramon *et al.* (2006)

Bioarth functional evaluation scale (Translated into Thai)

เลือกข้อที่ตรงกับพฤติกรรมสุนัขของท่านที่สุดเพียงข้อเดียว

1. ท่ายืนนิ่ง
   (0) ยืนได้ปกติ
   (1) ยืนเอียงไปข้างหนึ่ง
   (2) เอาปลายเท้าแตะ ไม่ลงน้ำหนักเต็มที่
   (3) ไม่ลงน้ำหนักเลย
2. การลุกขึ้นยืน
   (0) ลุกขึ้นได้ปกติ
   (1) ลุกยืนได้แต่มีท่าทางไม่ปกติ
   (2) ลุกขึ้นยืนอย่างลำบาก
   (3) ไม่ยอมลุกขึ้นยืนเลย
3. ช่วงเริ่มต้นออกกำลังกาย (0-10 นาที)
   (0) ไม่แสดงอาการขาเจ็บเลย
   (1) แสดงอาการขาเจ็บแต่เมื่อเดินสักพักอาการจะหายไป
   (2) แสดงอาการขาเจ็บตลอดเวลาที่ออกกำลังกาย
4. หลังอบอุ่นร่างกาย (>10 นาที)
   (0) ไม่แสดงอาการขาเจ็บเลย
   (1) แสดงอาการขาเจ็บเล็กน้อย
   (2) แสดงอาการขาเจ็บมาก
   (3) ยกขา ไม่ยอมลงน้ำหนัก
5. ระหว่างการเดิน
   (0) ไม่มีความลำบากในการเดิน
   (1) เดินและหยุดบ่อยๆ
   (2) เดินได้ไม่ทน (<5 นาที)
   (3) ไม่ยอมเดินเลย
6. ระหว่างการวิ่ง
   (0) ไม่มีความลำบากหรือเจ็บขาระหว่างวิ่ง
   (1) วิ่งได้ แต่มีความลำบากหรือเจ็บขาและเหนื่อยง่าย
   (2) วิ่งได้อย่างลำบาก และวิ่งต่อเมื่อถูกกระตุ้นเท่านั้น
7. การขึ้นบันได
   (0) สามารถขึ้นบันไดได้โดยไม่ลำบาก
   (1) ขึ้นบันไดได้อย่างลำบาก
   (2) ไม่ยอมขึ้นบันไดเลย
8. การกระโดดขึ้นที่สูง (40-50 ซม. เช่น รถหรือโซฟา)
   (0) กระโดดได้โดยไม่ลำบาก
   (1) ขึ้นได้อย่างลำบาก
   (2) ไม่ยอมกระโดดเลย
9. เมื่อถูกคลำตรวจข้อสะโพก
   (0) ไม่เจ็บและไม่มี crepitation
   (1) แสดงอาการเจ็บหลังคลำเสร็จ
   (2) เจ็บหรือมี crepitation ระหว่างคลำ
   (3) เจ็บมากจนไม่ยอมให้ตรวจคลำ
10. พิสัยของข้อสะโพก (ROM) ในท่างอขา
    (0) งอขาได้สมบูรณ์ 50-60°
    (1) งอได้อย่างจำกัด <80°
    (2) งอได้จำกัดมาก >80°
11. พิสัยของข้อสะโพก (ROM) ในท่ายืดขา
    (0) ยืดขาได้สมบูรณ์ 160-170°
    (1) งอได้อย่างจำกัด >150°
    (2) งอได้จำกัดมาก <150°
12. ความฝ่อลีบของกล้ามเนื้อขาหลัง
    (0) ไม่ฝ่อลีบเลย
    (1) ฝ่อลีบเล็กน้อย
    (2) ฝ่อลีบมาก

Orthopedic examination grading system (original scale)

Score	Clinical findings
Locomotor ability	
6	Stand and walk normally
5	Stand normally, slight lameness when walking
4	Stand normally, severe lameness when walking
3	Abnormal posture when standing, severe lameness when walking
2	Stand and walk abnormally, no discrete lameness
1	Reluctant to rise and will not walk more than a few strides
Weight bearing	
5	Normal weight bearing on all four limbs at rest and when walking
4	Normal weight bearing at rest, favors affected limb when walking
3	Partial weight bearing at rest and when walking
2	Partial weight bearing at rest, bears no weight when walking
1	Non-weight bearing at rest and when walking
Joint mobility	
6	No limitation of joint movement, no palpable joint crepitus
5	Mild (10-20%) decreased range of motion, no palpable joint crepitus
4	Mild (10-20%) decreased range of motion, palpable joint crepitus
3	Moderate (20-50%) decreased range of motion, palpable joint crepitus
2	Severe (>50%) decreased range of motion, palpable joint crepitus
1	Not applicable
Alleviation of pain	
5	No pain indicated on palpation of affected joint
4	Mild pain indicated on affected joint e.g. Animal turns head in recognition
3	Moderate pain on palpation of affected joint e.g. Animal pulls limb away
2	Severe pain on palpation of affected joint e.g. Animal vocalizes or become aggressive
1	Animal will not allow examiner to palpate joint due to pain

Source: Vijarnsorn (2004)

Orthopedic examination grading system (modified scale)

Score	Clinical findings
Locomotor ability	
1	Stand and walk normally
2	Stand normally, slight lameness when walking
3	Stand normally, severe lameness when walking
4	Abnormal posture when standing, severe lameness when walking
5	Stand and walk abnormally, no discrete lameness
6	Reluctant to rise and will not walk more than a few strides
Weight bearing	
1	Normal weight bearing on all four limbs at rest and when walking
2	Normal weight bearing at rest, favors affected limb when walking
3	Partial weight bearing at rest and when walking
4	Partial weight bearing at rest, bears no weight when walking
5	Non-weight bearing at rest and when walking
Joint mobility	
1	No limitation of joint movement, no palpable joint crepitus
2	Mild (10-20%) decreased range of motion, no palpable joint crepitus
3	Mild (10-20%) decreased range of motion, palpable joint crepitus
4	Moderate (20-50%) decreased range of motion, palpable joint crepitus
5	Severe (>50%) decreased range of motion, palpable joint crepitus
6	Not applicable
Alleviation of pain	
1	No pain indicated on palpation of affected joint
2	Mild pain indicated on affected joint e.g. Animal turns head in recognition
3	Moderate pain on palpation of affected joint e.g. Animal pulls limb away
4	Severe pain on palpation of affected joint e.g. Animal vocalizes or become aggressive
5	Animal will not allow examiner to palpate joint due to pain

Note: The scales are inversely modified from the original scales.

Gait analysis

Degree of lameness	Clinical findings
Stance	
0	Normal stance
1	Slightly abnormal stance (partial weight-bearing)
2	Moderately abnormal stance (toe-touch weight-bearing)
3	Severely abnormal stance (holds limb off the floor)
4	Unable to stand
Walk	
0	No lameness/weight-bearing on all strides observed
1	Mild subtle lameness with partial weight-bearing
2	Obvious lameness with partial weight-bearing
3	Obvious lameness with intermittent weight-bearing
4	Full non-weight-bearing lame
Trot	
0	No lameness/weight-bearing on all strides observed
1	Mild subtle lameness with partial weight-bearing
2	Obvious lameness with partial weight-bearing
3	Obvious lameness with intermittent weight-bearing
4	Full non-weight-bearing lame

Source: Levine and Adamson (2004)

Appendix B

Breed classification

Appendix Table B1 Frequencies of dog breed classified by disease group

Breed	Case		Control	
	N	%	N	%
Small size	18	12.1	135	45.3
Chihuahua	0	0.0	1	0.3
French Bull Dog	0	0.0	1	0.3
Maltese	0	0.0	1	0.3
Miniature Pinscher	2	1.3	9	3.0
Pekingese	1	0.7	2	0.7
Pomeranian	1	0.7	11	3.7
Poodle - miniature	11	7.4	52	17.4
Pug	1	0.7	8	2.7
Shih Tzu	1	0.7	45	15.1
Tenerife	0	0.0	1	0.3
Yorkshire Terrier	1	0.7	4	1.3
Medium size	31	20.8	129	43.3
American Cocker Spaniel	2	1.3	1	0.3
American Pitbull	1	0.7	2	0.7
Bangkaew	2	1.3	7	2.3
Basset Hound	0	0.0	1	0.3
Beagle	2	1.3	1	0.3
Bull Dog	1	0.7	4	1.3
Bull Terrier	0	0.0	1	0.3
Dachshund	0	0.0	2	0.7
Finnish Spitz	3	2.0	0	0.0
German Hound	1	0.7	0	0.0
Mixed	19	12.8	110	36.9
Large size	100	67.1	34	11.4
Affenpinscher	0	0.0	1	0.3
Bernese Mountain	1	0.7	0	0.0
Bull Mastiff	1	0.7	0	0.0
Chow Chow	2	1.3	0	0.0
Collie	0	0.0	1	0.3
Dalmatian	2	1.3	4	1.3
Doberman	0	0.0	2	0.7
German Shepherd	4	2.7	2	0.7
Golden Retriever	48	32.2	14	4.7
Labrador Retriever	16	10.7	2	0.7
Old English Sheepdog	2	1.3	0	0.0
Rottweiler	10	6.7	1	0.3
Saint Bernard	6	4.0	0	0.0
Siberian Husky	8	5.4	7	2.3
Total	149	100.0	298	100.0

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