UNIVERSITI PUTRA MALAYSIA

RETROSPECTIVE STUDY ON FELINE HEART DISEASE IN UNIVERSITY VETERINARY HOSPITAL, UNIVERSITI PUTRA MALAYSIA (UVH-UPM) FROM 2013 - 2015

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CERTIFICATION

It is hereby certified that we have read this project paper entitled "**Retrospective Study on Feline Heart Disease in University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) from 2013 - 2015**", by Zakaria bin Ahmad and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfilment of the requirement for the course VPD 4999 – Final Year Project.

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DEDICATION

This project paper is dedicated to the One Almighty God, who had created me and made all things possible,

To my family dedicated with bunch of Loves –

To my late father

My mother

My siblings

My supervisor and co-supervisor with full of respect

To all the cats

And to all my lecturers and teachers who have committed themselves towards the noble cause of education

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Last but not least, a big thanks to my most heartfelt gratitude to my family; my beloved mother, brothers and sisters for their prayers, my best friends for all the love and support throughout my studies.

CONTENTS

LIST OF ABBREVIATIONS

ASD	Atrial Septal Defect
DCM	Dilated Cardiomyopathy
DSH	Domestic Shorthair
HCM	Hypertrophic Cardiomyopathy
IVS	Interventricular Septum
LV	Left Ventricle
LVFW	Left Ventricle Free Wall
MYBPC3	Myosin Binding Protein C3
NYHA	New York Heart Association
RCM	Restrictive Cardiomyopathy
UCM	Unclassified Cardiomyopathy
UVH-UPM	University Veterinary Hospital – Universiti Putra Malaysia
VHS	Vertebral Heart Score
VSD	Ventricular Septal Defect

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ABSTRAK

Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 - Projek

KAJIAN RETROSPEKTIF PENYAKIT JANTUNG FELIN DI HOSPITAL VETERINAR UNIVERSITI, UNIVERSITI PUTRA MALAYSIA (UVH-UPM) DARI 2013 - 2015

Oleh

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Kajian retrospektif yang dikendalikan di UVH-UPM menunjukkan bahawa prevalens kucing yang didiagnos menghidapi penyakit jantung adalah 1% (*n*= 155/15,493) dengan tren yang meningkat sepanjang tempoh tiga tahun (2013 - 2015). Min umur pesakit jantung felin adalah 5.2 tahun (julat umur, 2-bulan sehingga 20-tahun) dengan kekerapan tertinggi dapat dilihat pada kucing jantan (57%) berbanding dengan kucing betina (43%). Dua baka kucing yang lazim terlibat ialah kucing domestik (54%)

dan kucing Parsi (26%). Sepuluh daripada 155 ekor pesakit kucing yang menghidapi penyakit jantung adalah asimptomatik manakala selebihnya (145 ekor kucing) pesakit jantung adalah simptomatik dan dikemukakan dengan pelbagai tanda klinikal seperti kegagalan jantung kongestif. Penyakit jantung perolehan sering kali didiagnos berbanding dengan penyakit jantung kongenital. Antara penyakit jantung perolehan adalah kardiomiopati hipertrofi (HCM) dengan prevalens yang tertinggi iaitu 47%, diikuti oleh kardiomiopati terdilat (DCM) (18%), kardiomiopati terhad (RCM) (15%), lain-lain jenis penyakit jantung (11%) (terdiri daripada lelehan perikardium, kekurangan aortik, tumor pangkal jantung, dan penyakit cacing jantung felin), miokarditis (7%), dan akhirnya, penyakit jantung kongenital (2%) (kecacatan septa atrium (ASD) dan kecacatan septa ventrikular (VSD)). Pemeringkatan penyakit pesakit jantung kucing diklasifikasikan mengikuti *New York Heart Association* (NYHA). Majoriti pesakit jantung kucing tergolong dalam Kelas II (*n*=52) dan Kelas III (*n*=67), diikuti dengan Kelas IV (*n*= 26), dan minoriti adalah Kelas I (*n*=10). Ekhokardiografi merupakan alat diagnosis yang terbaik berbanding dengan radiografi kerana saiz jantung yang normal tidak menolak kemungkinan penyakit jantung pada kucing.

Kata kunci: penyakit jantung kucing, prevalens, penyakit jantung perolehan, penyakit jantung kongenital, pemeringkatan penyakit jantung felin

ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfilment of the course VPD 4999 –Project

RETROSPECTIVE STUDY ON FELINE HEART DISEASE IN UNIVERSITY VETERINARY HOSPITAL, UNIVERSITI PUTRA MALAYSIA (UVH-UPM) FROM 2013 - 2015

By

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2016

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This restrospective study conducted in UVH-UPM revealed that the overall prevalence of cats diagnosed with heart disease was 1% (*n*=155/15,493) with an increased trend over the period of 3 years (2013 - 2015). The mean age of feline heart disease patient was 5.2 years old (age range, 2-month to 20-year-old), more often seen in male (57%) compared to female (43%) cats. The two most common breeds presented with heart disease were Domestic Shorthair (54%) and Persian (26%) cats. Ten out of 155 cats

diagnosed with heart disease were asymptomatic whereas the remaining (145 cats) patients were presented with varies clinical sign such as congestive heart failure. The acquired heart disease were often diagnosed compared to the congenital heart disease. Among the acquired heart diseases, hypertrophic cardiomyopathy (HCM) has the highest prevalence at 47%, followed by dilated cardiomyopathy (DCM) (18%), restrictive cardiomyopathy (RCM) (15%), and other types of heart disease (11%) (Consist of pericardial effusion, aortic insufficiency, heart base tumour, and feline heartworm disease), myocarditis (7%), and congenital heart disease (2%) (Atrial Septal Defect (ASD) and Ventricular Septal Defect (VSD)). These feline heart disease patients were stage using and the New York Heart Association (NYHA) Classification. Majority of the feline heart patient in this study were in Class II (*n*=52) and Class III (*n*=67), followed by Class IV (*n*=26), and minority was Class I (*n*=10). Echocardiography remains the best diagnostic tools compared to radiography, where normal size of heart does not rule out heart disease in cats.

Keywords: feline heart disease, prevalence, acquired heart diseases, congenital heart diseases, staging of feline heart diseases

CHAPTER 1.0

INTRODUCTION

1.1 INTRODUCTION

In Malaysia, the information on feline heart diseases has not been well documented. Heart diseases in cat are silent killer. The natural history of occult disease is variable and difficult to predict with certainty because majority of cats with heart diseases appear to remain asymptomatic throughout their life and only shows clinical sign when the disease became severe in case of congestive heart failure (CHF), feline arterial thromboembolism (FATE) and leading to death (Fox, 2015). Cats with asymptomatic heart disease often are undiagnosed due to their sedentary nature (Paige *et al.*, 2009)

Clinical signs presented were usually associated with the respiratory system such as dyspnoea, abdominal breathing and tachypnoea (Spalla *et al.,* 2015). Both, heart murmur and tachycardia were often auscultated (Ferasin *et al.*, 2003) and this is consistent with the observation by Ferasin (2009) and Paige *et al.* (2009), where the incidence of heart murmur and tachycardia were reported 60% and 30%, respectively. The mean age of cats diagnosed with heart disease was 6.8 years old (age range, 6-month-old to 16-year-old) (Ferasin *et al.*, 2003). The prevalence of heart disease in feline patient appears more

frequently in females than males for both, RCM and DCM at 73%, respectively, and followed by UCM at 64%. HCM was more prevalence in males at 64% (Ferasin *et al*. 2003). However, latest review by Ferasin (2009) stated that feline heart diseases were equally distributed between the male (50%) and female (50%) cats.

Radiography provides the primary means of assessing heart size in animals, however the accuracy and validity of interpretations in feline patient remains questionable (Nakamura *et al.*, 2011). Hence to date, the echocardiography provides a means of verifying the radiographic interpretation of cardiomegaly and it is the "gold standard" of assessing heart size, demonstrating the limits of radiography in this field. Interestingly, no objective studies have been performed to determine the accuracy of radiography in identifying generalized cardiomegaly based on the final diagnosis made after echocardiography was performed.

1.2 OBJECTIVES

The objectives of this study were:

1. To determine the prevalence of feline heart disease in UVH-UPM from 2013 to 2015.
2. To determine the age, sex, and breeds as associated factors that may contribute to occurrence of feline heart disease.
3. To determine the common clinical and radiographic findings for cats diagnosed with heart diseases.
4. To compare the Vertebral Heart Score (VHS) based on radiography to the definitive diagnosis of the heart (via echocardiography) and the stage of feline heart disease.

1.3 HYPOTHESES

The hypotheses for this study were:

1. HCM is the most prevalent type of feline heart disease diagnosed in UVH-UPM.
2. Feline heart diseases are often observed in older cats, breeds such as Maine coon and Persian and equally distributed among male and female.
3. The presenting clinical sign is associated with respiratory signs.
4. Radiography is not a sensitive diagnostic tool to diagnosed heart disease in cats.

CHAPTER 2.0

LITERATURE REVIEW

2.1 TYPES OF FELINE HEART DISEASES AND IT'S PREVALENCE

Feline heart diseases can be divided into three categories namely; congenital heart disease, acquired heart disease and other form of structural heart disease (Côté *et al.*, 2011). The overall prevalence of feline heart disease in Sweden reported was 3% (*n*=1817/65, 929) (Tidholm *et al.,* 2014).

Congenital heart disease is defined as heart defect that present at birth which could be due to genetically inherited or spontaneously without any known familial pattern and is generally less common than acquired heart disease in cats (Côté *et al.,* 2011; Tidholm *et al.,* 2014). According to study conducted in Swedish University of Agricultural Sciences in Sweden, the prevalence of congenital heart disease was 0.2% (*n*=145/65,929). From this 0.2% of cats diagnosed with congenital heart disease, 44% of the cats were diagnosed with VSD, followed by Tricuspid Valve Dysplasia (10%), Pulmonic Stenosis (9%), ASD (9%), Aortic Stenosis (8%), Mitral Valve Dysplasia (8%), Tetralogy of Fallot (4%), Patent Ductus Arteriosus (3%), and other defects (5%) (Common Atrioventricular Canal, Double Chamber Right Ventricle, Double Outlet Right Ventricle, Endocardial

Fibroelastosis, Dextroposition of Aorta, Persistent Right Aortic Arch, and Pulmonary Atresia) (Tidholm *et al.,* 2014).

Acquired heart disease is defined as heart muscle diseases or cardiomyopathy of unknown aetiological agent with dominant feature associated with cardiomegaly and heart failure (Ferasin, 2009a). Study conducted in Swedish University of Agricultural Sciences in Sweden, the prevalence of acquired heart disease was 8% (*n*=145/1817) (Tidholm *et al.,* 2014). It can be further subdivided into primary cardiomyopathy that consists of HCM, RCM, DCM and UCM with prevalence of 58%, 21%, 10%, and 10%, respectively (Ferasin *et al.*, 2003). Each primary acquired heart diseases are not the same and can be differentiated (refer Table 1). Secondary cardiomyopathy refers to heart muscle disease from the underlying and identifiable causes such as systemic (systemic hypertension, systemic infection by virus, bacteria, protozoa, or fungus), metabolic (hyperthyroidism, diabetes mellitus), or nutritional (taurine deficiency) (Côté *et al.*, 2011).

The other forms of structural heart disease are very rare. These heart diseases are further divided into three subcategories; acquired valvular disease, heart tumour, and miscellaneous myocardial disease. For acquired valvular disease, it is often due to degeneration of valve(s) leading to significant valvular regurgitation and eventually myocardial remodelling due to volume overload. Heart tumour in cats is uncommon and it may be encompassed by primary tumours or secondary tumours, which originate elsewhere and metastasize to the heart. Finally, miscellaneous myocardial diseases are

consists of myocarditis, endocardial fibroelastosis and excessive moderator bands (Côté *et al*, 2011).

2.2 ASSOCIATED FACTORS OF FELINE HEART DISEASES

Age is one of the important associated factors for feline heart disease. Ferasin *et al.* (2003) reported that the mean age of cats diagnosed with heart disease was 6.8 years old (age range, 6-month to 16-year-old).

Sex of feline heart disease patients were equally distributed among male and female (Ferasin *et al.,* 2003). However, recent study shown male cats were slightly predominant over female cats at 53% and 47%, respectively (Spalla *et al.,* 2015). Similarly, Tidholm *et al.* (2014) reported that male cats (54%) were frequently diagnosed with heart disease compared to female cats (46%).

All breeds of cat are preponderance to have heart disease (Ferasin, 2009a). The most commonly presented feline breed diagnosed with heart disease were DSH (58%) and Persian (13%), followed by other breeds (29%) (Ferasin *et al.,* 2003). Similarly was reported by Spalla *et al.* (2015) that DSH was frequently diagnosed at 65% and Persian (21%), and followed by other breeds (14%).

2.3 CLINICAL SIGNS OF FELINE HEART DISEASES

Symptomatic feline heart disease patients are often presented with the clinical sign of dyspnoea (50%), exercise intolerance (20%), cachexia (10%), pot-bellied (10%), syncope (10%), and hind limb paresis or paralysis (8%) (Ferasin, 2009a). However, not all cats will show clinical sign(s) of the heart disease as these cats are sedentary in nature (Paige *et al.*, 2009). Ferasin *et al.* (2003) reported that 3% of the cats diagnosed with heart disease were asymptomatic.

2.4 IMPORTANT DIAGNOSTIC TOOLS OF FELINE HEART DISEASES

2.4.1 HEART AND LUNG AUSCULTATION

The highest incidence of heart auscultation of feline heart disease patients were heart murmur (60%), followed by tachycardia (30%), gallop rhythm (20%), arrhythmia (10%), bradycardia (6%) and lastly muffled heart sound (5%) (Ferasin *et al.,* 2003; Ferasin, 2009a). Meanwhile, the incidence of abnormal lung sound auscultated was approximately 10% (Ferasin, 2009a). The presence of heart murmurs were highly suggestive of structural heart disease that is clinically latent state (Côté *et al.*, 2004; Nakamura *et al.,* 2011). Often , associated with Dynamic Right Ventricular Outflow Tract Obstruction (DRVOTO), Dynamic Left Ventricular Outflow Tract Obstruction (DLVOTO), Mitral Valve Disease, enlarged Left Atrium to Aorta ratio (La: Ao), some

due to unknown cause (Nakamura *et al.,* 2011). Systolic Anterior Motion (SAM) of mitral valve leaflet has been reported contributing to heart murmur (Smith and McEwan, 2012).

2.4.2 THORACIC RADIOGRAPHY

Thoracic radiography is commonly employed to determine the Vertebral Heart Score (VHS) of the heart with the accepted cut-off point of healthy cats' VHS in lateral view was less than 8.0 (Guglielmini & Diana, 2015). Increase cardiac silhouette is a reliable evidence of cardiomegaly with heart shape changes may indicate focal heart enlargement that commonly described as "Valentine" heart shape which often associated to atrial or bi-atrial enlargement. In conjunction, it had been reported that 'Valentine' heart shape was strongly associated with heart disease at 93%, however with a possible false positive rate of 7% (Winter *et al.,* 2015).

Dyspnoea observed in cats diagnosed with heart disease were often associated with cardiogenic pulmonary oedema or pleural effusion where increase radio-opacity of lung field either generalize or patchy with alveolar (±interstitial) pattern or generalize radio-opacity concurrent with lung lobes retraction is consistent with congestive heart failure (Ferasin, 2009b; Guglielmini and Diana, 2014).

2.4.3 ECHOCARDIOGRAPHY

Echocardiography is the most important definitive diagnostic tool in diagnosing feline heart disease due to its non-invasiveness feature (Ferasin, 2009b). Three important techniques such as B-mode or Two-dimensional (2D), Motion mode (M-mode) and colour Doppler echocardiography are often used to provide a definitive diagnosis of feline heart disease (refer Table 1).

Table 1: The criteria of diagnosing acquired feline heart disease

(Boon, 1998; Ferasin *et al.,* 2003)

Acquired Feline Heart Diseases	Description
HCM	Characterized by concentric hypertrophy with an increased in the left ventricular free wall (LVFW) thickness and/or interventricular septum (IVS) accompanied by left atrial dilatation.
RCM	Characterized by myocardial stiffness and diastolic dysfunction. It consists of two forms: 1. **Myocardial form**, it portrayed by restrictive filling, normal or mildly thickened LVFW or IVS apparently preserved systolic function, and severe atrial or bi-atrial dilatation. 2. **Endomyocardial form**, it portrayed by extensive reparative fibrotic lesions, left ventricle (LV) is primarily affected, and presence of scars bridging ventricular lumen.

DCM	Characterized by severely dilated LV chamber associated with hypocontractile of myocardium.
UCM	Characterized by atypical feline myocardial diseases that do not fit into or it may possess overlapped features of HCM, RCM, and DCM.

CHAPTER 3.0

MATERIALS AND METHODS

3.1 SOURCE OF DATA

This retrospective study was conducted in University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) focusing on feline patients diagnosed with heart disease from 2013 to 2015, over a period of three years. The Case Log Book (CLB) from both, the Clinic and Diagnostic Imaging Unit (specifically ultrasound) were retrieved. Each CLB were screened thoroughly and the case numbers of feline diagnosed with cardiomegaly, suspected or confirmed diagnosis of heart disease were recorded. Each feline heart disease patients' medical record was retrieved for data collection. Data inclusive of age, sex, breed, clinical signs and physical examination findings were recorded. Findings from radiography and echocardiography were reviewed and included.

3.2 INCLUSION CRITERIA

Inclusion criteria of feline heart disease patients recruited in this study were as follows: i) retrievable patient medical records, ii) complete patient signalment, iii) clinical

signs and physical examination findings associated to heart diseases, iv) retrievable radiography files and its findings, and v) the echocardiographic images and its findings.

3.2.1 Patient signalment

The age and body weight of each feline patient diagnosed with heart disease was recorded and averaged. Based on age categories established by the American Association of Feline Practitioners (AAFP) and American Animal Hospital Association (AAHA) (2010), the feline heart disease patients were categorized into six age groups as follows; (i) Kitten (birth to 6 months old), (ii) Junior (7 months to 2 years old), (iii) Prime (3 to 6 years old), (iv) Mature (7 to 10 years old), (v) Senior (11 to 14 years old), and (vi) Geriatric (more than 15 years old). The sex of each feline heart disease patients were recorded as either intact male, castrated male, intact female or spayed female.

3.2.2 Clinical signs

Information on clinical signs from each feline heart disease patient as observed by their owner and veterinarian (during consultation and/or hospitalisation) was recorded. Clinical signs of feline with suspected or diagnosed with heart diseases further divided to groups of asymptomatic and symptomatic.

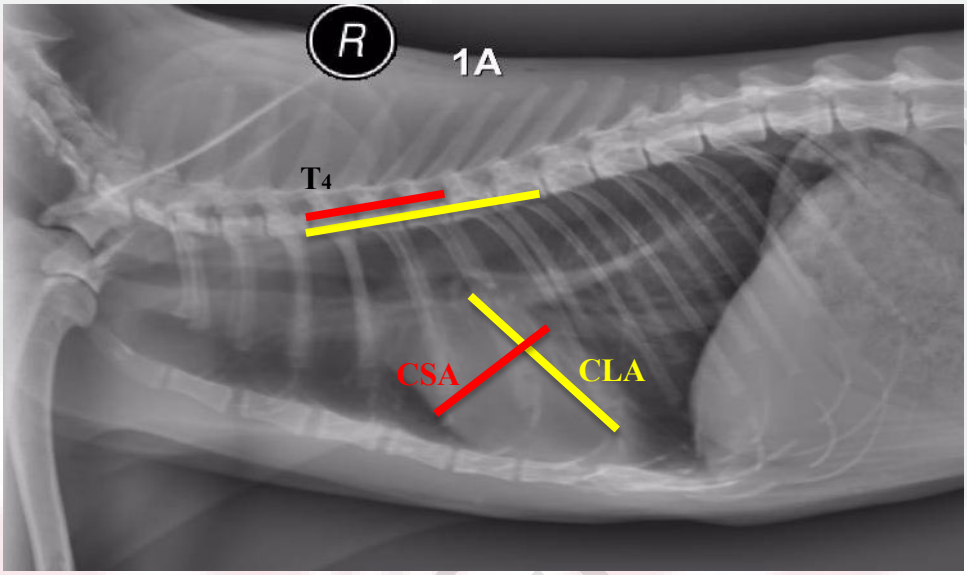
3.2.3 Physical examination - Heart and lung auscultation

Each feline heart disease patient's thoracic auscultation findings such as heart murmur (Grade I to VI, refer Appendix 1), tachycardia or bradycardia, gallop rhythm, arrhythmia, muffled heart sound and any abnormal respiratory sounds were documented.

3.2.4 Radiography

The thoracic radiography of each feline heart disease patients were retrieved and re-evaluated. The Vertebral Heart Score (VHS) for each cat patient were calculated and verified. The cardiac long axis (CLA) and cardiac short axis (CSA) on the lateral view of thoracic radiograph was determined and compared with the length of mid-thoracic vertebrae starting from cranial edge of 4th thoracic vertebra (T_4) (refer Figure 1). The CLA was measured from ventral border of largest main stem bronchi at the tracheal bifurcation point to the most distant points of heart apex. Whereas, the CSA was measured perpendicular to the measurement of CLA at the point of maximum heart width (Guglielmini *et al*., 2015).

Figure 1: Measurement of VHS of cat on lateral view



The evaluation of the lung patterns were described as alveolar, bronchial or interstitial pattern with patchy or diffuse distribution over the lungs field. Abdominal radiography was also reviewed if there was evidence of distended abdomen during physical examination for ascites.

3.2.5 Echocardiography

Echocardiography is the most important diagnostic tools because of its ability to access both structural and functional changes of the heart and it is also non-invasive approach to diagnose heart disease. In this study, echocardiography provides the confirmatory diagnosis of the heart disease (Ferasin, 2009b). All the images were

retrieved for verification of the diagnosis of each feline patient diagnosed with heart disease.

3.3 STAGING OF FELINE HEART DISEASE PATIENTS (ASYMPTOMATIC AND SYMPTOMATIC)

Feline heart disease staging system was adapted from New York Heart Association (NYHA) Classification established in human heart patients. This staging system is divided into two main stages: Asymptomatic Stage - Class I; and Symptomatic Stage - Class II, Class III and Class IV (Refer to Appendix 2) that varied in details but serve as semi-quantitative schemes as to stage the feline heart disease patient. Each feline patient diagnosed with heart disease was based on medical record data inclusive of clinical signs, auscultation findings, and evidence-based changes of radiography findings of the heart and lungs as well as functional and structural heart changes on echocardiography.

3.4 DATA ANALYSIS

All the data were recorded in Microsoft Office Excel for descriptive analysis.

CHAPTER 4.0

RESULTS

In this study, 155 feline patients diagnosed with heart disease were recruited. The average body weight of feline heart disease patient was 3.27kg (body weight range, 0.4 to 9.0kg).

4.1 PREVALENCE OF FELINE HEART DISEASE IN UVH-UPM (2013 - 2015)

The total numbers of feline cases presented to UVH-UPM between 2013 to 2015 were 23,087 cats. The total number of feline heart disease cases for each year were as follows; 2013 (*n*=24/5238), 2014 (*n*=62/8459), and 2015 (*n*=105/9390), respectively (refer Figure 2). Of the 23,087 feline cases presented, 7594 cases were excluded from the study for being presented for more than one time (i.e. for annual check-up, treatment of the same problem or other diseases). Meanwhile, of 191 feline heart disease patients, 36 cases were excluded due to presented for more than one time. Hence, the total populations of feline patients presented to UVH were 15,493 whereas feline heart disease patients were 155. Therefore, the prevalence of feline heart disease presented from 2013 – 2015 was 1% (*n*=155/15,493) (refer Figure 3).

Figure 2: The total number of feline patients presented for heart diseases (*n*=155) and others (*n*=23,087)

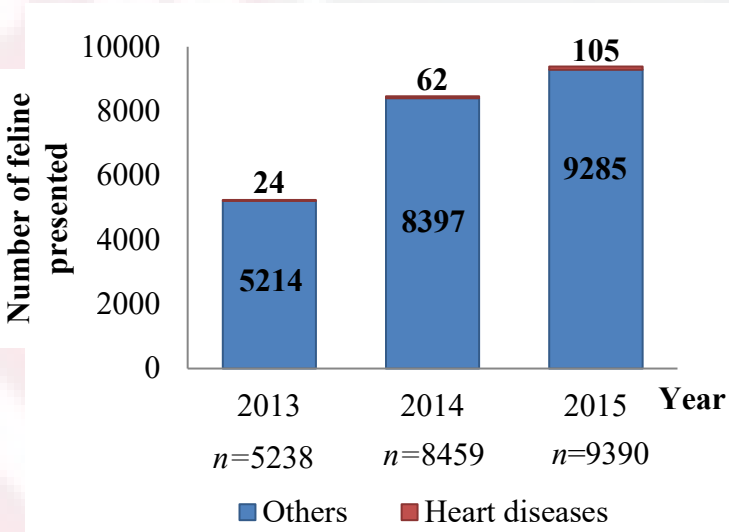


Figure 3: The prevalence of feline heart disease patients (*n*=155)

Prevalence of feline heart disease over period of 3 years' time (2013 - 2015)

$$= \frac{Number\ of\ feline\ heart\ disease\ patient\ presented}{Size\ of population}$$

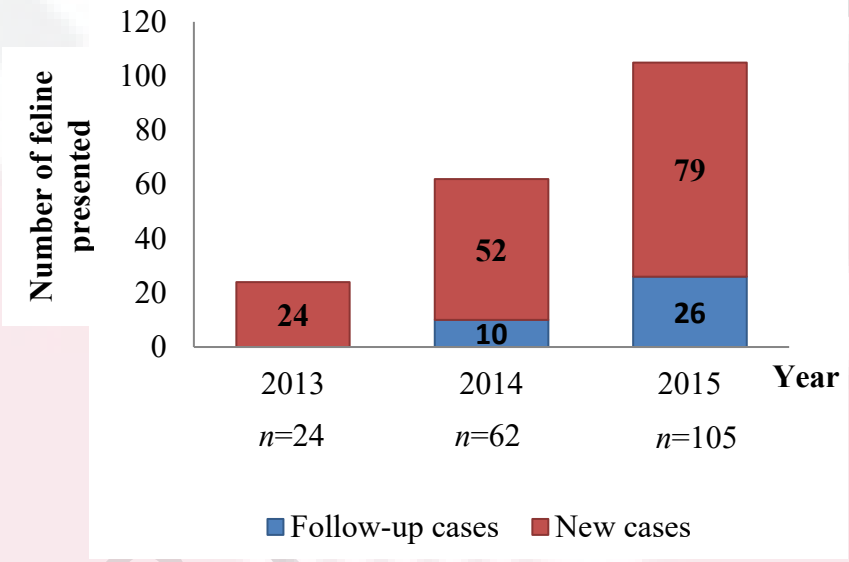
$$= \frac{155}{15,493} \times 100\%$$

$$= 1\%$$

The total number of feline heart disease patients presented increases each year. In 2013, there were 24 feline heart disease patients presented. In 2014 and 2015, there was an increment of new cases of feline heart disease by 54% (*n*=28/52) and 34% (*n*=27/79),

respectively. In addition, the number of revisit feline heart disease patient also increases from 0 to 10 (increase by 10) in 2014 and increases from 10 to 26 (increase by 16) in 2015 (refer Figure 4).

Figure 4: Trend of feline heart disease patients (*n*=155)



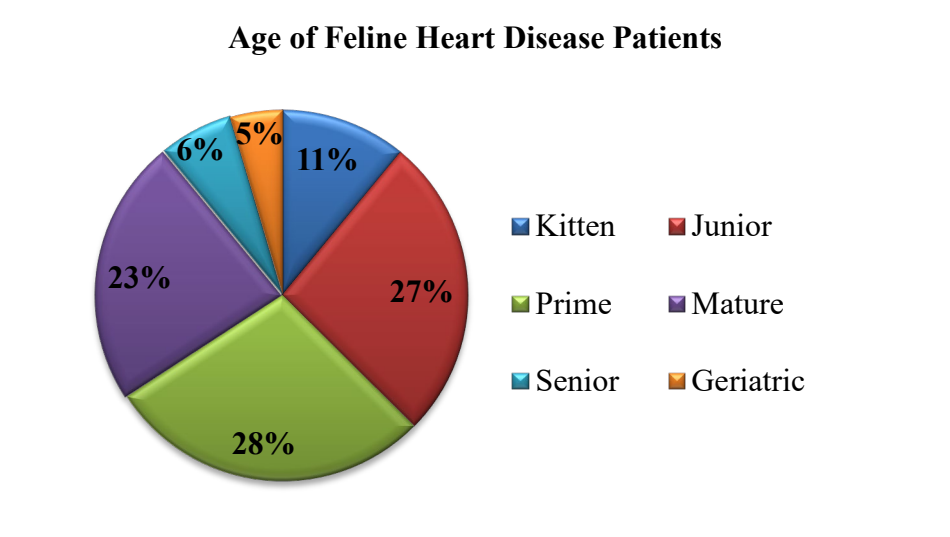
4.2 THE AGE, SEX, AND BREEDS AS THE ASSOCIATED FACTORS OF FELINE HEART DISEASE

4.2.1 Age

The mean age of the feline patients diagnosed with heart disease were 5.2 years old (age range, 2-month to 20-year-old). In this study 28% (*n*=44) of the cats with heart

disease were in the Prime age group (between 3 – 6 years old), followed by Junior (27%, *n*=41), Mature (23%, *n*=36), Kitten (11%, *n*=17), Senior (6%, *n*=10) and lastly, Geriatric (5%, *n*=7) age group (refer Figure 5).

Figure 5: Age of feline heart disease patients (*n*=155)



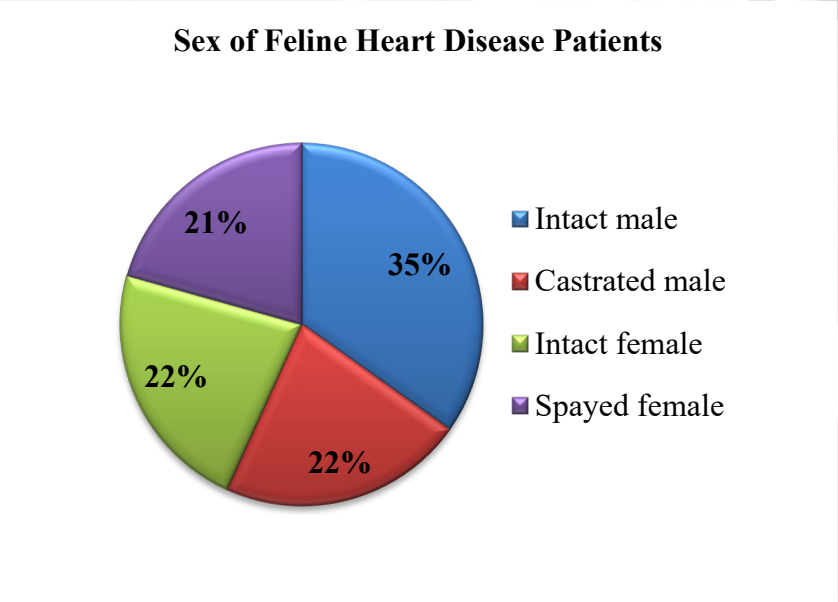
Category	Age	Number of cats	Percentage (%)
Kitten	<7 months old	17	11
Junior	7 months - 2 years old	41	27
Prime	3 - 6 years old	44	28
Mature	7 – 10 years old	36	23
Senior	11 – 14 years old	10	6
Geriatric	≥15 years old	7	5

4.2.2 Sex

From the pie chart below, majority of the feline diagnosed with heart disease were consist of 57% (*n*=88) male and 43% (*n*=67) female cats. From the 88 male cats,

there were 35% (*n*=54) intact and 22% (*n*=34) castrated male cats. Meanwhile, 22% (*n*=35) were intact and 21% (*n*=32) were spayed female cats (refer Figure 6).

Figure 6: Sex of feline heart disease patients (*n*=155)



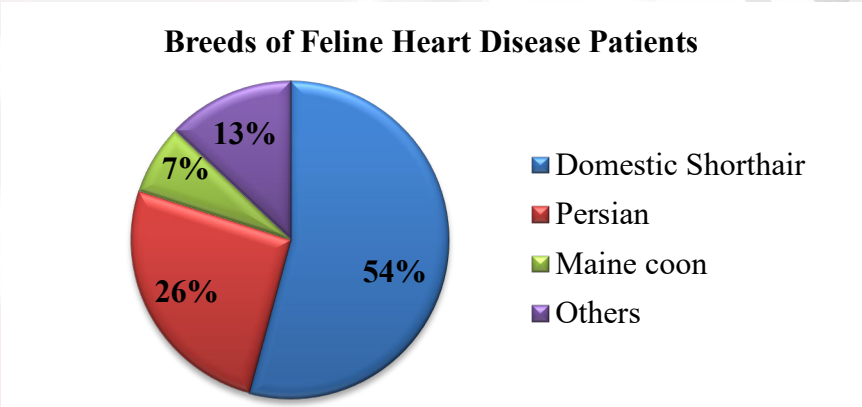
Sex	Number of cats	
Intact male	54 (35%)	88 (57%)
Castrated male	34 (22%)	
Intact female	35 (22%)	67 (43%)
Spayed female	32 (21%)	

4.2.3 Breeds

In this study, majority of feline diagnosed with heart disease were DSH (54%, *n*=84), followed by Persian (26%, *n*=40), Maine coon (7%, *n*=11), and lastly other breeds of cats (13%, *n*=20). The other breeds of cats were consist of American Curl (1.5%, *n*=2),

Siberian (1.5%, *n*=2), Domestic Longhair (2%, *n*=3), Exotic Shorthair (2%, *n*=3), Bengal (3%, *n*=5), and Siamese (3%, *n*=5) cats (refer Figure 7).

Figure 7: Breeds of feline heart disease patients (*n*=155)



Breeds	Number of cats	Percentage (%)
DSH	84	54
Persian	40	26
Maine coon	11	7
Others*	20	13

*American Curl, Siberian, Domestic Long Hair, Exotic Shorthair, Bengal, and Siamese

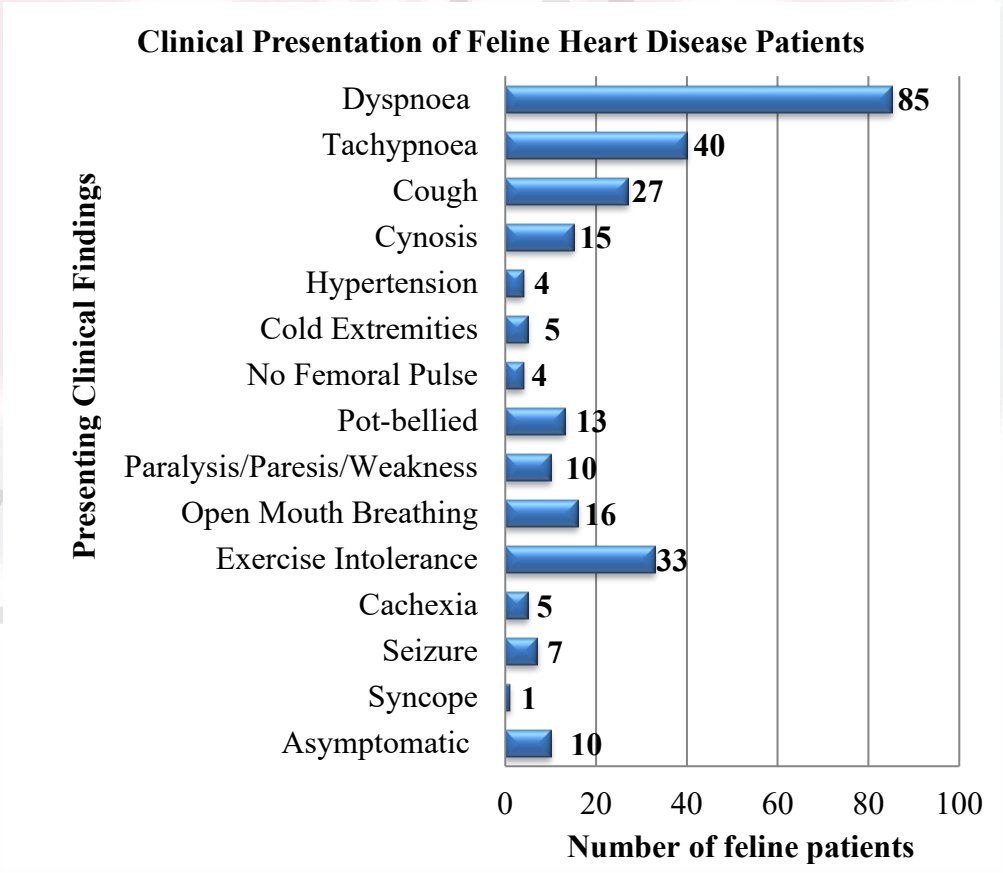
4.3 COMMON CLINICAL AND RADIOGRAPHIC FINDINGS OF FELINE HEART DISEASE IN UVH-UPM (2013 - 2015)

4.3.1 Clinical Presentation

Ten out of 155 feline heart disease patients were asymptomatic and majority were symptomatic (*n*=145). The four most common presented clinical signs were dyspnoea (*n*=85), tachypnoea (*n*=40), exercise intolerance (*n*=33), and coughing (*n*=27). In

addition, there were also modest clinical signs presented by the feline heart disease patient such as open-mouth breathing (*n*=16), cynosis (*n*=15), and pot-bellied (*n*=13). The least common clinical findings shown were seizure (*n*=7), paralysis, paresis or weakness (*n*=10), cold extremities (*n*=5), cachexia (*n*=5), hypertension (*n*=4), no femoral pulse (*n*=4), and syncope (*n*=1) (refer Figure 8).

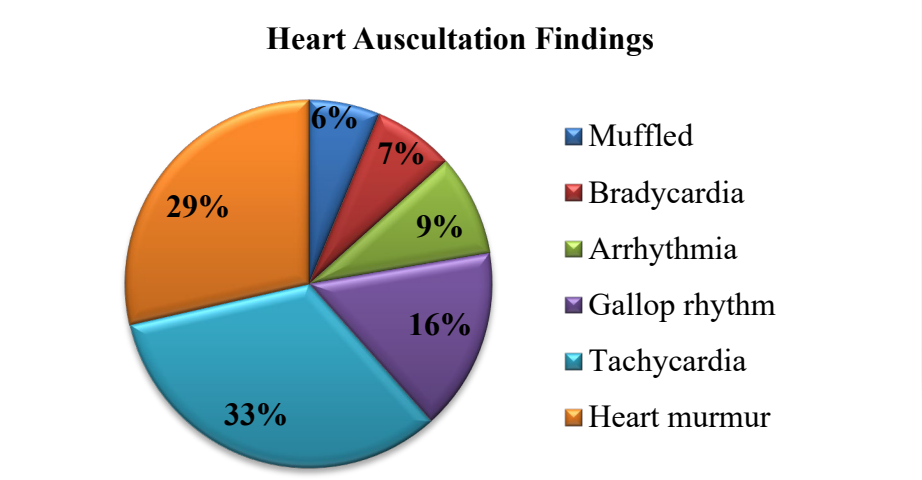
Figure 8: Clinical findings shown by feline heart disease patients (*n*=155) upon physical examination



4.3.2 Thoracic Auscultation of the Heart and Lungs

Feline heart disease patients were often presented with tachycardia and heart murmur at 33% (*n*=37) and 29% (*n*=32), respectively. This was follow by gallop rhythm (16%, *n*=18) and arrhythmia (9%, *n*=10). Lastly, the least heard upon auscultation of cat with heart disease were bradycardia at 7% (*n*=8), followed by muffled heart sound at 6% (*n*=7) (refer Figure 9).

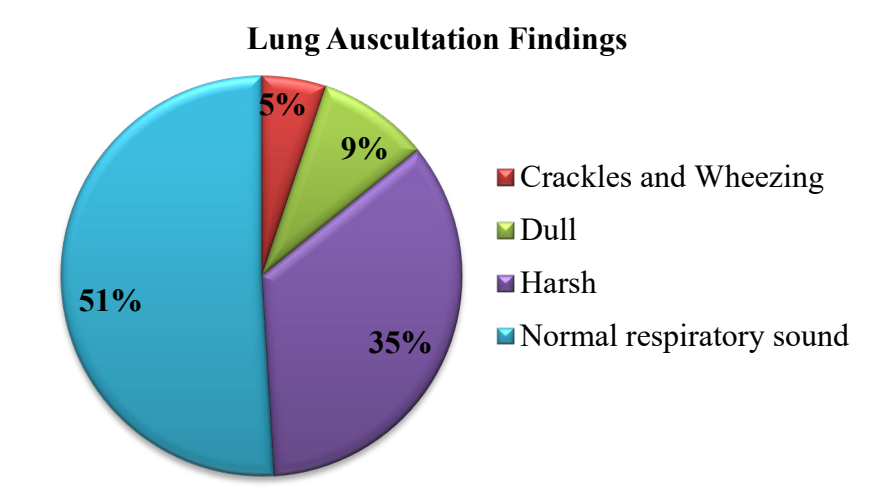
Figure 9: Auscultation findings of the heart sound of feline heart disease patients (*n*=155) upon physical examination



Heart Auscultation Findings	Number of cats	Percentage (%)
Muffled	7	6
Bradycardia	8	7
Arrhythmia	10	9
Gallop rhythm	18	16
Heart murmur	32	29
Tachycardia	37	33

For the respiratory sounds, it was divided into two groups which were normal (51%, *n*=79) and abnormal (49%, *n*=76) sounds. Thirty-five percent (n=54) of the feline heart disease patient have harsh lung sound upon auscultation. This was followed by dull lung sound at 9% (n=14) and crackles and wheezing were the least heard at 5% (n=8) (refer to Figure 10).

Figure 10: Auscultation findings of the lung sound of feline heart patient (*n*=155) upon physical examination

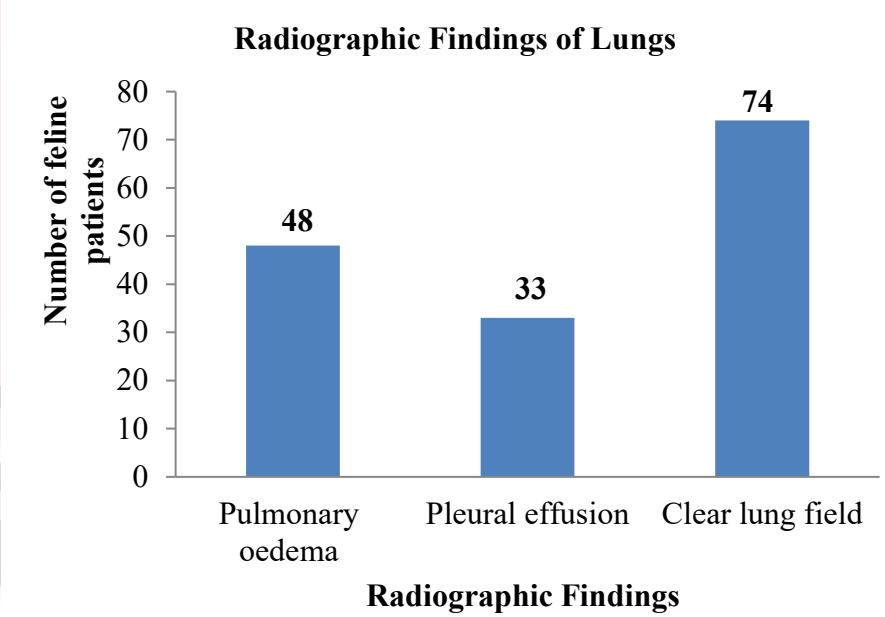


Lung Auscultation Findings	Number of cats	Percentage (%)
Crackles and Wheezing	8	5
Dull	14	9
Harsh	54	35
Normal respiratory sound	79	51

4.3.3 Radiographic Findings of Lungs

Seventy-four feline heart disease patients had a normal lung radiographic finding, meanwhile the remaining 48 feline heart disease patients were diagnosed with pulmonary oedema and 33 were diagnosed with pleural effusion. Therefore, the lungs radiography findings were almost consistent with lung auscultation findings of the 76 feline patients that had abnormal lung sound (refer Figure 11).

Figure 11: Thoracic radiographic findings of the feline heart disease patients (*n*=155)

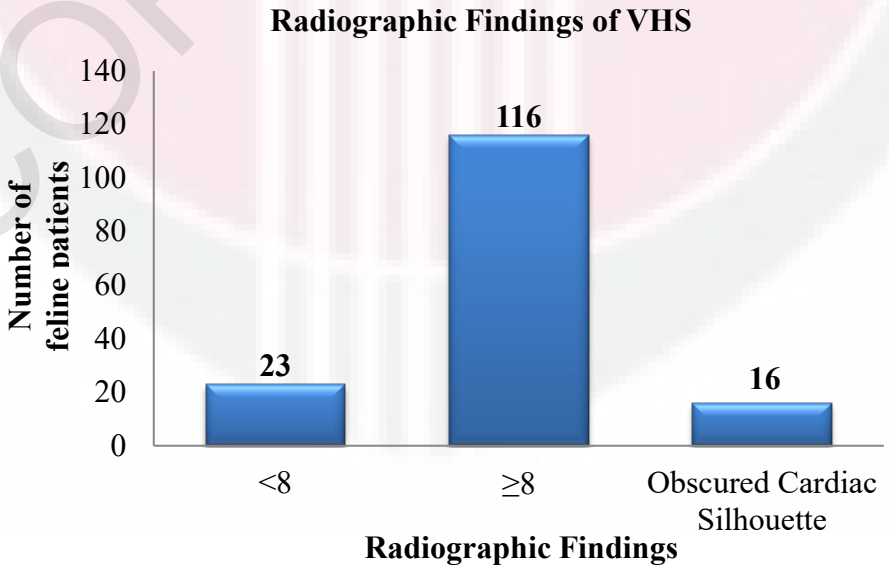


4.4 COMPARISON OF THE VERTEBRAL HEART SCORE (VHS) BASED ON RADIOGRAPHY AND ECHOCARDIOGRAPHY FINDINGS OF FELINE HEART DISEASE PATIENTS WITH THE STAGING OF HEART DISEASE BASED ON THE NYHA CLASSIFICATION

4.4.1 Radiographic Findings of Heart

A total of 16 feline heart disease patients' VHS were excluded for evaluation due to obscured cardiac silhouette (refer Figure 12). Majority of feline heart disease patients' VHS were ≥8 vertebrae (*n*=116) and were diagnosed as cardiomegaly, followed by normal VHS which is <8 vertebrae (*n*=23).

Figure 12: Radiographic findings of feline heart disease patients' (*n*=155) VHS based on lateral view of radiography

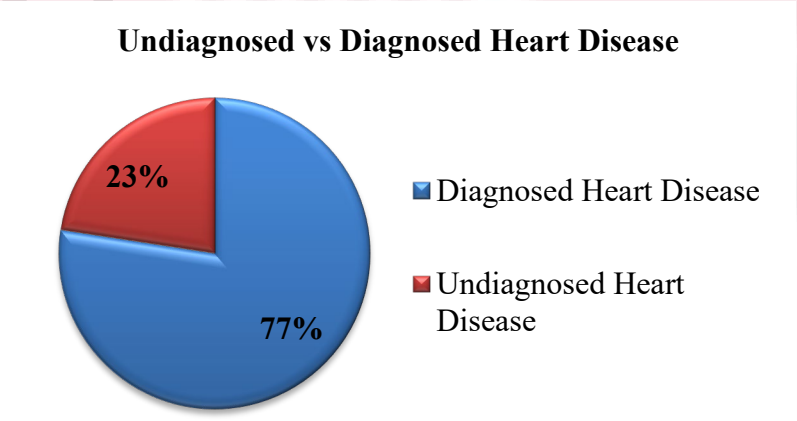


Severity	VHS	Number of Cats
Normal	<8	23
Cardiomegaly	≥8	116
Obscured Cardiac Silhouette		16

4.4.2 Echocardiographic Findings of the Heart

The echocardiography images of all the 155 feline heart disease patients with radiographic findings of cardiomegaly were reviewed. The final diagnoses for 35 feline heart patients (23%) were not retrievable and grouped as undiagnosed heart disease. On the other hand, 77% (*n*=120) feline heart patients had a definitive diagnosis of heart diseases based on echocardiography (refer Figure 13).

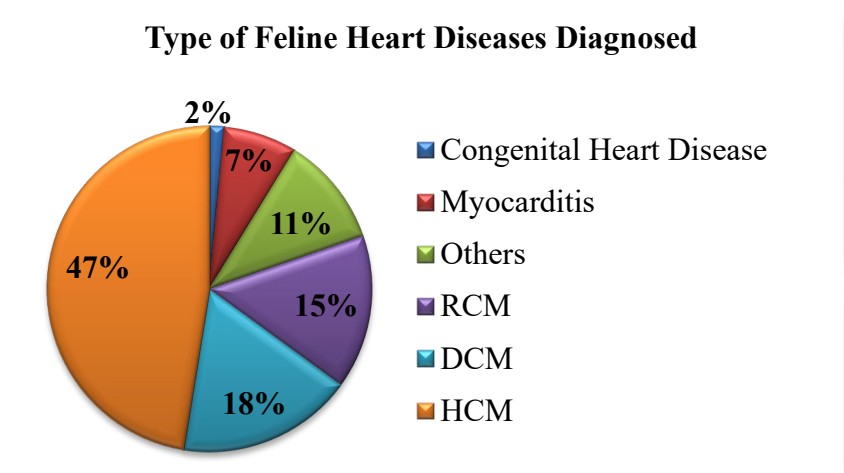
Figure 13: Undiagnosed versus diagnosed heart disease of feline heart disease patients (*n*=155)



Echocardiographic findings	Number of cats	Percentage (%)
Diagnosed Heart Disease	120	77
Undiagnosed Heart Disease	35	23

From 77% (*n*=120) of the feline heart patient diagnosed, majority of the feline heart disease patient (47%; *n*=65) were diagnosed with HCM, followed by DCM (18%, *n*=23), and RCM (15%, *n*=18). The feline heart disease patients categorized as others (11%; *n*=15) were diagnosed with pericardial effusion (*n*=4), aortic insufficiency (*n*=1), heart base tumour (*n*=1), and feline heartworm disease (*n*=1). This was followed by myocarditis at 7% (*n*=8). Congenital heart disease where the least diagnosed at 2% (*n*=2), consist of ASD (*n*=1) and VSD (*n*=1) (refer Figure 14).

Figure 14: Type of feline heart diseases diagnosed (*n*=120)



Heart Disease	Number of Cats	Percentage (%)
Congenital Heart Disease*	2	2
Myocarditis	10	7
Others**	15	11
RCM	18	15
DCM	23	18
HCM	65	47

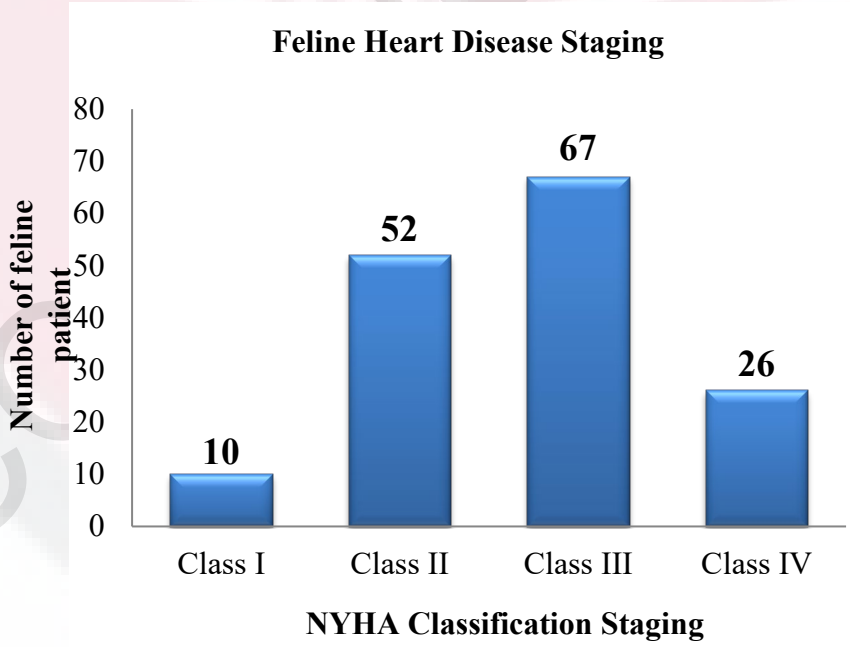
*ASD, VSD

**Pericardial effusion, aortic insufficiency, heart base tumour, feline heartworm disease

4.4.3 Staging of Feline Heart Disease using New York Heart Association (NYHA) Classification

Ten heart disease cats were staged as Class I (Asymptomatic) feline heart disease (*n*=10). Majority of the feline heart patient were presented with clinical sign (Symptomatic). These cats were predominantly group as Class II (*n* =52) and Class III (*n*=67) (refer Figure 15). The least common was Class IV feline heart disease with total number of 26 cats.

Figure 15: Staging of feline heart disease patients (*n*=155) adapted from New York Heart Association (NYHA) Classification



4.4.4 Comparison between Radiography Findings, Echocardiography Findings and NYHA Classification

Table 1 showed the comparison between VHS and echocardiography findings associated with the NYHA Classification staging. The VHS was divided into two major groups; <8 refers to normal heart size and ≥8 refers to as cardiomegaly. The total of 120 feline heart disease patients were recruited for this comparison while the remaining 35 cat patients were excluded due to unavailability of echocardiographic images. The definitive diagnoses of each feline heart disease were based on ecocardiography. Based on the clinical findings obtained from the feline heart patient, the cats were further staged as asymptomatic (Class I) and symptomatic (Class II, III and IV) based on the NYHA Classification. From the table, 19 feline heart patients with a normal VHS (<8) were diagnosed with heart disease and 16 out of 19 patients were expressing clinical signs (NYHA Class II, III and IV). Three asymptomatic feline heart patient with normal VHS were diagnosed with HCM (*n*=1) and RCM (*n*=2). Interestingly, four asymptomatic feline heart patients has cardiomegaly based on the radiograph were diagnosed with HCM (*n*=3) and DCM (*n*=1), respectively (refer Table 1).

Table 2: Comparison of the Vertebral Heart Score (VHS) based on radiography and echocardiography findings of feline heart disease patients with the staging of heart disease based on the NYHA Classification.

VHS	Echocardiography diagnosis of Feline Heart Disease Patients	*n*	NYHA Classification			
			Class I	Class II	Class III	Class IV
< 8	1. HCM	7	1	3	3	0
	2. DCM	2	0	1	1	0
	3. RCM	6	2	1	3	0
	4. Myocarditis	3	0	2	0	1
	5. Pericardial effusion	1	0	1	0	0
≥ 8	1. ASD	1	0	0	1	0
	2. VSD	1	0	1	0	0
	3. HCM	58	3	13	34	8
	6. DCM	21	1	8	8	4
	7. RCM	12	0	5	6	1
	8. Myocarditis	5	0	2	3	0
	9. Pericardial effusion	3	0	0	3	0

CHAPTER 5.0

DISCUSSION

This study provides information on different types of feline heart disease presenting to a teaching hospital, UVH-UPM. The overall prevalence of feline heart disease in UVH-UPM from 2013 to 2015 was 1% (*n*=155/15,493), where acquired heart disease was 0.99% and congenital heart disease was 0.01%. A study conducted in Sweden reported that the overall prevalence of feline heart disease was 3% (*n*=1817/65,929) which consist of acquired heart disease (8.0%) and congenital heart disease (0.2%) (Tidholm *et al*., 2014). From our observation, we suspected that the actual prevalence maybe under estimated. One of the main reasons were irretrievable patient medical records due to missing case files and files of deceased feline patients that were sealed and kept away in UPM archives centres. It was also noted that some of the cat patients registered in the Cat Log Book (CLB) between 2013 to 2015 did not have final diagnosis and therefore, it is unclear whether the cat was having heart disease or disease of other related system. In some cases, the feline patients with suspected heart disease were undiagnosed because further diagnostic workout was not able to be carried out due to cost constraint. A handful of the feline patients presented with critical clinical signs especially dyspnoea and/or tachypnoea suspected due to heart disease often goes undiagnosed due incidence of cardiorespiratory arrest and episodes of sudden death. Unfortunately, we do not have an

actual numbers for the entire scenario mentioned above but these inputs were based on our observation during case file searching and reading for data collection of this study. We believe that the actual prevalence of feline heart disease would be even more.

The trend of feline heart disease patients presented increased over the three year period of the study. It can be speculated with the continuous training provided to the hospital's veterinarians and coupled with their experience over time during in-practice, they were able to screen and identify feline patients with heart disease. On top of that, the availability of echocardiography as a diagnostic tool has helped to diagnose cats with heart disease accurately. Cats' owners are now more aware of their cat's health and they often allowed their pets to have regular health check-ups. In this study, all the asymptomatic cats diagnosed with heart disease were detected at the early stage of the heart disease during its annual screening and pre-anaesthetic screening. Besides that, there were an increased number of revisit cases probably because some of the cat owners' were compliance with the long term treatment regime aimed to provide good quality life and prolong the cat's lifespan. To date, there is none ideal treatment that demonstrated its ability to improve survival and/or quality life of the feline heart disease patients due to life expectancy of the cat was actually depends on form of myocardial damage and its degree of severity (Ferasin, 2012).

The mean age of feline heart disease patient was 5.2 years old (age range, 2-month to 20-year-old). Based on the age group categories established by AAFP and AAHA, the Prime group cats were commonly diagnosed with heart disease and followed by the Junior and Mature group cats. This study was supported by Ferasin *et al.* (2003). The mean age was 6.8 years old (age range, 6-month to 16-year-old) which were the Prime group cats category.

Sex of cats with heart disease has been reported as an associated risk (Tidholm *et al.*, 2014; Spalla *et al.*, 2015). Ferasin *et al.* (2003) reported that male and female were equally predisposed to heart diseases. But, Tidholm *et al.* (2014) and Spalla *et al.* (2015) found that the male cats are more commonly presented with heart disease compared to female cats. Similarly was observed in this study where the sex distributions of feline heart disease patients were commonly observed in male, especially intact male cats. However, whether the practice of castration would reduce the risk of cats diagnosed with heart disease warrant further investigation.

The breeds commonly presented with heart disease were DSH and Persian. Similarly was observed in studies by Ferasin *et al.* (2003), Tidholm *et al.* (2014), and Spalla *et al.* (2015) where in their study, DSH was most commonly presented followed by Persian except for Tidholm *et al.* (2014) whereby the Maine Coon cats comes second. Spalla *et al.* (2015) claimed that the DSH cats were a popular breed in Italy as pet and this

scenario may be similar in our local setting. Therefore, it may contribute to an over presentation of DSH cats at the hospital. Thus, to further confirm if breed would be a contributing risk factor of feline heart disease, a risk factor analysis should be conducted in future study.

The natural history of occult heart disease is variable and difficult to predict with certainty because majority of cats with heart diseases appear to remain asymptomatic throughout their life and only shows clinical sign when the disease became severe in case of congestive heart failure (CHF), feline arterial thromboembolism (FATE) and leading to sudden death (Fox, 2015). The clinical findings of feline heart disease patients were divided into two groups as follows; asymptomatic cats (*n*=10) and symptomatic cats (*n*=145). Majority of the asymptomatic cats diagnosed with heart disease were presented during annual heart screening and pre-anaesthetic health screening. These cats were overtly healthy upon presentation. Another study had shown that 16 out of 103 cats which appeared healthy had heart diseases (Paige *et al.*, 2009). For the symptomatic feline heart disease patient, the most common clinical signs seen were dyspnoea, tachypnoea and exercise intolerance. Ferasin *et al.* (2003) and Spalla *et al.* (2015) reported that the most commonly seen clinical signs were dyspnoea followed by exercise intolerance. Dyspnoea or tachypnoea is highly associated with congestive heart failure (Côté *et al.*, 2011; Smith and McEwan, 2012).

Auscultation of the cardiovascular system is useful to identify normal and abnormal heart sounds, assess heart rhythm and rate, and evaluate lungs sounds. Most of the feline heart disease patients were presented with tachycardia and followed by heart murmur upon heart auscultation. However, two studies noted that heart murmur was the most common findings (Ferasin *et al.*, 2003; Smith and McEwan, 2012) and followed by tachycardia (Ferasin *et al.*, 2003). According to Côté *et al.* (2004), heart murmur in cats frequently develop in conjunction with structural heart disease that is clinically latent state with prevalence of 21% (*n*=22/103). The low detection of heart murmur even though with many presented symptomatic feline heart disease patient could probably be due the different levels of experience or skill of auscultations between the veterinarians. But, Wagner *et al.* (2010) reported that there were 66% (*n*=132/199) feline heart disease patients does not have heart murmur. As for the lung auscultation, 49% (*n*=76/155) of feline heart disease patients had abnormal respiratory sound. Harsh lung sound was the most commonly heard upon auscultation followed by dull lung sound. Harsh lung sound is highly associated with pulmonary oedema whilst dull lung sound highly associated with pleural effusion (Côté *et al.*, 2011). It was observed that these abnormal respiratory sound findings were consistent with the radiographic findings in which there were 48% of feline heart diseases patients had radiological findings of generalized opacity of lung field with alveolar pattern and generalized opacity of the lung field concurrent with lung lobes retraction. These findings were suggestive of cardiogenic pulmonary oedema and pleural effusion associated with congestive heart failure (Guglielmini and Diana, 2014). The remaining 1% abnormal respiratory sound was falsely heard upon auscultation and in the

event when the patients were panting or purring, lung auscultation could be challenging. Therefore, radiography remains to be an important diagnostic tool in diagnosis of feline heart disease.

The measurement of heart VHS was based on vertebral length since it has good correlation between heart sizes on lateral axis sum (Litster & Buchanan, 2000). In cats, Guglielmini *et al.* (2014) had determined that the cut-off point for normal heart VHS on lateral view was less than and equal to 7.9. Therefore, the heart VHS of more than and equal to 8 was considered as cardiomegaly. In this study, 16 cats were excluded due to obscured cardiac silhouette and the remaining 139 cat's radiography were evaluated and findings were as follows; normal heart sizes (n=23) and cardiomegaly (n=116). Cats with radiological findings of cardiomegaly are reliable evidence of heart disease and its degree can be used to judge the severity of the disease (Litster and Buchanan, 2000).

From the 155 feline heart disease patients recruited, 35 patients were excluded for comparison between radiography, echocardiography and staging of the heart disease as these cats does not have a final diagnosis based on echocardiography. Majority of the cats were diagnosed with acquired heart disease, specifically HCM (47%, n=65/120). HCM was commonly diagnosed feline heart disease as compared to RCM and DCM (Ferasin *et al.*, 2003; Guglielmini *et al.*, 2014; Spalla *et al.*, 2015). This could probably because HCM had a familial pattern occurrence that had been observed in mix-breed cats, Persian,

American Shorthair, including pure breed cats and mutation of MYBPC3 in Maine coon and Ragdoll cats that eventually pass to next generation due to its genetic basis (Meurs *et al.*, 2008; Abbott, 2010; Côté *et al.*, 2011). In this study, we noted three families of cats from different household to have occurrences of familial pattern of HCM.

Gender versus the three main types of cardiomyopathies; HCM, DCM and RCM revealed that male cat were often presented for HCM and DCM whereas RCM is commonly seen in female cat. For HCM, 60% (*n*=39/65) were male and 40% (*n*=26/65) were female cats. Similarly pattern was seen in DCM where male cats were commonly presented compared to female at 62% (*n*=15/24) and 38% (*n*=9/24), respectively. However for RCM, female (67%, *n*=14/21) were often presented with the disease compared to male cats (33%, *n*=7/21). However, Ferasin *et al*. (2003) claimed that the prevalence of heart disease in feline patient appears more frequently observed in females than males for both, RCM (73%, *n*=16/22) that similarly seen in this study but not for DCM (73%, *n*=8/11). HCM also shows similarity to the Ferasin *et al.* (2003) study whereby males (64%, *n*=39/61) had a higher prevalence compared to female cats (36%, *n*=22/61). The mean age of HCM, DCM and RCM of feline heart disease patients were 5.8 years old (age range, 3-month-old to 20-year-old), 5.4 years old (age range, 4-month-old to 17-year-old) and 4.8 years old (age range, 4-month-old to 12-year-old), correspondingly.

Staging of feline heart disease is important as it helps with clinical judgement, determination of long term treatment and prognosis evaluation for each case. In this study, the NYHA Classification that was adapted for human heart disease patient was used. Here, we depend on the observation of clinical signs by their owner and/or veterinarian as noted in the file and further staged the based on the NYHA Classification (refer Appendix 2). Most of the feline heart disease patients were staged as NYHA Class III (n=67) and these cats were presented with severe clinical signs such as dyspnoea, tachypnoea, and exercise intolerance. Therefore, it can be concluded that often cats with heart disease were presented at the chronic stage of heart disease. Cats are good at "masking" the heart condition probably because they are sedentary in nature (Paige *et al.*, 2009). In this study, we found the asymptomatic as an incidental finding upon annual heart check-up and during pre-anaesthetic screening.

Radiography is an insensitive diagnostic tool to diagnose heart disease but it is an important screening tool to sum up the VHS and lung field evaluation for pulmonary oedema and pleural effusion (Côté *et al.*, 2011). Nineteen feline heart disease patient diagnosed with HCM had a normal VHS. This is because in early HCM development, the cat's VHS would remain within normal range due to no significant chambers enlargement (Ferasin, 2012). However, only echocardiography could provide an accurate evaluation on heart structural and functional especially by determining the thickness of LVFW and/or IVS at diastole accurately (Côté *et al.*, 2011). One hundred and one feline heart patients

with the radiological diagnosis of cardiomegaly (VHS ≥8) had a definitive diagnosis of the heart disease. However, four (3 HCM; 1 DCM) out of the 101 feline heart disease patient were apparently healthy cats (NYHA Class I) as these cats did not showed any clinical signs when thou the echocardiographic measurement obtained were abnormal. Ferasin *et al.* (2003) and Paige *et al.* (2009), reported in their study that 3% (*n*=3/106) and 15% (*n*=15/103), respectively, of cats with HCM were appeared healthy.

CHAPTER 6.0

CONCLUSION AND RECOMMENDATIONS

The prevalence of pet cats with heart disease presented to UVH-UPM was 1% (*n*=155/15,493) with mean age of 5.2 years old (age range, 2 month-old to 20-year-old) predominantly in male cats and frequently seen DSH and Persian cats with common clinical signs of dyspnoea, tachypnoea and exercise intolerance. Meanwhile for diagnostic tools for feline heart disease, radiography is crucial but it is insensitive due to its incapability to evaluate the heart structural and functional changes. However, from radiography the pathological lung changes can be evaluated such as cardiogenic pulmonary oedema and pleural effusion that strongly associated with congestive heart failure. The echocardiography remains the most important diagnostic tool to diagnose feline heart disease due to its non-invasive characteristic. On top of that, annual heart screening is recommended and it is important because early sign of heart disease in cats can be detected, especially those feline heart disease patients that were asymptomatic and cats diagnosed with greyzone HCM.

As my recommendation, I would like to suggest that a systematic and a more detailed management of records keeping of the patient data base are crucial. This practice

would help in the conduct of future retrospective study to be efficient and retrieving patients' medical records could be done swiftly. Feline heart disease patient were often diagnosed with HCM, therefore, future studies such as survival analysis, risk factor analysis, and treatment efficacy for cats diagnosed with HCM is warranted.

CHAPTER 7.0

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CHAPTER 8.0

APPENDIX I

Heart Murmur Grading System adapted from Feline Cardiology Book (Côté *et al,*. 2011)

GRADES	DESCRIPTION
Grade I	Very soft murmur that is not immediately audible but can be heard only after careful auscultation in a quiet environment.
Grade II	Soft murmur that is audible with careful auscultation.
Grade III	Moderate murmur immediately audible with auscultation.
Grade IV	Loud murmur without a thrill.
Grade V	Loud murmur with a palpable thrill.
Grade VI	Audible murmur with stethoscope held slightly off chest wall.

APPENDIX II

The New York Heart Association (NYHA) classification of heart failure in humans was adapted to stage feline heart disease patient as follows (Atkins *et al.,* 2009):

STAGES		
Asymptomatic	Class I	Cat patient with asymptomatic heart disease in which heart disease is present, but no clinical signs are evident even with exercise.
Symptomatic	Class II	Cat patient with heart disease that causes clinical signs only during strenuous exercise.
	Class III	Cat patient with heart disease that causes clinical signs with routine daily activities or mild exercise.
	Class IV	Cat patient with heart disease that causes severe clinical signs even at rest.