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The spectrum of healthy aging in pets

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Veterinarians have long been taught that age is not a disease, but it is a risk factor for disease. There is not a single consensus definition of "aging," but it is commonly perceived as approaching the end of life and associated with increasing risk of disease and death due to accumulated cellular changes and damage over time.[1] This perception fails to emphasize the nonlinear, individual aspects of aging that can differentiate healthy from nonhealthy aging. It also fails to recognize that although the cellular changes occur and accumulate over time, the passage of time may not be the primary driver of aging in an individual.[1]

Hallmarks of Aging

Aging is a complex, heterogeneous, and modifiable process involving a number of interdependent cellular and molecular changes that reflect altered repair and homeostatic mechanisms. To date, twelve hallmarks of aging have been identified, highlighting the complex and multifactorial nature of the aging process.[2] These hallmarks include actionable cellular processes such as mitochondrial function, cellular senescence, and stem cell exhaustion, as well as systemic processes such as chronic inflammation and dysbiosis.

Cellular- and molecular-level changes are responsible for producing the observed signs typically associated with aging, which may include cognitive changes, metabolic diseases, arthritis, sarcopenia, frailty, reduced bone mass, kidney disease, cardiovascular disease, and cancer.

"Aging" Does Not Equal "Old"

Aging does not start in "senior" pets: the aging process is a continuum, and tissue function and health start to decline even before midlife, emphasizing the importance of early preventive care as well as early management of later-life health events. The spectrum of aging reflects the range of an individual's aging processes from unhealthy to healthy and is indicated by the relationship between lifespan, which is the actual length of time an individual lives, and healthspan, which is the period of life with good health and freedom from disease. The greater the overlap between healthspan and lifespan, the healthier the pet and their aging process. (**Figure 1**)

Of Note

- Age is not a disease, but it is a risk factor for disease and pets' aging trajectories are individual.
- Biological age is an indicator of how well an individual is aging and is malleable.
- A focus on healthspan and healthy aging can empower proactive and preventive veterinary care.

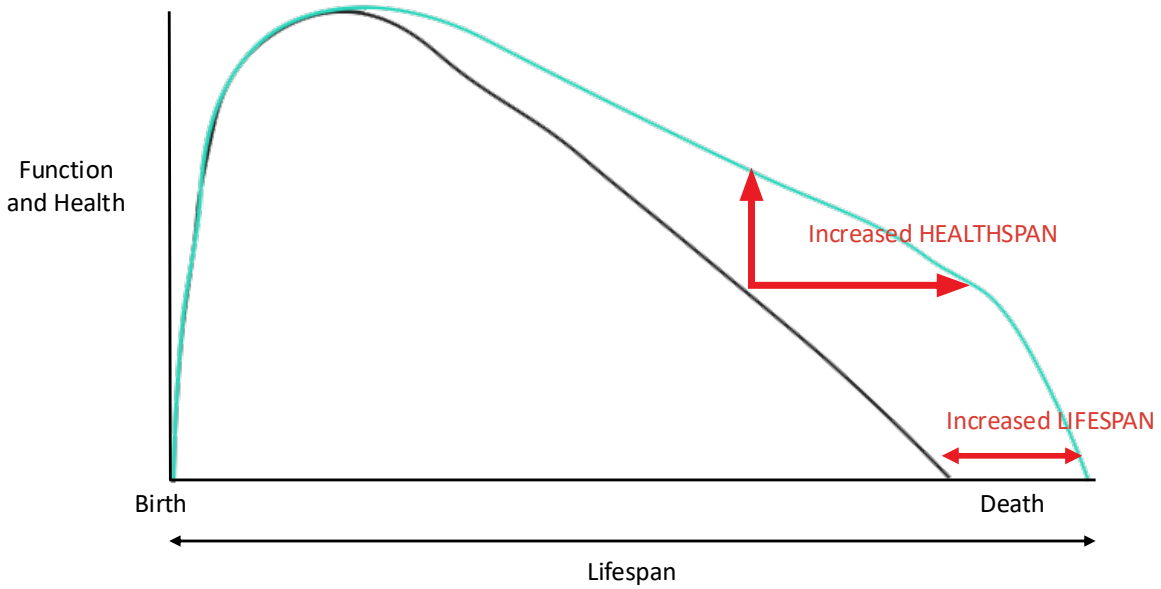
Targeting the aging hallmarks with nutritional, lifestyle, and/or pharmaceutical interventions may help mitigate the aging process and improve an individual pet's healthspan and aging trajectory.

Chronological Age vs Biological Age

Chronological age (CA), or calendar age, is the number of years, months, and days an individual has lived since birth. However, the inherent weakness of chronological age is evident when considering a small-breed dog and a large-breed dog of the same age; although both dogs have lived the same number of years since birth, they do not age at identical rates. Similarly, a dog or cat that develops chronic comorbidities will age differently than their littermates. Biological age (BA) reflects the physiological and functional status of the individual and provides a more accurate indication of how well an individual is aging.[3,4] Although CA cannot be changed, BA is malleable. Factors known to impact BA in humans and likely to influence BA in pets include body weight, exercise, stress, nutrition, and disease conditions.[2]

BA is measured by biomarker-based complex algorithms called biological clocks.[3,4] Epigenetic biological clocks are based on DNA methylation, whereas phenotypic clocks are based on laboratory blood analysis results.[3,4] Other clocks, such as those based on organ-specific plasma biomarkers or the microbiome, are also in various stages of investigation.[3]

Figure 1. Representation of healthspan and lifespan of two individuals, one of which (green line) showed healthier aging than the other (black line).



When BA is higher than CA, it indicates accelerated aging, and the mismatch between BA and CA may reflect increased disease susceptibility as well as reduced healthspan and lifespan.[3,4] When BA is lower than CA, it indicates the favorable condition of aging more slowly than one's years.[3,4]

Biological Age as a Wellness Indicator

Focusing on the pet's position and trajectory on the spectrum of aging can empower proactive veterinary care. As biological clocks for pets improve and become more accessible, biological age can provide a measurable indicator of the quality of a pet's aging process. Tracking biological age has the potential to foster client adherence and reinforce the effects of health interventions. For example, information regarding a pet's lifespan is a critical driver of pet owner acceptance of veterinary recommendations for weight management.[5,6] The Purina lifespan study discovered that feeding dogs to maintain an ideal body condition throughout life increased the dogs' lifespan as well as their healthspan[7] and reduced their biological age compared to overweight control dogs,[4] providing an aspirational, yet realistic, incentive for adherence to veterinary recommendations.

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Aging and sarcopenia–inevitable or preventable?

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Senior pet care is increasingly important for veterinary healthcare teams (VHCT) and pet owners alike because pets are living longer. Senior pets in the US are estimated to make up well over one-third of the population with this proportion continuing to grow.[1] Even in health, physiologic changes associated with aging are characterized by a functional decline and a gradual accumulation of changes over time, resulting in increased vulnerability to chronic disease, frailty, and ultimately, the end of life.

Loss of Lean Muscle

Sarcopenia is defined as the progressive, generalized loss of skeletal muscle mass and function that occurs with aging in the absence of disease. The pathogenesis of sarcopenia is multifactorial and complex. Briefly, the rate of muscle injury and degradation exceeds the rate of repair and regeneration. Contributing factors include altered protein turnover with decreased muscle synthesis. Sarcopenia leads to reduced muscle strength, impaired physical performance, and diminished quality of life. Both sarcopenia and cachexia (loss of lean mass associated with disease) can independently have a negative impact on clinical outcomes. Cachexia and sarcopenia can occur together, since chronic disease commonly impacts older pets. When they occur concurrently their effects can be synergistic, accelerating functional decline and further compromising quality of life. As companion animals live longer, recognition and management of sarcopenia is increasingly important to preserve strength, mobility, immune function, and overall well-being.[2]

Identifying Sarcopenia: Despite recognition of the negative health aspects of sarcopenia, it can go undetected. The guidelines[3] for nutritional assessment of patients recommend assessing every pet's body weight, body condition score (BCS), and muscle condition score (MCS). Body condition scoring primarily provides an assessment of fat stores, while MCS is the clinical method for evaluating lean body mass (LBM) and an important way to identify sarcopenia. Typically, the epaxial muscles in the thoracolumbar region are sites where muscle loss can be identified in its earliest stages. Careful evaluation of both BCS and MCS is important to detect LBM loss in the face of excess body fat (sarcopenic obesity). With the high prevalence of overweightness and obesity in senior pets, excess fat can obscure detection of muscle loss. Consistently evaluating a pet's MCS throughout life will help identify early changes in muscle mass so loss can be identified at an early stage when intervention strategies will be more successful.

Intervention Strategies: Since the etiology of sarcopenia is multifactorial, approaches to mitigating muscle loss must also be multimodal, integrating nutritional modification, physical activity and life style changes, and potentially medical therapies in the future. Exercise is the most effective proactive and preventive strategy to minimize sarcopenia and should be incorporated as tolerated.[4]

Of Note

- Sarcopenia—the age-related loss of muscle mass and function in the absence of disease—contributes to frailty, a decline in quality of life, and a shortened lifespan.
- Early detection with targeted interventions can slow progression and support healthy aging.
- Multimodal management, primarily nutritional intervention and exercise, offers the greatest benefit for preserving muscle mass and function.

Nutritional Management of Sarcopenia

Providing an individualized nutritional recommendation addressing the needs of aging pets also plays a critical role.

Energy: Meeting a patient's unique energy needs to achieve and maintain an ideal BCS and MCS promotes healthy aging and healthspan. Excess body fat promotes inflammaging, the chronic inflammation contributing to the pathogenesis of sarcopenia.

Protein: Healthy older pets do not benefit from protein restriction, and based on evidence that aging dogs[5] and cats[6] benefit from increased protein intake, senior pets may benefit from increasing protein intake by up to 1.5–2 times maintenance intake with the inclusion of muscle building amino acids (leucine) and those amino acids that may decrease muscle degradation (lysine).[4] Protein recommendations can be found in **Box 1.**

Vitamin D: Epidemiologic studies in humans showed an association between low serum vitamin D and sarcopenia, with supplementation leading to improvement in muscle strength and mass. Studies on supplementation of vitamin D in aging dogs and cats are lacking, and complete and balanced commercial pet food provides vitamin D. Evaluating vitamin D status in healthy aging pets is an area for future study.

Omega-3 fatty acids: Dietary fats such as omega-3 polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) may benefit senior pets by modulating inflammation, thus supporting muscle mass. Some omega-3 interventional studies have shown improvement in sarcopenia of aging people, but this has not been evaluated in senior dogs or cats.

Box 1. Protein recommendations for senior and geriatric dogs and cats.

As a general guide the adult daily maintenance protein requirement should be considered "minimum" for healthy senior pets. Based on the NRC 2006[7] recommended allowance of daily protein requirements for healthy adults:

- Cats should have at least 5 x $BW_{kg}^{0.67}$ grams of protein/day
  - The increased protein intake for healthy senior and geriatric cats would be up to 7.5–10 x $BW_{kg}^{0.67}$ grams of protein/day
- Dogs should have at least 3.5 x $BW_{kg}^{0.75}$ grams of protein/day
  - The increased protein intake for healthy senior and geriatric dogs would be up to 5.25–7 x $BW_{kg}^{0.75}$ grams of protein/day

The increased level of protein intake should help preserve lean body mass (LBM), especially when combined with physical activity.

Summary

Growing evidence highlights the vital role of nutrition in preserving LBM during aging. A proactive, individualized approach to feeding senior pets focused on maintaining optimal body weight and condition with complete and balanced nutrition provides the foundation for preventive care to promote their health-span. In healthy senior dogs and cats, increased dietary protein can help attenuate the loss of LBM associated with aging. Further investigation is needed to explore nutrients studied in other species and to define optimal nutrient requirements and strategies to reduce or prevent sarcopenia in companion animals.

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Digestive health in senior dogs and cats

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Impact of Aging on Digestive Health

Aging may impact digestive health by decreasing digestive function via reduced nutrient digestibility and assimilation.[1] Decline in pancreatic enzyme secretion may also be seen in senior pets, and colonic motility may be reduced with aging, which may lead to constipation.[1]

Digestive Health Considerations for Senior Pets

Reduced pancreatic enzyme secretion and decreased nutrient digestibility, assimilation, and gut motility are key considerations for senior pets. This may manifest as decreased food intake, reduced body condition, dehydration, diarrhea, or constipation. In addition, as animals age, they may be susceptible to other morbidities and subclinical disease. Therefore, careful monitoring of food intake, body weight, body condition, and lean body mass in senior pets is paramount so that adjustments in the diet and feeding management can be made as soon as possible to address these, or so further diagnostic investigations can be performed to assess for any underlying disease conditions. Interestingly, the few studies evaluating the effect of aging on the nutritional needs of dogs have shown minimal changes to nutrient requirements.[2] Therefore, in order to meet the nutritional goals for senior pets, which include optimizing the quality and longevity of life, as well as minimizing disease, they should be fed to ensure adequate food intake of a complete and balanced diet.

Key Dietary Factors for Digestive Health in Senior Pets

Ensuring fresh clean **water** is readily available and intake monitored is important for all senior pets, as they may be more prone to dehydration.[1-3] Switching cats to a canned food or adding water to the food may be needed to encourage water intake. As animals age, their subcutaneous fat increases, lean body mass decreases, and their basal metabolic rate gradually declines.[4] Therefore, for those pets, particularly those that are no longer as active, reducing the number of **calories** fed may be warranted to help prevent obesity.

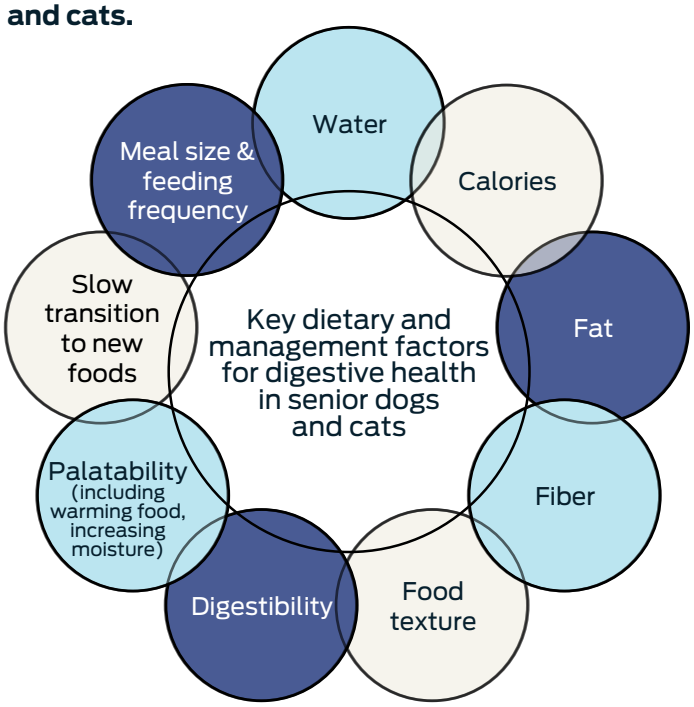
Of Note

- Senior pets may have altered calorie needs, depending on body condition score, activity level, health conditions, and other factors.
- Due to the impact of aging on digestive health, senior pets may be susceptible to diarrhea and constipation and therefore should be monitored for this and nutritional adjustments made as warranted for the individual animal.
- Senior pets are prone to dehydration; therefore, ensuring fresh clean water is always available and monitoring intake are paramount.

However, for those dogs and cats that are geriatric and underweight and have been demonstrated to have inadequate energy intake, calories should not be reduced. Instead, a more energy dense food should be considered. In addition, feeding a diet with higher **fat** to these pets is advantageous as this will increase the energy density, palatability, caloric intake, and absorption of fat-soluble vitamins. Cats twelve years and older have been shown to have 10% reduction in fat digestibility;[5] this may be due to the decline in pancreatic enzyme secretion that is seen with aging. Fat should be in a highly digestible form in foods for senior cats.

As senior pets are prone to constipation from decreased water intake, decreased activity, and reduced colonic motility, diets higher in **fiber** can be considered.[2] Fiber has many advantageous effects on digestive health; for example, fiber promotes normal intestinal motility and provides fuel for colonocytes via the production of butyrate following fermentation by colonic microbiota.[6] However, for those pets that are very old and have reduced intake and body condition, feeding a diet with increased caloric

Figure 1. Schematic of key dietary and management factors for digestive health in senior dogs and cats.



density and digestibility is preferred over a diet with higher fiber.

Finally, as senior pets are more predisposed to periodontal disease, changing **food texture** may be needed to help with intake and mastication. For those senior cats where oral intake is reduced due to decreased or altered smell or taste from oral disease, metabolic disorders, or medications, diets with higher **palatability** and **digestibility** should be prioritized. Similarly, diets that are highly palatable and highly digestible should be prioritized for any senior pet with inadequate food intake and weight loss.

Dietary Supplements and Feeding Management for Digestive Health in Senior Pets

Dietary supplements to improve digestive health in senior pets may include probiotics to help maintain healthy gut microbiota; fiber supplements, such as psyllium, if constipation is present; or cellulose if reduced colonic motility is suspected. Additional feeding management for digestive health in senior pets includes slower transitions to new foods over a 7- to 10-day period to help prevent any digestive upset, and consideration of feeding smaller more frequent meals throughout the day to increase digestibility and colonic motility. Finally, for those senior pets with reduced intake, feeding moist foods and warming the food may help to encourage intake. Furthermore, for underweight cats, allowing all-day access to dry food or combining this with canned meals throughout the day may help with intake.

Monitoring Digestive Health in Senior Pets

Regular monitoring of body weight, body condition score, muscle condition, food and water intake, and stool frequency and consistency is important to determine tolerance to the diet and feeding management and whether any adjustments or changes are needed for the individual pet.

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