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Review paper

Extraordinary canine potential − alternative service domains for working dogs: a review

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Abstract

Working dogs are professionally trained canines that assist humans in various tasks, with a long-standing history. Their traditional roles primarily include military dogs, police dogs, herding dogs, and guide dogs. With societal progress and the diversification of human needs, working dogs have emerged in roles and applications far beyond the traditional fields they have historically been associated with. This review describes and analyzes these developing roles and explores the scientific basis, outcomes, and trends behind them. Common non-traditional areas of working dog applications include animal-assisted therapy (AAT), biological disease detection, and animal-assisted education (AAE). Additionally, working dogs may be used in interventions such as prison and drug rehabilitation centers, wildlife protection, and special odor search and location. These roles not only broaden the scope of working dog use and increases their economic value, but also show potential for significant societal benefits.

Keywords: working dogs, animal-assisted therapy, disease detection, animal-assisted education

Introduction

Working dogs refer to dogs that have undergone specialized training to perform specific tasks and assist humans in their work (Hall et al. 2021). The history of working dogs is long, and over time, relatively stable areas of canine use have gradually formed. These include military applications such as guarding, mine clearance, and biting (Storer et al. 2024), police applications such as tracking, drug interdiction, and quarantine (Gatlin 2024), and civilian applications such as guiding blind people, hunting, and sheep herding (Brown 2021, Ridgway 2021). With the development and progress of human society, working dogs have gradually emerged with new opportunities beyond traditional fields. These emerging non-traditional areas of canine use have developed rapidly, with related research and attempts emerging continuously. For example, therapy dogs may support human mental health (Santaniello et al. 2021), identify medical diseases based on scent (Louie 2024), and support reading skills in children (Fung 2019).

However, the current literature primarily focuses on progress summaries of working dogs in a certain emerging field, and there are no reported reviews on their applications across multiple non-traditional fields. This makes it difficult for professionals in the working dog industry and veterinarians to gain a holistic understanding of what working dogs can do, especially regarding their roles in non-traditional fields and the types of dogs required for these roles. Based on this practical need, this review describes and analyzes the latest application research results in these emerging non-traditional areas of canine use, providing interdisciplinary knowledge integration for diverse stakeholders (including canine professionals, veterinarians, public health experts, and policymakers). A comprehensive search was conducted in PubMed, Web of Science, and Scopus databases to identify relevant studies published between 2015 and 2025. The search terms included combinations of "canine"or "dog" and "animal assisted" or "diseases" and "working " or "service" or "detection". Peer-reviewed original articles, reviews, and case reports were considered. Studies were included if they focused on non-traditional roles of canines. Exclusion criteria comprised studies on traditional working roles (e.g., police dog, army dogs, herding, guide dogs) and non-academic reports. Our goal is to expand the understanding of working dogs' functional spectrum and inform future innovation.

Utilization of dogs in animal-assisted therapy

Animal-assisted therapy (AAT) is a goal-directed intervention where an animal is an integral part of the treatment process, as defined by the health body and directed by a healthcare professional to improve physical, social, emotional, or cognitive functioning (Bert et al. 2016, Serpell 2025), with dogs being the primary animal source in animal-assisted therapy (Cirulli et al. 2011). Studies indicate that the use of modern working dogs for therapy dates back to the 1960s, with the auxiliary therapeutic functions of working dogs gradually emerging thereafter (Doan et al. 2023). Over time, the direction of dog-assisted therapy has formed, specifically applied in the treatment of mental illnesses such as autism (Rodrigo-Claverol et al. 2023), depression (Hunjan and Reddy2023), anxiety (Silva and Osório 2018), and social disorders (Angetand MacDougall 2022). The use of dogs in animal-assisted therapy is currently the most established and widely applied non-traditional area.

Assisted therapy for autism

The use of working dogs for intervention therapy in autism is the most common treatment approach in animal-assisted therapy (Beavers et al. 2023). Compared to humans, dogs are easier to establish connections and attachments with autistic patients, and gradually transfer the patient's connection and attachment to the therapist, which is the primary reason for using working dogs in assisted therapy for autism (Rodrigo-Claverol et al. 2023). Furthermore, the presence of working dogs can elicit more interactive behaviors from patients, make them easier to stay calm, and better cooperate with therapeutic activities (Guillen Guzmán et al. 2022, Beavers et al. 2023) all of which can have a positive impact on autism treatment. Wijker et al. (2020) observed changes in patients' behavior after receiving dog-assisted therapy and confirmed that the use of working dogs for assisted therapy in autism can effectively enhance patients' self-confidence and self-esteem, promoting their prosocial behavior. A study by Angetand MacDougall (2022), through interviews with therapists and patients' families, indicated that dog-assisted therapy can help patients improve abilities in behavioral learning, emotion recognition, anger management, and other aspects through interactions with dogs.

Assisted therapy for attention deficit hyperactivity disorder (ADHD)

Attention deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder characterized by persistent and developmentally inappropriate levels of inattention, hyperactivity, and impulsivity. Dogs, as the main characters in animal-assisted therapy, have an excellent calming effect, helping to reduce hyperactivity and impulsivity symptoms and positively impacting the social and emotional functioning of patients with ADHD (Nieforth et al. 2024). Schuck et al. (2018) conducted a randomized controlled trial on 88 children with ADHD and found that dog-assisted intervention can effectively improve and enhance ADHD children's self-perception, behavioral performance, and learning abilities, with relevant scores significantly higher after treatment than before. Tepper et al. (2023) analyzed relevant studies over the past decade and found that many studies have confirmed the positive impact of dogs on ADHD patients and further pointed out that there is little difference in the impact of interventions lasting 4-6 weeks, while continuous treatment exceeding 7 weeks can show improvement or even significant improvement.

Assisted therapy for depression

Depression is a mental systemic disorder. Symptoms can vary from person to person in severity and presentation, but generally include persistent sadness, loss of interest or pleasure in activities (anhedonia), and can also involve physical and cognitive changes. In some cases, learned helplessness is occurred (Cui 2015). In some patients, there may even be suicidal tendencies, making depression a global public health issue. Studies have clearly shown that animal-assisted therapy has a certain effect on depression, with dogs still being the most widely used live animals in this context (Ambrosi et al. 2019). Hunjanand Reddy (2023) conducted a controlled experiment with 30 participants aged 20-30 with mild to moderate depression and found that the use of therapy dogs had a positive impact on depressive symptoms. Villarreal-Zegarra et al. (2024) conducted a systematic review and meta-analysis of randomized clinical trials on dog-assisted therapy, other animal-assisted therapies, and pet robot interventions for reducing depressive symptoms in individuals over 65 years old. The study found that dog-assisted therapy was the most effective, significantly reducing depressive symptoms in the elderly, helping to prevent the triggering of depressive symptoms, and delaying further progression.

Assisted therapy for post-traumatic stress disorder (PTSD)

PTSD is a long-term mental disorder that occurs after a person experiences catastrophic or harmful events, leading to emotional abnormalities, social avoidance, personality changes, and severely affecting the patient's quality of life (Bäärnhielm et al. 2024). Research on the application of therapy dogs in PTSD mainly focuses on abused children and military veterans. Chapman et al. (2024) reviewed relevant research on the use of therapy dogs in addressing complex trauma in children and pointed out that therapy dogs can address internalized (emotional) and externalized (behavioral) symptoms of complex trauma, as well as post-traumatic stress. A study with a sample of 65 military veterans and emergency personnel with PTSD compared their subjective and physiological parameters after therapy dog treatment through a controlled experiment and found that the presence of therapy dogs improved patients' subjective experiences of health, sleep quality, and PTSD-related symptoms (van Houtert et al. 2022).

Other assisted therapy applications

Based on the positive impacts of therapy dogs on patients' physical, emotional, and social aspects, researchers have conducted additional studies on broader AAT uses. A study with a sample of 24 children diagnosed with leukemia and solid tumors confirmed the effectiveness of using therapy dogs in the context of oncology for most groups undergoing tumor, cancer, and advanced palliative treatment, resulting in improvements in pain, anxiety, tension (Silva and Osório 2018). Children that interacted with, cared for, walked, played, or had regular visits from a dog as part of AAT were found to have lower pain levels for conditions or procedures such as venipuncture, tumor pain, and severe disability (Sobo et al. 2006, Vagnoli et al. 2015). Based on the stress-reducing, emotion-regulating, and pain-alleviating effects provided by the mere presence of dogs (without requiring active interaction), research suggests their potential therapeutic applications across outpatient, emergency, and inpatient healthcare settings as emotional support animals (Kline et al. 2019, Clark et al. 2020, Fornefeld et al. 2023).

Utilization of dogs in biological disease detection

The use of working dogs in biological disease detection has a long history. As early as 1989, The Lancet published a case where a dog, through

continuous sniffing, enabled its owner to discover a melanoma on their leg (Williams and Pembroke 1989). In 2001, The Lancet again published a similar case (Church and Williams 2001), sparking a research surge in using dogs to detect human diseases. Since then, research on using working dogs to detect cancers, infections, and other human diseases has grown, reaching a climax in research and application after the COVID-19 pandemic. Besides human disease detection, research on using dogs for animal and plant disease detection has gradually increased in recent years. These applications constitute the overall direction of using dogs in biological disease detection, becoming another emerging field of working dog applications.

Human disease detection

Human disease detection is the primary development direction of biological disease detection dogs. Over the past three decades, a significant amount of research has focused on this area, including various cancers (Seo et al. 2018), bacterial infections (Charles et al. 2019), epileptic seizures (Maa et al. 2021), infectious diseases (Eskandari et al. 2021), and human metabolic diseases (Dehlinger et al. 2013). Among these, cancer is the most heavily researched. A systematic review article points out that among various human disease detection projects using dogs, approximately 68% are cancer detection, with lung cancer, prostate cancer, and breast cancer being the top three (Bauër et al. 2022). Double-blind clinical trials show that dogs can detect lung cancer with a sensitivity of 97.6% (Feil et al. 2021), with overall sensitivity and specificity of 96.7% and 97.5%, respectively (Junqueira et al. 2019). For prostate cancer detection, both sensitivity and specificity exceed 90% (Taverna et al. 2015, Cornu et al. 2011). For breast cancer detection, sensitivity and specificity are over 88% and 98%, respectively (Thuleau et al. 2019). In addition, various cancers such as primary tumors (the original site where cancer begins, composed of abnormal cells that grow and multiply uncontrollably), urothelial tumors, ovarian cancer, and colorectal cancer have been relatively well-studied, with overall detection rates also being ideal (Pellin et al. 2023).

In addition to cancer, another area of intense interest is the detection of human diseases by dogs focuses on infectious diseases. Currently, dogs have been proven to be useful in detecting infectious diseases such as infectious colitis, tuberculosis, malaria, and others (Cambau and Poljak 2020). In clinical trials, dogs' sensitivity and specificity for detecting Clostridium difficile are 92.3% and 95.4%, respectively (Bryce et al. 2017). For malaria detection, sensitivity and specificity are 73.3% and 91%, respectively (Guest et al. 2019). For pathogens such as Escherichia coli, Staphylococcus aureus, Klebsiella, and Enterococcus, the overall sensitivity is close to 100%, and specificity is higher than 90% (Maurer et al. 2016). During the outbreak of COVID-19, research on disease-detection dogs reached its zenith (Maughan et al. 2022). A study using 3,249 COVID-19 patients as subjects for a controlled experiment found that dogs' detection sensitivity was superior to that of reverse transcription-polymerase chain reaction (RT-PCR) testing, with unique advantages of high sensitivity, short turnaround time, low cost, minimal invasiveness, and ease of application (Hag-Ali et al. 2021).

For disease detection, dogs are typically presented with biological samples from individuals, which contain disease-specific volatile organic compounds (VOCs). The dogs then sniff these samples to identify potential illnesses based on VOC profiles. Urine from the person to be tested is the most commonly used sample (Giró Benet et al. 2022, Guest et al. 2021). Additionally, depending on the specific characteristics of the disease, other samples such as blood (Horvath et al. 2013, Kane et al. 2022), feces (Sonoda et al. 2011), axillary sweat (Devillier et al. 2022, Sarkis et al. 2022), skin contact materials (Elliker et al. 2016, Kantele et al. 2022), and respiratory samples (Jezierski et al. 2015, Guirao Montes et al. 2017, Crawford et al. 2022) can also be selected for testing. Recently, studies have also used human tear samples to detect the presence of Staphylococcus aureus (Ramos et al. 2024).

Animal and plant disease detection

Canine olfaction has also proven effective in identifying diseases in plants and animals. A 15-year study using two disease-detecting dogs to track and identify wildlife infected with Sarcoptes scabiei var. canis (Sarcoptes) found 292 dead and 63 surviving wildlife infected with sarcoptic mange during this period, marking the beginning of the use of disease-detection dogs for animal disease detection (Alasaad et al. 2012). Additionally, studies have used nasal mucus swabs from cows as odor carriers to screen beef cattle for diseases such as bovine viral diarrhea virus, bovine herpesvirus, and bovine parainfluenza virus using dogs (Juge et al. 2022, Juge et al. 2024). The results showed that canine olfaction is an effective means of detecting diseases in beef cattle. The studies also pointed out that there are differences in detection capabilities among different individual dogs, and sample handling methods have a significant impact on test results (Juge et al. 2022, Juge et al. 2024). Another study used working

dogs to detect Staphylococcus aureus in cow milk, with sensitivity and specificity of 91.3% and 97.9%, respectively (Fischer-Tenhagen et al. 2018). A study also used disease-detection dogs to screen white-tailed deer potentially suffering from Chronic Wasting Disease (CWD), finding an average sensitivity of 92% and an average specificity of 98% among the dogs (Golden et al. 2024).

Plant pest and disease detection also holds research and application value. Since 2010, the United States Department of Agriculture (USDA) has organized the use of working dogs to detect citrus canker (caused by Xanthomonas citri subsp. citri), noting that dog detection can achieve accuracy of about 98% (http://portal.nifa.usda.gov/web/crisprojectpages/0417002-assessment-of-canine-detection-for-huanglungbing-hlb-in-citrus-canker-cc.html). Researches have trained working dogs to detect avocado trees infected with laurel wilt (Pseudomonas syringaepv. syringae), using volatile compounds from the pathogen as the odor source. Field tests in nine avocado orchards found that dogs had an average accuracy and positive predictive value of 99.4% and 94.8%, respectively. The results showed that the use of working dogs could significantly reduce the spread of laurel wilt, help delineate disease areas, and effectively lower maintenance costs (Mendel et al. 2018). In terms of pests, a study confirmed that dogs can be used to detect eggs of the spotted lanternfly (SLF), a pest threatening forestry and agriculture, with average sensitivity and specificity of 99.14±0.33% and 99.41±0.21%, respectively (Aviles-Rosa et al. 2023). Another study evaluating working dogs to detect bark beetle-infested spruce trees found they were four times more efficient than human experts (Vošvrdová et al. 2023). Since an infected trees should be removed within a short period of time ranging from one week to one month, it is imperative that diseased trees be quickly and efficiently identified. In this way, working dogs can save valuable time for forestry experts and minimize the spread of disease. The main advantage of using the dog search method is to amplify the time-window from about one week to one month from the detection to prompt removal of the infested trees from the forest (Vošvrdová et al. 2023).

Utilization of dogs in education

Animal-Assisted Education, or AAE, is an innovative approach where animals are intentionally integrated into educational settings under the guidance of education and related service professionals to promote student learning and development (Beetz 2013, Nakajima 2017). Dogs are most frequently used for AAE (Kiesewetter al al. 2023) with the goals of improving cognitive development, academic success and social skills (Jegatheesan et al. 2024). An observational study in 2023 found that after dogs were fully integrated into teaching (Verhoeven et al. 2023), students' self-rated confidence and interpersonal relationship scores increased significantly, and teachers' evaluations also showed improvements in students' learning attitudes, emotions, and other aspects, demonstrating the advantages and effectiveness of using working dogs in education. Regarding the specific mechanisms of action, Verhoeven et al. (2023) conducted a detailed exploration and proposed that working dogs likely exert their effects through three key aspects: providing extrinsic motivation, emotional facilitation, and enhanced engagement (Verhoeven et al. 2023). Currently, the utilization of dogs in education can be broadly divided into two categories: assisting with reading and campus-based integrated therapy (Steel et al. 2023, Poleshuck et al. 2024). The use of working dogs in education is gradually being implemented and may represent a potential development direction with significant economic value and social benefits.

Reading assistance activities

The Reading Education Assistance Dogs (R.E.A.D.) Program was created by a non-profit organization that encourages children to read through the use of therapy animals (Intermountain Therapy Animals, 2010). This program taps into the benefits associated with animal interaction to encourage and motivate children to improve their reading skills. Subsequently, various dog clubs, reading clubs, public libraries, and other organizations worldwide began organizing similar activities (LeRoux et al. 2014). As such activities increased, they gradually began to be applied in kindergartens, schools, and other educational institutions (Lenihan et al. 2016). Dog-assisted reading can include one-on-one reading with a dog, group reading, and classroom reading. Dogs are expected to remain quiet and listen, as directed by their trainers, while the student reads aloud to the dog (Jalongo 2018). In terms of effectiveness, a controlled experiment with 103 students as subjects showed that the experimental group receiving dogs assistance had significantly improved subjective feelings compared to the control group, although the quantitative results were not significant (Steel et al. 2023). Some studies have also shown that students with poorer reading abilities experience the most significant progress (Connell et al. 2019). A questionnaire survey of 253 primary school teachers, with the teachers' perspective as the evaluation criterion, showed that teachers generally had very positive views on READ and believed that READ had a greater positive impact on children's reading motiva-

tion than on their reading frequency or skills, which is consistent with the conclusions of most studies (Steel et al. 2022).

Campus integrated therapy

Studies have shown that the use of working dogs for campus integrated therapy can enhance students' willingness to socialize, relieve their academic stress, and improve their memory and learning effectiveness (Trammell 2017). Against the backdrop of increasing academic pressure and rising depression rates among students, this may have broader application prospects. A meta-analysis study in 2020 extracted data from 20 related studies, yielding 66 independent effect sizes for analysis, and the results indicated that incorporating dogs into the learning environment brings positive learning outcomes for students (Reilly et al. 2020). An experimental study targeting elementary school classrooms and students found that elementary school students could express their emotions and demonstrate more active social initiative by recognizing dogs' behaviors and nonverbal communication. The study further pointed out that the presence of dogs in educational settings may provide fun and interactive experiences, enhance mental health, and increase empathy and socio-emotional development (Correale et al. 2017). Barber and Proops (2019) conducted a comparative experiment with 11-12-year-old junior high school students and found that the introduction of campus-based integrated therapy dogs was also effective for them. Notably, unlike reading assistance dogs, which are more effective for younger children and adolescents, campus integrated therapy dogs can also have a positive impact on college students. A survey of students at universities with campus integrated therapy dogs found that the students reported increased positive emotions, decreased negative emotions, and greater connectedness to their university community (Poleshuck et al. 2024). Another study showed that campus integrated therapy dogs had a more significant impact on college students' emotions during final exams (Peel et al. 2023).

Other non-traditional fields

Assisted interventions in prisons and drug rehabilitation centers

The application of working dogs in assisted interventions in prisons and drug rehabilitation centers follows principles and requirements similar to those in the educational field (Strimple 2003, Cooke and Farrington 2015), leveraging the positive effects of human-dog interaction to rehabilitate inmates and facilitate drug abstinence. Villafaina-Domínguez et al. (2020) conducted a meta-analysis of 20 studies using therapy dogs in prisons, finding that single therapy sessions lasted between 60 and 120 minutes, with a frequency of 1 to 3 days per week. 65% of the studies confirmed significant improvements in inmates' anxiety, stress, likelihood of recidivism, and other social variables. Additionally, the use of dogs in prisons creates a unique and comprehensive sense of comfort and support for inmates, enhancing their empathy (Gibson et al. 2023), which also contributes to their rehabilitation. In drug rehabilitation centers, working dogs primarily aim to assist individuals recovering from substance use disorders (SUD) (Kerr-Little et al. 2023). The assistance provided by working dogs to SUD patients includes enriching sources of social connections and helping establish channels for interpersonal social interaction; providing a certain calming and comforting effect to reduce stress and anxiety, and motivating patients to seek positive changes through the human-animal bond (Dell et al. 2024). Studies also indicate that the intervention of working dogs is beneficial in changing patients' thinking patterns and perspectives, thereby aiding their recovery from addiction and mental health challenges (Kosteniuk et al. 2023).

Wildlife conservation

Utilizing working dogs in wildlife conservation is an area of growing interest and research. Well-trained dogs can effectively search for specific or multiple species without disturbing wildlife, providing valuable data (Grimm-Seyfarth et al. 2021). Compared to traditional methods, working dogs offer significant non-invasive and low-disturbance advantages, as they do not require sampling inside animals or additional equipment on animals. Furthermore, they are efficient and cost-effective (Beebe et al. 2016). In practice, working dogs can be used to locate animals and their prey remains (Petroelje et al. 2021), search for animal habitats (Chambers et al. 2015), search for animal fecal samples (Arandjelovic et al. 2015), detect invasive species (Quaife 2018, Rosell et al. 2019) and distinguish between similar species (Arnesen et al. 2020). Besides these direct uses in wildlife conservation, working dogs can also indirectly contribute to wildlife conservation. Studies have used working dogs to search for bird and bat carcasses killed by wind turbines, helping assess impacts, determine collision factors, and develop mitigation measures to reduce bird and bat mortality (Smallwood et al. 2020). Moreover, researchers have also leveraged dogs' keen sense of smell to achieve low-cost, non-invasive monitoring of wildlife estrus and pregnancy (Curry et al. 2021, Roberts et al. 2023).

Specialized odor search and localization

The use of dogs for searching and locating specific odors is not confined to a single application field, but rather represents a collection of fields that leverage dogs' olfactory capabilities to search for and pinpoint specific odors in order to accomplish specialized tasks. Among these emerging fields, the most intriguing is the use of working dogs to detect water leaks. Researchers utilize dogs to detect and locate hypochlorous acid in tap water to identify leak points (Zhong and Chen 2023). Applications include patrolling critical pipelines for prevention when there are no leaks, searching and locating leaks when they occur, and cross-verification with equipment. This technology has rapidly developed to small-scale practical applications, verifying its accuracy and efficiency in practice (Zhong and Chen 2023). Additionally, studies have utilized canine scent detection for identifying fungi and bacteria (Kauhanen et al. 2002) and termites (Hassan and Nanda 2024) in buildings, with the aim of preventing damage to houses and public structures.

Conclusion

Working dogs in non-traditional fields is an area of continued interest and research with a variety of applications. With their sensitive sense of smell and affectionate nature, working dogs can provide multifaceted positive impacts on social development. These emerging application areas not only broaden the scope of use for working dogs but also offer more possibilities for their future development, potentially leading to more significant economic value and social benefits in the future. However, the further development of working dogs is currently limited by the lack of unified industry standards in both training and use. Therefore, researchers in related fields should continue to strengthen cooperation and jointly promote exploration and innovation in the application of working dogs in non-traditional fields.

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