The 2018-2019 Rainbow Bridge Survey Report

Sara D. Dellorto, Dr. Adam King, DVM, Dr. Rafe H. Schindler,

Representing

The Health Committee[1] of
The Havanese Club of America, Inc.

KEYWORDS
Havanese, Bichon Havanese, Longevity, Mortality, Canine Lifespan, Lifestyle, Spay, Neuter

EXECUTIVE SUMMARY

We present herein the results of the 2018-2019 Rainbow Bridge Survey, the follow-on to the 2017 Longevity Survey which measured the lifespan and survival rates of Havanese from a sample of 156 males and females. In combination with the age distribution of a sample of 512 living Havanese, the 2017 Survey presented the first evidence that the lifetime distribution of both males and females was consistent with being bimodal, having a small component (approximately 20%) of the male and female population with a significantly shorter lifespan (peaking around 9 to 10 years of age) than the balance (peaking at ~13 years).[2]

The Rainbow Bridge Survey was conducted to attempt to uncover the origin of this bimodal distribution, by exploring the specific causes of death as a function of age from a second sample of 156 Havanese. As the samples used in both Surveys were provided anonymously, there may be some overlap in the populations. This however will not impact the results, as the second survey addresses a different set of questions. At each step of the process, we have attempted to reduce bias, but it is important to keep in mind that with the low statistics, there is no method we can apply to test how well the survey population reflects the population at large.

The 156 dogs in the survey represented 87 distinct owners and/or responders of which 35 were HCA members and 31 were past or current breeders. Almost all (91%) of the Havanese in the survey were registered with the AKC. There were 118 dogs with a spay or neuter age reported and another 32 which were spayed or neutered but did not report a known age. Of the dogs with a spay/neuter age reported, about ½ the males, and 1/3 of the females were neutered / spayed respectively after age 2 years, again suggesting that a modest proportion of dogs in the

[1] The 2018/2019 HCA Health Committee: Chair: Dr. Rafe H. Schindler. Members: Mary Cane, Sara Dellorto, Natasha Ghearing, Kim Gillette, Dr. Adam King, Kathleen King, Lucy Lancaster and Joan Little

[2] A consequence of this, is that once you passed this early threshold, the average lifespan increased. A dog for example that survived to 12 years of age would have an average lifetime of 15 years.

survey were being used in breeding programs (and thus consistent with the makeup of the pool of responders).

The new survey yields male and female average lifetimes consistent with but slightly shorter than those reported in the Longevity Survey. The average lifetime for 156 males and females is 12.0+/-0.3 years. Individually, the 84 females and 72 males have average lifetimes of 12.1+/-0.5 and 11.9+/-0.4 years, respectively. The systematic error on average lifetimes is estimated to be an additional +/-0.3 years, similar to the Longevity Survey. These lifetimes are well below what we describe as the "natural lifespan" of Havanese, ~15.1 years, as discussed in the final section of the report.

The new survey confirms the observation that the lifetime distribution is not a simple Gaussian one, but has significant contributions from two (or more) health issues which contribute to death earlier than the natural lifespan. These skew the lifetime distribution downward, as was seen in the Longevity Survey.

As a percent of the total survey population, the two most prominent issues identified, and which result in these earlier mortalities are cancers (26+/-4%) and cardiovascular diseases (27+/-4%). The most frequently reported cardiovascular conditions are known to appear first in midlife and subsequently lead to death – often via congestive heart failure. There is however no dominant form of cancer that can be identified here as a primary cause of death, but the most frequent types reported are: Liver/Spleen, followed by B- or T-cell Lymphoma, and finally Leukemia. Cancers occur more frequently in the male population (37.5+/-8.5%) compared to females (17.9+/-5.0%) while cardiovascular diseases overall are more prevalent in the female population (35.7+/-7.6%) compared to the males (22.2+/-6.1).[3] The latter difference between males and females for all cancer related deaths[4] has a statistical significance of ~2.78 standard deviations (or a 1 in 386 chance of being a fluctuation). The statistical difference for cardiovascular related death rates (see footnote 4) between males and females is ~2.84 standard deviations (or 1 chance in 476 of being a fluctuation).

For males and females, the mean age at death from primary cancer is 10.3+/-0.5 years (well below the overall mean lifetime). From primary cardiovascular causes it is 12.4 +/- 0.4 years, close to the mean lifetime of the full survey population but well below the ages that long-lived dogs survive to. While the rate of occurrence is different for males and females, there is no statistically significant difference in the lifetimes between males and females, in either of these disease categories.

The next smaller contributor to early mortality appears to be non-cancerous diseases of the liver. They occur at a significantly lower frequency (5.8+/-1.9%) in the total population and with no statistically significant difference between sexes. They result in an average age at death of 6.9+/-1.1 years. Somewhat surprisingly, these are reported primarily as chronic liver disease

[3] Only the most prevalent conditions reported occur at a somewhat closer to equal rate in males and females.
[4] Here the small additional number of secondary and tertiary cancer and cardiovascular occurrences are included.

and Hepatitis as opposed to Microvascular Disease (MVD) or Portosystemic Vascular Disease (PSVD). About an equal number of cases of liver cancer (reported in the Cancers category) were also observed but resulting in death at a much later average age of 9 ½ to 10 ½ years.

Examining the longer-lived end of the mortality curve, 9.6 % of the total survey population died naturally of an unknown (undiagnosed) cause with an average lifetime of 14.7+/-0.4 years. A small fraction of all dogs (8.3%) were euthanized for quality of life issues (without any underlying diagnosis being reported). Their average age was 15.3+/-0.3. In both these cases there were almost an equal number of males and females in the sample.[5]

Kidney disease/failure stands out as a leading component of mortality in the older dogs. As a primary cause it occurs in 9.6+/-2.5% of the survey population and leads to death at about 14.2 +/-0.9 years. It appears as a primary, secondary or tertiary cause in an almost equal number of males and females.

The final large category is neurological causes. When reported as the primary cause of death it appears in about 5.8+/-2.0% of the survey population. While spread out widely in age there is some suggestion of possible enhancements at younger and older ages which depend on the detailed cause (e.g.: dementia). The overall average age at death however is 10.8+/-1.6 years. The frequency is statistically similar for males and females. They appear as well as secondary and tertiary causes.

All other primary categories combined, make up a small percentage of the total survey population (7.7%) and tend to be widely spread out in the age of their impact. They will be discussed separately in the balance of the text.

The survey also examined health correlations with factors such as the age at neuter/spay and lifestyle. While no statistically discernible differences in lifespan nor cause of death was observed with spay/neuter age, there is evidence that dogs in rural environments (versus urban and suburban) have longer average lifetimes. The latter observation requires confirmation by a separate study with both higher statistics and more precise definitions of lifestyles.

Finally, the survey attempted to define *the natural lifespan of Havanese* based on data from three of the primary categories. We found a value of 15.1+/-0.4 years based on 41 dogs in the survey sample.

The dissemination of this report has been approved by the Board of Directors of the Havanese Club of America, Inc.

[5] Euthanization is listed in the survey as a secondary cause of death, when the primary cause is known.

TABLE OF CONTENTS

1. Introduction

The 2018-2019 Rainbow Bridge Survey is the follow-on survey to the 2017 Longevity Survey. Approved by the Board of Directors of the HCA in 2018, the first survey forms were distributed to the membership at the 2018 National Specialty and subsequently solicited from the membership and other Havanese owners using our mailing lists as well as many of the regional and local club lists and Havanese Rescue Inc. We also solicited various Havanese groups on social media as well. Appendix B has the survey as it was distributed. In early 2019 we added a second part to the survey to address ongoing health issues in living dogs. That data will be separately reported at a later time. The full report of the earlier 2017 Longevity Survey can be found at the following link:

https://www.havanese.org/images/Report_on_the_Results_of_The_2017_Longevity_Survey.pdf

Table I. 2017 Longevity Survey Statistics

Sex	Number Reported	Average Lifetime (years)	Error on Average (years)	RMS Width of Distribution (years)
Male	59	12.9	0.5	3.6
Female	97	13.0	0.3	3.3
Male+Female	156	13.0	0.3	3.4

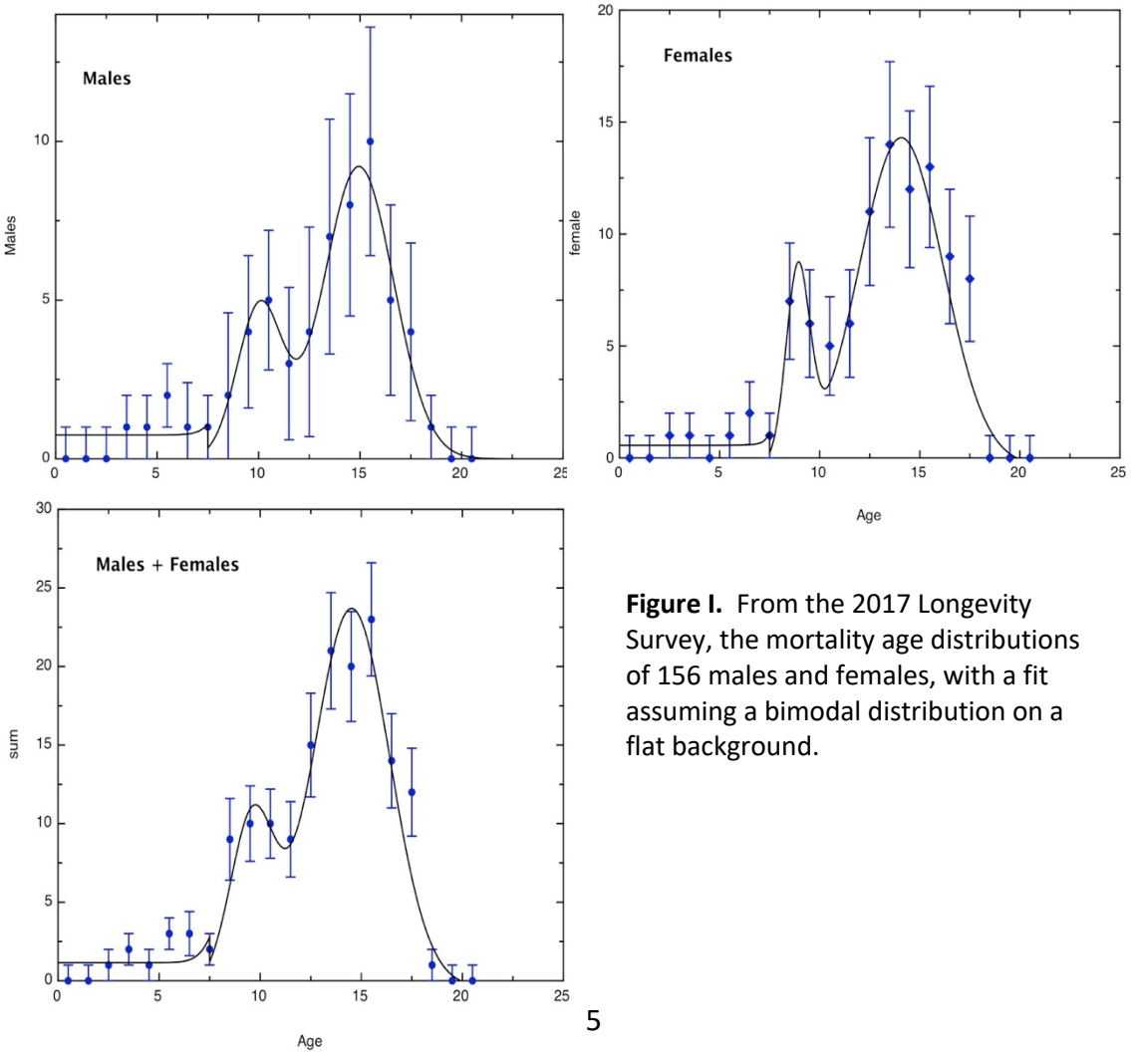


Figure I. From the 2017 Longevity Survey, the mortality age distributions of 156 males and females, with a fit assuming a bimodal distribution on a flat background.

The 2017 survey measured the lifespan and survival rates of Havanese from a sample of 156 deceased males and females. In combination with the distribution of a sample of 512 living Havanese, the Survey presented evidence that the mortality distribution was consistent with being bimodal, having a small component (~19%) of the population with a significantly shorter lifespan than the balance. Table I shows the summary data from the Longevity Survey for the average lifetimes of males and females. An average lifetime of 13 years was observed overall.

Figure 1 a, b, and c shows the fit (presented in the 2017 report) to the raw lifetime data assuming a flat uniform background below 7.5 years and two possible peaks. About 19% of the sample occupies the lower peak with a mean of 9.6+/- 0.3 years. The second larger peak contains 73% of the sample and has a mean of 14.5+/-0.2 years. The flat background below 7.5 years has the remaining 8% of the population.

The very simple model used in the Longevity Survey addresses the dominant structure in the data, given the small statistics available. As we will see from the Rainbow Bridge Survey, this model is indeed over-simplified. The motivation of the Rainbow Bridge survey is to attempt to understand in more detail the underlying structure seen in Figure 1 by determining whether there are specific causes of death as a function of age which can explain the observed structure.

2. Rainbow Bridge Survey Statistics

History: The collection of the data for the new survey began in August 2018 and ended in December 2019. As we had not yet started to analyze the sample, we were able to add two additional dogs to the survey after the formal close in 2019, as well as some additional underlying health data provided subsequently on several previously entered dogs.

Affiliation: Table II shows the affiliation of the responders. There are 87 distinct survey responders for the 156 total dogs in the survey. About 53% of the responders are HCA or other breed club members while about 40% are owners not involved in the "dog world." Only about 1/3 of the responders (36%) are currently or had previously been Havanese breeders.

Table II. Affiliation of Survey Responders

87	Distinct Owners or Reporters	
35	HCA Members	40.2 %
31	Past or Current Breeders	35.6 %
35	Owners Without A Club Affiliation	40.2 %
46	HCA or Another Breed Club Member	52.9 %

AKC Registration: Table III shows the breakdown of the dogs entered by sex and registration. Of the roughly 2 dogs per responder, the number of females is slightly larger (54%) than the number of males (46%). A larger disparity existed in the Longevity Survey where almost 2/3 of the dogs were female. The registered dogs make up 91% of the total, suggesting that we likely have a very pure sample of Havanese.

Table III. Dog Survey Statistics and the Registration Data

156	Total Dogs	
72	Total Males	46.2 % of Total
84	Total Females	53.8 % of Total
142	Registered Dogs	91.0 % of Total
66	Registered Males	46.5 % of Registered
76	Registered Females	53.5 % of Registered

Spay-Neuter: The survey asked about spay or neuter of each dog. There were 118 dogs with a spay or neuter age reported and another 32 spayed or neutered but without an associated age reported, some of these being "rescue dogs" or dogs obtained as adults. Only 6 of the dogs are reported as not spayed or neutered. The spay – neuter statistics are summarized in Table IV. Figure II and Figure III show the actual age distributions for this population. Table IV also provides the average age at death of the non-spay or non-neutered sample. See Section 8 for more details.

Table IV. Neuter and Spay Statistics

Sex	Males	Females
Number Reported	54	64
Average Age at Spay/Neuter (years)	2.9	2.7
Statistical Error on Spay Neuter Age (years)	+/- 0.4	+/- 0.4
Standard Deviation of Spay Neuter Age Distribution (years)	3.2	2.9
Fraction Neutered or Spayed Before 2 Years	54 %	63%
Average Age at Death of 54 Neutered & 64 Spayed	12.0+/-0.4	12.0+/-0.4
Average Age at Death of Un-Neutered (4)/Spayed (2)	11.3 years	7.5 years

Lifestyle: Finally, the survey asked about lifestyle. Breaking the dogs down into large categories as reported we found the following numbers in Table V. Of the 156 dogs in the survey, 123 were classified based on the descriptions provided by the responder. See Section 9 for more details.

Table V. Lifestyle Reported (123 Known)

Lifestyle	Males	Females
Rural	12	12
Suburban	40	43
Urban	8	8
Unknown	12	21

3. Rainbow Bridge Survey – Classification of the Causes of Mortality

The Survey Health Questions: The survey asked respondents (see Appendix B) to provide information on the sex, age at death, the cause of death, how the cause was diagnosed, and any further factors or information they could provide. The latter often included details of the health

issues and the veterinary analysis leading up to the death. In general, the responders were very forthcoming in providing detailed information in their initial response to the survey.

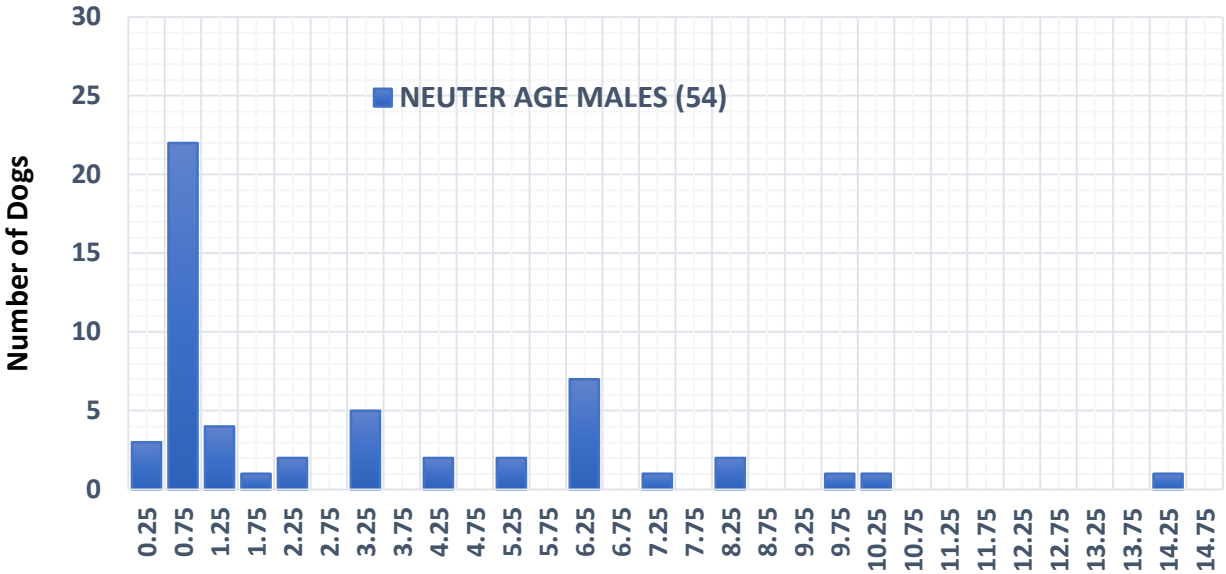


Figure II. Age at Neuter for Males (Years)

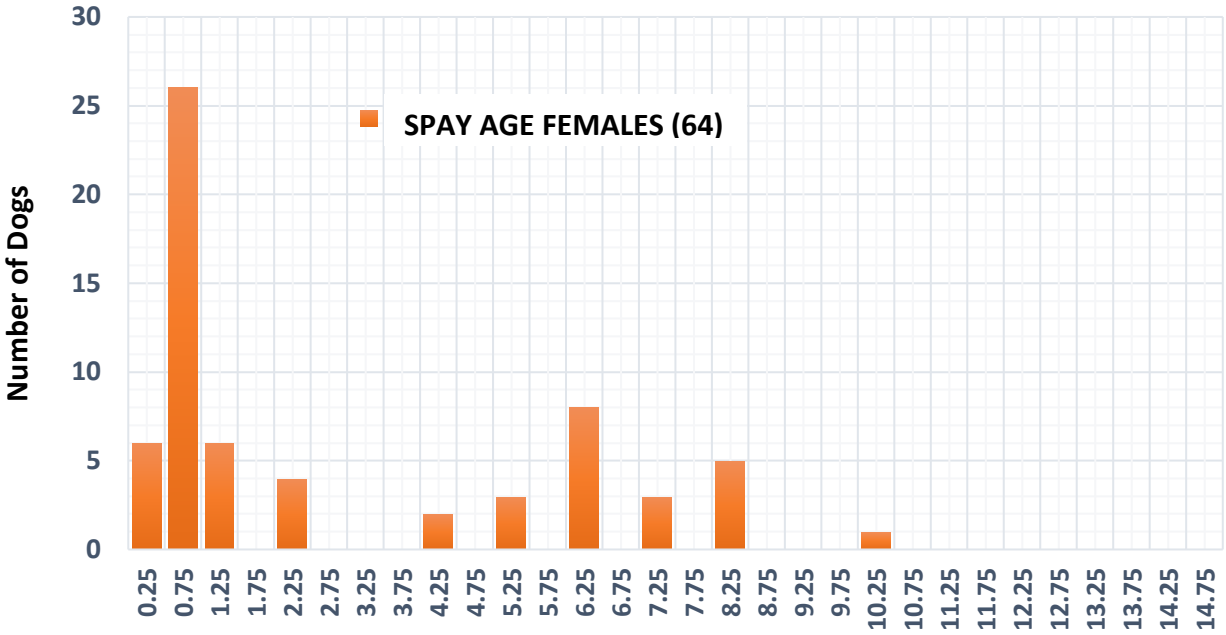


Figure III. Age at Spay for Females (Years)

Methodology for Assigning the Primary Cause of Death: The information provided to us was initially compiled into a spreadsheet from which the main or primary categories that would be used were established. Appendix A shows the table that was created based on all the reported information. There are 13 primary categories, including "Miscellaneous." Each has distinct subcategories (see the details in Appendix A) to match the information reported by the survey

responders. There are 67 distinct subcategories being employed.[6] For quick reference, Table VI lists the thirteen primary categories.

Table VI. Primary Categories

Category #	Health Category
1.0	UNKNOWN
2.0	EUTHANIZED
3.0	CANCER
4.0	CARDIOVASCULAR
5.0	KIDNEY
6.0	LIVER
7.0	URINARY
8.0	ENDOCRINE
9.0	INTESTINAL
10.0	NEUROLOGICAL
11.0	ORTHOPEDIC
12.0	MISCELLANEOUS
13.0	DERMATOLOGICAL

Each dog in the survey was next assigned a primary cause of death based on the reported information. Each dog could additionally have a secondary and/or tertiary cause recorded if significant.

The assignment of the primary, secondary and tertiary causes for all 156 dogs were first done by one of the authors, and then independently by a second author. The results of the two sets of assignments were then compared. Where discrepancies existed, the material provided by the responder was discussed and reconciled in a consistent fashion. In a few cases it was necessary to resolve ambiguities by follow-up email exchanges with the survey responders.

The first two major categories are unique, and it is very important to understand how these first two categories, are used as we have chosen to report the data in a way that conveys the most information available.

The first category 1.0, "**UNKNOWN**" means that the dog died undiagnosed, and without a cause being reported. In many cases these are "died in sleep with unknown pre-existing condition(s)." The next major category, 2.0, "**EUTHANIZATION**" has three subcategories being used. The first two (2.3 and 2.4) are simply that the dog was euthanized for old-age and/or poor "quality of life." They are distinguished only if "pain" is also reported as a component of the decision to euthanize. In these cases, the underlying cause(s) is undiagnosed and unreported.

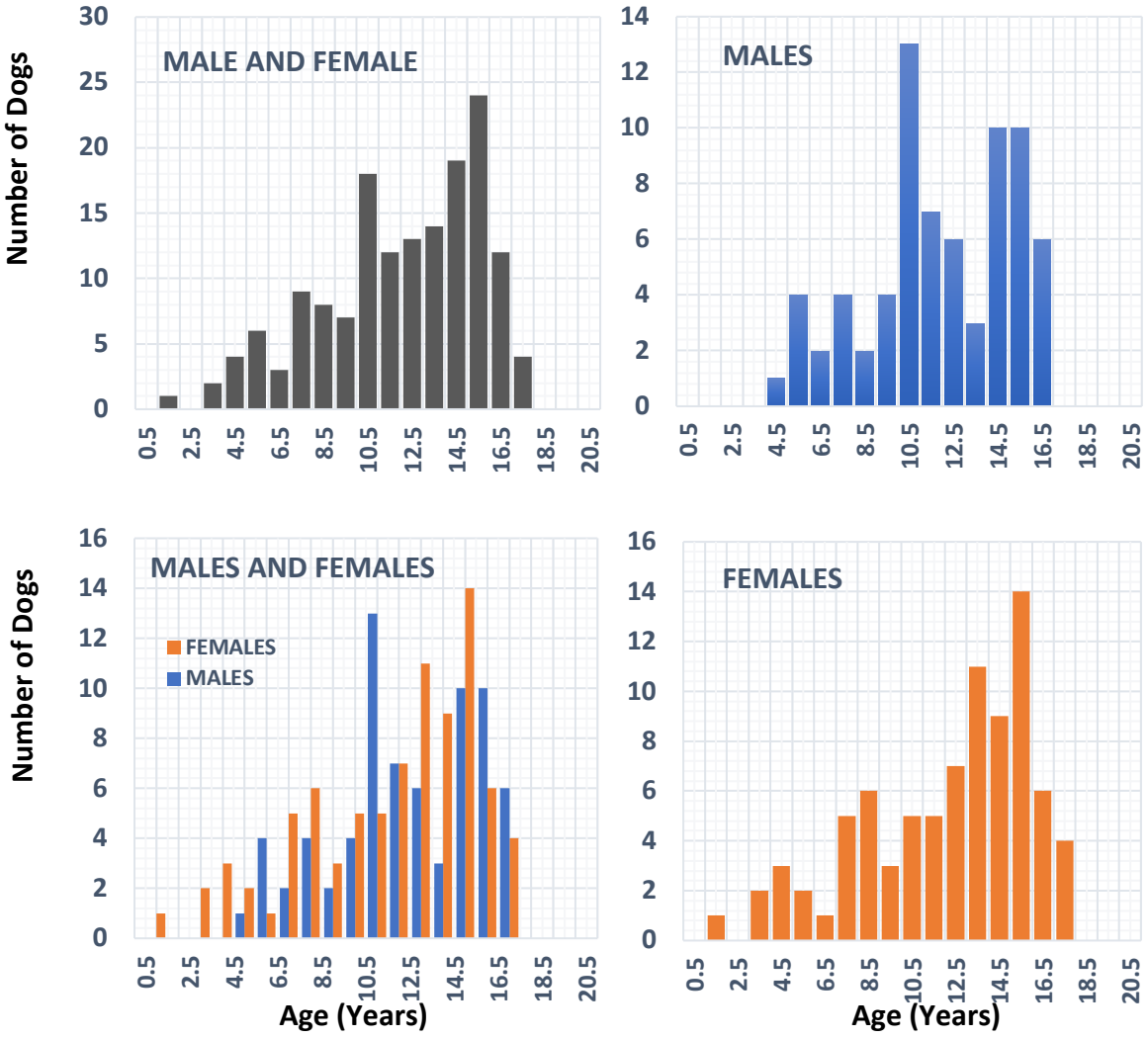
[6] Note that some of these categories are used only in the second part of the survey for ongoing health issues and will have no entries in the first part of the survey. Some sub-category numbers are unused for technical or accounting reasons.

The third subcategory (2.5) under **EUTHANIZATION** is: Euthanized - Underlying Cause is Known. Since the primary cause of death is known, this subcategory will only appear as a secondary cause of death. The reported reason for euthanization will appear as a primary cause (one of the remaining categories or subcategories), and any additional complications may appear as tertiary causes.

All other health issues / diseases in the table in Appendix A, will appear as primary, secondary or tertiary causes. Because the statistics are generally poor as the causes are broken down, the main inclusive categories are examined first in this report.

4. Age Distribution at Death

The first distributions to examine are the overall reported age distribution at death of the full sample (independent of the cause of death). Figures IV a, b, c, and d show the age distributions at death of males and females combined, individual males and females, and side by side:



Figures IV: The age distributions at death of **a)** males and females combined, **b)** individual males, **c)** individual females, and **d)** males and females, side by side.

These distributions are not unlike those shown in Figure I. The age distribution is skewed with a main peak ~ 15 years of age, but a significant number of early deaths that create a large lower shoulder on the total distribution. While the structure seems more prominent in the male distribution, and distinct peaks are suggestive, the statistics here are too low to claim that is the case. As will be shown, the underlying causes will offer more insight into the age structure.

From these distributions the average ages at death are obtained, and summarized in Table VII:

Table VII: Age at Death of Males and Females

Sex	Male and Female	Males	Females
Number Reported	156	72	84
Average Age at Death (years)	12.0	11.9	12.1
Statistical Error on Age at Death (years)	0.3	0.4	0.5
Standard Deviation of Distribution (years)	3.6	3.7	4.2

The systematic error on average lifetimes is estimated to be an additional +/-0.3 years, similar to the Longevity Survey. These numbers are lower than, but not inconsistent with the average lifetimes obtained in the Longevity Survey. Keep in mind that the male-to-female ratios are different, and looking at the distributions, there are somewhat fewer very long-lived dogs in this survey and somewhat more younger dogs being reported. Both contribute to the shift in the mean age of death. It is important to keep in mind that the populations of the two surveys may also have overlap and hence can neither be combined nor averaged together.

5. Underlying Causes of Death

Thus far we have averaged over all causes of mortality. The new feature of this survey is to add the cause of death as an additional variable. First let us summarize the data that has been obtained and classified.

Figures V a, b, c shows the primary causes of death for the 156 males and females, as well the 72 males and the 84 females, separately. As a reminder, when EUTHANIZED appears as a primary cause of death, it means that the dog had poor quality of life but was otherwise undiagnosed.

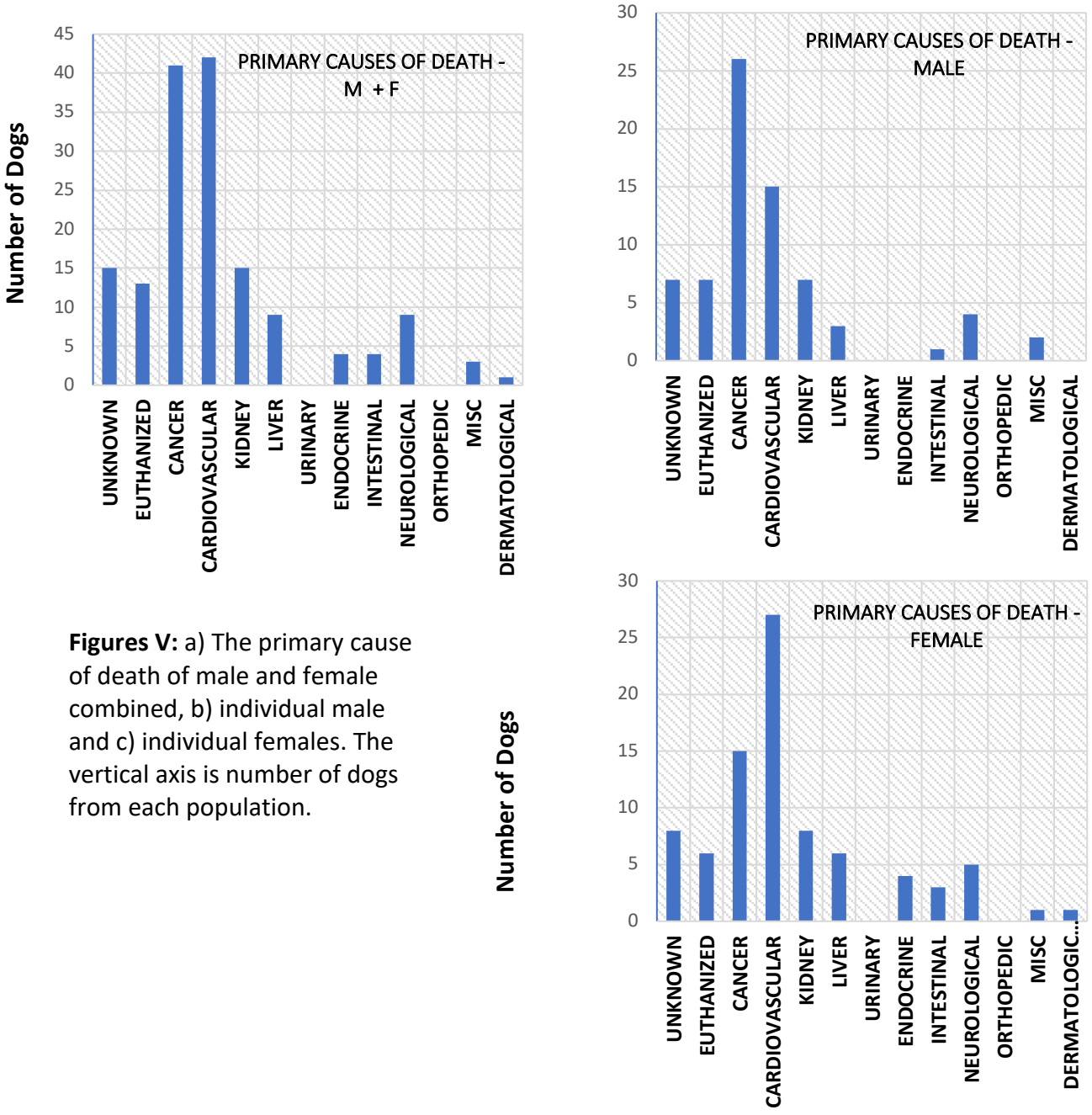
In Figure VI a, b, c these plots have been repeated, but now normalized to represent the primary cause of death as a percentage of the male and female, male, and female populations in the survey.

Finally, in Figure VII a, b, c the plots show the secondary and tertiary contributions as well as the previously shown primary causes, by numbers of dogs. We have not provided the plots in percentages – but they are available in subsequent tables. It is important to note that dogs in some primary categories (CANCER, CARDIOVASCULAR) may also have a secondary or tertiary cause of death in the same category, and thus some plots may show the same dog twice.

Table VIII summarizes the numbers of dogs in each category, while Table IX has the corresponding percentages listed for those categories. *All errors are statistical only in these tables.*

5.1. Discussion of Primary Causes

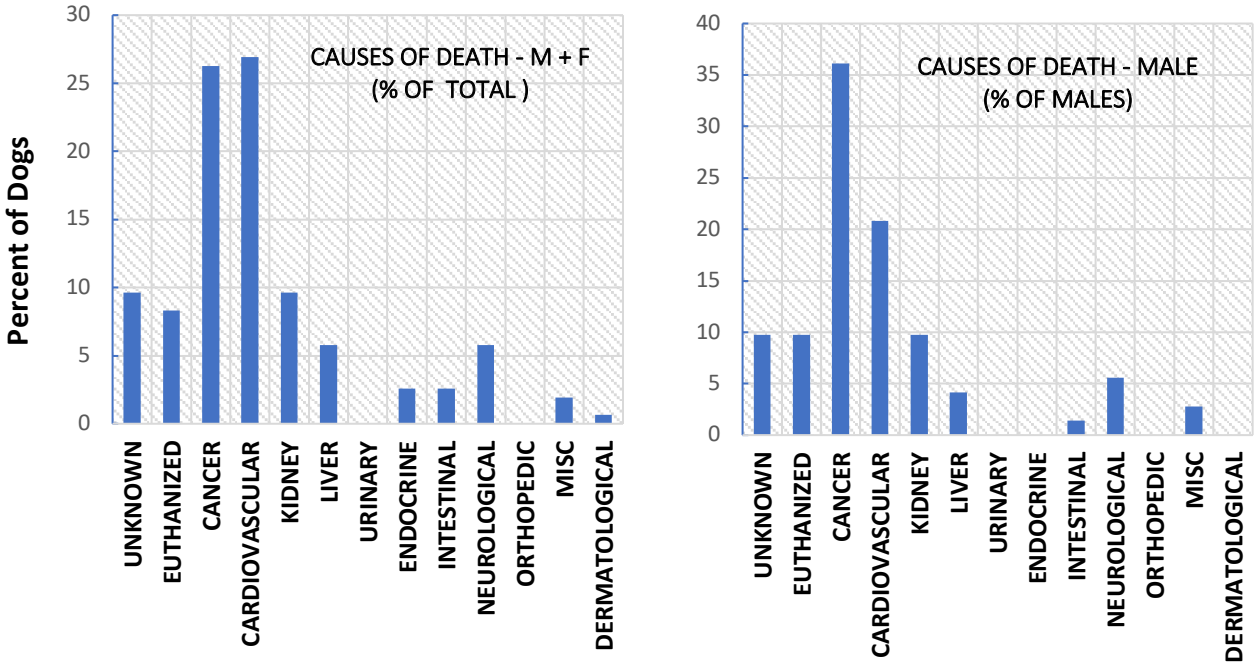
One can immediately see from Figures V and VI and the corresponding Table VIII that the leading primary causes of death in Havanese is a combination of cancer and cardiovascular



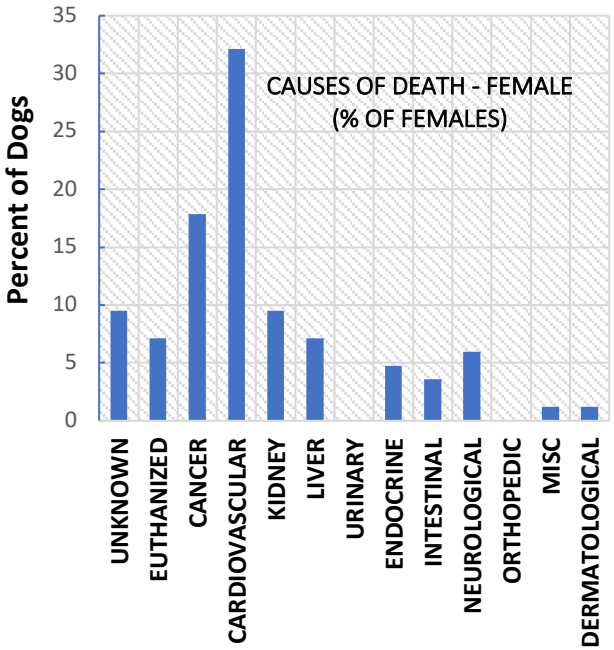
Figures V: a) The primary cause of death of male and female combined, b) individual male and c) individual females. The vertical axis is number of dogs from each population.

diseases. Combined, the two account for 53.2+/-7.2% of the deaths (26.3+/- 4.6% and 26.9+/- 4.7% respectively), the errors being statistical.

The other observation one can make from the data are the differences in occurrence for males and for females, for each of these two causes. Males appear to have a larger fraction of deaths from cancer (36.1+/-8.3%) than females (17.9+/-5.0%) while females have a larger fraction of deaths of cardiovascular origin (32.1+/-7.1 %) than males (20.8 +/- 5.9%).



Figures VI: a) The primary cause of death of males and females combined, b) individual males and c) individual females. The vertical axis is the % of dogs from each population.



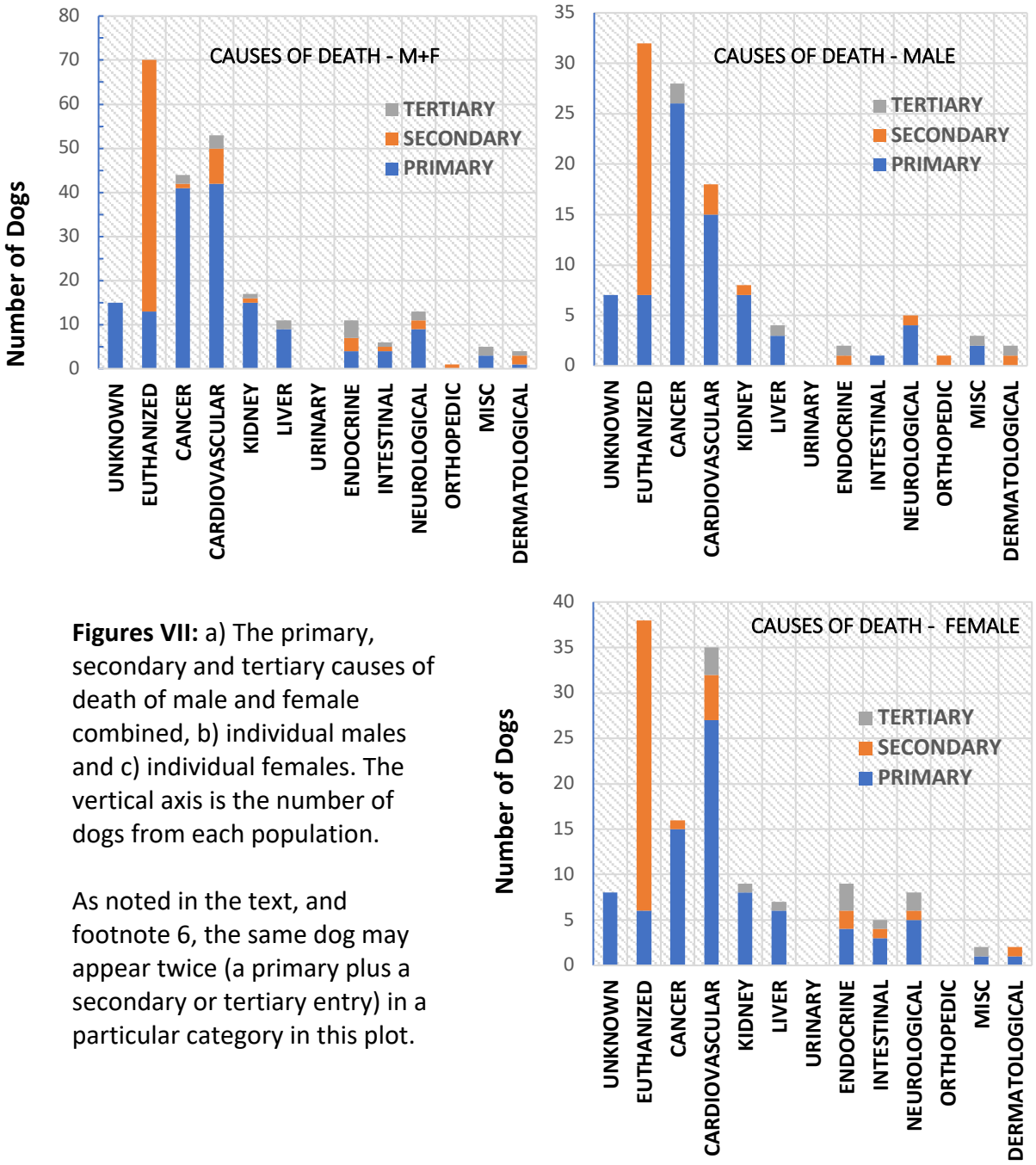
After cancer and cardiovascular disease, we see approximately equal contributions ranging from 5% to 10% for males and females overall from the five other primary categories: UNKNOWN, EUTHANIZED, KIDNEY, LIVER and NEUROLOGICAL. As will be shown in the next section, all these categories have distinct age correlations.

Table VIII. Number of Entries in Each Primary, Secondary (2nd) and Tertiary (3rd) Category

	MALE + FEMALE			MALE			FEMALE		
DISEASE CATEGORY	**Primary (1st)**	**2nd**	**3rd**	**Primary (1st)**	**2nd**	**3rd**	**Primary (1st)**	**2nd**	**3rd**
UNKNOWN	15			7			8		
EUTHANIZED	13	57		7	25		6	32	
CANCER	41	1	2	26		2	15	1	
CARDIOVASCULAR	42	8	3	15	3		27	5	3
KIDNEY	15	1	1	7	1		8		1
LIVER	9		2	3		1	6		1
URINARY									
ENDOCRINE	4	3	4		1	1	4	2	3
INTESTINAL	4	1	1	1			3	1	1
NEUROLOGICAL	9	2	2	4	1		5	1	2
ORTHOPEDIC		1			1				
MISC	3		2	2		1	1		1
DERMATOLOGICAL	1	2	1	0	1	1	1	1	
TOTALS	**156**	**76**	**18**	**72**	**33**	**6**	**84**	**43**	**12**

Table IX. Percentage Assigned to Each Primary, Secondary (2nd) and Tertiary (3rd) Category

	MALE + FEMALE			MALE			FEMALE		
DISEASE CATEGORY	**Primary (1st)**	**2nd**	**3rd**	**Primary (1st)**	**2nd**	**3rd**	**Primary (1st)**	**2nd**	**3rd**
UNKNOWN	9.6			9.7			9.5		
EUTHANIZED	8.3	75.0		9.7	75.8		7.1	74.4	
CANCER	26.3	1.3	11.1	36.1		33.3	17.9	2.3	
CARDIOVASCULAR	26.9	10.5	16.7	20.8	9.1		32.1	11.6	25.0
KIDNEY	9.6	1.3	5.6	9.7	3.0		9.5		8.3
LIVER	5.8		11.1	4.2		16.7	7.1		8.3
URINARY									
ENDOCRINE	2.6	3.9	22.2	0.0	3.0	16.7	4.8	4.7	25.0
INTESTINAL	2.6	1.3	5.6	1.4			3.6	2.3	8.3
NEUROLOGICAL	5.8	2.6	11.1	5.6	3.0		6.0	2.3	16.7
ORTHOPEDIC	0.0	1.3			3.0				
MISC	1.9		11.1	2.8		16.7	1.2		8.3
DERMATOLOGICAL	0.6	2.6	5.6		3.0	16.7	1.2	2.3	0.0
TOTALS (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**



Figures VII: a) The primary, secondary and tertiary causes of death of male and female combined, b) individual males and c) individual females. The vertical axis is the number of dogs from each population.

As noted in the text, and footnote 6, the same dog may appear twice (a primary plus a secondary or tertiary entry) in a particular category in this plot.

5.2. Discussion of Secondary and Tertiary Causes

Figures VII a, b, and c and Table VIII and Table IX contain all the data on secondary and tertiary assignments. In the bar graphs of Figure VII, the orange bars show the secondary and the grey bars show the tertiary assignments on top of the blue primary ones. We immediately observe that in the scheme that we have adopted, the major secondary category is EUTHANIZED where a primary cause has been reported – and leading to the euthanization.

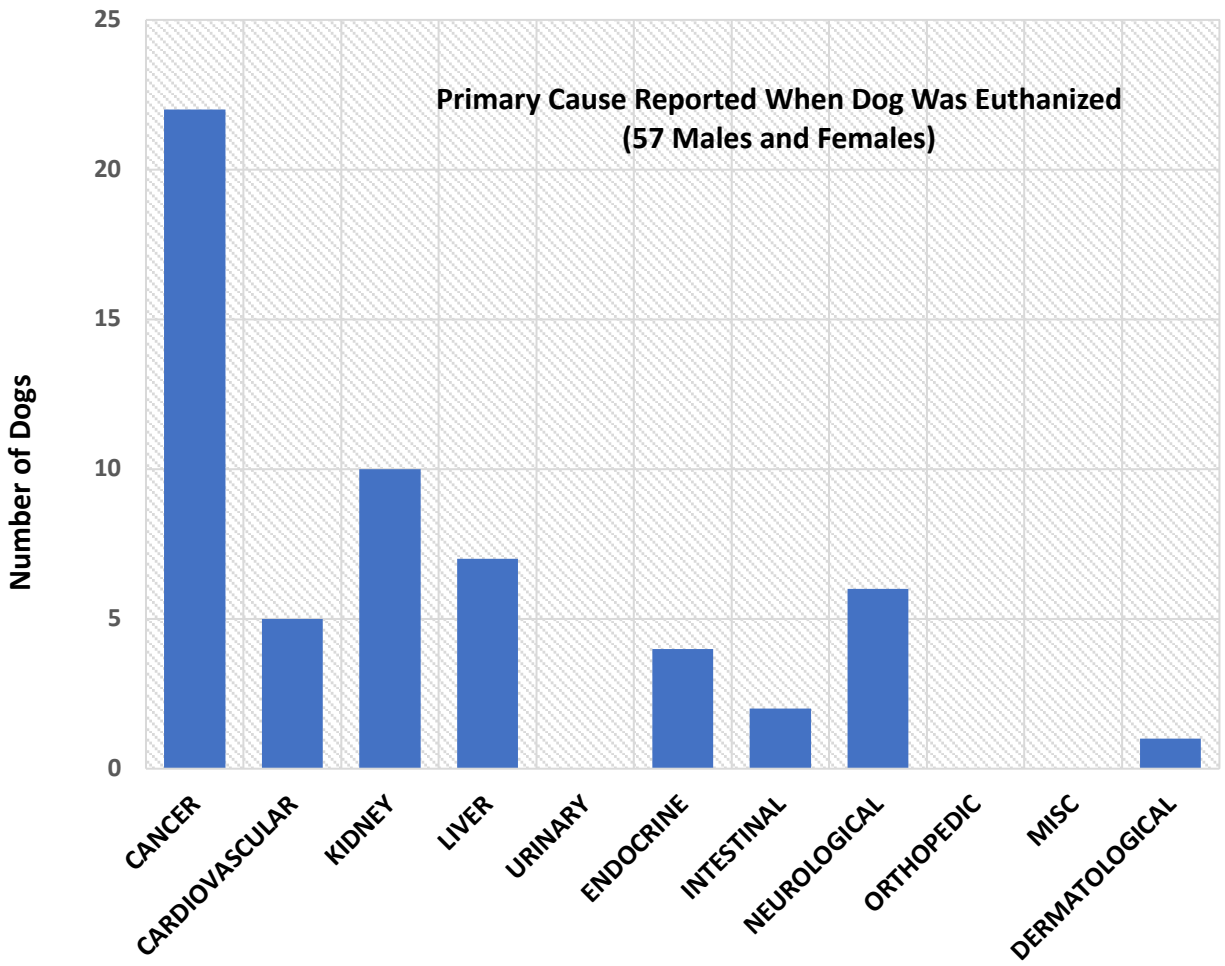


Figure VIII: Primary cause of death (horizontal axis) when the secondary cause is Euthanization (sub-category 2.5) for Known Cause. The number of dogs (male + female) in each category are accounted on the vertical axis.

That Euthanization for known cause category represents 57 dogs in total which account for about 37+/-6% of the total dogs in the entire survey. In detail, there are 35 males and 22 females in this category, which actually represent an approximately equal percentage (~75+/-13%) of their individual contributions – by sex - to secondary causes.

Figure VIII shows the precise breakdown of the primary diseases that were reported for each dog and which lead to euthanization by the owner. The plot shows all 57 dogs (male and female) in this category. The horizontal axis has the primary disease category leading to the euthanization, and the vertical axis has the number of dogs in each of those categories. The breakdowns by male and female counts are not distinguished here.

It is seen from this plot that the largest number of dogs (22) are euthanized due to various cancers (that amounts to about *one half* of all dogs with Cancer as a primary cause of death),

while cardiovascular disease – the other large contributor to primary causes of death – are rarely euthanized (5 total dogs).

Albeit the statistics are small (in a total of 94 secondary and tertiary entries), cardiovascular (~11%) and endocrine system (~7%) diseases represent the other two principle secondary and tertiary contributions to death in males and females.

Finally, since cancer and cardiovascular diseases are the largest primary contributors to death in Havanese, we can combine secondary and tertiary assignments of cancer and coronary disease, respectively, with the primary ones, to find that in the total population of 156 dogs (72 males and 84 females), 26.9+/-4.7% and 29.5+/-4.9% either die from, or are effected by cancer or coronary disease, respectively.[7] Table X summarizes these numbers and also breaks them down by sex. It is seen that adding these into the primary count does not change the observed disparity between males in females for these two underlying causes.

Table X. Percentage of Dogs That Succumb to, or are Affected by Cancer and Cardiovascular Diseases [Primary, Secondary and Tertiary causes combined]

Leading Diseases	Male and Female (156)	Males (72)	Females (84)
Cancer	42 (26.9+/-4.7 %)	27 (37.5+/-8.5 %)	15 (17.9+/-5.0 %)
Cardiovascular	46 (29.5+/-4.9 %)	16 (22.2+/-6.1 %)	30 (35.7+/-7.6 %)

6. The Correlation of Age with the Cause of Death

In this section we combine the information on the age at death discussed in Section 4, along with the assigned causes discussed in Section 5. The data can be displayed on a single scatter plot shown in Figure IX which contains the age at death on the horizontal axis with the primary cause of death on the vertical axis. There are 156 entries in Figure IX, one for each male and female in the survey. Figure X is similarly structured but contains those dogs with secondary and/or tertiary causes listed. In Section 7 we will look in more detail at each major category – projecting them individually onto the age axis, and including the breakdown of the category's entries by the finer subcategories enumerated in Appendix A.

The patterns exhibited in Figure IX are quite striking. The first six categories appear visually to have a very distinct age structure (clumping) while the other categories are more spread out (uniformly distributed) in age.

The first two primary categories (UNKNOWN and EUTHANASIA) reflect the presence of dogs in the survey that either died naturally of "old age" or were euthanized for poor "quality of life" at very old ages. Diagnosed kidney problems (KIDNEY) leading to death also appear to reside predominantly in this older group. The category for LIVER issues appears to be clumped as well, but in the young to middle age region around 5 years. *This is an important observation*.

[7] Here we have corrected for the number of dogs that would be double counted: 5 females and 2 males with both primary and secondary cardiovascular diseases, and 1 male with primary and tertiary cancers, and 1 female with primary and secondary cancers.

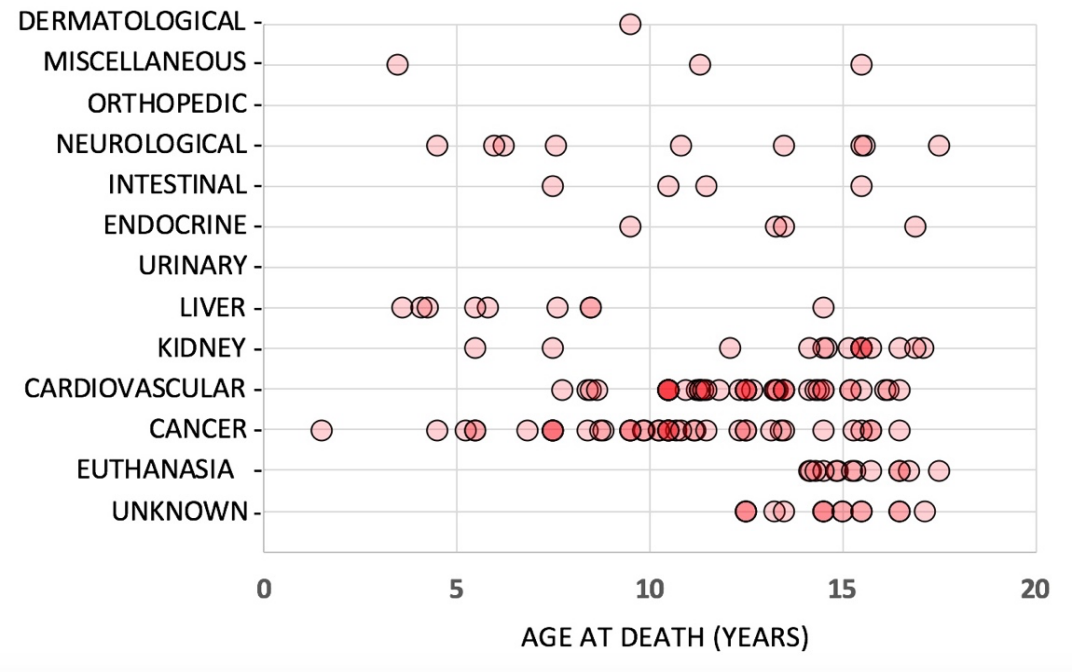
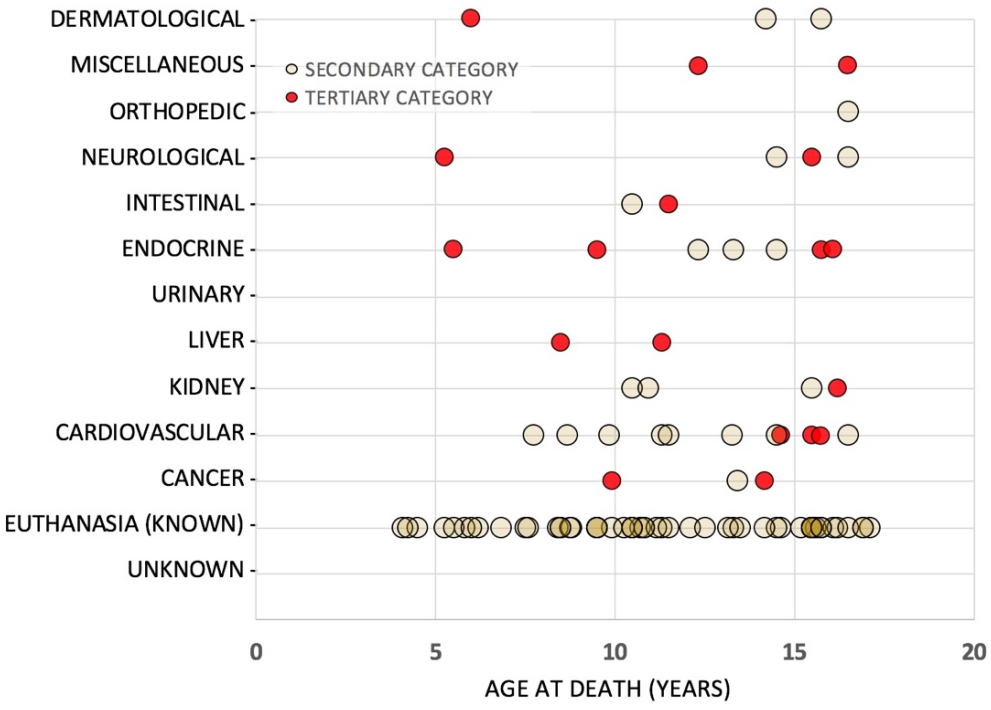


Figure IX: The primary cause of death versus the age at death (horizontal axis) for 156 dogs.

Finally, examining the two largest categories, CANCER and CARDIOVASCULAR we see that the cardiovascular deaths are clumped, starting ~10 years but extending well above the mean lifetime (~12 years). The CANCER deaths are distributed somewhat more broadly but appear distinctly shifted down in age from the CARDIOVASCULAR deaths, peaking around 10 years.



Figures X: The secondary & tertiary causes of death vs age at death for 156 dogs.

Figure X contains only those male and females which have either a secondary or tertiary cause of death listed. Examining Figure X, we see the dominant band from EUTHANASIA for known causes, which contains about 75% of the entries.

Within that category, looking more closely one can perhaps see three regions (around ~5, 10, and 16 years) which seem to have clumping that perhaps reflects the age – correlations characteristic of the underlying primary causes. CARDIOVASCULAR is the next most populated secondary and tertiary cause, with a structure similar to but perhaps shifted a few years older, than the primary entries in this category. Indeed, cardiovascular deaths seem to accompany a number of other primary causes, at older ages. Finally, the ENDOCRINE problems as secondary and tertiary causes again appear primarily in the somewhat older age group (10-15 years).

7. The Age Distributions Reported by Cause of Death, and Their Sub-Categories

In this section we will look in detail at the projections of each of the 13 major categories onto the age axis, to enumerate more quantitatively, the structure observed in the two scatterplots of Section 6. In addition, we will include the final piece of data that we have, namely, namely the breakdown of the entries into the finer subcategories enumerated in the Appendix A.

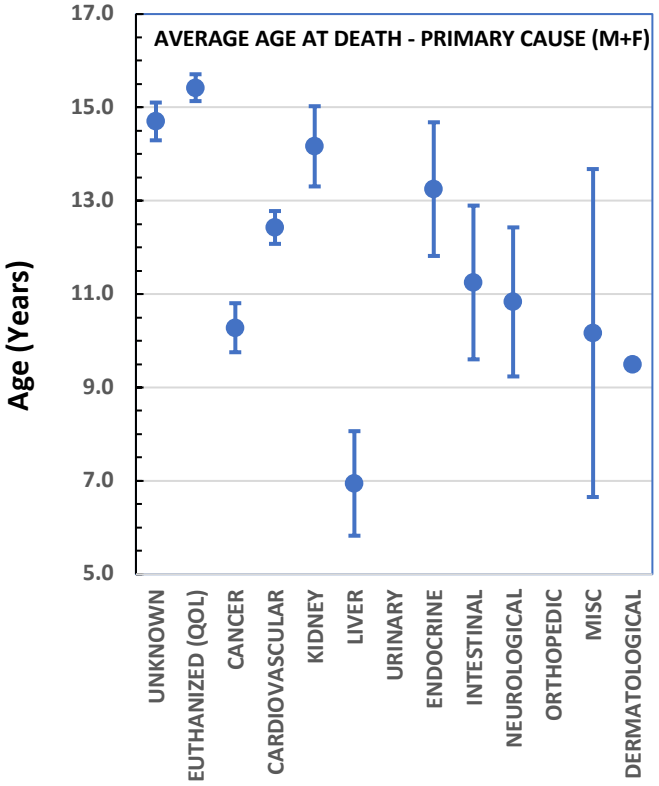
Table XI summarizes the average age at death from each of the 13 primary categories. The table contains the average (AVG), the statistical error on the average, and the spread (RMS) of the distribution. It also breaks down the numbers by sex. All the numbers are reported in years. The errors are calculated from the RMS and assume Gaussian statistics which is not completely precise for those categories having very small numbers of entries. The error is assigned to be zero for single entry categories. The systematic error on the absolute ages, is 0.3 years

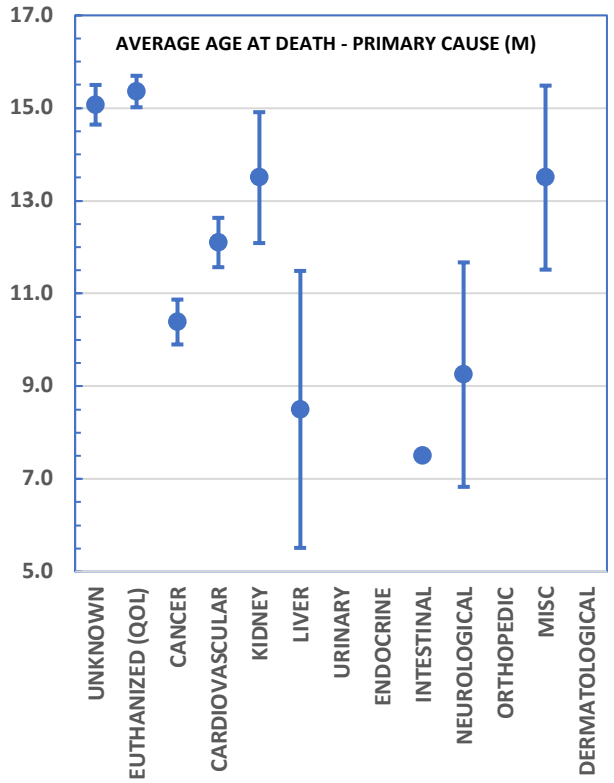
Table XI. Average Age of Death (in Years) Within Each Primary Category

	MALE + FEMALE				MALES				FEMALES			
DISEASE CATEGORY	**#**	**AVG AGE (years)**	**ERROR ON AVG**	**RMS**	**#**	**AVG AGE (years)**	**ERROR ON AVG**	**RMS**	**#**	**AVG AGE (years)**	**ERROR ON AVG**	**RMS**
UNKNOWN	15	14.7	0.4	1.6	7	15.1	0.4	1.1	8	14.4	0.7	1.9
EUTHANIZED*	13	15.4	0.3	1.0	7	15.4	0.3	0.9	6	15.5	0.5	1.3
CANCER	41	10.3	0.5	3.4	26	10.4	0.5	2.5	15	10.1	1.2	4.6
CARDIOVASCULAR	42	12.4	0.4	2.3	15	12.1	0.5	2.1	27	12.6	0.5	2.4
KIDNEY	15	14.2	0.9	3.3	7	13.5	1.4	3.7	8	14.7	1.1	3.1
LIVER	9	6.9	1.1	3.4	3	8.5	3.0	5.2	6	6.2	0.9	2.2
URINARY	0				0				0			
ENDOCRINE	4	13.2	1.4	2.9	0	0.0	0.0	0.0	4	13.2	1.4	2.9
INTESTINAL	4	11.2	1.6	3.3	1	7.5	0.0	0.0	3	12.5	1.5	2.6
NEUROLOGICAL	9	10.8	1.6	4.8	4	9.2	2.4	4.8	5	12.1	2.2	4.9
ORTHOPEDIC	0				0		0.0	0.0	0			
MISC	3	10.2	3.5	6.1	2	13.5	2.0	2.8	1	3.5	0.0	0.0
DERMATOLOGICAL	1	9.5			0			0.0	1	9.5	0.0	0.0

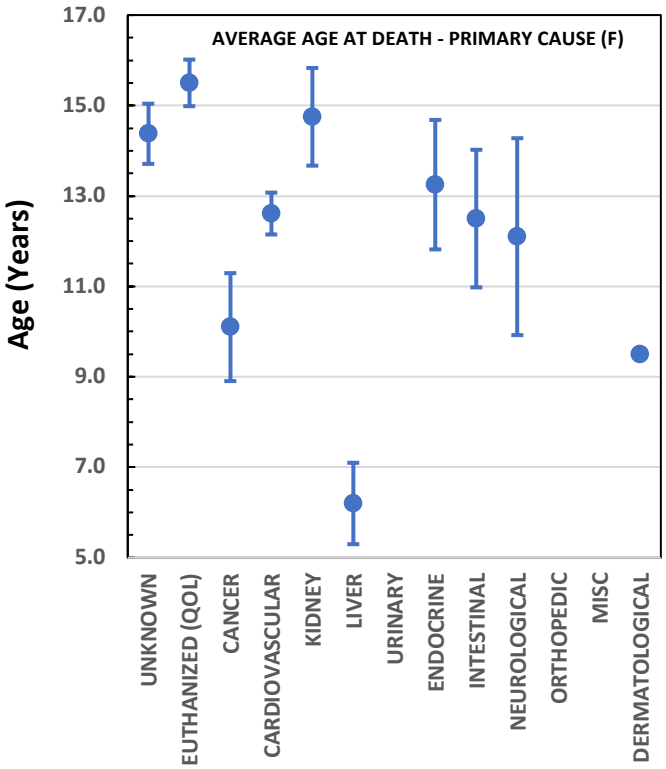
***Quality of Life

The numbers in Table XI are next plotted with error bars in Figure XI a,b,c so they can be visualized more easily.





Figures XI: a, b, and c: The average age at death on the vertical axis for each primary cause of death on the horizontal axis for males and females combines, and males and females, separately. Statistical errors only.



The numbers in Table XI and the graphical representation in Figure XI support quantitatively the conclusions discussed in Section 6 where we looked visually at the structures in scatterplots of age versus cause of death.

First, we see that dogs dying from Unknown causes are generally quite older (14.7 years of age) than the mean age of the whole population (13 years). There is no significant difference between males and females. Dogs that are Euthanized for quality of life issues follow the same pattern, living to 15.4 years on average (about 2.4 years longer than the average Havanese). Once again, there is no significant difference between males and females in this category.

Cancer plays a major role in diminishing the average lifespan of Havanese. Both males and females die at an average of ~ 10.3 years of age, almost 2 years below the mean lifetime. About 27% of the survey population succumbs to cancer, or has cancer associated with their death.[8] A dramatic difference we observe is the frequency of occurrence between males and females, first indicated in Table X. Males are almost twice as likely (37.5%) as females (17.9%) to die from cancer.

The difference between males and females is (37.5+/-8.5 - 17.9+/- 5.0) % = 19.6 +/-7.0 %. Statistically, this is ~ 2.78 standard deviation difference, which is moderately significant, i.e.: the likelihood of females and males having the same rate for cancer is about 1 part in 386.

Cardiovascular disease is the other major contributor to deaths. Both males and females die at ~12.4 years of age from cardiovascular diseases, close to the mean lifetime of 12 years - of all Havanese in the sample. There is a dramatic difference however in the rate of occurrence between males and females, first indicated in Table X. As shown, about 29.5% of the survey population succumbs to cardiovascular issues or has secondary or tertiary cardiovascular issues at death. Females are almost twice as likely (35.7%) as males (22.2%) to die from a cardiovascular cause. The difference between males and females is|22.2+/-6.1 – 35.7 +/- 7.6) |%= 13.5 +/-4.7 % which is a 2.84 standard deviation effect. Statistically, this is moderately significant, i.e.: the likelihood of females and males having the same rate for cardiovascular related deaths is less than 1 part in 476.

Kidney issues as a primary cause of death occur at ages well above the mean, 14.2 +/- 0.9 years. The incidence rate and average age at death are similar for males and females in the survey.

Liver issues are surprisingly prevalent as a cause of early death. The average age of death is 6.9+/- 1.1 years for males and females. While the average age is similar for each, there is a somewhat larger percentage of females than males being reported. Liver cancer is listed separately under cancers and will be discussed in the next section when we enumerate the sub-categories of each disease. There it will be seen to be one of the more prevalent cancers.

---

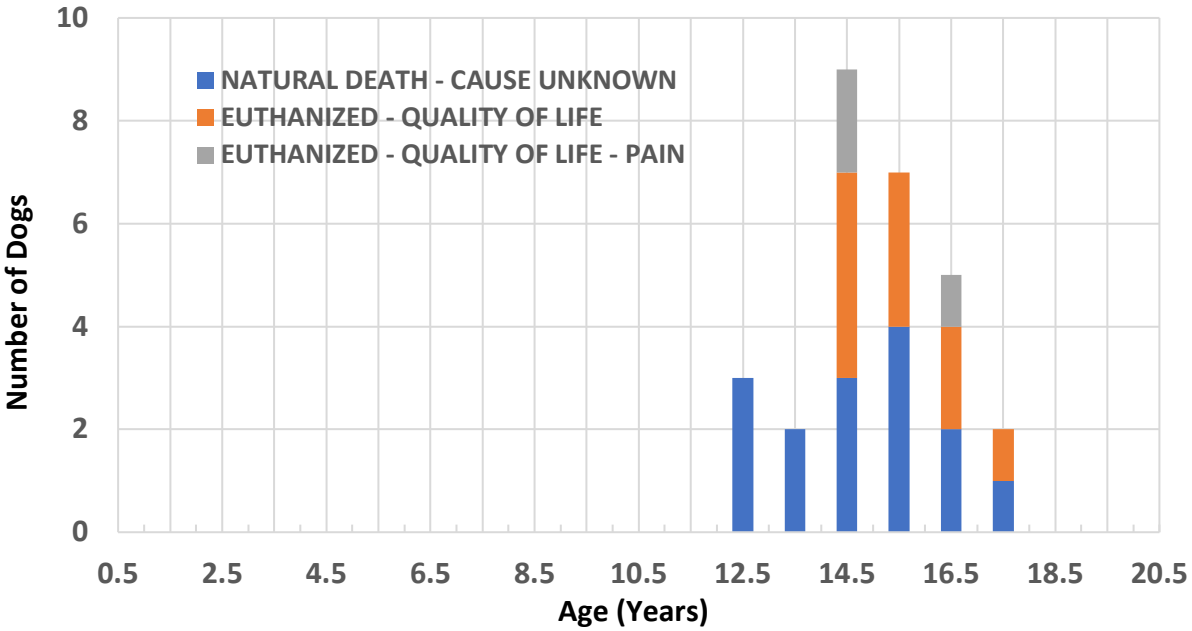
[8] If the real population of Havanese is half male and half female, then the total rate of cancer in the at-large population would be closer to 28%.

Neurological problems leading to death are present in about 6% of the population. While having a mean associated lifetime of 10.8+/-1.6 years they have a very large RMS, meaning they are widely spread out over age. The nature of these problems is discussed in the next section.

Diseases of the Endocrine system, intestinal diseases, dermatological and miscellaneous diseases are each a small component of the population resulting in death, typically in middle ages (11-13 years). In total they represent ~ 7.6% of the population in the survey. They will be discussed in the next section.

8. The Age Distributions Reported by Detailed Sub-Categories

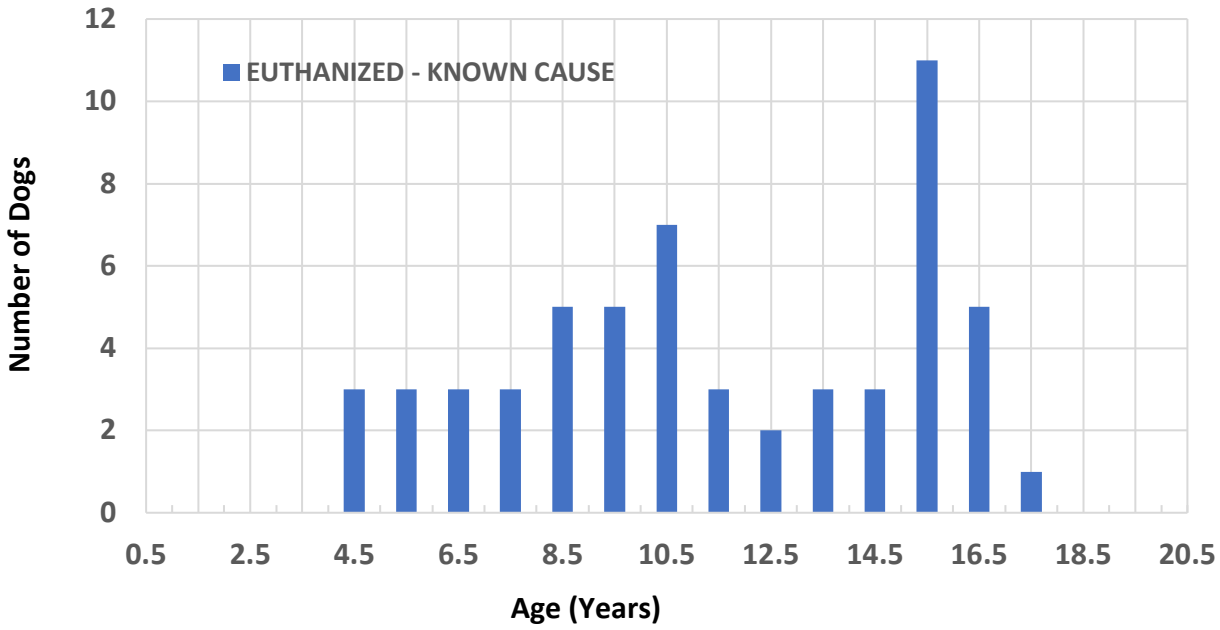
Unknown Cause and Euthanized Dogs: The next set of plots contain the information for each individual category of cause of death. Figure XII below shows the age when dogs died for natural UNKNOWN cause or were EUTHANIZED for quality of life issues. Figure XIII shows the age that dogs were euthanized when there was a known primary cause of death. Finally, Figure XIV breaks out the males and females shown in Figure XIII individually.



Figures XII: The age at death (horizontal axis) for males and females that die naturally (blue) or were euthanized for poor quality of life.

Figures XII shows that the dogs that die of natural causes without diagnosis live between 12 and almost 18 years, peaking around 15 years. Dogs that were Euthanized for quality of life issues live between 14 and 18 years of age with the peak closer to 16 years.

Figure XIII shows dogs that are Euthanized for a known cause. The distribution is fairly flat from ~4 years of age to ~18 years of age with enhancements around 9.5 years and 15 years.

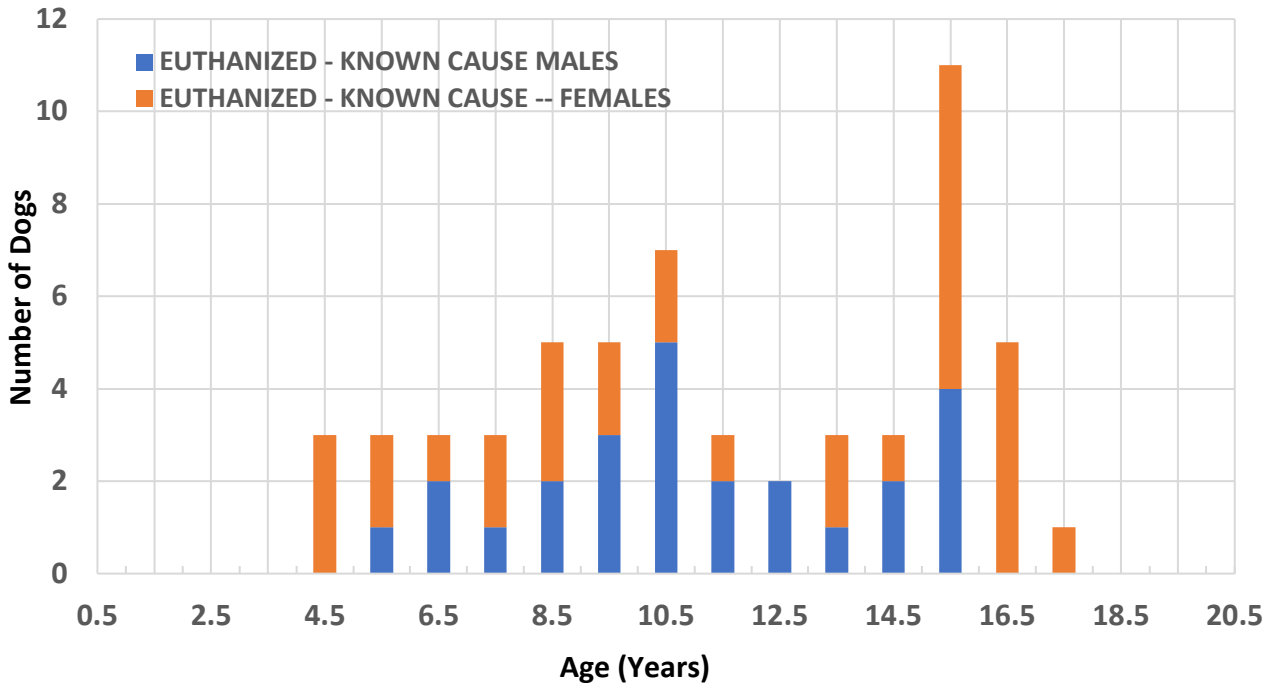


Figures XIII: The age at death (horizontal axis) for males and females combined, that were euthanized for a specific known primary cause.

Figure XIV breaks this down by males and females. It can be seen from this plot that males contribute predominantly to the structure around the lower age of 8.5 to 12.5 years while females have a larger contribution in the older aged dogs (15 years and older). Figure VIII previously showed the primary category associated with these euthanization. As shown in Table XI, cancer played a prominent role in the male deaths, and resulted in an average age of death ~10.4 years. While cardiovascular issues were more prominent in females and led to an average age of death at ~12.6 years, the rate of euthanization is fairly small according to Figure VIII.

Cancer: Next we examine the detailed forms of cancer leading to or associated with death in 42 unique Havanese. Figure XV shows the breakdown of cancer deaths by age that are associated with 41 primary, 1 secondary and 2 tertiary cases (see footnote 7). This plot combines males and females. Figures XVI and XVII breaks this down by sex while Table XII gives the precise frequency of each form, also shown graphically in Figure XVIII. The striking feature of the plots by sex, is the strong peaking around 9 to 10 years for males, and the relatively uniform distribution for females, perhaps rising just slightly with age.

Of the 44 entries in the M+F combined plot, 8 cases are of unknown/suspected cancer. Liver/Spleen cancer (7 cases) followed by B- or T-cell Lymphoma (5 cases) and Leukemia (4 cases) represent the three leading forms that were actually identified. The statistics as a whole are too small to claim any particular age dependency of the many different forms of cancer.



Figures XIV: The age at death (horizontal axis) for males and females now separated out, that were euthanized for a specific known primary cause.

Cardiovascular Diseases: Next we examine the detailed forms of cardiovascular disease leading to or associated with death in 46 unique Havanese. Figure XIX shows the breakdown of these deaths by age that are associated with 42 primary, 8 secondary and 3 tertiary cases (see footnote 7). This plot combines males and females. Figures XX and XXI breaks this down by sex while Table XIII gives the precise frequency of each form, also shown graphically in Figure XXII.

The male + female combined plot (Figure XIX) shows graphically the broad swath of deaths from congestive heart failure between 10 and 17 years of age. Aside from the large overall difference in the frequency of cardiovascular disease between males and female pointed out earlier, a striking feature of the plots by sex, is the strong peaking around 11.5 years for males, and the relatively broader distribution for females, that rises and peaks between 13 and 15 years of age.

Of the 53 entries in the male and female combined plot, 31 cases are of suspected heart failure or congestive heart failure. To this one could add the 6 cases of Mitral Valve disease (MVD) and 1 case of Chronic Valve disease (CVD), bringing the total to 38. Those two modes (MVD and CVD) represent the condition reported as diagnosed, but which were likely to have resulted ultimately in congestive heart failure as the actual cause of death. Adult onset heart murmur or AOHM (4 cases) might also be included as well, as they were reported as a primary cause. [9]

[9] It is generally observed that heart murmurs in small breeds tend to be first detected between 6 and 10 years of age. Most however do not lead to visible symptoms, nor progress to become the primary cause of death.

Enlarged heart or Cardiomegaly (2 cases) and Cardiac Tamponade (1 case) were also reported. Cardiomegaly is not a disease per-se but the symptom of another condition which would require additional testing (that was not reported) to diagnose. The condition can arise from a host of causes such as disease of coronary artery, heart valve problems, stress, or conditions which cause the heart muscle to thicken, or cause one of the chambers of the heart to dilate.

Cardiac Tamponade is also a condition associated with compression of the heart by fluid in the sac that surrounds it, resulting in sudden drops in blood pressure. Causes of this condition can range from the rupture of an aortic aneurysm, lung cancer, inflammation of the pericardium (acute pericarditis), to heart attacks.

Strokes and blood clots occurred in 5 cases while diseases of the blood, such as Immune Mediated Thrombocytopenia and Immune Mediated Hemolytic Anemia make up three of the cases. It is questionable if these latter two immune mediated diseases should truly be grouped with the cardiovascular issues themselves and might better fit in the Miscellaneous category.

In Figure XXII the cardiovascular frequencies are replotted, where several categories are combined as described in the text above. Interestingly, males fall exclusively in the first two combined categories, and the difference between the total number of males (18) and total number of females (26) is now less distinct. Indeed, if the total underlying population of males and females were equal in number, then the males would make up ~47% of the first two categories, and the females 53% -- closer to equal within the statistical errors.

Kidney Disease: Figure XXIII a, b, and c show the age distributions for kidney disease reported as a primary, secondary and tertiary cause. Kidney failure is the dominant contributor, with only one chronic kidney disease reported in 17 cases. The mortality rate is similar for males and females, peaking sharply at old ages (15 -16 years), well above the 12-year avg. age of death.

Liver Disease: Figure XXIV a, b, and c show the age distributions for diseases of the Liver reported as a primary and tertiary causes. While folklore places external liver shunt (PSVD) and microvascular disease (MVD) as being prominent in small breeds such as Havanese, the survey results do not support this, at least as a prominent cause of death. Only 9 of 156 dogs in the sample had liver disease as a primary cause. Of these, 5 cases are reported as Chronic Liver disease, and two each are reported as Hepatitis and PSVD. One case of Hepatitis and one case of Liver failure are also reported as tertiary causes of death.

The diagnosis of Chronic Liver disease implies the gradual destruction of liver's tissue over time. Liver diseases in this category includes Cirrhosis, Fibrosis of the liver. Without a biopsy, it is possible for liver cancer to also be a cause.

The mortality rate for females in the sample is somewhat larger than males. For the most part, this appears to be a disease that causes death in young to middle age dogs – 9 of the 11 cases are between 4 and 9 years of age, and the average age of death in the survey is 6.9+/-1.1 years (from Table XI) which is well below the sample mean of 12+/-0.3 years.

Endocrine System Diseases: Figure XXV a,b,c shows the age distributions associated with diseases of the Endocrine system. These include pancreatitis, Cushing's Disease (hyperadrenocorticism), diabetes, and pituitary adenomas (noncancerous tumors in the pituitary gland). We see that these are frequently appearing as secondary and tertiary causes and are largely occuring in females (9 of the 11 reported cases). They result in deaths that largely are in older aged dogs (over 10 years of age), with the bulk between 13 and 17^{+} years.

Intestinal Tract Diseases: Figure XXVI a, b, and c shows the span of Intestinal tract diseases reported. These include protein-losing enteropathy (PLE), and enteritis with clostridium. The contribution represents a small part of the population. Only four cases are reported as primary, 1 as secondary and 1 as tertiary. They are predominantly in the female population and seem to result in fairly late deaths, over 10 years of age.

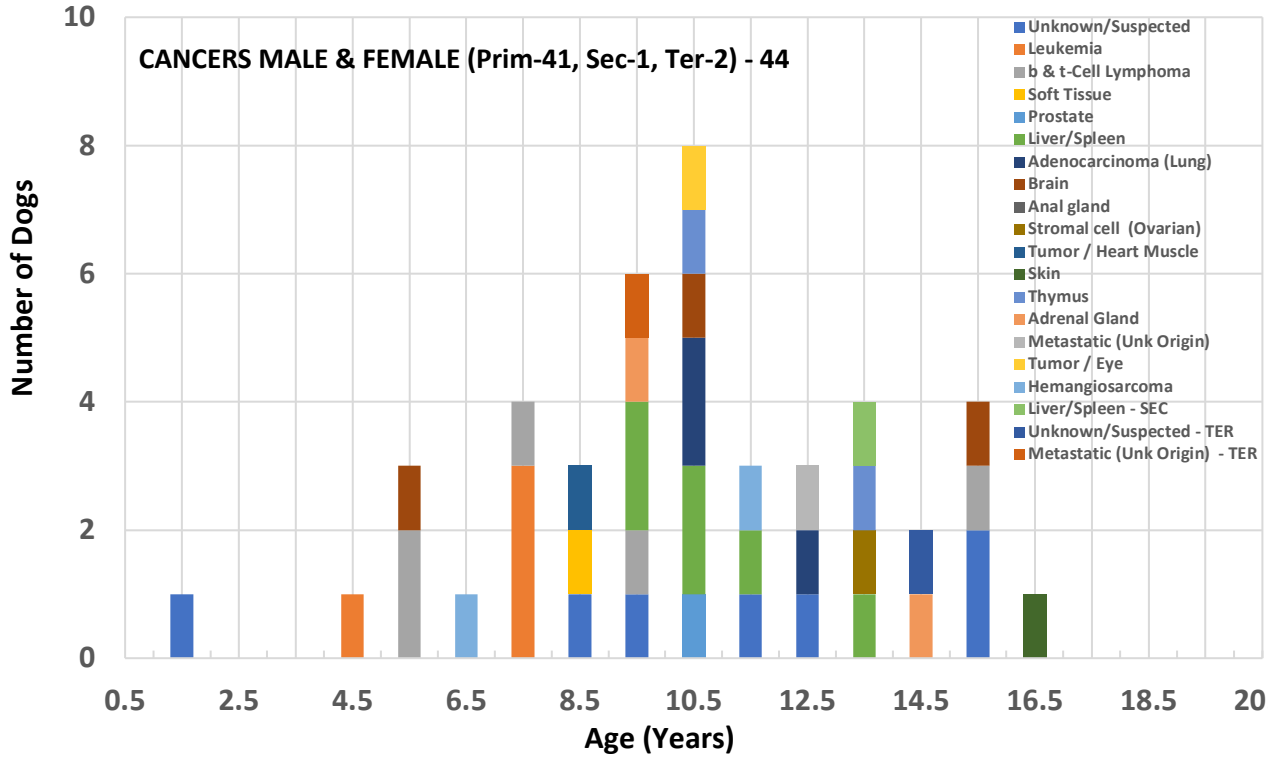
Neurological Diseases: Figure XXVII a, b, and c shows the span of neurological diseases reported. These include seizures (congenital and adult), dementia, epilepsy and immune mediated meningitis (IMM). IMM is included here as it is an inflammation of brain and spinal cord membranes, caused by an attack by the immune system. It is the most common form of meningitis in dogs.

The contribution of neurological diseases represents a small part of the population. Only 9 cases are reported as primary, 2 as secondary and 2 as tertiary. They appear at a similar rate in both the male and female population of the survey. While the statistics are low, one can see some clustering ~4 to 6 years of age, and additional clustering around 13-15 yrs of age, depending on the exact nature of the problem (e.g. dementia at older ages).

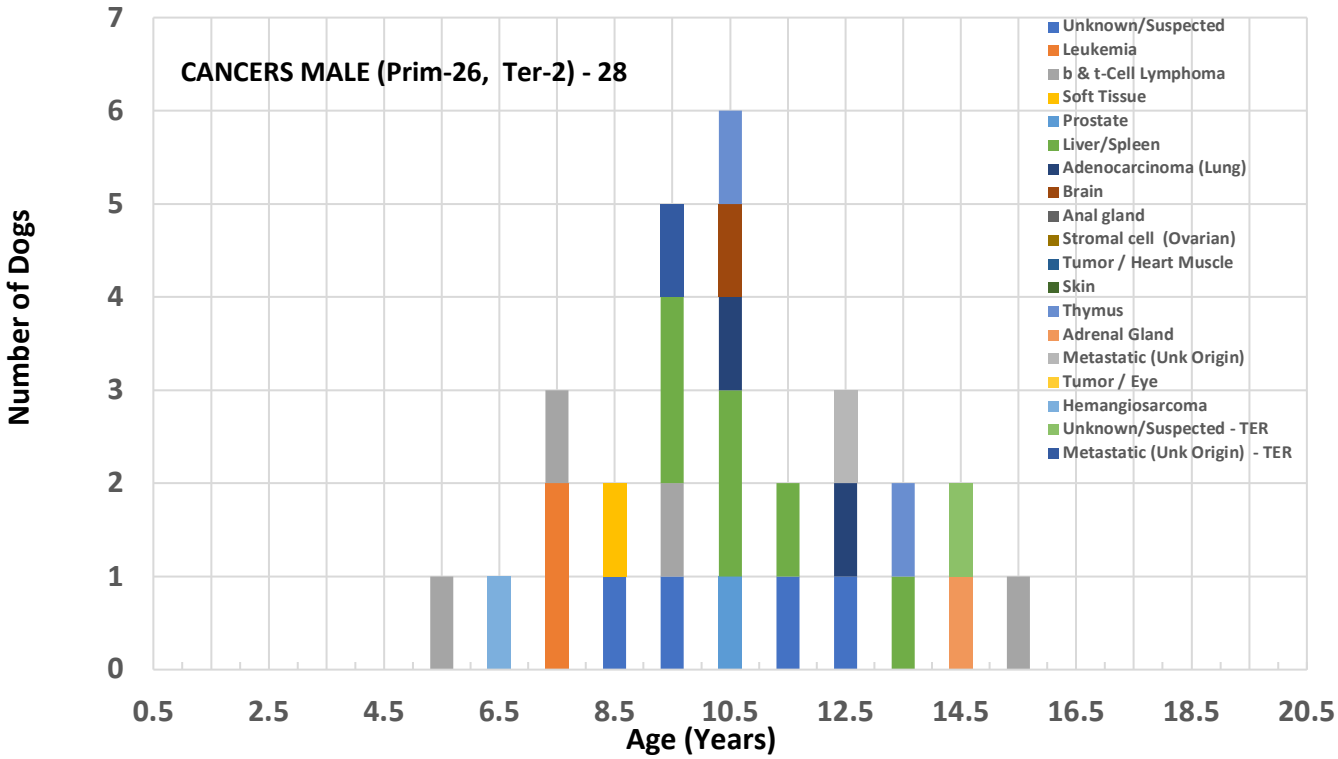
Orthopedic Diseases: An orthopedic problem leading to the primary cause of death have not been reported. Figure XXVIII shows the single case of a 16+ year old male having an orthopedic issue (arthritis causing immobility) being secondary to another primary cause of death.

Miscellaneous: Figure XXIX a and b shows the five dogs with miscellaneous causes of death. Three males with 2 primary and 1 tertiary cause and two females with 1 primary and 1 tertiary cause. These include pyometra, surgical complications, and pneumonia as primary causes. Blindness is listed as a tertiary cause in one male and one female. The ages at death are scattered.

Dermatological: Figure XXX a and b are the final figures in this section describing the dermatological diseases of males and females, respectively. One primary cause, one secondary and two tertiary causes are listed for the 2 males and 2 females. Panniculitis (inflammation of the fat-containing tissues just under the skin when bacteria, fungi or other organisms infect the area) is the only primary cause listed for one of the females – at age 9.5 years**.** The other secondary and tertiary causes are Sebaceous Adenitis (when the sebaceous glands become inflamed), and other skin allergies (unspecified) with no clear age dependence.



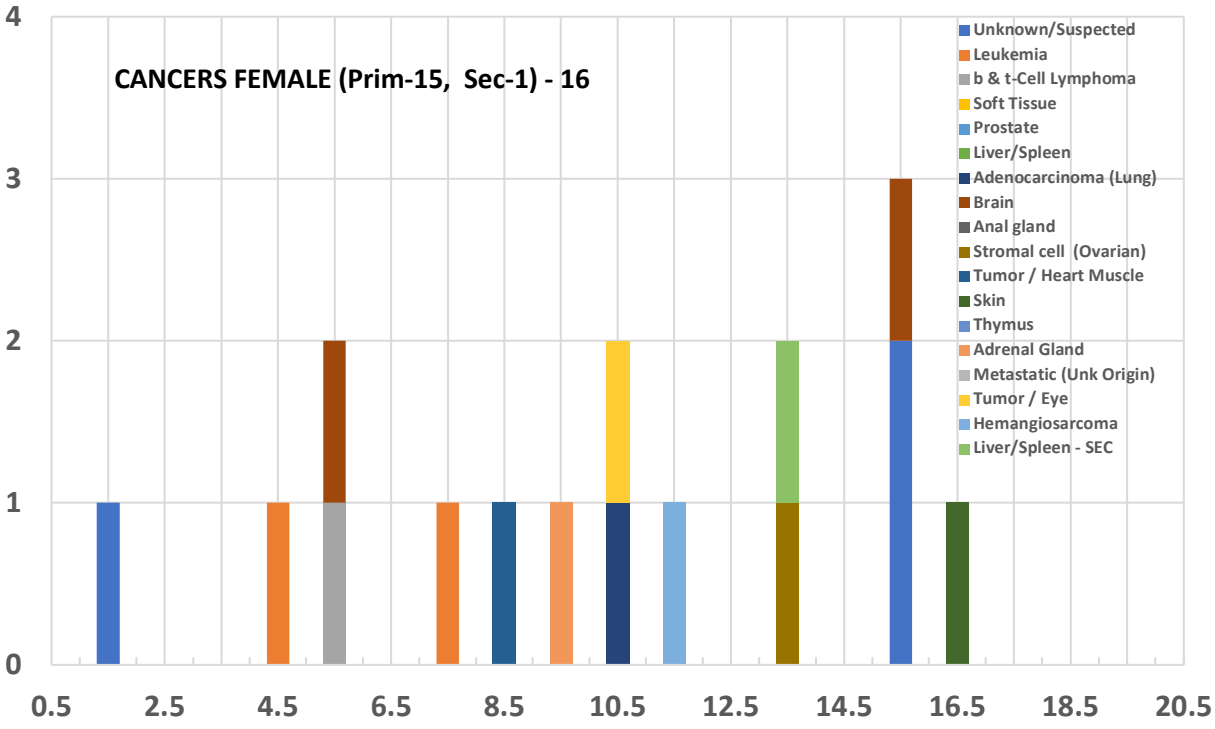
Figures XV: The age at death (horizontal axis) for 42 unique males and females that succumbed to cancer a primary (41 entries), secondary (1) or tertiary (2) cause. (see footnote 6)



Figures XVI: The age at death (horizontal axis) for 27 unique males that succumbed to cancer as a primary (26 entries), or tertiary (2) cause (see footnote 7).

Table XII. Total Cancer Frequencies Reported (41 Primary, 1 Secondary, and 2 Tertiary)

CANCER TYPE	M+F	M	F
Unknown Type (Suspected)	8	5	3
Leukemia	4	2	2
Lymphoma (B & T Cell)	5	4	1
Soft Tissue	1	1	0
Prostate	1	1	0
Liver/Spleen	7	6	1
Lung (Adenocarcinoma/Other)	3	2	1
Brain (suspected)	3	1	2
Stromal cell (Ovarian)	1	0	1
Skin	1	0	1
Thymus	2	2	0
Adrenal gland cancer	2	1	1
Metastatic cancer (Unknown Origin)	2	2	0
Tumor on tissue near eye (suspected)	1	0	1
Hemangiosarcoma/Tumor on Heart Muscle	3	1	2
SUM	**44**	**28**	**16**



Figures XVII: The age at death (horizontal axis) for 15 unique females that succumbed to cancer as a primary (15 entries), or secondary (1) cause (see footnote 7).

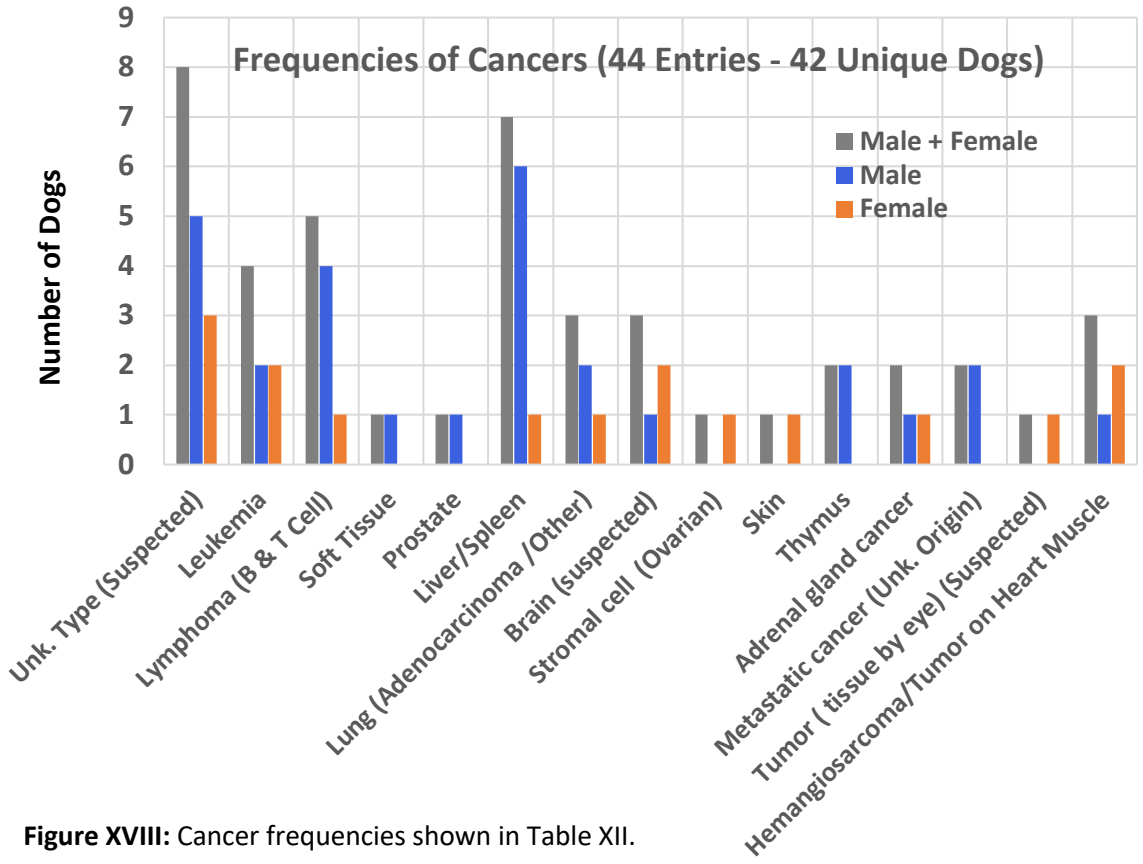
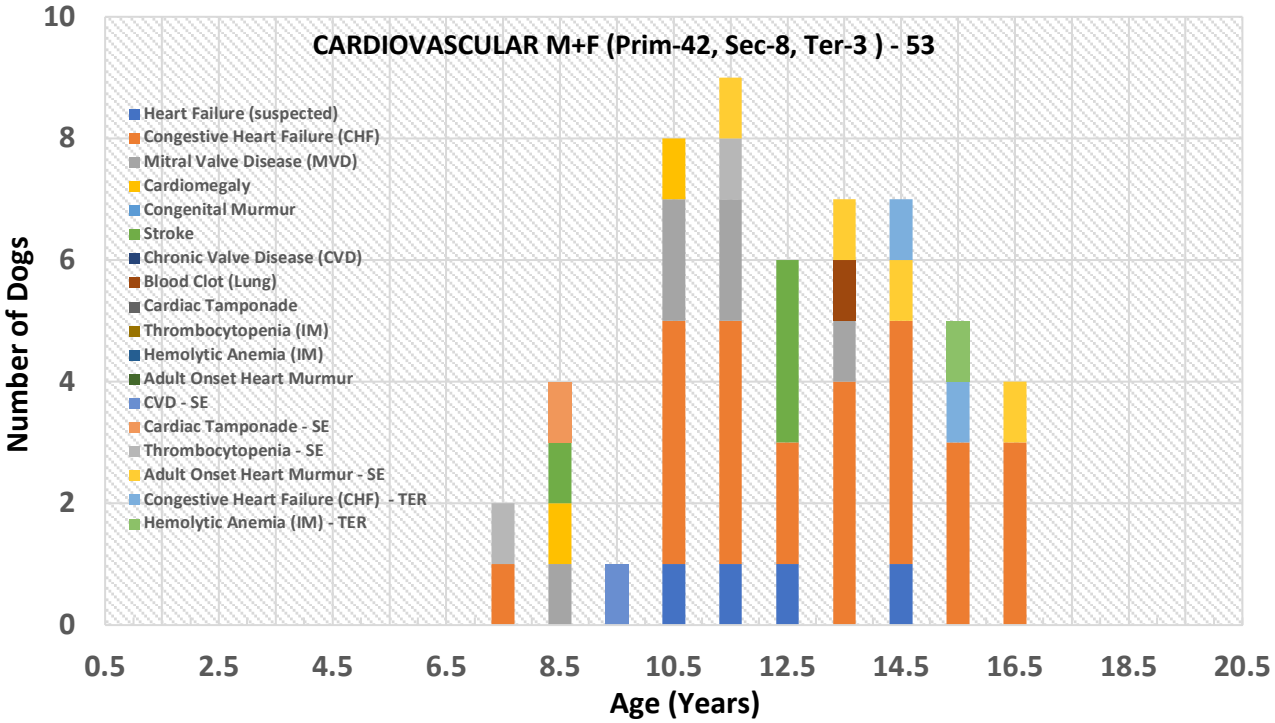
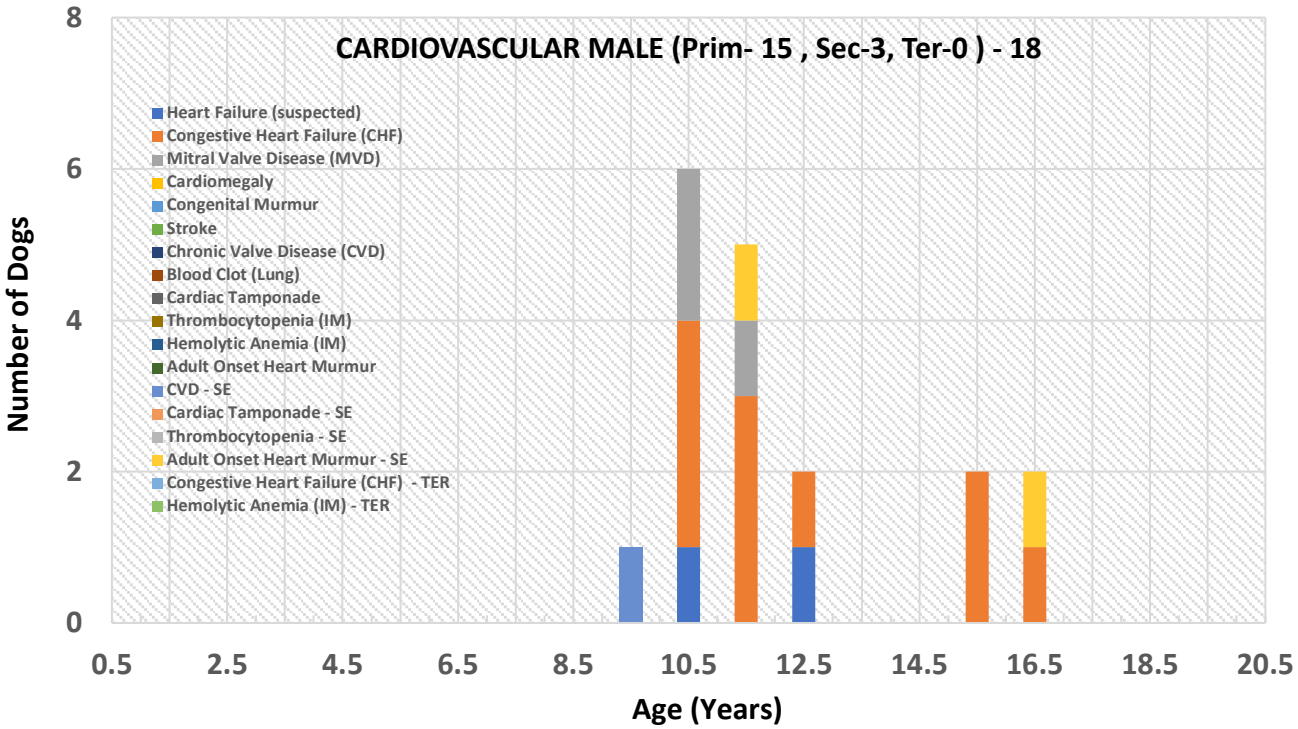


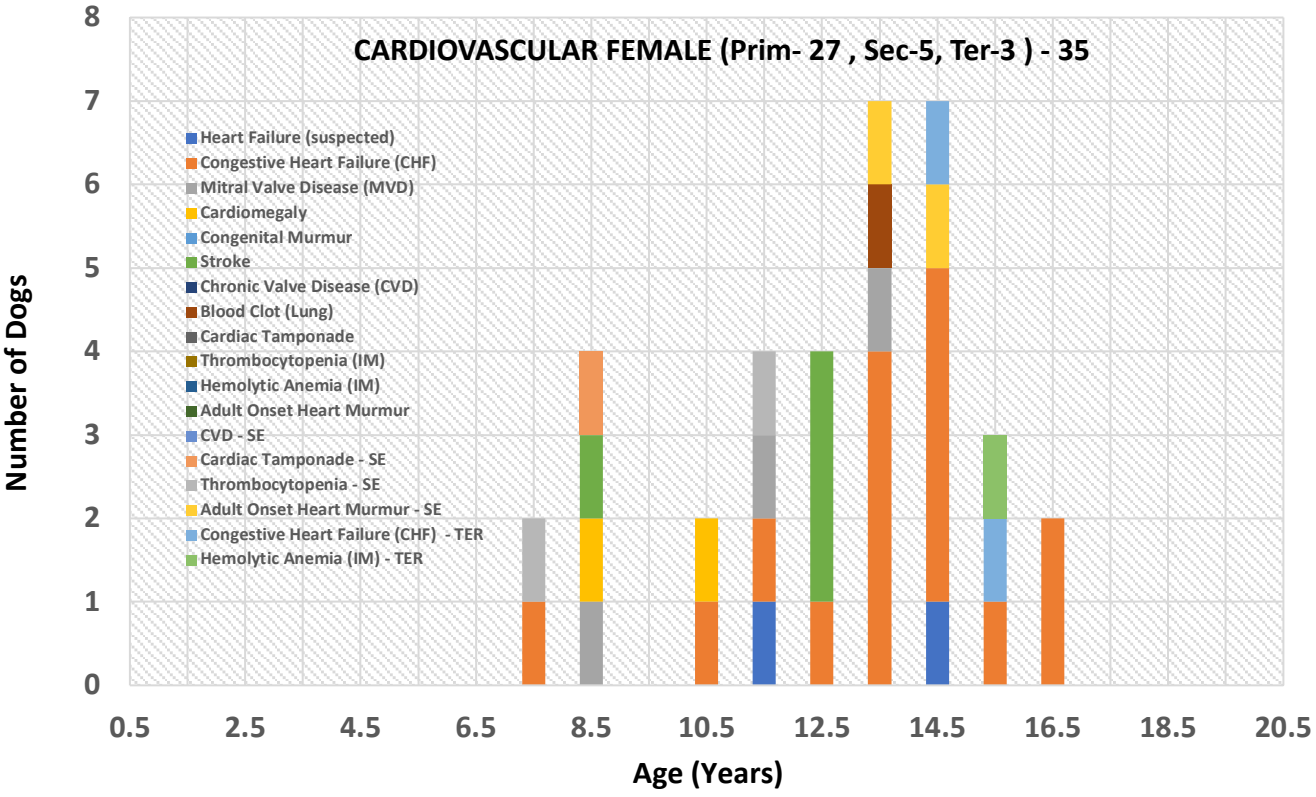
Figure XVIII: Cancer frequencies shown in Table XII.



Figures XIX: The age at death for 46 unique males and females, succumbing to cardiovascular disease as a primary (42 entries), secondary (8 entries) or tertiary (3 entries) cause (see footnote 7).



Figures XX: The age at death for 16 unique males that succumbed to cardiovascular disease as primary (15 entries), or secondary (3 entries) causes (see footnote 7).



Figures XXI: The age at death (horizontal axis) for 30 unique females that succumbed to cardiovascular disease as a primary (27 entries), secondary (5 entries) or tertiary (3 entries) cause (see footnote 7).

Table XIII. Cardiovascular Frequencies (42 Primary, 8 Secondary, and 3 Tertiary) – 16 Unique Male and 30 Unique Female (46 Unique Dogs)

CARDIOVASCULAR ISSUE	M+F	M	F
Heart Failure (Suspected)	4	2	2
Congestive Heart Failure (CHF) (Known or Unknown Cause)	27	10	17
Mitral Valve Disease (MVD)	6	3	3
Enlarged Heart (Cardiomegaly)	2	0	2
Stroke	4	0	4
Chronic Valve Disease (CVD)	1	1	0
Blood Clot (lung)	1	0	1
Cardiac Tamponade	1	0	1
Immune-Mediated Thrombocytopenia	2	0	2
Immune-Mediated Hemolytic Anemia	1	0	1
Adult onset Heart Murmur (AOHM)	4	2	2
SUM	**53**	**18**	**35**

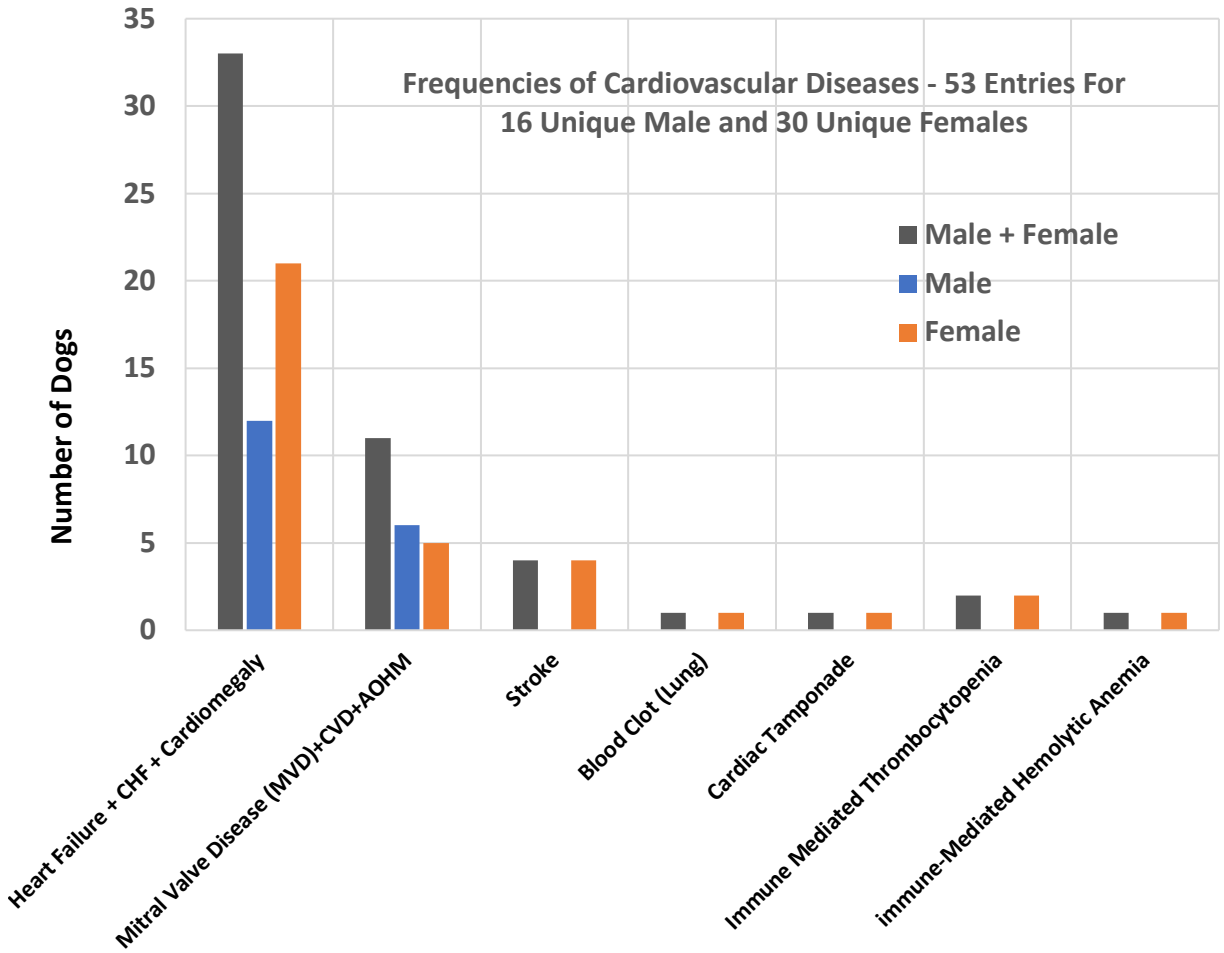
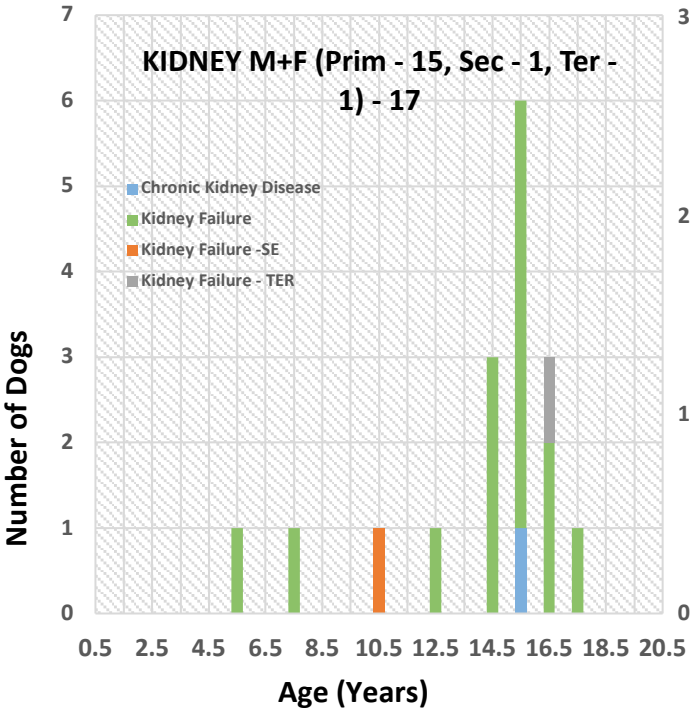
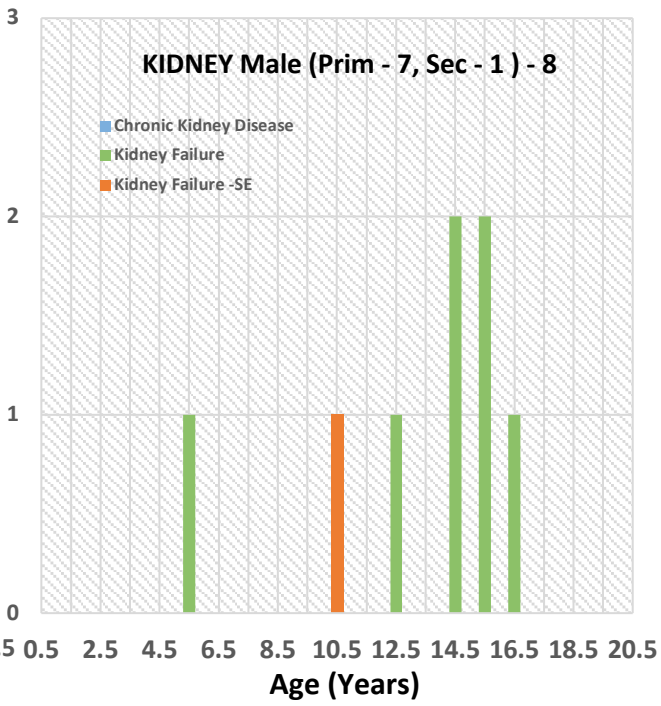
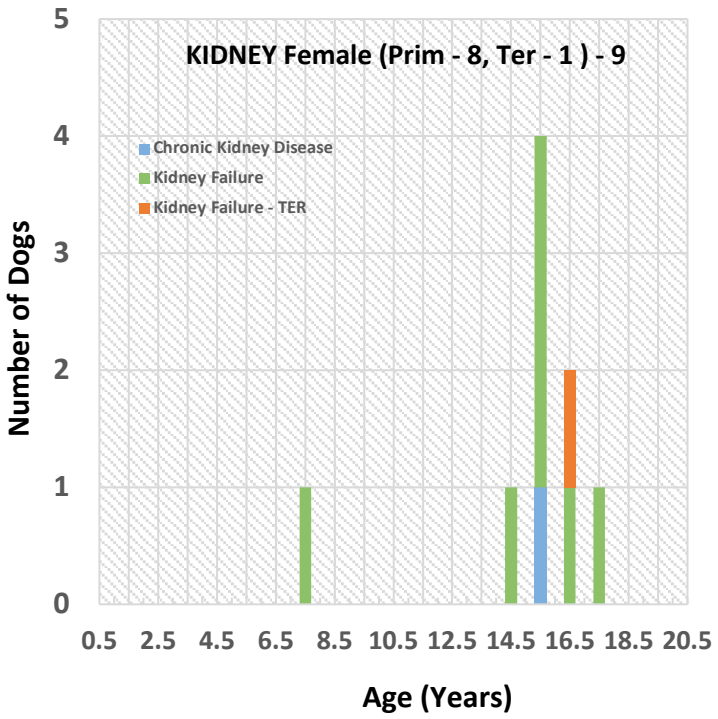


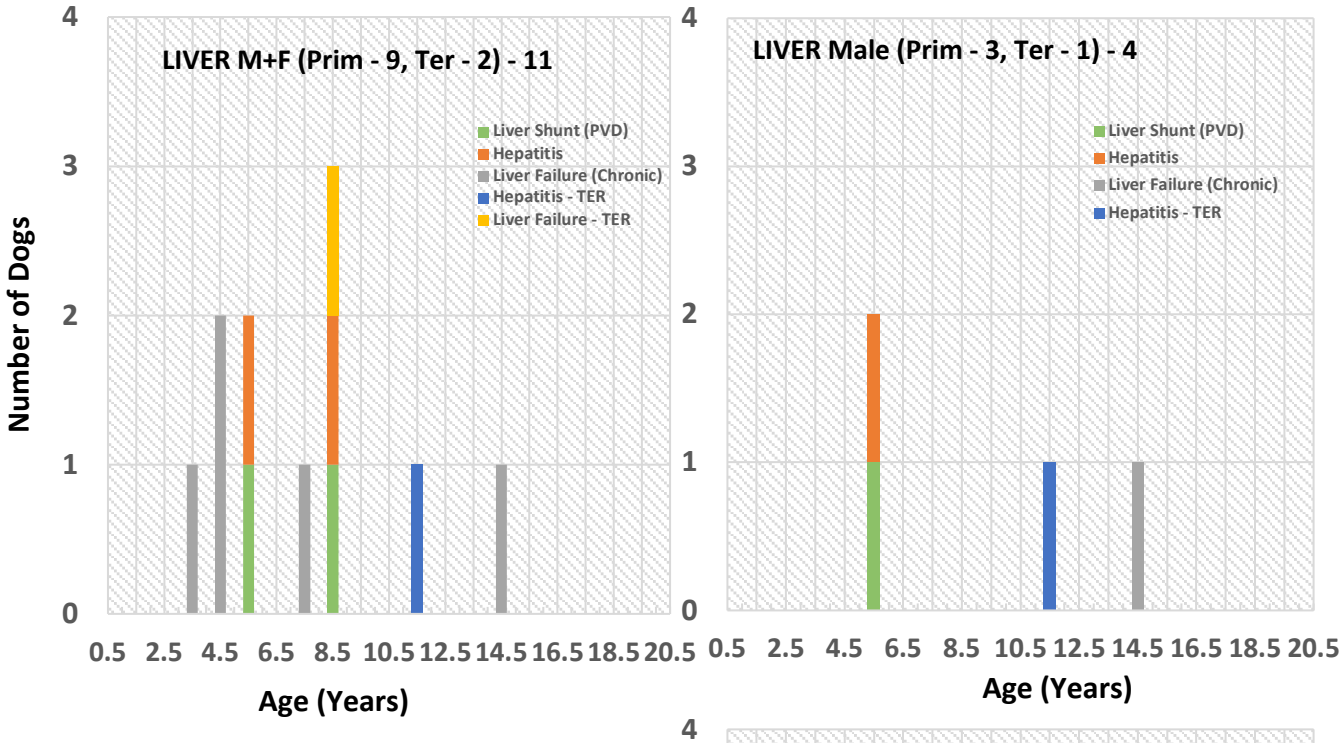
Figure: XXII Cardiovascular frequencies where several categories are combined as described in the text (heart failure + congestive heart failure + enlarged heart as well as MVD+CVD+AOHM).

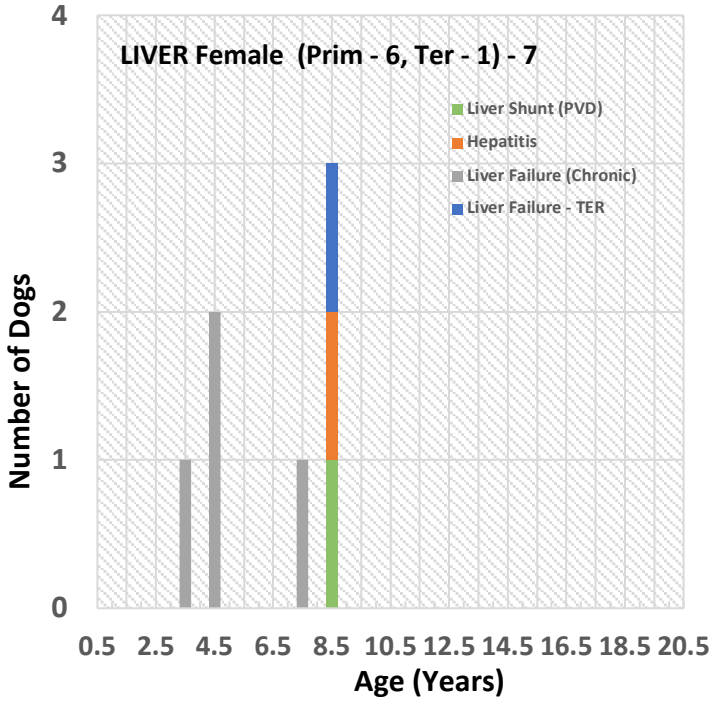




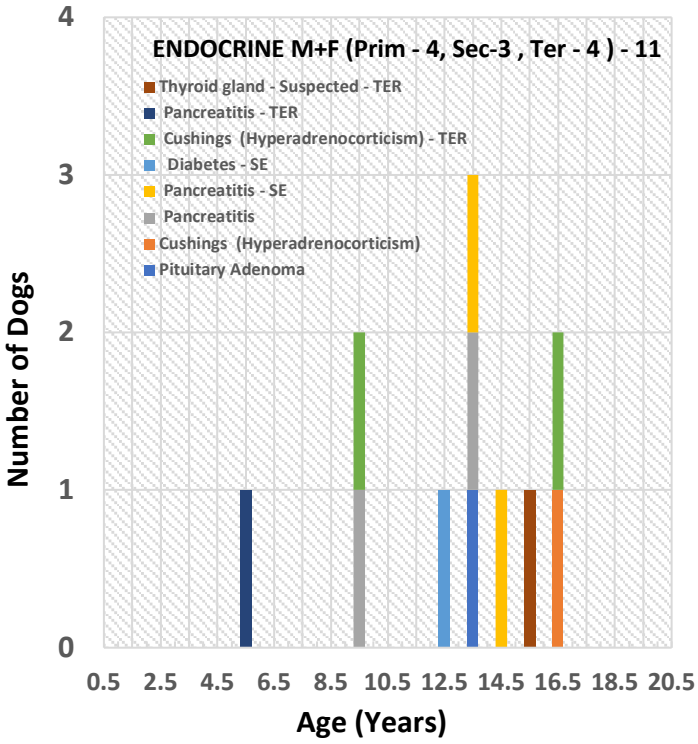
Figures XXIII: a) The age at death for 17 males and females that succumb to Kidney related disease as a primary (15 entries), secondary (1 entry) or tertiary (1 entry) cause.
b) same for 8 males (7 primary and 1 secondary)
c) same for 9 females (8 primary and 1 tertiary)

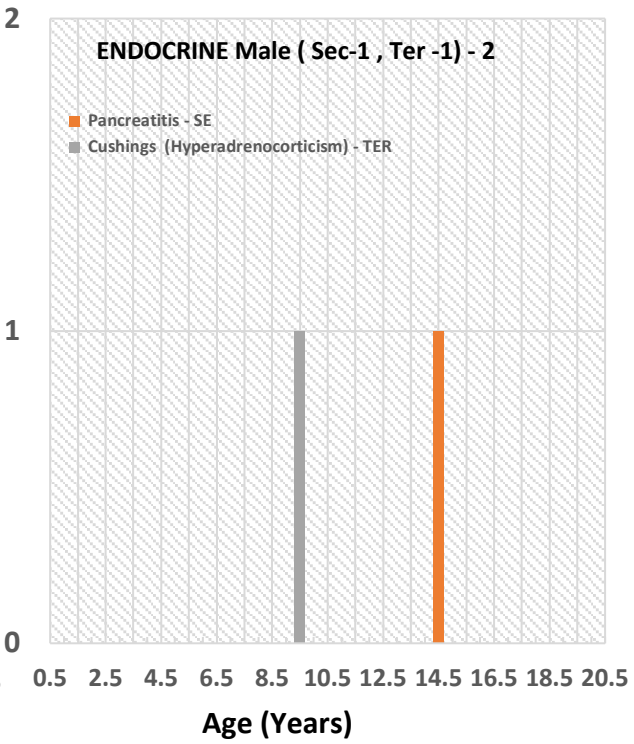




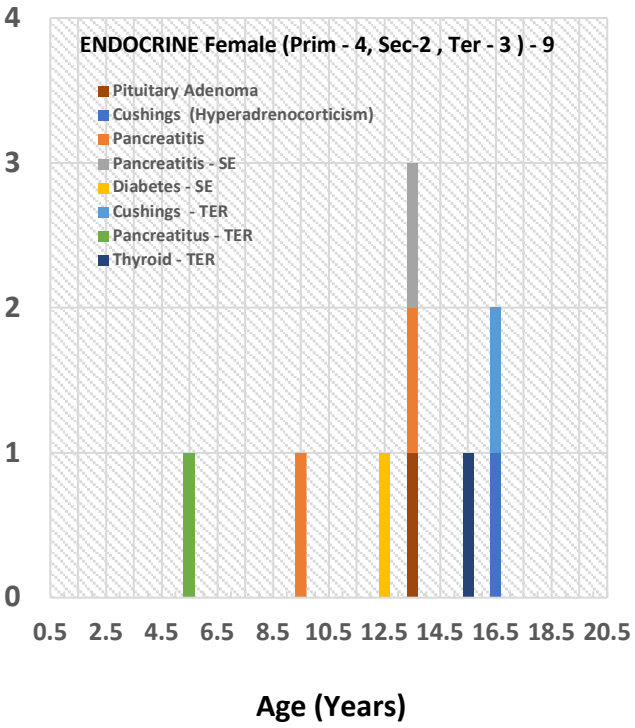


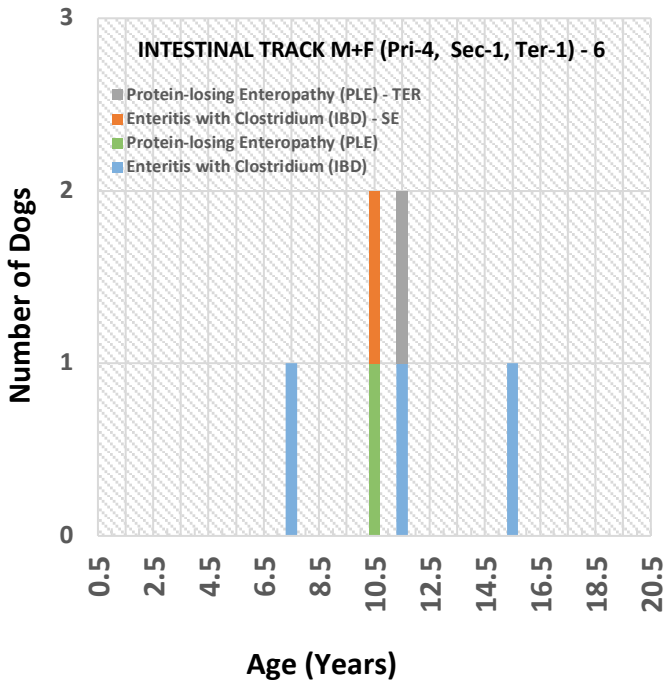
Figures XXIV: a) The age at death (horizontal axis) for 11 males and females that succumbed to Liver related disease as a primary (9 entries), or tertiary (2) cause.
b) same for 4 males (3 primary and 1 tertiary).
c) same for 7 females(6 primary and 1 tertiary)

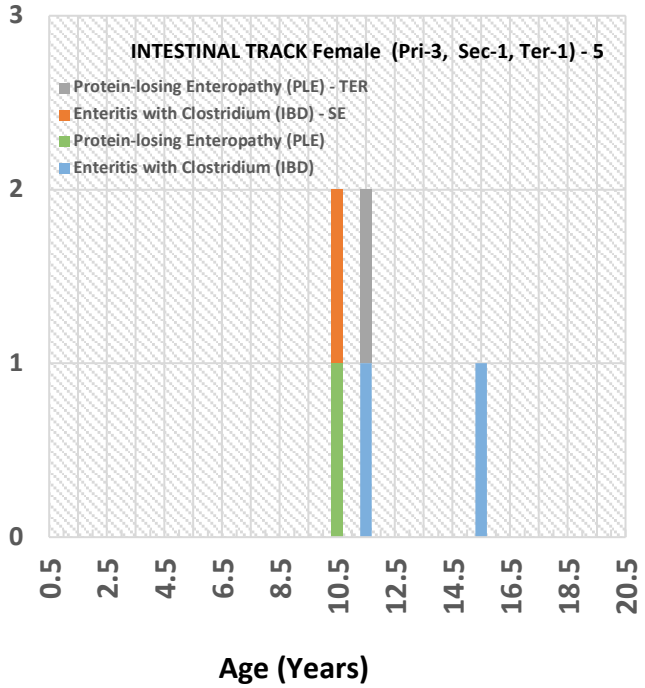




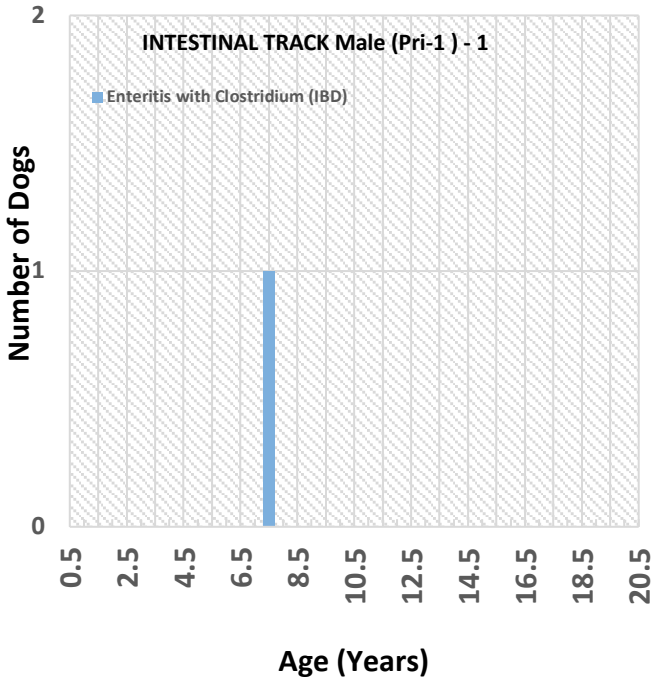
Figures XXV: a) The age at death (horizontal axis) for 11 males and females that succumbed to Endocrine related disease as a primary (4 entries), secondary (3 entries) or tertiary (4 entries) cause.
b) same for 2 males (1 secondary, 1 tertiary)
c) same for 9 females (4 primary, 2 secondary, and 3 tertiary)

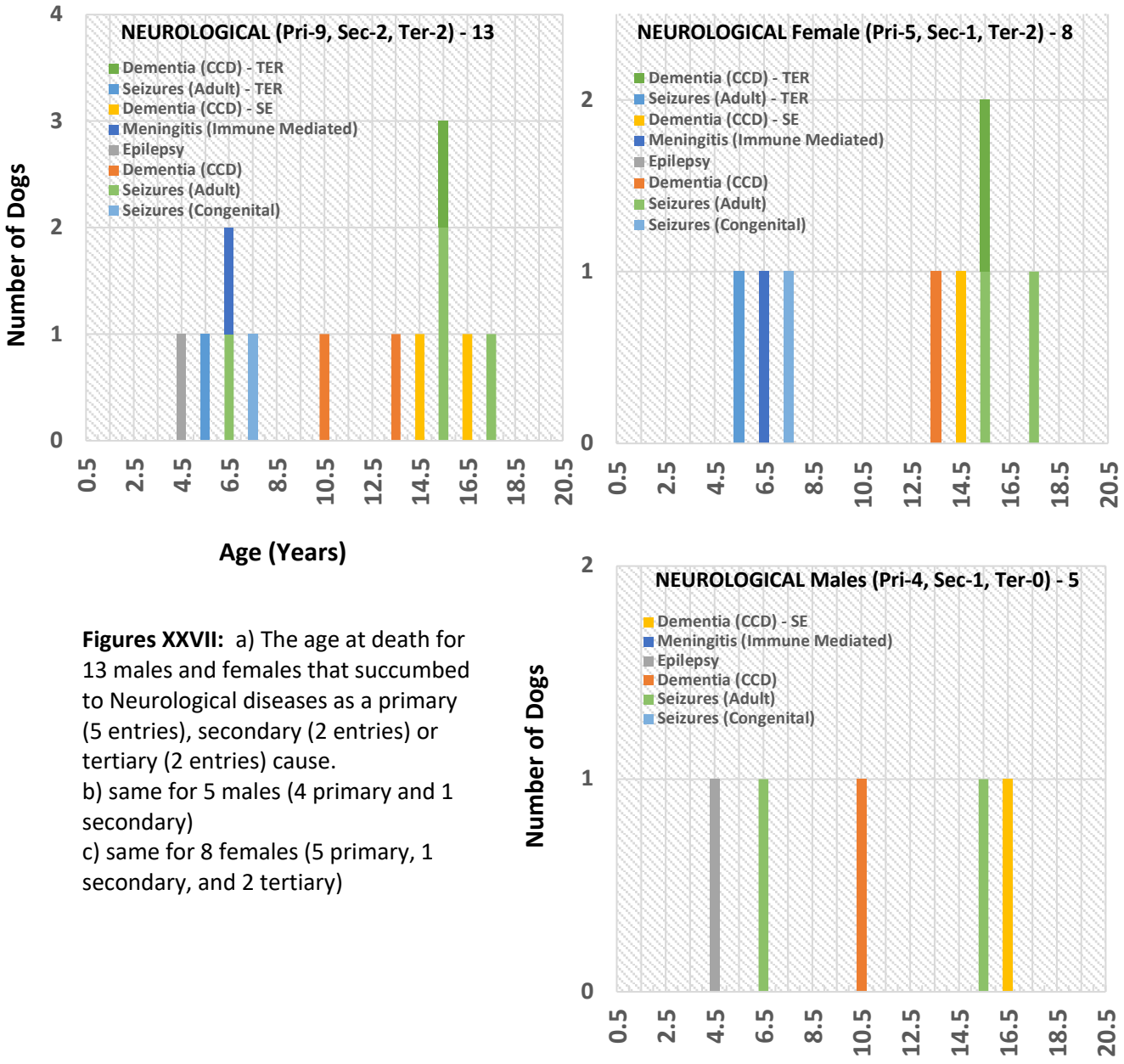






Figures XXVI: a) The age at death for 6 males and females that succumbed to Intestinal Track related diseases as a primary (4 entries), secondary (1 entry) or tertiary (1 entry) cause.
b) same for 1 male (1 primary)
c) same for 5 females (3 primary, 1 secondary, and 1 tertiary)





Figures XXVII: a) The age at death for 13 males and females that succumbed to Neurological diseases as a primary (5 entries), secondary (2 entries) or tertiary (2 entries) cause.
b) same for 5 males (4 primary and 1 secondary)
c) same for 8 females (5 primary, 1 secondary, and 2 tertiary)

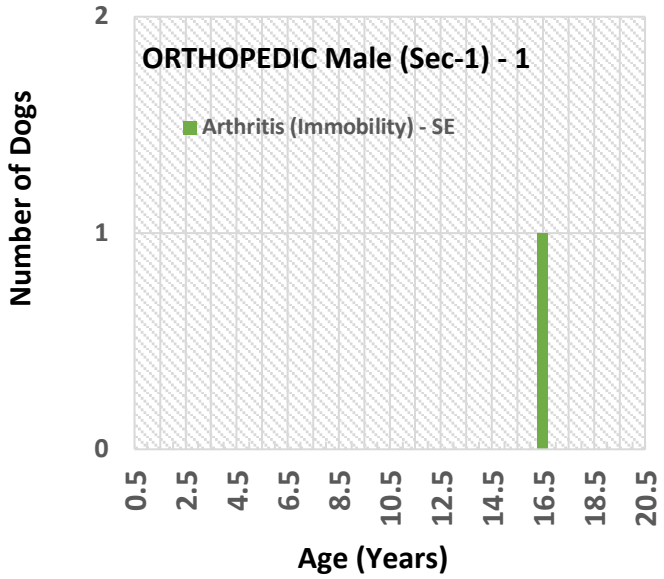
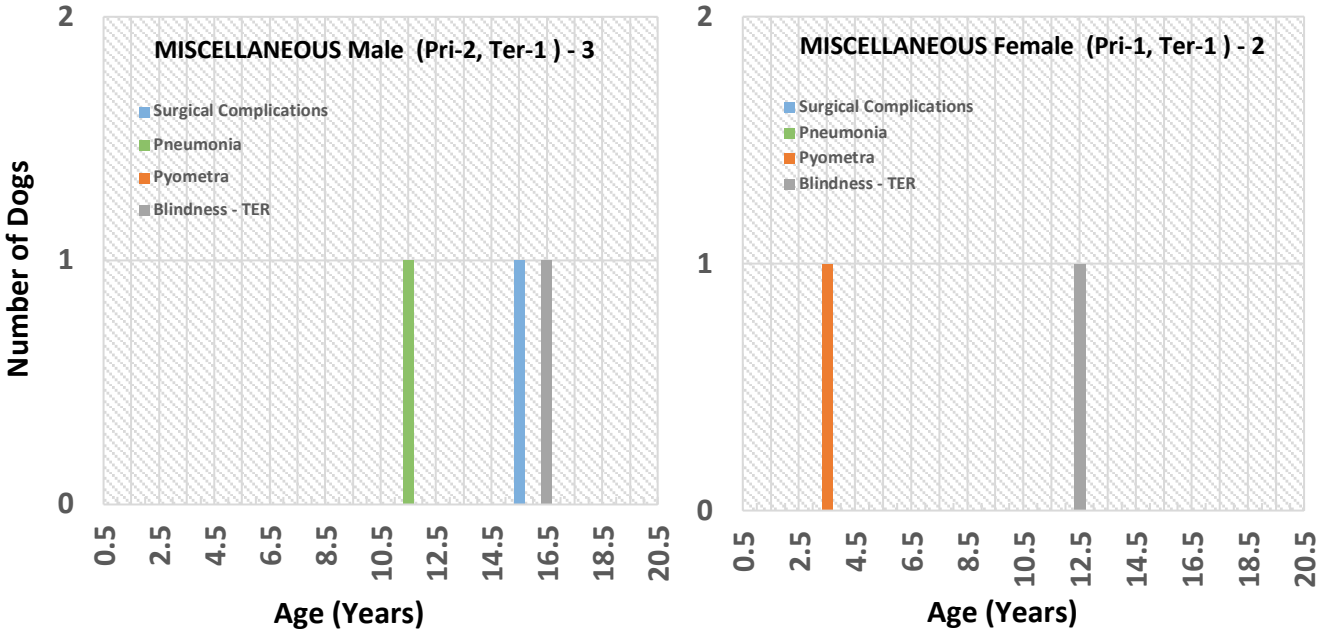
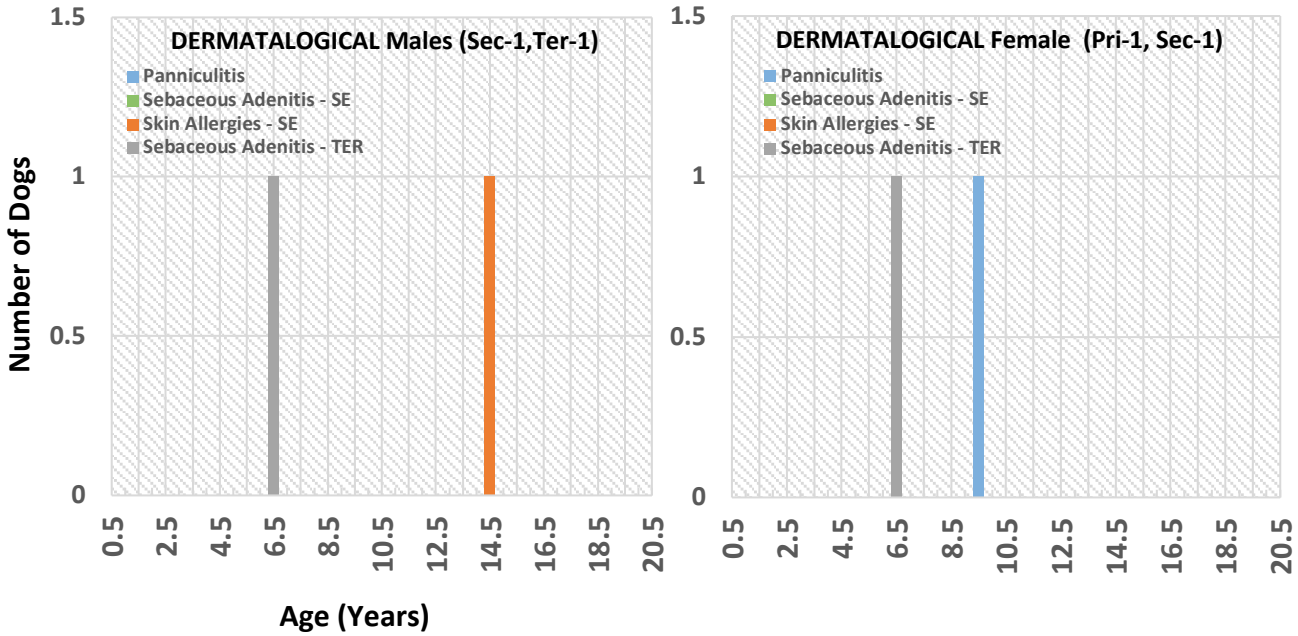


Figure XXVIII: The age at death for 1 male that succumbed in part to an Orthopedic problem as a secondary (1) cause.



Figures XXIX: The age at death for 5 males and females that succumbed to miscellaneous problems. Three males with 2-primary and 1-tertiary cause and two females with 1-primary and 1-tertiary cause.



Figures XXX: a) The age at death for 2 males and 2 females that succumbed to Dermatological related causes. as primary problems. The males with 1 secondary and 1 tertiary cause and the two females with 1 primary and 1 secondary cause.

9. Health Correlations: Spay-Neuter Age

In Section 2 the population of spay – neutered dogs is described. While all but six of the 156 dogs in the survey were spayed or neutered, the age was only provided for 118 dogs. Table IV contains the detailed statistics of the sample. About 54% males and 63% of the females were neutered or spayed before age 2. The average age at death for the males and females in the subsample of 118 dogs is given in Table IV and is consistent with the population of 156 dogs total in the survey.

Figure XXXI below shows the spay – neuter age versus the age of death of the dog, for the 118 dogs where we have information. All the dogs must lie above the dashed blue line and we see no clear correlation between the two ages, for males or females. One can see the slight increase in density around 6 years, as that is typically the age that breeding – females are spayed. The same increase is seen in the projection of the age at spay for females (Figure III).

If we sample those that were spayed or neutered before 2 years and compare with those spayed or neutered later, we show in Table XXII the average age at death for those males and females. This can be compared to the overall sample of 156 dogs of which all but 6 were reported to be spayed or neutered. The late spay – neutered dogs have a slightly longer lifetime. It is also possible that these are breeding program dogs and their health has been scrutinized more thoroughly. From a statistical standpoint however, there is no significant difference (<< 3 standard deviations) in the lifetimes reported for either of the categories.

Finally, Figure XXXII shows the cause of death for 118 spay or neutered dogs, versus the age at which they were reported to be spayed or neutered. In this plot, the cause is enumerated at the sub-category level shown in Appendix A, primarily to spread the points out within each main category. The main categories remain 1,2,3,4,5….13. Again, the populations do not show any obvious differences for the causes of death with the age of spay-neuter, recognizing of course the smallness of the sample.

Table XXII: Average Lifetimes of Spay or Neutered Dogs

Sample	**Male + Female (156)**	**Male (84)**	**Female (72)**
Average Lifetime (Whole Survey)	12.0+/-0.3	11.9+/-0.4	12.1+/-0.5
Sample	**Male + Female (118)**	**Male (54)**	**Female (64)**
Average Lifetime for 118 Spay–Neuter reported	12.0+/-0.3[118]	12.0+/-0.4	12.0+/-0.4
Average Lifetime for Spay-Neuter Before 2 yrs.	11.3+/-0.4 [74]	11.3+/-0.6	11.4+/-0.6
Average Lifetime for Spay-Neuter at 2 yrs. or Later	13.1+/-0.4 [44]	13.1+/-0.6	13.1+/-0.6

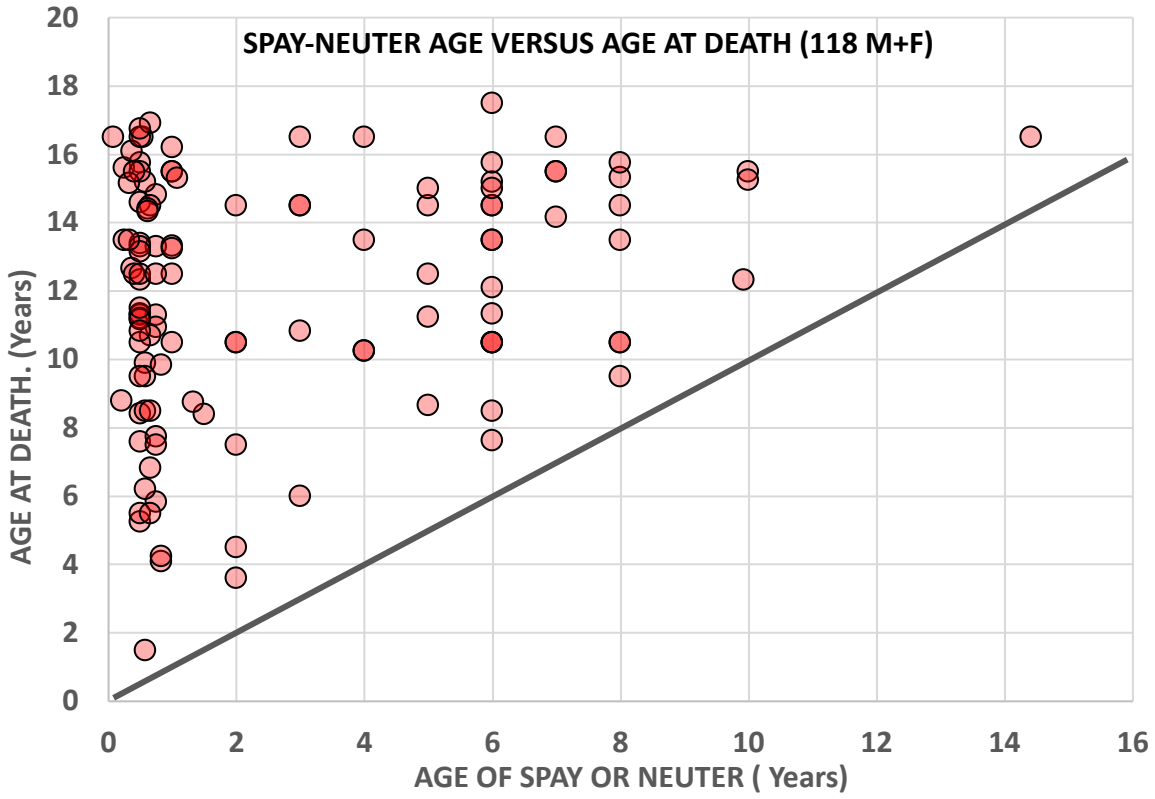


Figure XXXI: Age at spay – neuter versus the age of death of the dog, for the 118 dogs.

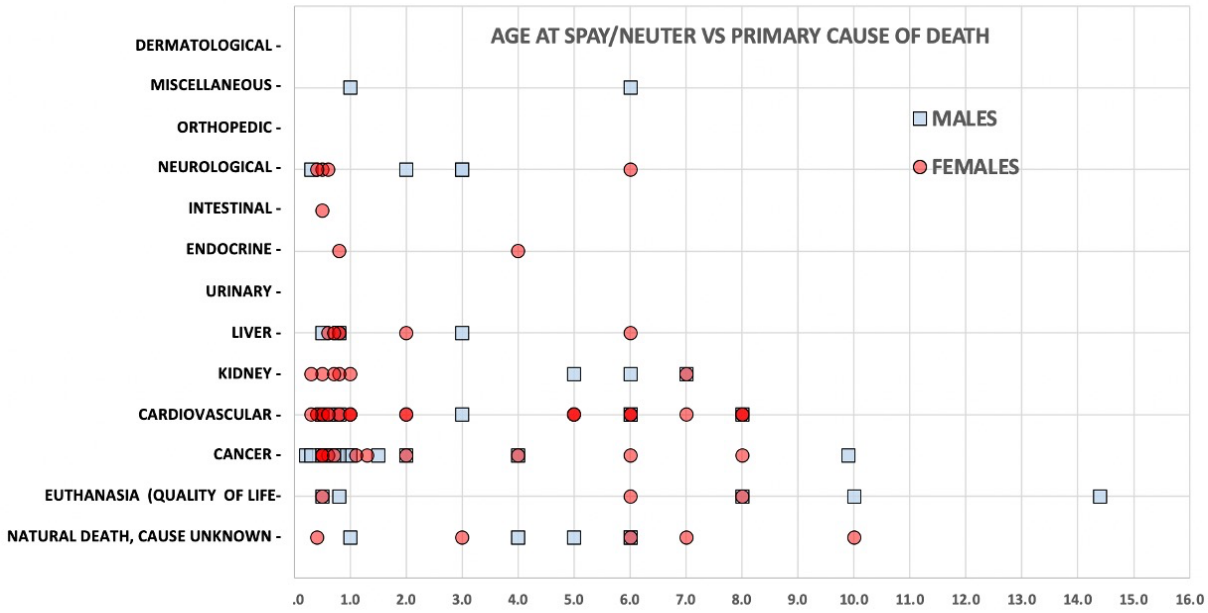


Figure XXXII. The primary cause of death for 118 males and females (vertical axis) versus spay-neuter age in years (horizontal axis).

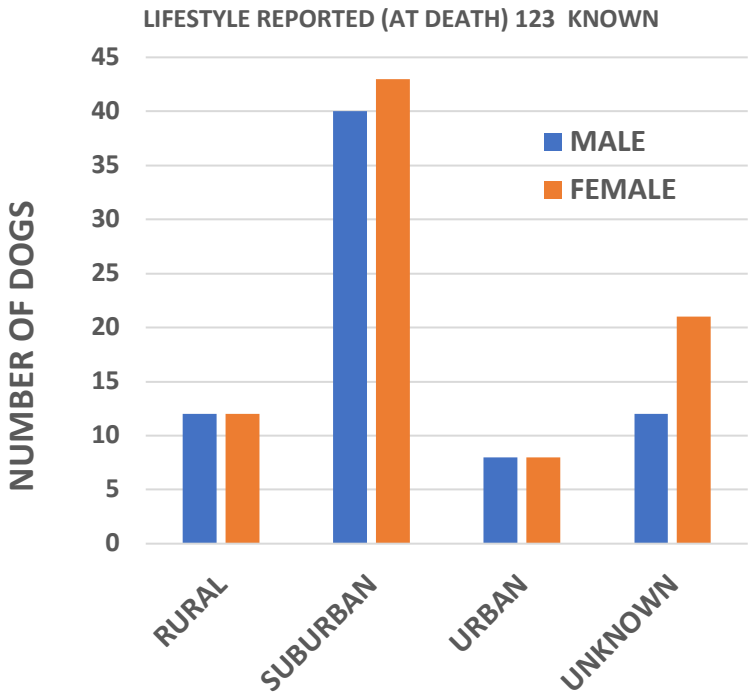


Figure XXXIII: The distribution of assignments of lifestyle for males and females. Unless indicated otherwise, the environment at the time of death was used to categorize each dog.

10. Health Correlations: Lifestyle

The lifestyles reported were categorized as shown in Table V and shown graphically in Figure XXXIII. We have chosen these simple categories to retain reasonable statistics in each. From the responses, only 123 of the dogs could be identified with specific lifestyles at the time of death. After being categorized, the average age at death was calculated for each category and sex. These average ages for all males and females are shown in Table XXIII and broken down by sex in Table XXIV. The errors are statistical only.

Table XXIII: The average age at death for all males and females categorized by lifestyle

MALE + FEMALE (156)				
Lifestyle Category	**RURAL**	**SUBURBAN**	**URBAN**	**UNK**
Number Assigned to Category	24	83	16	33
Average Age at Death (Years)	13.9	11.5	11.5	12.2
Error (Years)	+/- 0.6	+/- 0.4	+/- 0.9	+/- 0.6
RMS SPREAD (Years)	2.8	3.5	3.8	3.7

From the data in the two tables it can be observed that there is evidence for a difference in average lifetimes between dogs in rural environments to dogs in suburban and urban environments. This distinction appears both for males and females. The statistical significance for a difference between rural and suburban lifetimes is 3.6 standard deviations. Between rural and urban it is 2.2 standard deviations.

If we combine urban and suburban populations (99 total) and compare them to the rural population (24), the mean ages at death are 11.47+/- 0.35 years (suburban + urban) compared to 13.93+/-0.56 years (rural). The observed difference of 2.46 years in mean lifetime is a 3.71 standard deviation effect, which is quite significant. *The probability of a fluctuation that is this large is about 1 part in 10,000 if the probability distribution is Gaussian.*

Table XXIV: The average age at death, separated by sex and categorized by lifestyle

	MALES (72)				FEMALES (84)			
Lifestyle Category	**RURAL**	**SUBURBAN**	**URBAN**	**UNK**	**RURAL**	**SUBURBAN**	**URBAN**	**UNK**
Number Assigned	12	40	8	12	12	43	8	21
Average Age at Death (Y)	14.0	11.0	12.3	12.3	13.9	11.9	10.7	12.1
Error (Y)	+/-0.7	+/-0.5	+/-1.1	+/-1.0	+/-0.8	+/-0.6	+/-1.5	+/-0.8
RMS Spread (Y)	2.5	2.9	3.2	3.6	2.9	3.9	4.1	3.7

Examining Figure XXXV, we see that dogs in rural environments seem to show somewhat smaller incidents of cancer and heart diseases, but the statistics are very low. There are a larger percentage of deaths with “cause unknown” and “euthanization”, and a higher rate of kidney

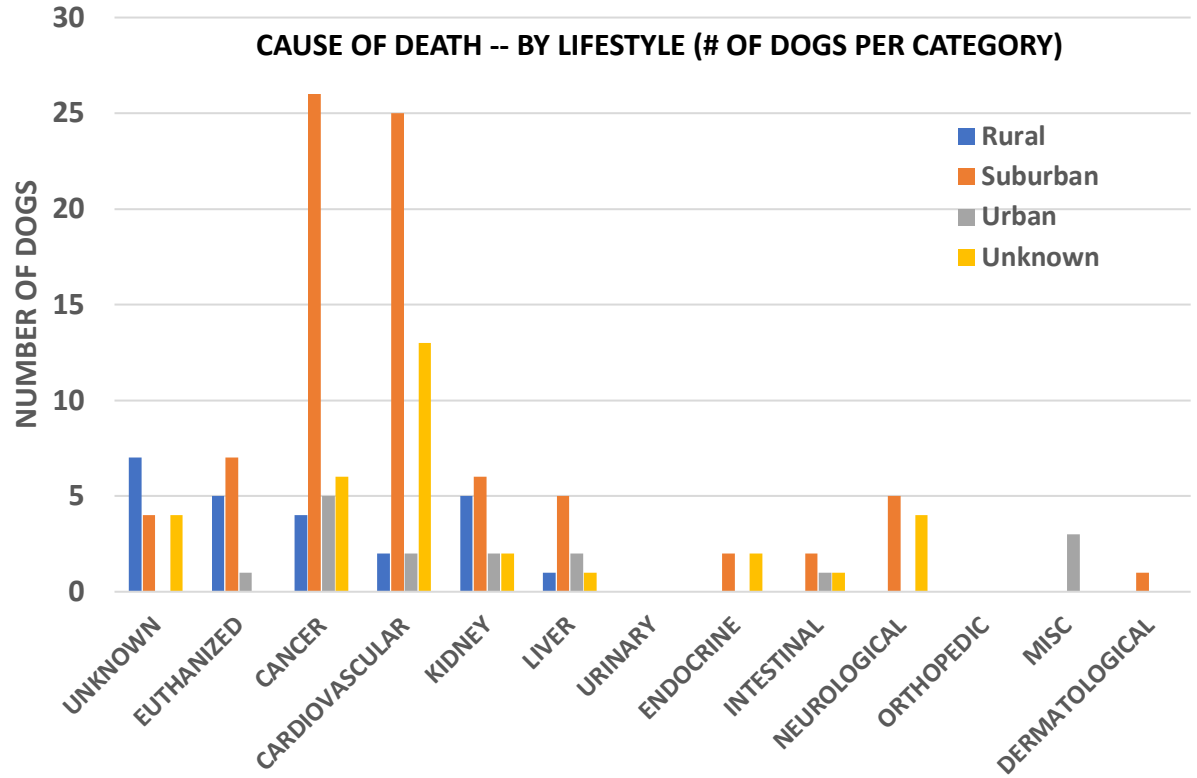


Figure XXXIV: The primary cause of death by lifestyle (number of dogs).

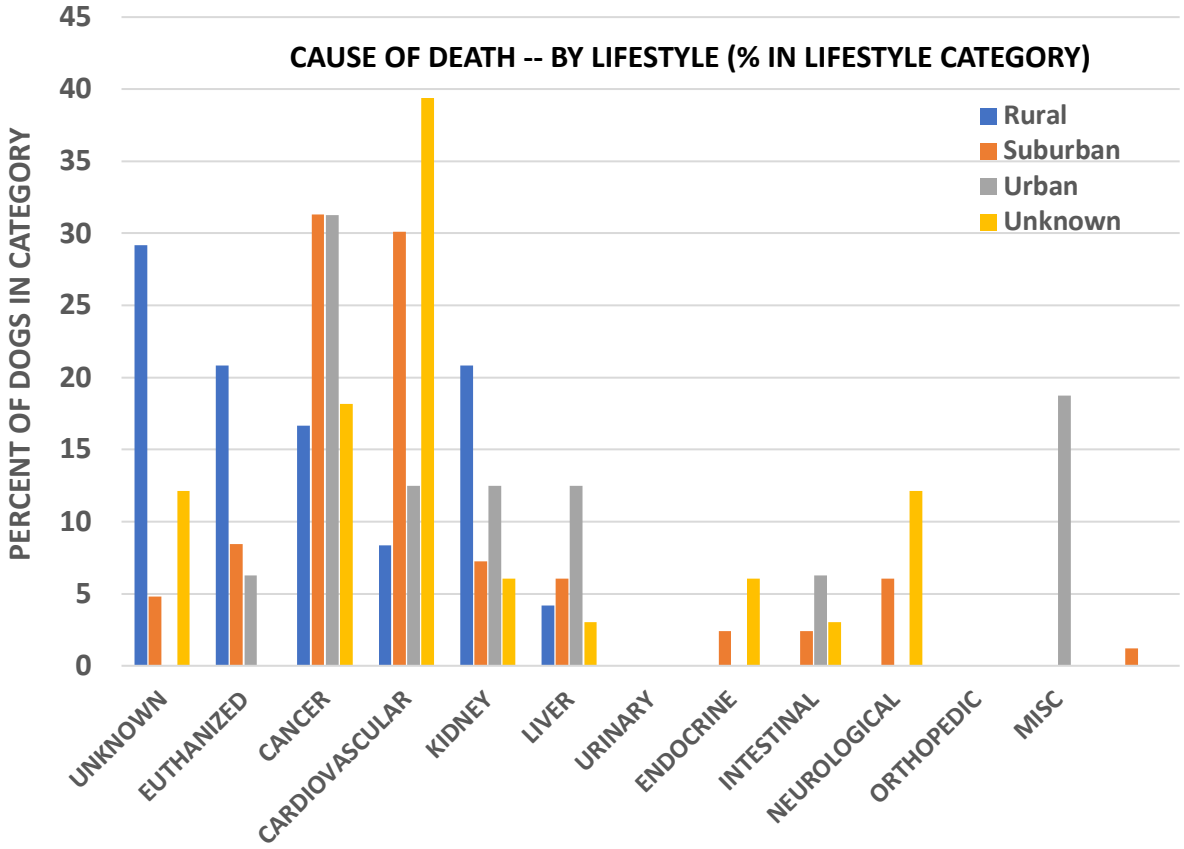


Figure XXXV: The primary cause of death by lifestyle (% per category).

diseases. All of the latter are consistent with having longer lifetimes than suburban and urban dogs (but these observations cannot be demonstrated as statistically significant differences).

11. Conclusions – The Natural Lifespan of Havanese

At each step of the process we have attempted to reduce bias, however it is important to keep in mind that given the small statistics, there is no method we can apply to test how well the survey population actually reflects the Havanese population at large.

The 2018-2019 Rainbow Bridge survey has proven useful in determining the primary causes of death in Havanese, their relative frequency, and the age distribution associated with each. In addition, the study reported (and discussed earlier in the text) more detailed correlations with gender, lifestyle and spay-neuter age, all of which had modest statistical support warranting follow-up. Figure XXXVI combines the former information together into a single plot.

Like all living animals, we expect there to be a natural progression of degeneration of cells ultimately leading to death by the failure of one or more organs. This process is frequently accelerated by diseases which lead to earlier degeneration in the functioning of one or more individual organs, followed by death.

Accordingly, we can use the survey to answer the question "*What is the natural lifespan of Havanese?*" One way to think about characterizing the natural lifespan (the "old-age" category) is to define it by those dogs that died either of unknown cause, or were euthanized for quality of life, or died from a classic natural organ failure that is associated with old-age – such as kidney failure.[10,11]

Figure XXXVII next shows the previous plot but now with just those three primary categories. From this we can define the natural lifespan of Havanese as the mean of those dogs in the peak (15.1 +/-0.4 years). This is well beyond the average lifetime of 12 years observed in the entire sample. It is what we mean when we say the dog lived to a "ripe old-age" – the age that all Havanese should aspire to.

Within the 13 primary disease categories, it was observed that many exhibited distinct age dependence. These included the three categories that were just used to define "old-age" (unknown, euthanasia for quality of life, and kidney failure). The remaining categories having distinct age dependence are liver diseases, cancer, and cardiovascular diseases. Those three are plotted alone in Figure XXXVIII. They are distributed largely below the "old-age" category from which we defined the natural lifetime and have only a small overlap out to its 15.1-year peak. *We could call these the "diseases of youth and middle age."* As we saw earlier in the

[10] The first two categories imply by our definition that there was no specific disease that was diagnosed.
[11] Endocrine diseases might be included in this categorization as well, as they appear to peak in the range of "old-age", however the statistics are very low. Neurological problems show a bimodal structure, with some grouping in young dogs and some grouping in this "old-age" category. Again, the statistics are poor.

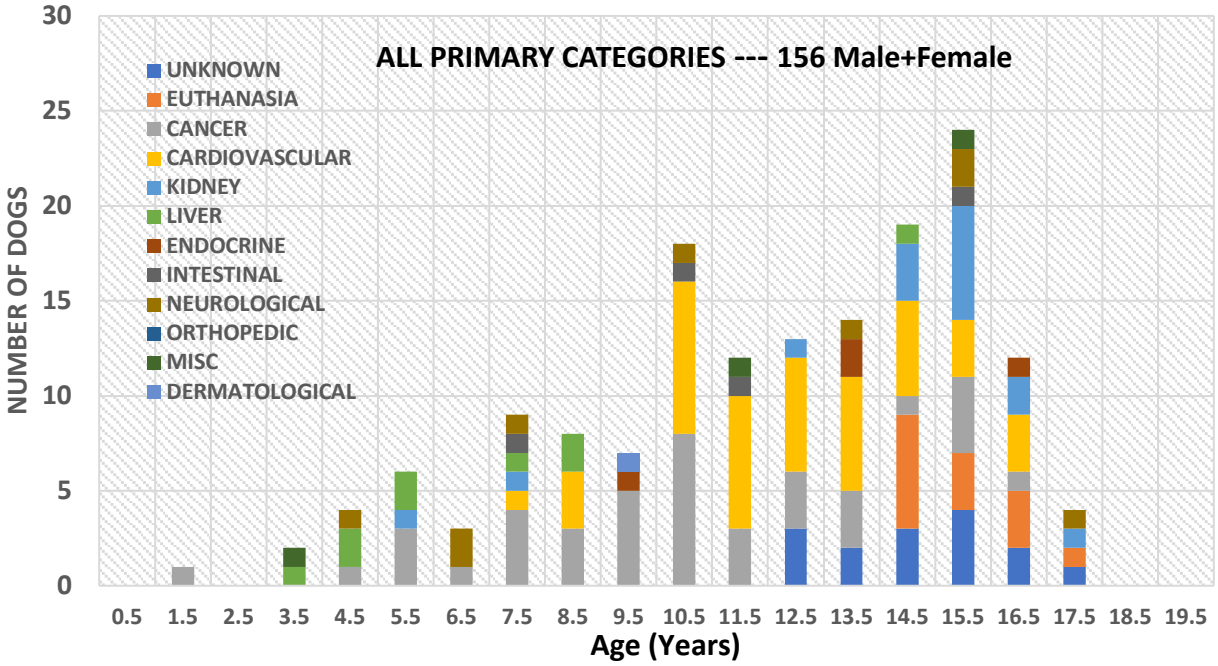


Figure XXXVI: The number of dogs in the 13 primary categories, by age - (156 total).

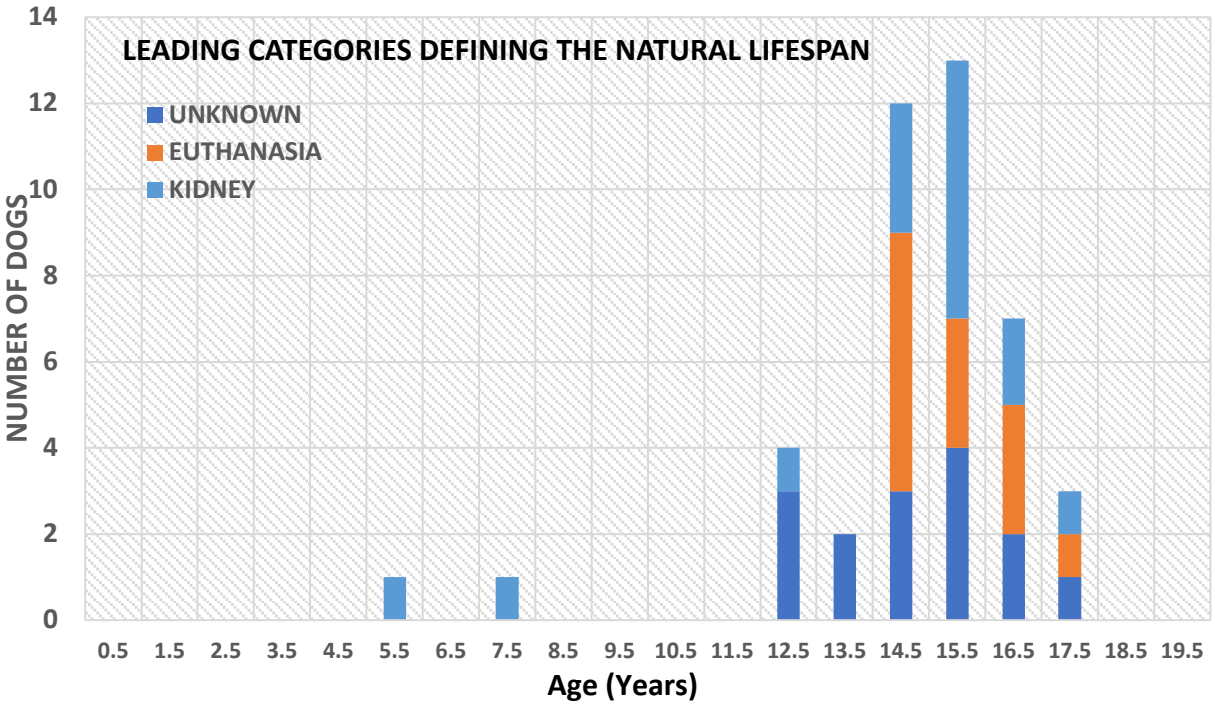


Figure XXXVII: The number of dogs in the 3 categories, used to define the natural lifespan.

study, each has a unique average lifetime associated with it, some gender dependence, and almost all the actual deaths lie below that of the old-age group.

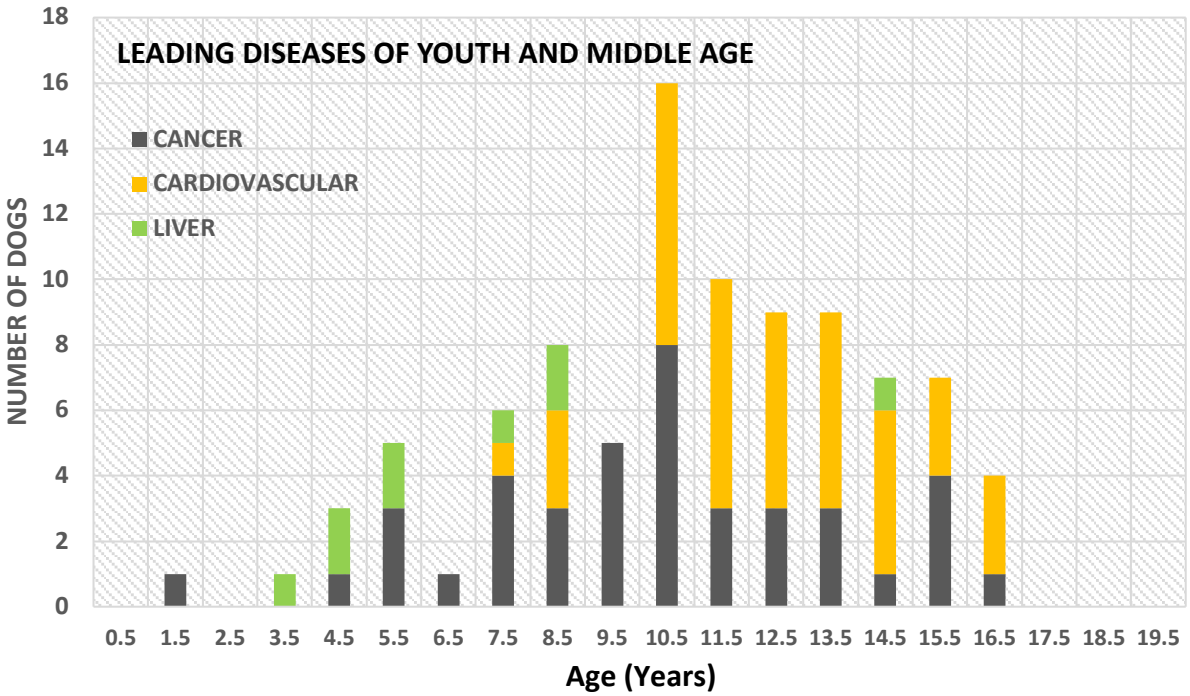


Figure XXXVIII: The number of dogs in each of the remaining primary categories which have a distinct age structure.

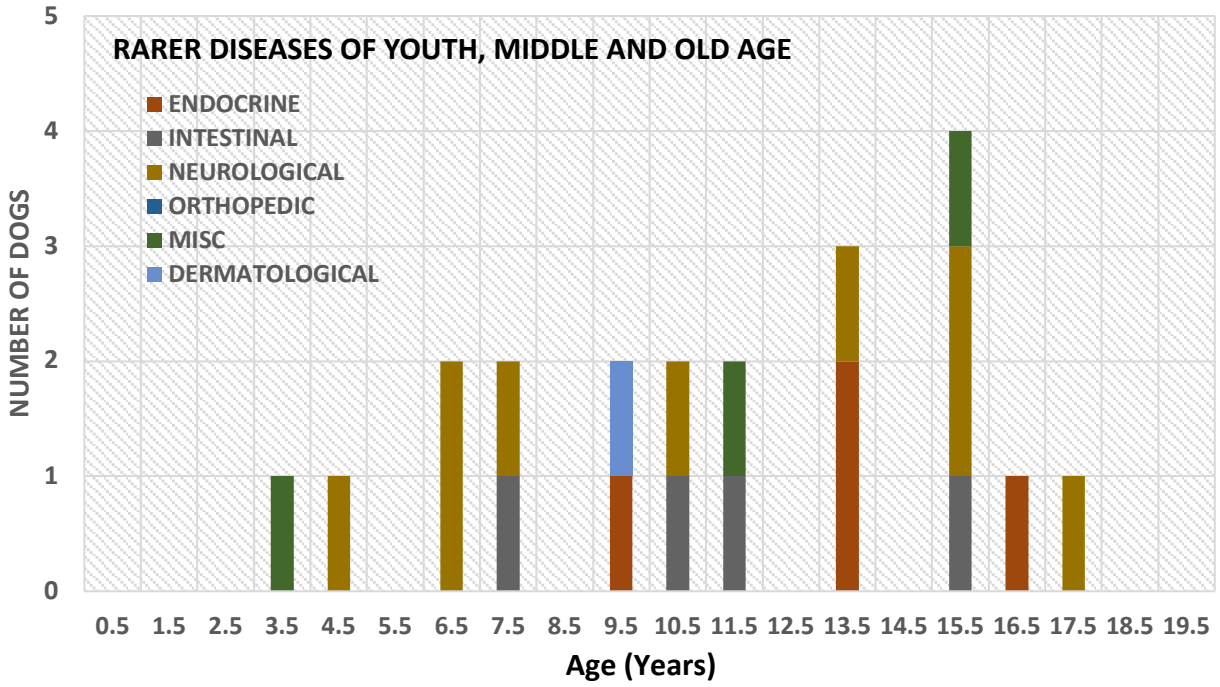


Figure XXXIX: The number of dogs versus age in each of the remaining primary categories which have low statistics and/or no distinct age structure.

Finally, we can plot what is left over in Figure XXXIX. There are only 21 dogs in this group (13% of the survey population). The plot is statistically flat, perhaps with some increase towards the "old-age" region. As indicated in Footnote 11, Endocrine diseases might have been included in the "old-age" group, save for their low statistics. Neurological diseases cluster both at short and long lifetimes, and if narrowed down to only certain categories (such as dementia), might also have been included in the old-age group. Accordingly, we can label this last category as the " rarer *diseases of youth, middle and old age*."

ACKNOWLEDGEMENTS

The authors would like to recognize the owners of all the Havanese that have been included in this survey. By taking the time to participate in this survey and provide detailed information about the health and lifestyle of their Havanese, the legacy of their dogs will be preserved. That information as compiled in this report, will no-doubt prove invaluable for improving the health of all future generations of Havanese.

APPENDIX A: DISEASE CATEGORIES

Category Labels	MAJOR CATEGORY SUB-CATEGORY
1	UNKNOWN
1.1	Cause Unknown - Natural Death
2	EUTHANIZATION (KNOWN AND UNKNOWN)
2.1	Unused
2.2	Unused
2.3	Old Age - Poor Quality of Life - Euthanized
2.4	Old Age - Poor Quality of Life - Pain - Euthanized
2.5	Euthanized (For other known cause)
3	CANCER
3.1	Unknown Type (Suspected)
3.2	Leukemia
3.3	Lymphoma (B & T Cell)
3.4	Soft Tissue
3.5	Prostate
3.6	Liver/Spleen
3.7	Lung (adenocarcinoma or other)
3.8	Brain (suspected)
3.9	Anal gland
3.10	Unused
3.11	Stromal cell (ovarian)
3.12	Tumor on heart muscle
3.13	Skin
3.14	Thymus
3.15	Adrenal gland cancer
3.16	Metastatic cancer (unknown origin)
3.17	Tumor on tissue near eye (suspected)
3.18	Hemangiosarcoma
4	CARDIOVASCULAR
4.1	Heart Failure (suspected)
4.2	Congestive Heart Failure (CHF) (known or unknown cause)
4.3	Mitral Valve Disease (MVD)
4.4	Enlarged Heart (Cardiomegaly)
4.5	Congenital Murmur
4.6	Stroke
4.7	Chronic Valve Disease (CVD)
4.8	Blood Clot (lung)
4.9	Cardiac Tamponade
4.10	Unused
4.11	Immune Mediated Thrombocytopenia
4.12	immune-Mediated Hemplytic Anemia
4.13	Adult onset Heart murmur
5	Kidney
5.1	Chronic Kidney Disease
5.2	Kidney Failure
6	Liver
6.1	Liver Shunt (PVD)
6.2	Microvascular Disease (MVD)
6.3	Hepatitis (Lymphoplasmacytic)
6.4	Chronic Liver Disease / Failure
7	Other Urinary Track
7.1	Bladder stones

8	**Endocrine System**
8.1	**Pituitary Gland: adenoma (growth, not cancer)**
8.2	**Pituitary Gland: Cushings Disease (hyperadrenocorticism)**
8.3	**Pancreas: Pancreatitis**
8.4	**Pancreas: Diabetes**
8.5	**Adrenal Gland: Addisons Disease - hypoadrenocorticism**
8.6	**Adrenal gland - rupture**
8.7	**Thyroid gland - suspected issue**
9	**Intestinal Tract**
9.1	**IBD (Enteritis with Clostridium)**
9.2	**Protein-losing enteropathy (PLE)**
10	**Neurological**
10.1	**Seizures: congenital defects (suspect)**
10.2	**Seizures: adult**
10.3	**Dementia (CCD: Canine Cognitive Dysfunction)**
10.4	**Epilepsy**
10.5	**Immune mediated meningitis**
11	**Orthopedic**
11.1	**Luxating patella**
11.2	**Hip dysplasia**
11.3	**Chondrodysplasia (CD)**
11.4	**Immobility due to Arthritis**
12	**Miscellaneous [fatal and non-fatal issues]**
12.1	**Surgical Complications**
12.2	**Pneumonia**
12.3	**Pyometra**
12.4	**Blindness**
12.5	**Hearing loss**
13	**Dermatological**
13.1	**Panniculitis**
13.2	**Sebaceous Adenitis**
13.3	**Chronic staph infections**
13.4	**Skin Allergies**

APPENDIX B: RAINBOW BRIDGE SURVEY (PART 1)

2018-2019 RAINBOW BRIDGE SURVEY

Please take a few minutes to answer these questions and return the survey either by mail or by email to:

rafe@slac.stanford.edu
or
Dr. Rafe H. Schindler
325 Sharon Park Drive, S.T.E. 214
Menlo Park, CA 94025

All information provided to the Health Committee will be treated confidentially. No information identifying a survey responder or a dog's name, registration or pedigree will ever be released publicly or privately.

RAINBOW BRIDGE SURVEY QUESTIONS, PART I

1) **Your Affiliation (check all that apply)**
   a. HCA member. [ ]
   b. Local or Regional Havanese Club member. [ ]
   c. Other AKC breed or all-breed club member. [ ]
   d. Havanese owner without a club affiliation. [ ]

2) **Your Status:**
   a. Currently a breeder of Havanese? [ ]
   b. Have been a breeder of Havanese? [ ]
   c. Owner but non-breeder of Havanese? [ ]

3) **Your email address just in case we have further questions surrounding your answers to the questions below: [** *optional* **].**

4) **If you have lost one or more Havanese by natural causes (i.e. disease, old age etc.), please answer the following questions for each dog:**

#	AKC Registered ? (Yes/No)	Sex (M/F)	Approximate Age at Death (Years, Mo)	Primary Cause(s) of Natural Death *	How Was Cause of Death Determined?	Age When Neutered or Spayed (Years, Mo) If Intact, Leave Blank	Describe Lifestyle **	Registered Name and/or Registration Number (optional) ***
1								
2								
3								
4								
5								

* Provide details as necessary. If cause of death is unknown, write "unknown." If it was necessary to euthanize a dog, please explain the circumstances:
for example, dog had T-cell lymphoma, in pain and had poor quality of life.

** We want to understand the kind of environment the dog was exposed to; e.g. urban, suburban, rural, or primarily a kenneled dog. Some brief information about the dog's lifestyle will also be helpful. For example; whether the dog lived as a pet, a kennel dog; whether it travelled a lot or stayed primarily at home.

*** This allows us to verify the dog's information isn't duplicated and will be kept strictly confidential. Indicate whether the dog has AKC (or other) registration, and if you know it, the registration number or registered name. If not registered, indicate "unregistered." If an HRI rescue, please also indicate "HRI."