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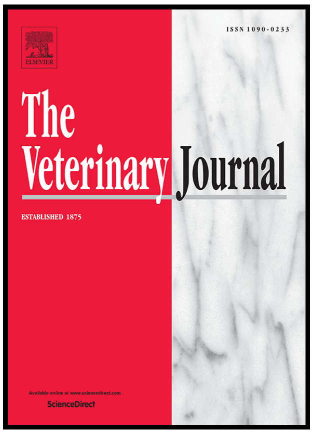

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Review

Mobility, functionality and functional mobility: A review and application for canine veterinary patients

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Abstract

Mobility is an essential aspect of a dog's daily life. It is defined as the ability to move freely and easily and deviations from an animals' normal mobility capabilities are often an indicator of disease, injury or pain. When a dog's mobility is compromised, often functionality (ability to perform activities of daily living; ADL), is also impeded, which can diminish an animal's quality of life. Given this, it is necessary to understand the extent to which conditions impact a dog's physiological ability to freely move around their environment to carry out ADL, a concept termed functional mobility. In contrast to human medicine, validated measures of canine functional mobility are currently limited. The aim of this review is to summarise the extent to which canine mobility and functionality are associated with various diseases and how mobility and functional mobility are currently assessed within veterinary medicine. Future work should focus on developing a standardised method of assessing functional mobility in dogs, which can contextualise how a wide range of conditions impact a dog's daily life. However, for a true functional mobility assessment to be developed, a greater understanding of what activities dogs do on a daily basis and movements underpinning these activities must first be established.

Keywords: Canine activity; Dogs; Lameness; Mobility assessment; Pain

Introduction

Mobility is defined as the ability to move freely and easily (Bouça-Machado et al., 2020). It is an essential element in understanding the health and welfare of animals within the veterinary profession as changes to the animals' mobility capabilities are commonly an indicator of an injury or disease, which could ultimately impact a dog's daily life. Limitations in mobility may be the adaptive response to pain, or a mechanical dysfunction as a result of chronic or acute conditions affecting nerves, soft tissue, joints, bones or organs in one or more parts of the body (Hudson et al., 2004; Montalbano, 2022).

Alterations to mobility may also be accompanied by changes to an animal's functionality, which specifically refers to the ability to perform activities of daily living (ADL) (Fig.1). For humans, basic ADL typically include factors such as: ambulation/transferring, feeding, dressing, toileting, continence and personal hygiene (Katz et al., 1963; Mlinac and Feng 2016). Other more complex activities which enable humans to independently function and integrate within a community are often referred to as Instrumental ADL. Instrumental ADL include activities such as managing finances, transportation, telephone calls, medications, housekeeping and shopping for groceries (Lawton and Brody 1969; Mlinac and Feng 2016). The establishment of a comprehensive list of ADL for domestic dogs has lacked attention. Frye et al. (2022) set out basic activity for daily independent mobility (BADIM) and Instrumental activities for daily quality of life (IADQOL) to categorise canine geriatric patient function. The BADIM includes rising from a down position, ambulation in and out of the home, posturing to eliminate and posturing to eat and drink. The IADQOL includes; ascending/descending a full flight of stairs, moving in and out of a vehicle, walking short distances outside, exploring the home environment, interacting in play, ability to navigate place of rest and maintain control of urination and defecation for six to eight hours. However, there is a lack of justification to why these factors should be defined as a dog's basic and instrumental ADL, therefore further exploratory research is required, as discussed later in the present paper.

The combination of the terms mobility and functionality refer to the umbrella concept of functional mobility; defined as a patient's physiological ability to freely move around their environment to carry out ADL (Fig.1; Forhan and Gill 2013; Bouça-Machado et al., 2020). As a concept, functional mobility differs from sole mobility and functionality since it concerns itself with movements that underpin and permit the performance of ADL, which have been described to include standing, walking, bending and climbing for humans (Forhan and Gill 2013; Bouça-Machado et al., 2020). Little attention has been given to the fundamental movements which underpin activities for dogs, which perhaps may be due to the limited work defining ADL for dogs.

Reduced functional mobility has been shown to impact QoL in humans. For example, the inability of an individual to navigate around their environment to perform basic everyday activities can result in a loss of independence (Covinsky et al., 2003). Arguably this factor is less disadvantageous to a domestic dog since they are generally reliant upon owners providing necessities such as food, shelter and healthcare (McKenzie and Chen 2022). However, most healthy dogs are still usually expected to perform certain movements and functions without physical assistance, including transitions (such as sit to stand), posture (to feed or eliminate) and ambulation around their environment (Frye et al. 2022). The lack of ability to perform such physical movements can present a significant emotional, physical and financial burden on the primary caregiver of the dog (Thomovsky and Ogata 2022). For example, in extreme cases, onus may be placed on the dog's primary caregiver to be responsible for assisting ambulation through a supportive harness or sling, or expressing the bladder (Granger et al., 2020; Thomovsky and Ogata 2022). Furthermore, compromised functional mobility may impact the psychological state of a dog; the inability to move around and perform activities a dog was once able to do may induce stress or reduce cognitive stimulation leading to boredom. (Burn 2017; Belshaw et al., 2020a; Thomovsky and Ogata 2022).

There are several differing methods of assessing canine mobility which exist within veterinary medicine. However there is need for a greater inclusion and attention to functionality, and fundamental movements underpinning the performance of ADL to further evaluate a canine patient's overall functional mobility; especially given that reduced functional mobility can present consequences to both the dog and their owner. Whilst various tools have been developed to assess functional mobility or the performance of ADL in humans (e.g. Katz et al., 1963; Lawton and Brody 1969; Collen et al., 1991; Podsiadlo and Richardson, 1991; Graham et al., 2004; Nitz et al., 2006; Bouça-Machado et al., 2020), there is a lack of generic mechanisms specifically validated to measure canine functional mobility in veterinary medicine, particularly outside the context of musculoskeletal or neurological conditions.

This review aims to explore the extent to which various diseases or conditions can impact canine mobility and functionality. We aim to summarise measures currently used to assess mobility and functional mobility, before highlighting the importance and future direction of research into canine functional mobility, to further bring forth its valuable practical application into canine veterinary medicine.

Prevalence of mobility and functionality impairments

Compromised mobility is a common reason for owners to seek veterinary advice (Kerwin and Taylor, 2021). The prevalence of mobility-compromising disorders in canine veterinary medicine is deemed high. For example, in veterinary practice, musculoskeletal disorders, which are commonly associated with compromised mobility and functionality, are the fourth most prevalent disorder seen in primary care practice in the UK (Scott and Witte, 2011; O'Neill et al., 2021). The most common musculoskeletal condition reported is osteoarthritis (OA) which is estimated to affect up to 20% of the canine population (Johnston, 1997; O'Neill et al., 2014; Marcellin-Little et al., 2014). Although OA in dogs has been considered a disease associated with ageing, in one study radiographic evidence of the disease has been observed in 39.8% of dogs under 4 years of age, with up to 23.6% showing clinical signs of the condition (Marcellin-Little et al., 2014; Anderson et al., 2018; Enomoto et al., 2024). Interestingly research by Belshaw et al. (2020b) found many owners of dogs with OA recognised subtle changes in their dog's ability to perform functionalities, including reluctance to go for a walk, get out of bed, play, a reduced ability to jump into a car, as well as lameness.

Mobility-inhibition can also commonly stem from neurological conditions (Bartner, 2020). Neurological disorders can often cause gait abnormalities and can be categorised as neurogenic lameness, such as those causing pain, paresis or ataxia (Bartner, 2020). Examples include degenerative disc disease or vertebral malformations, resulting in compression of the spinal cord, or tumours of the brain, spinal cord or peripheral nerves (McKee, 2007). In extreme cases canine patients with neurological disorders may become recumbent (Spinella et al., 2022), ultimately compromising their functionality in such instances. In many cases neurological disease may present with similar signs to orthopaedic diseases, which can prove challenging during initial diagnosis (McKee, 2007; Kerwin and Taylor, 2021), although the impact on mobility may be similar.

Non-musculoskeletal and neurological conditions can also impede a dog's ability to move freely and easily as well as their ability to perform ADL. For example, respiratory and cardiac diseases, such as canine idiopathic pulmonary fibrosis (CIPF), brachycephalic obstructive airway syndrome (BOAS), and congestive heart failure (CHF), compromise mobility by diminishing a dog's exercise tolerance (Boddy et al., 2004; Lilja-Maula et al., 2014; Lilja-Maula et al., 2017) which could reduce their ability to participate in physical, or high intensity activities such as going out for walks or behaviours associated with play. Canine oncology patients are reported by owners to have reduced mobility and be less playful post initial cancer diagnosis (Iliopoulou et al., 2013). Common clinical signs of gastrointestinal, liver and kidney disease can often include lethargy, weakness and pain (Hughes and King, 1995; Jergens, 1997; Weingarten and Sande, 2015; Dunaevich et al., 2020). Thus, ideally any measurement of an animals' mobility needs to be sufficient to encompass all diseases which could have such affects, as well as how their ability to perform daily activities is compromised.

Diagnosis and monitoring of mobility and functional mobility impairments

Clinical veterinary assessment

Clinical veterinary examinations are often used to assess mobility and the performance of certain functionalities. These generally comprise of gathering historical information reported by the owner on their pet's ability to undertake daily activities, observation of movement or gait and palpation of body regions. Clinical veterinary examinations are important as they are a rapid and cost-effective way to localise the problem or areas requiring medical interventions and guide further diagnostic workups such as targeted ancillary tests (Millis and Mankin, 2014). However, there is currently a lack of standardisation within clinical veterinary examinations (Montalbano, 2022), which means mobility assessments in clinic are at risk of intra- and inter-observer variation.

The clinical veterinary examination can only offer a one-off insight into the dog's mobility and functional mobility capabilities at a given time on a given day. In reality, both mobility and functional mobility are continuous traits that require a temporal context since capabilities can be impacted by other factors (Brown et al., 2013), such as activities undertaken on a previous day. Additionally, the clinical environment may induce arousal or stress which may mask subtle clinical changes or the expression of pain (Brown et al., 2013; Girault et al., 2022). This is of particular significance as 78.5% of dogs are reported to display fear-related behaviours within veterinary clinics, such as fixedly staring, alteration to posture, trembling and hesitance to enter the clinical treatment room (Döring et al., 2009); ultimately these factors may compromise clinical examinations. Furthermore, whilst some pain responses are obvious, other behaviours such as avoidance, stargazing, submission, change in body posture or lip licking are more subtle and may be missed (Dobromylskyj et al., 2000; Wiseman-Orr, 2005; Mills et al., 2020).

The extent of activities a veterinary professional can observe within clinic is restricted. For example ADL, as expressed in the home environment, such as daily exercise, play, self-grooming and movements associated with drinking, feeding and elimination behaviours cannot necessarily be observed. Ultimately this means the capacity for a clinician to holistically assess functional mobility in practice is somewhat limited.

The use of historical recollection from owners can mitigate some problems noted above. They offer an insight into the impact of a condition on mobility or the ability to perform various ADL. For example, owners can identify behavioural changes in their dog's ability to perform daily activities, such as exacerbated or reduced self-grooming; alterations to inactivity levels, exercise capabilities and exercise tolerance; and locational or postural changes related to feeding, urination and defecation habits (Wiseman-Orr, 2005; Pettitt and German, 2015; Reid et al., 2018; Kerwin and Taylor, 2021). However, the ability to precisely identify changes is likely to differ depending on the owner (Scott and Witte, 2011).

Kinetic and kinematic measures

Kinetic measures such as force plate analysis or pressure mat analysis, are often described as the objective 'gold standard' in assessing limb function. Additionally, kinematic measures can be used to supplement kinetic measures, providing objective data evaluating movement patterns. However, kinetic and kinematic analysis are rarely used outside of clinical research or speciality practices because of the time, space, specialist equipment, costs and need for adequately trained personnel to use these systems (Brown et al., 2013; Prankel et al., 2016; Lee et al., 2021; Montalbano, 2022). Additionally, more complex problems such as bilateral or multi-limb lameness can be difficult to assess, and limb loading or analysis of gait in isolation fails to capture all the facets of both mobility and functional mobility, outside lameness (Walton et al., 2013).

Clinical metrology instruments

Various Clinical Metrology Instruments (CMIs), which may also be known as testing batteries, have been produced and validated for use in canine veterinary medicine. CMIs are questionnaire-based measurements of health, usually completed by owners or clinicians.

Many CMIs have been produced to quantify the level of pain, severity of a specific disease (commonly OA) or assess a dog's health related quality of life (HRQOL) either on a generic or disease specific level (e.g. for cancer, atopic dermatitis, cardiopathies) (Wiseman-Orr et al., 2004; Freeman et al., 2005; Brown et al., 2007; Hielm-Björkman et al. 2009; Lynch et al., 2011; Walton et al., 2013; Brown 2014; Noli, 2019; Fulmer et al., 2022). Whilst these CMIs do not directly set out to assess mobility per se, many of these incorporate some level of functionality, or functional mobility assessment for canine patients. For example, several CMIs validated to assess musculoskeletal disease and generic HRQOL, which have been extensively reviewed by Clark and Comerford (2023) and Fulmer et al., (2022), incorporate gait assessments, lameness and functional activities such as jumping up, jumping down, stair use, ability to transfer, exercise and play.

To date, one CMI has been validated which specifically sets out to assess canine mobility. GenPup-M is a novel CMI which aims to detect early mobility changes in dogs through repeated measures at differing time-points within a dog's life (Clark et al., 2023). The scale includes 24 owner-completed questions relating to supplements given and exercise capabilities. Whilst GenPup-M provides an innovative pathway for mobility assessments outside of a clinical environment, its validity has only been tested and compared between healthy dogs, and dogs with a mobility problem resulting from a musculoskeletal disease. Further work is needed to determine GenPup-M's suitability for assessing canine mobility for dogs with hindered mobility from a non-musculoskeletal origin. Furthermore, whilst GenPup-M evaluates mobility, the construct does not aim to capture how the given conditions impacts the movements involved with a dog's overall functionality.

A limited number of other CMI's have also been developed which dive further into the realms of assessing canine functional mobility. For example, Boström et al., (2018) developed a neurological function testing battery to assess the overall motor functioning in dogs, named the Finnish neurological function testing battery for dogs (FINFUN). The FINFUN consists of scoring the performance of a dog's ability to perform 11 tasks, based upon human physical outcome measures, including: lying, standing up from lying, sitting, standing up from sitting, standing, proprioceptive positioning, starting to walk, walking, trotting, walking turns and walking stairs. FINFUN was developed to explicitly assess motor functioning in dogs, and its application has been tested on dogs with paraparesis or paraplegia. All observers where human physiotherapists specialising in animal physiotherapy, they received training and practice in the scoring process. Thus, there is still a need for the development of similar mechanisms to measure functionality in the context of other diseases and with other observers. With this in mind, considerations should be given to the ease of clinicians to implement the use of FINFUN in practice.

Wright et al., (2022) described using 'functionality' tests as part of a study to measure response to carprofen treatment in dogs with OA-associated pain. The functionality test involved an evaluator scoring the performance of five activities: walking on a flat surface, jogging on a flat surface, rising from a sitting/lying position an ascending and descending stairs on a VAS (Visual Analogue Scale) via video recordings taken within a clinic. Whilst this methodology provides foundations for functional mobility tests in canine patients, its validity is untested. These functionality tests only touch on five assumed ADL for dogs, without justification as to why these activities were selected for use within the scale. Dogs must perform more than these five activities, requiring different movement patterns, as part of everyday living to survive, such as feeding or elimination behaviours.

Frye et al. (2022) proposed the Canine Geriatric Functional Score (CGFS) as a standardised method to test canine function. The CGFS requires a dog to complete four tasks and scores are assigned by an observer outlined in Table 1, derived from human-equivalent functional mobility tests, to test a dog's strength, endurance, and balance/spatial awareness. To date no studies have been published investigating the validity of CGFS. However, at face value the suitability of the scale to reflect a dog's true functional mobility capabilities may be questioned due to the artificial nature of the tasks the scale involves. It is arguably unrealistic for a dog to walk over cavaletti, repeatedly walk in a figure of eight sequence or complete repetitions of a 'down' to 'stand' within a 60 second timeframe, thus may be unrepresentative of movements involved in the performance of ADL for dogs. Furthermore, the performance of physical activity tests may exacerbate a disease, thus considerations must be given to relative contraindications when asking a medically compromised dog to perform non-routine physical activities to simply assess function.

Although many CMIs are open-access, they are not yet widely used in practice. Hale et al., (2023) found that just 4.4% of dog owners had been asked to complete a questionnaire related to their dog's health and well-being by a vet in the UK. This poses reason to suggest that veterinary professionals are not typically using available CMIs in the assessment of canine patients. Further research should be conducted to establish what barriers exist to using CMIs within veterinary practice, especially since Hale et al., (2023) found that 70.8% of dog owners were open to using such assessment tools.

Wearable technology

Wearable technology is advancing and becoming increasingly popular for monitoring activity in dogs. Such technological advancements are allowing owners to track various parameters of their dog's health, though current clinical use is arguably premature. Using collar-mounted accelerometers (sometimes in conjunction with other sensor signals such as from gyroscopes, magnetometers or Global Positioning Satellite (GPS) recorders) and complex algorithms, activity monitors can distinguish between a dog at rest or in a form of active state; identifying parameters such as activity type, distance travelled, acceleration, velocity and step count (Hansen et al., 2007; Bruno et al., 2015; Chambers et al., 2021). Advancement in machine learning has also enabled activity monitors to commonly detect the performance and duration of specific activities such as walking, running, lying down, or resting; some companies claim to be even more specific in measuring eating, drinking, playing, scratching, and head-shaking behaviours (Ladha et al., 2013; Bruno et al., 2015; den Uijl et al., 2017; Chambers et al., 2021). This enables owners to objectively track changes in their dog's activity levels using non-invasive measures, usually through automated feedback to integrated mobile devices, and the results of which can act as an indicator of illness, pain or mobility impairment, pruritis or poor-sleep quality (Nuttall and McEwan, 2006; Ladha et al., 2013; Colpoys and DeCock, 2021; Schork et al., 2023). Evidently this is important for objectively quantifying canine activity, however it is imperative to note that activity is not definitively the same as mobility, nor functional mobility. Whilst activity monitors may be able to collect a range of data relating to time spent performing a given functional activity, number of times an activity was performed or distance moved, the quality of the movements involved in the activity performed cannot be directly assessed. For example, an activity monitor would not detect lameness or if pain was expressed when undertaking an activity.

Limited scientific evidence has been published assessing the validity of many commercially available activity monitors and their associated algorithms due to their proprietary nature (Belda et al., 2018). Belda et al., (2018) reported that only three commercially available devices, Actical (Respironics Mini Mitter division), Actigraph (Actigraph, LLC) and Whistle (Whistle Labs, Inc.), of 22 available on the market had published tests of validity available at the time of their study, although others have been validated since (Belda et al., 2018; Colpoys and DeCock, 2021). Validation has typically involved correlation between visual assessment of an animal performing a defined activity and the monitor's output; although it should be noted that such research is still confounded by several variables, such as small sample sizes, assessment of healthy dogs only, and conducted in artificial or controlled environments.

Exercise tests

Studies have touched on exercise tests as a measure of physical performance outside of analysing gait. For example, the 6-minute walk test, in which a canine patient walks for 6-minutes at their own pace and the distance travelled is measured, has been used to evaluate exercise tolerance, particularly for dogs with upper airway, pulmonary or cardiac disease (Boddy et al., 2004; Swimmer and Rozanski 2011; Lilja-Maula et al., 2014; Lilja-Maula et al., 2017). Physical activity can also be measured with GPS recorders in the outdoor environment. These provide more nuanced information, such as data on acceleration, deceleration, maximum velocity and distance travelled. Furthermore they have been used to demonstrate the impacts of osteoarthritis on playing (chasing a ball), on-lead walking and off-lead walking in comparison to healthy dogs, and their response to treatment (Bruno et al., 2015). Interestingly the measures of acceleration during play were most impacted by disease in comparison to healthy dogs, yet returned to normal in this small cohort.

Tests of exercise performance relate to mobility assessments since it may offer a reflection to how well a dog can move freely and easily. However, they do not offer a holistic approach to functional mobility assessments since only a few functional activities are captured within their measures. Furthermore, similarly to certain CMI tests described above, consideration must be given to the risk of exacerbating disease through exercise performance tests.

Joint and limb-specific function

Goniometry can be used as an objective, cost-effective way to quantify a dog's joint angles and range of motion (Jaegger et al., 2002). It can also be symbolic of a dog's mobility capabilities. For example, research has shown that a loss of joint specific flexion or extension in dogs is associated with lameness (Jandi and Schulman, 2007). Given this, it may be argued that goniometry could also be indicative of functional mobility to a certain extent since lameness may impede movements associated with a dog's ability to perform ADL, such as going out for walks, escalating stairs or navigating around the environment to access resources; though further researched based evidence is needed to support this. Nevertheless, measurements from goniometry are often used as an important measure by clinicians to quantify the success of treatments or recovery, particularly from orthopaedic diseases in dogs (Prostredny et al., 1991; Marcellin-little et al., 1998; Marcellin-little et al., 1999; Jaegger et al., 2002; Jandi and Schulman, 2007; Moeller et al., 2010). However, comparative goniometry measurements between dogs should be treated with caution since research has shown normal ROM and joint angles differ between breeds (Thomovsky et al., 2016; Sabanci and Ocal, 2016; Reusing et al., 2020).

It is important to note that various testing batteries have also been produced to evaluate joint-specific and limb-specific function in dogs. For example, three testing batteries to evaluate stifle function have been developed for dogs, including the, (1) Finnish Canine Stifle Index, (2) Bologna Healing Stifle Injury Index and (3) Stifle Functional Score (Hyytiäinen, et al. 2018; Pinna, et al. 2019; Gundersen et al. 2022). These tests specifically require a clinician to gather differing physical measurements, or score the performance of certain functional movements, such as: passive range of motion (stifle flexion and extension), visual active range of motion (including sitting to stand and lying down to stand), thigh muscle mass, pain on manipulation, symmetry of weight bearing at a stand and lameness when using various gaits. Additionally, the Bologna Healing Stifle Injury Index require owners to rate their dog's performance of various functional activities, such as stair use, getting in a car, urination, sitting down and standing up.

Evidently goniometry, joint-specific and limb-specific outcome measures are highly valuable for evaluating localised function of specific body regions. However, they do not aim to specifically quantify how localised limb or joint inhibition impact the animal as a whole. For example, whilst it may be argued that the tests used to assess stifle function noted above do include assessments of the movements involved in performing ADL, it is important to note that their overall objective is to quantify stifle function rather than a dogs' overall functional mobility in its entirety.

Future direction for canine functional mobility in practice

As discussed throughout the paper various methods of assessing canine mobility, and somewhat functional mobility to varying degrees, currently exist in veterinary medicine. However, their capacity for current assessment methods to evaluate functional mobility is limited because, (1) their constructs are not designed to specifically quantify functional mobility, (2) little to no justification is given to the inclusion or exclusion of activities or movements within assessments, or (3) extensive validity testing has not taken place. With this in mind there is still a need for the development of a validated system to explicitly assess a dog's overall functional mobility capabilities.

In contrast to veterinary medicine, many tools have been developed to specifically assess human patients' overall capacity to perform ADL and functional mobility as outlined in Table 2, particularly for the elderly or patients with various brain injuries, cancer, neurological or orthopaedic conditions (Badke et al., 1993; Scott et al., 2007; Marchese et al., 2007; Marchese et al., 2012; Bouça-Machado et al., 2018). These assessments require an observer or patient to self-report their capacity to carry out a range of basic ADL, or basic movements associated with their performance, and if aids are required, to evaluate a person's risk of fall, ability to live independently, disease progression or effectiveness of treatment (Zijlstra and Aminian, 2007; Scott et al., 2007; Sun et al., 2019; Bouça-Machado et al., 2020).

Similar validated scoring systems to those displayed in Table 2 would be valuable for measuring functional mobility in canine patients. Such measures would be particularly useful for contextualising how a wide range of diseases impact a dog's daily functioning, as well as disease progression or treatments. Furthermore, a greater understanding of ADL a dog finds particularly challenging can help with the implementation of targeted nursing interventions, physical therapy or environmental modifications which can be made to help maintain or restore optimal physical functioning for canine patients.

Before any overall canine functional mobility assessment can be produced and validated, a comprehensive list of canine ADL must be objectively established, building on Fryer et al.'s (2022) BADIM and IADQOL. This would allow for an objective selection of relevant activities and associated movements involved in performing the activities, which should be included in any given functional mobility assessment. Although the performance of activities is likely to significantly differ between dogs of different ages, breeds, size or health statuses, basic ADL in human medicine are defined as essential, routine tasks which most healthy individuals are able to perform without assistance to meet their basic physical needs (Katz et al., 1969; Mlinac and Feng 2016). Based on this, work should be done to at least categorically define basic ADL of the domestic dog, which could be achieved by consulting owners to find out what activities their dog undertakes daily. Additionally, for any assessment tool to be effective it must meet the needs of the intended users. Therefore, it is important that a range of stakeholders, including dog owners and professionals in the veterinary field, are consulted to define what is important in relation to canine functional mobility and what would be useful in a tool designed to quantify it.

After the development of a functional mobility assessment tool, it is essential thorough validity testing takes place to ensure that the construct is suitable for assessing functional mobility in dogs. Such validity testing should incorporate investigations into the ability of the developed tool to assess functional mobility in dogs with a wide range of pathologies. This would ensure the assessment tool can contextualise how various diseases can impact functional mobility.

Conclusions

It is important to recognise the impact of pathologies associated with compromised mobility extend beyond lameness or abnormalities to gait since functionality is often affected. In human medicine various tools exist to assess the performance of ADL and functional mobility, but the concept in veterinary medicine is underdeveloped. The development of a non-disease specific system, validated to measure functional mobility in canine patients would be valuable in holistically assessing how certain conditions impact a dog's daily life. This would be beneficial to veterinary patients, particularly because it could identify how treatments, including physical therapy and nursing interventions, or disease progression alter the performance of ADL and potentially highlight what modifications can be made in the home to aid their performance. However, for a functional mobility assessment tool to be developed, a comprehensive list of a dog's ADL must be first identified to objectively establish what daily activities and associated movements should be included within a functional mobility assessment. Additionally, extensive validation must take place of any functional mobility assessment tool to ensure it can contextualise how a wide range of diseases impact a dog's functional mobility.

Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

References

Anderson, K. L., O'Neill, D. G., Brodbelt, D. C., Church, D. B., Meeson, R. L., Sargan, D., Summers, J. F., Zulch, H., Collins, L. M., 2018. Prevalence, duration and risk factors for appendicular osteoarthritis in a UK dog population under primary veterinary care. Scientific Reports 8.

Badke, M. B., Di Fabio, R. P., Leonard, E., Margolis, M., Franke, T., 1993. Reliability of a functional mobility assessment tool with application to neurologically impaired patients: a preliminary report. Physiotherapy Canada. Physiotherapie Canada 45, 15–20.

Barker, R. N., Amsters, D. I., Kendall, M. D., Pershouse, K. J., Haines, T. P., 2007. Reliability of the clinical outcome variables scale when administered via telephone to assess mobility in people with spinal cord injury. Archives of Physical Medicine and Rehabilitation 88, 632–637.

Barker, A. L., Nitz, J. C., Low Choy, N. L., Haines, T. P., 2008. Clinimetric evaluation of the physical mobility scale supports clinicians and researchers in residential aged care. Archives of Physical Medicine and Rehabilitation 89, 2140–2145.

Bartner, L., 2020. The Neurologic Examination. In: Canine Lameness, John Wiley and Sons Inc, Hoboken, NJ, USA, pp. 41-66.

Belda, B., Enomoto, M., Case, B. C., Lascelles, B. D. X., 2018. Initial evaluation of PetPace activity monitor. Veterinary Journal 237, 63–68.

Belshaw, Z., Dean, R., Asher, L., 2020a. Slower, shorter, sadder: a qualitative study exploring how dog walks change when the canine participant develops osteoarthritis. BMC Veterinary Research 16, 85.

Belshaw, Z., Dean, R., Asher, L., 2020b. Could it be osteoarthritis? How dog owners and veterinary surgeons describe identifying canine osteoarthritis in a general practice setting. Preventive Veterinary Medicine 185, 105198.

Boddy, K. N., Roche, B. M., Schwartz, D. S., Nakayama, T., Hamlin, R. L., 2004. Evaluation of the six-minute walk test in dogs. American Journal of Veterinary Research 65, 311–313.

Boström, A. F., Hyytiäinen, H. K., Koho, P., Cizinauskas, S., Hielm-Björkman, A. K., 2018. Development of the Finnish neurological function testing battery for dogs and its intra- and inter-rater reliability. Acta Veterinaria Scandinavica 60, 56.

Bouça-Machado, R., Maetzler, W., Ferreira, J. J., 2018. What is functional mobility applied to Parkinson's disease? Journal of Parkinson's Disease 8, 121–130.

Bouça-Machado, R., Duarte, G. S., Patriarca, M., Castro Caldas, A., Alarcão, J., Fernandes, R. M., Mestre, T. A., Matias, R., Ferreira, J. J., 2020. Measurement instruments to assess functional mobility in Parkinson's disease: A systematic review. Movement Disorders Clinical Practice 7, 129–139.

Bouwstra, H., Smit, E. B., Wattel, E. M., van der Wouden, J. C., Hertogh, C. M. P. M., Terluin, B., Terwee, C. B., 2019. Measurement properties of the Barthel index in geriatric rehabilitation. Journal of the American Medical Directors Association 20, 420-425.e1.

Brooks, D., Davis, A. M., Naglie, G., 2006. Validity of 3 physical performance measures in inpatient geriatric rehabilitation. Archives of Physical Medicine and Rehabilitation 87, 105–110.

Brown, D. C., Boston, R. C., Coyne, J. C., Farrar, J. T., 2007. Development and psychometric testing of an instrument designed to measure chronic pain in dogs with osteoarthritis. American Journal of Veterinary Research 68, 631–637.

Brown, D. C., Bell, M., Rhodes, L., 2013. Power of treatment success definitions when the Canine Brief Pain Inventory is used to evaluate carprofen treatment for the control of pain and inflammation in dogs with osteoarthritis. American Journal of Veterinary Research 74, 1467–1473.

Brown, D. C., 2014. The Canine Orthopedic Index. Step 1: Devising the items: Canine orthopedic index: Devising the items. Veterinary Surgery 43, 232–240.

Bruno, E. A., Guthrie, J. W., Ellwood, S. A., Mellanby, R. J., Clements, D. N., 2015. Global positioning system derived performance measures are responsive indicators of physical activity, disease and the success of clinical treatments in domestic dogs. PloS One 10, e0117094.

Burn, C. C., 2017. Bestial boredom: a biological perspective on animal boredom and suggestions for its scientific investigation. Animal Behaviour 130, 141–151.

Chambers, R. D., Yoder, N. C., Carson, A. B., Junge, C., Allen, D. E., Prescott, L. M., Bradley, S., Wymore, G., Lloyd, K., Lyle, S., 2021. Deep learning classification of canine behavior using a single collar-mounted accelerometer: Real-world validation. Animals 11, 1549.

Choy, N., Kuys, S., Richards, M., Isles, R., 2002. Measurement of functional ability following traumatic brain injury using the Clinical Outcomes Variable Scale: a reliability study. The Australian Journal of Physiotherapy 48, 35–39.

Clark, N. L., Bates, K. T., Harris, L. K., Tomlinson, A. W., Murray, J. K., Comerford, E. J., 2023. GenPup-M: A novel validated owner-reported clinical metrology instrument for detecting early mobility changes in dogs. PloS One 18, e0291035.

Clark, N., Comerford, E., 2023. An update on mobility assessment of dogs with musculoskeletal disease. The Journal of Small Animal Practice 64, 599–610.

Collen, F. M., Wade, D. T., Robb, G. F., Bradshaw, C. M., 1991. The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment. International Disability Studies 13, 50–54.

Colpoys, J., DeCock, D., 2021. Evaluation of the FitBark activity monitor for measuring physical activity in dogs. Animals 11, 781.

Covinsky, K. E., Palmer, R. M., Fortinsky, R. H., Counsell, S. R., Stewart, A. L., Kresevic, D., Burant, C. J., Landefeld, C. S., 2003. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. Journal of the American Geriatrics Society 51, 451–458.

de Oliveira Silva, F., Ferreira, J. V., Plácido, J., Chagas, D., Praxedes, J., Guimarães, C., Batista, L. A., Marinho, V., Laks, J., Deslandes, A. C., 2019. Stages of mild cognitive impairment and Alzheimer's disease can be differentiated by declines in timed up and go test: A systematic review and meta-analysis. Archives of Gerontology and Geriatrics 85, 103941.

den Uijl, I., Gómez Álvarez, C. B., Bartram, D., Dror, Y., Holland, R., Cook, A., 2017. External validation of a collar-mounted triaxial accelerometer for second-by-second monitoring of eight behavioural states in dogs. PloS One 12, e0188481.

Dobromylskyj, P., Flecknell, P. A., Lascelles, B. D., Livingston, A., Taylor, P., Waterman-Pearson, A., 2000. Pain Assessment. In: Pain Management in Animals, Saunders, London, pp. 53–79.

Dos Santos Barros, V., Bassi-Dibai, D., Guedes, C. L. R., Morais, D. N., Coutinho, S. M., de Oliveira Simões, G., Mendes, L. P., da Cunha Leal, P., Dibai-Filho, A. V., 2022. Barthel Index is a valid and reliable tool to measure the functional independence of cancer patients in palliative care. BMC Palliative Care 21, 124.

Döring, D., Roscher, A., Scheipl, F., Küchenhoff, H., Erhard, M. H., 2009. Fear-related behaviour of dogs in veterinary practice. Veterinary Journal 182, 38–43.

Duffy, L., Gajree, S., Langhorne, P., Stott, D. J., Quinn, T. J., 2013. Reliability (inter-rater agreement) of the Barthel Index for assessment of stroke survivors: systematic review and meta-analysis: Systematic review and meta-analysis. Stroke; a Journal of Cerebral Circulation 44, 462–468.

Dunaevich, A., Chen, H., Musseri, D., Kuzi, S., Mazaki-Tovi, M., Aroch, I., Segev, G., 2020. Acute on chronic kidney disease in dogs: Etiology, clinical and clinicopathologic findings, prognostic markers, and survival. Journal of Veterinary Internal Medicine 34, 2507–2515.

Enomoto, M., de Castro, N., Hash, J., Thomson, A., Nakanishi-Hester, A., Perry, E., Aker, S., Haupt, E., Opperman, L., Roe, S., et al., 2024. Prevalence of radiographic appendicular osteoarthritis and associated clinical signs in young dogs. Scientific Report 14, 2827

Forhan, M., Gill, S. V., 2013. Obesity, functional mobility and quality of life. Best Practice & Research. Clinical Endocrinology & Metabolism 27, 129–137.

Freter, S. H., Fruchter, N., 2000. Relationship between timed 'up and go' and gait time in an elderly orthopaedic rehabilitation population. Clinical Rehabilitation 14, 96–101.

Freeman, L. M., Rush, J. E., Farabaugh, A. E., Must, A., 2005. Development and evaluation of a questionnaire for assessing health-related quality of life in dogs with cardiac disease. Journal of the American Veterinary Medical Association 226, 1864–1868.

Frye, C., Carr, B. J., Lenfest, M., Miller, A., 2022. Canine geriatric rehabilitation: Considerations and strategies for assessment, functional scoring, and follow up. Frontiers in Veterinary Science 9, 842458.

Fulmer, A. E., Laven, L. J., Hill, K. E., 2022. Quality of life measurement in dogs and cats: A scoping review of generic tools. Animals 12, 400

Girault, C., Priymenko, N., Helsly, M., Duranton, C., Gaunet, F., 2022. Dog behaviours in veterinary consultations: Part 1. Effect of the owner's presence or absence. Veterinary Journal 280, 105788.

Granger, N., Olby, N. J., Nout-Lomas, Y. S., Canine Spinal Cord Injury Consortium (CANSORT-SCI), 2020. Bladder and bowel management in dogs with spinal cord injury. Frontiers in Veterinary Science 7, 583342.

Graham, H. K., Harvey, A., Rodda, J., Nattrass, G. R., Pirpiris, M., 2004. The functional mobility scale (FMS). Journal of Pediatric Orthopedics 24, 514–520.

Gundersen, K., Millis, D., Zhu, X., 2022. Development and testing of a stifle function score in dogs. Frontiers in Veterinary Science 9, 895567.

Hale, H., Blackwell, E., Roberts, C., Roe, E., Mullan, S., 2023. Broadening the veterinary consultation: Dog owners want to talk about more than physical health. Animals 13, 392.

Hansen, B. D., Lascelles, B. D. X., Keene, B. W., Adams, A. K., Thomson, A. E., 2007. Evaluation of an accelerometer for at-home monitoring of spontaneous activity in dogs. American Journal of Veterinary Research 68, 468–475.

Hartigan, I., 2007. A comparative review of the Katz ADL and the Barthel Index in assessing the activities of daily living of older people. International Journal of Older People Nursing 2, 204–212.

Hielm-Björkman, A. K., Rita, H., Tulamo, R.-M., 2009. Psychometric testing of the Helsinki chronic pain index by completion of a questionnaire in Finnish by owners of dogs with chronic signs of pain caused by osteoarthritis. American Journal of Veterinary Research 70, 727–734.

Hsieh, C. L., Hsueh, I. P., Mao, H. F., 2000. Validity and responsiveness of the rivermead mobility index in stroke patients. Scandinavian Journal of Rehabilitation Medicine 32, 140–142.

Hudson, J. T., Slater, M. R., Taylor, L., Scott, H. M., Kerwin, S. C., 2004. Assessing repeatability and validity of a visual analogue scale questionnaire for use in assessing pain and lameness in dogs. American Journal of Veterinary Research 65, 1634–1643.

Hughes, D., King, L. G., 1995. The diagnosis and management of acute liver failure in dogs and cats. The Veterinary Clinics of North America. Small Animal Practice 25, 437–460.

Hyytiäinen, H. K., Mölsä, S. H., Junnila, J. J. T., Laitinen-Vapaavuori, O. M., Hielm-Björkman, A. K., 2018. Developing a testing battery for measuring dogs' stifle functionality: the Finnish Canine Stifle Index (FCSI). The Veterinary Record 183, 324–324.

Iliopoulou, M. A., Kitchell, B. E., Yuzbasiyan-Gurkan, V., 2013. Development of a survey instrument to assess health-related quality of life in small animal cancer patients treated with chemotherapy. Journal of the American Veterinary Medical Association 242, 1679–1687.

Jandi, A. S., Schulman, A. J., 2007. Incidence of motion loss of the stifle joint in dogs with naturally occurring cranial cruciate ligament rupture surgically treated with tibial plateau leveling osteotomy: longitudinal clinical study of 412 cases. Veterinary Surgery 36, 114–121.

Jaegger, G., Marcellin-Little, D. J., Levine, D., 2002. Reliability of goniometry in Labrador Retrievers. American Journal of Veterinary Research 63, 979–986.

Jergens, A. E., 1997. Gastrointestinal disease and its management. The Veterinary Clinics of North America. Small Animal Practice 27, 1373–1402.

Johnston, S. A., 1997. Osteoarthritis. Joint anatomy, physiology, pathobiology. The Veterinary Clinics of North America: Small Animal Practice 27, 699–723.

Katz, S., Ford A, Moskowitz R, Jackson B, Jaffe M., 1963. Studies of illness in the aged: The index of ADL: A standardized measure of biological and psychosocial function. The Journal of the American Medical Association 185, 914.

Kristensen, M. T., Foss, N. B., Kehlet, H., 2007. Timed 'up & go' test as a predictor of falls within 6 months after hip fracture surgery. Physical Therapy 87, 24–30.

Kerwin, S. C., Taylor, A. R., 2021. Assessment of orthopedic versus neurologic causes of gait change in dogs and cats. The Veterinary Clinics of North America: Small Animal Practice 51, 253–261.

Ladha, C., Hammerla, N., Hughes, E., Olivier, P., Ploetz, T., 2013. Dog's life: Wearable activity recognition for dogs. Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing, Zurich, Switzerland, pp. 415–418.

Lawton, M. P., Brody, E. M., 1969. Assessment of older people: Self-maintaining and instrumental activities of daily living. The Gerontologist 9, 179–186.

Lee, A. H., Detweiler, K. B., Harper, T. A., Knap, K. E., de Godoy, M. R. C., Swanson, K. S., 2021. Physical activity patterns of free living dogs diagnosed with osteoarthritis. Journal of Animal Science 99.

Lilja-Maula, L., Laurila, H. P., Syrjä, P., Lappalainen, A. K., Krafft, E., Clercx, C., Rajamäki, M. M., 2014. Long-term outcome and use of 6-minute walk test in West Highland

White Terriers with idiopathic pulmonary fibrosis. Journal of Veterinary Internal Medicine 28, 379–385.

Lilja-Maula, L., Lappalainen, A.K., Hyytiäinen, H.K., Kuusela, E., Kaimio, M., Schildt, K., Mölsä, S., Morelius, M., Rajamäki, M., 2017. Comparison of submaximal exercise test results and severity of brachycephalic obstructive airway syndrome in English bulldogs. The Veterinary Journal 219, 22–26.

Lynch, S., Savary-Bataille, K., Leeuw, B., Argyle, D. J., 2011. Development of a questionnaire assessing health-related quality-of-life in dogs and cats with cancer. Veterinary and Comparative Oncology 93, 172–182.

Marcellin-Little, D. J., Ferretti, A., Roe, S. C., DeYoung, D. J., 1998. Hinged Ilizarov external fixation for correction of antebrachial deformities. Veterinary Surgery 27, 231–245.

Marcellin-Little, Denis J., De Young, B. A., Doyens, D. H., De Dyoung, D. J., 1999. Canine uncemented porous-coated anatomic total hip arthroplasty: Results of a long-term Prospective evaluation of 50 consecutive cases. Veterinary Surgery 28, 10–20.

Marcellin-Little, D. J., Levine, D., Millis, D. L., 2014. Physical rehabilitation for geriatric and arthritic patients. In Canine Rehabilitation and Physical Therapy, Second Edn. Elsevier, Philadelphia, Pa, pp. 628–641

Marchese, V. G., Rai, S. N., Carlson, C. A., Hinds, P. S., Spearing, E. M., Zhang, L., Callaway, L., Neel, M. D., Rao, B. N., Ginsberg, J. P., 2007. Assessing functional mobility in survivors of lower-extremity sarcoma: reliability and validity of a new assessment tool. Pediatric Blood and Cancer 49, 183–189.

Marchese, V. G., Oriel, K. N., Fry, J. A., Kovacs, J. L., Weaver, R. L., Reilly, M. M., Ginsberg, J. P., 2012. Development of reference values for the Functional Mobility Assessment. Pediatric Physical Therapy: The Official Publication of the Section on Pediatrics of the American Physical Therapy Association 24, 224–230.

McKee, M., 2007. Lameness and weakness in dogs: is it orthopaedic or neurological? In Practice 29, 434–444.

McKenzie, B. A., Chen, F. L., 2022. Assessment and management of declining physical function in aging dogs. Topics in Companion Animal Medicine 51, 100732.

Millis, D., Mankin, J., 2014. Orthopedic and Neurologic Evaluation. In Canine Rehabilitation and Physical Therapy, Second Edn. Saunders, St. Louis, Missouri, pp. 180–200.

Mills, D. S., Demontigny-Bédard, I., Gruen, M., Klinck, M. P., McPeake, K. J., Barcelos, A. M., Hewison, L., Van Haevermaet, H., Denenberg, S., Hauser, H., et al., 2020. Pain and problem behavior in cats and dogs. Animals 10, 318.

Mlinac, M. E., Feng, M. C., 2016. Assessment of activities of daily living, self-care, and independence. Archives of Clinical Neuropsychology 31, 506–516.

Montalbano, C., 2022. Canine comprehensive mobility assessment. The Veterinary Clinics of North America: Small Animal Practice 52, 841–856.

Moeller, E.M., Allen, D. A., Wilson, E. R., Lineberger, J. A., Lehenbauer, T., 2010. Long-term outcomes of thigh circumference, stifle range-of-motion, and lameness after unilateral tibial plateau levelling osteotomy. Veterinary and Comparative Orthopaedics and Traumatology 23, 37–42.

Morris S., Morris M.E., Iansek R., 2001. Reliability of measurements obtained with the timed 'up & go' test in people with Parkinson disease. Physical Therapy 81.

Nitz, J. C., Hourigan, S. R., Brown, A., 2006. Measuring mobility in frail older people: reliability and validity of the Physical Mobility Scale. Australasian Journal on Ageing 25, 31–35.

Noli, C., 2019. Assessing quality of life for pets with dermatologic disease and their owners. The Veterinary Clinics of North America. Small Animal Practice 49, 83–93.

Nuttall, T., McEwan, N., 2006. Objective measurement of pruritus in dogs: a preliminary study using activity monitors. Veterinary Dermatology 17, 348–351.

O'Neill, D. G., Church, D. B., McGreevy, P. D., Thomson, P. C., Brodbelt, D. C., 2014. Prevalence of disorders recorded in dogs attending primary-care veterinary practices in England. PloS One 9, e90501.

O'Neill, D. G., James, H., Brodbelt, D. C., Church, D. B., Pegram, C., 2021. Prevalence of commonly diagnosed disorders in UK dogs under primary veterinary care: results and applications. BMC Veterinary Research 17, 69.

Pettitt, R. A., German, A. J., 2015. Investigation and management of canine osteoarthritis. In Practice 37, 1–8.

Pinna, S., Lambertini, C., Grassato, L., Romagnoli, N., 2019. Evidence-based veterinary medicine: A tool for evaluating the healing process after surgical treatment for cranial cruciate ligament rupture in dogs. Frontiers in Veterinary Science 6.

Podsiadlo, D., Richardson, S., 1991. The timed "up & go": A test of basic functional mobility for frail elderly persons. Journal of the American Geriatrics Society 39, 142–148.

Prankel, S., Corbett, M., Bevins, J., Davies, J., 2016. Biomechanical analysis in veterinary practice. In Practice 38, 176–187.

Prostredny, J. M., Toombs, J. P., VanSickle, D. C., 1991. Effect of two muscle sling techniques on early morbidity after femoral head and neck excision in dogs. Veterinary Surgery 20, 298–305.

Rao, A. K., Muratori, L., Louis, E. D., Moskowitz, C. B., Marder, K. S., 2009. Clinical measurement of mobility and balance impairments in Huntington's disease: validity and responsiveness. Gait & Posture 29, 433–436.

Reid, J., Nolan, A. M., Scott, E. M., 2018. Measuring pain in dogs and cats using structured behavioural observation. Veterinary Journal 236, 72–79.

Reusing, M., Brocardo, M., Weber, S., Villanova, J., Jr., 2020. Goniometric evaluation and passive range of joint motion in chondrodystrophic and non-chondrodystrophic dogs of different sizes. Veterinary and Comparative Orthopaedics and Traumatology 3, 66–71.

Sabanci, S. S., Ocal, M. K., 2016. Comparison of goniometric measurements of the stifle joint in seven breeds of normal dogs. Veterinary and Comparative Orthopaedics and Traumatology 29, 214–219.

Salter, K., Jutai, J., Foley, N., Teasell, R., 2010. Clinical Outcome Variables Scale: A retrospective validation study in patients after stroke. Journal of Rehabilitation Medicine: Official Journal of the UEMS European Board of Physical and Rehabilitation Medicine 42, 609–613.

Schork, I. G., Manzo, I. A., Oliveira, M. R. B. de, Costa, F. V., Young, R. J., De Azevedo, C. S., 2023. Testing the accuracy of wearable technology to assess sleep behaviour in domestic dogs: A prospective tool for animal welfare assessment in kennels. Animals 13.

Scott, V., Votova, K., Scanlan, A., Close, J., 2007. Multifactorial and functional mobility assessment tools for fall risk among older adults in community, home-support, long-term and acute care settings. Age and Ageing 36, 130–139.

Scott, H., Witte, P., 2011. Investigation of lameness in dogs: 1. Forelimb lameness. In Practice 33, 20–27.

Sebastião, E., Sandroff, B. M., Learmonth, Y. C., Motl, R. W., 2016. Validity of the timed up and go test as a measure of functional mobility in persons with multiple sclerosis. Archives of Physical Medicine and Rehabilitation 97, 1072–1077.

Spinella, G., Bettella, P., Riccio, B., Okonji, S., 2022. Overview of the current literature on the most common neurological diseases in dogs with a particular focus on rehabilitation. Veterinary Sciences 9, 8

Sun, R., Aldunate, R. G., Sosnoff, J. J., 2019. The validity of a Mixed Reality-based automated functional mobility assessment. Sensors 19, 2183.

Swimmer, R. A., and Rozanski, E. A., 2011. Evaluation of the 6-minute walk test in pet dogs: 6 MWT in dogs. Journal of Veterinary Internal Medicine 25, 405–406.

Taghizadeh, G., Martinez-Martin, P., Meimandi, M., Habibi, S. A. H., Jamali, S., Dehmiyani, A., Rostami, S., Mahmuodi, A., Mehdizadeh, M., Fereshtehnejad, S.-M., 2020. Barthel Index and modified Rankin Scale: Psychometric properties during medication phases in idiopathic Parkinson disease. Annals of Physical and Rehabilitation Medicine 63, 500–504.

Thomovsky, S. A., Chen, A. V., Kiszonas, A. M., Lutskas, L. A., 2016. Goniometry and limb girth in miniature Dachshunds. Journal of Veterinary Medicine 2016, 5846052.

Thomovsky, S. A., Ogata, N., 2021. A canine's behavior and cognitive state as it relates to immobility and the success of physical rehabilitation in the non-ambulatory spinal cord patient. Frontiers in Veterinary Science 8, 599320.

Unnanuntana, A., Jarusriwanna, A., Nepal, S., 2018. Validity and responsiveness of Barthel index for measuring functional recovery after hemiarthroplasty for femoral neck fracture. Archives of Orthopaedic and Trauma Surger 138, 1671–1677.

Van Hedel, H. J., Wirz, M., Dietz, V., 2005. Assessing walking ability in subjects with spinal cord injury: validity and reliability of 3 walking tests. Archives of Physical Medicine and Rehabilitation 86, 190–196.

Vaney, C., Blaurock, H., Gattlen, B., Meisels, C., 1996. Assessing mobility in multiple sclerosis using the Rivermead Mobility Index and gait speed. Clinical Rehabilitation 10, 216–226.

Walton, M. B., Cowderoy, E., Lascelles, D., Innes, J. F., 2013. Evaluation of construct and criterion validity for the 'Liverpool osteoarthritis in dogs' (LOAD) clinical metrology instrument and comparison to two other instruments. PloS One 8, e58125.

Weingarten, M. A., Sande, A. A., 2015. Acute liver failure in dogs and cats: Acute liver failure. Journal of Veterinary Emergency and Critical Care 25, 455–473.

Wiseman-Orr, M., Nolan, A.M., Reid, J., Scott, M., 2004. The development of an instrument to measure chronic pain in dogs. American Journal of Veterinary Research 65, 1077–1084.

Wiseman-Orr, M., 2005. The development of an instrument to measure chronic pain in dogs. Doctoral thesis, University of Glasgow.

Wright, A., Amodie, D. M., Cernicchiaro, N., Lascelles, B. D. X., Pavlock, A. M., Roberts, C., Bartram, D. J., 2022. Identification of canine osteoarthritis using an owner-reported questionnaire and treatment monitoring using functional mobility tests. The Journal of Small Animal Practice 63, 609–618.

Yi, Y., Ding, L., Wen, H., Wu, J., Makimoto, K., Liao, X., 2020. Is Barthel Index suitable for assessing activities of daily living in patients with dementia? Frontiers in Psychiatry 11, 282.

Zijlstra, W., Aminian, K., 2007. Mobility assessment in older people: new possibilities and challenges. European Journal of Ageing 4, 3–12.

Tables

Table 1. The Canine Geriatric Functional Score (Frye et al. 2022)

Test	Test description	Score	Scoring description
(A) TUG–timed up and go	Rise from down sternal position and move straight (+/– leash) 10 body length units on flat ground with good footing at quickest manageable gait	0	Incapable
		1	> 15 s
		2	>10–15 s
		3	>5–10 s
		4	≤ 5 s
(B) Cavaletti Walk	On leash two rails at hock height, body length apart (nose to rump), two rails, two passes (once in each direction) for a total of four rails	0	Incapable
		1	Major contact, navigates slowly with extreme difficulty
		2	Moderate contact, partial gait adjustment
		3	Some contact, adjusts gait accordingly, completes task
		4	Minimal to no contact, navigates well
(C) Figure 8's	Figure 8 with diameter of body length for four complete repetitions on leash at a walk	0	Incapable without falling
		1	Consistent knuckling, heavy crossing over, scuffing, delayed pivot
		2	Occasional knuckling, mild to moderate crossing over, scuffing, delayed pivot
		3	Abnormal or delayed pivot (no falls), +/– scuffing
		4	Completes without abnormal crossing over or tripping
(D) Down	Sternal to rise until failure within a 60 s period (manual assistance to reposition in sternal allowed)	0	Incapable
		1	5 reps
		2	5–10 reps
		3	>10–15 reps
		4	>15 reps

Table 2. Examples of tools used to assess the performance of activities of daily living and functional mobility in human medicine

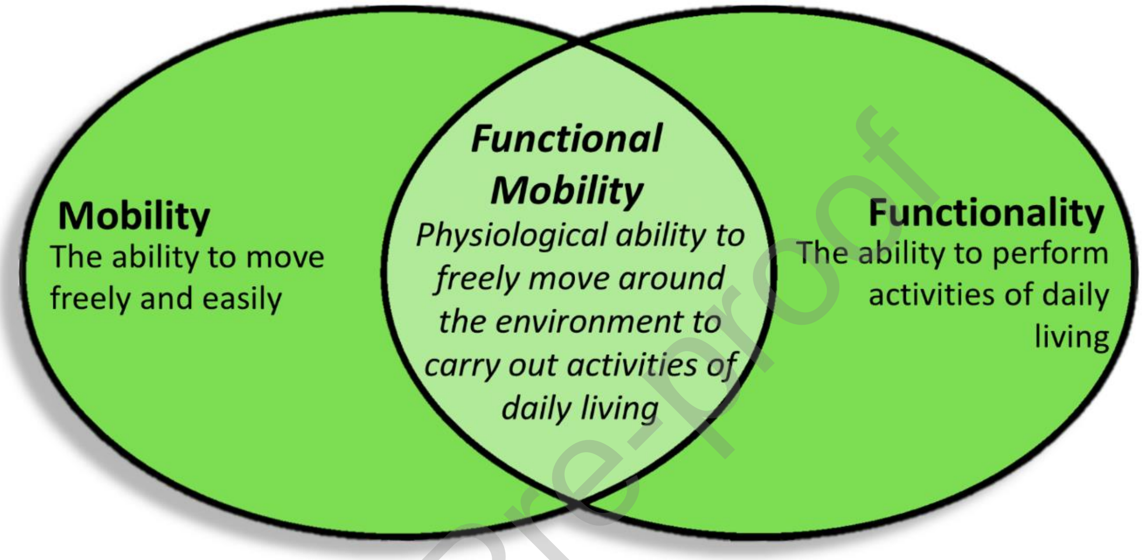
Assessment tool	Methodology	Original purpose	Patients type used for	References

Physical Mobility Scale (PMS)	Observer uses a 6-point scale (0 to 5) to score the performance of 8 mobility activities, based on if they can execute the task independently, with aids or not at all. Activities include rolling, various transitions, transfer and ambulation	Evaluate the functional mobility of aging adults	Elderly	Nitz et al., (2006); Barker et al., (2008)
Rivermead Mobility Index (RMI)	Patients self-report the capability to perform 14 mobility activities with no aids (though walking inside with an aid is accounted for), including various transitions, transfer, ambulation inside and outside on even and uneven surfaces, picking up items from floor, bathing, escalating/ deescalating four stairs and running. Observer also watches patient stand up for 10 seconds unaided. The activity is scored 1 if it can be performed and 0 if it cannot	Measure fundamental mobility of neurologically impaired patients in a clinical or home setting	Stroke; head injuries; multiple sclerosis	Collen et al., (1991); Vaney et al., (1996); Hsieh et al., (2000)
Clinical Outcomes Variables Scale (COVS)	Observer scores the performance of 13 motor tasks on a 7-point scale (1 to 7) depending on their ability to perform the task, and if help or aids are required. Assessments include evaluating various transitions, transfer, ability to roll, sitting balance, arm function, wheelchair reliance, ambulation capabilities including endurance and speed	Developed to assess the functional mobility of patients	Stroke; spinal cord injuries; brain injuries	Choy et al., (2002); Barker et al., (2007); Salter et al., (2010)
Functional Mobility Scale (FMS)	Observer scores the performance of walking 5m, 50m and 500m on a 6-point scale (1 to 6) depending on the reliance of assistive aids. Scores of 1 indicate a wheelchair or similar is required and 6 indicates no use of aids	Evaluate the functional mobility capabilities of children (4–18-year-olds) with cerebral palsy	Children with cerebral palsy	Graham et al., (2004)

Barthel Index (BI)	Observer scores, or patient self-reports, the performance of 10 ADL on a weighted scale, accounting for the capacity to carry out the activity, and if they do so independently or with aids. Activities include continence, toileting, self-grooming, feeding, ambulation, transfer, stair use and bathing	Measure of disability for people with impaired independent use of limbs	Elderly; stroke; hemiarthroplasty (following a hip fracture); Parkinson's disease; palliative oncology	Hartigan, (2007); Duffy et al., (2013); Unnanuntana et al., (2018); Bouwstra et al., (2019); Taghizadeh et al., (2020); Yi et al., (2020); Dos Santos Barros et al., (2022)
The Timed Up and Go (TUG)	An observer records the time taken for a patient to rise to a stand from a chair, walk three meters, turn around and return to the chair. A time >14 seconds indicates a high risk of fall	Assess functional mobility in frail elderly patients	Elderly; Parkinsons disease; spinal cord injuries; multiple sclerosis; Orthopaedic rehabilitation (hip fracture, hip and knee replacement); Alzheimer's; Huntington disease	Podsiadlo and Richardson, (1991); Freter and Fruchter, (2000); Morris et al., 2001; van Hedel et al., (2005); Brooks et al., (2006); Kristensen et al., (2007); Rao et al., (2009); Sebastião et al., (2016); de Oliveira Silva et al., (2019)

Figure legends

Fig. 1. Mobility, functional mobility and functionality (adapted from Bouça-Machado et al., 2020).



Highlights

- Several conditions can impair a dog's mobility and functionality
- Methods of assessing canine functional mobility are currently limited
- A validated canine functional mobility assessment tool would be useful in practice