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# Police dogs in forensic investigation

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## **POLICE DOGS IN FORENSIC INVESTIGATION**

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## **ABSTRACT**

As a result of their long history of domestication, dogs are widely recognized for their sociable behaviour and remarkable ability to understand and obey commands. Their unparalleled capabilities coupled with ease of training, make them indispensable in assisting law enforcement to achieve better results in forensic investigations. They play a crucial role in law enforcement, actively contributing to the detection of individuals and substances, maintaining law and order, or engaging in search and rescue operations. Acknowledging their significance, the main objective of this master's dissertation was to assess the importance of law enforcement canines in forensic investigation, considering: a) the functions and key characteristics of law enforcement dogs; b) how these animals are selected, trained, and the risks they face; c) the main characteristics of their human handlers; and d) whether the welfare of these dogs is a concern for those working with them.

This study was based on a systematic review of existing literature, which identified the German Shepherd, Belgian Malinois, and Labrador Retriever as the most common breeds used by law enforcement canine units, due to their high trainability and effectiveness. The methodology and training tools employed align with the primary function these animals perform, that according to the literature involves different substances and people detection. However, to fulfil these tasks these dogs undergo an intense scrutiny process aimed at preparing them for demanding functions, often in unfavourable and dangerous conditions, placing them at risk of injury and premature retirement. Understanding the relationship between the dog and its handler, the primary responsible for ensuring the welfare of the animal throughout its life, is therefore crucial.

Through this dissertation, we hope to have contributed to clarifying the role of law enforcement dogs in forensic investigation, emphasizing the challenges these animals face throughout their lives while performing essential tasks for our society.

**Keywords:** law enforcement working dog; forensic investigation; detection dog; dog training; dog welfare; dog handler.

## RESUMO

Os cães são amplamente reconhecidos pelo seu comportamento sociável e pela sua notável capacidade de compreender e obedecer a comandos, fruto da sua longa história de domesticação. As capacidades inigualáveis que possuem aliadas à facilidade de treino torna-os imprescindíveis para auxiliar as forças de autoridade a alcançar melhores resultados na investigação forense. Desempenham assim um papel muito importante nas brigadas cinotécnicas, contribuindo ativamente na deteção de pessoas e substâncias, na manutenção da lei ou na busca e salvamento. Cientes da sua relevância, o objetivo principal desta dissertação de mestrado foi avaliar a importância das brigadas cinotécnicas na investigação forense, considerando: a) as funções que desempenham os cães das brigadas cinotécnicas e quais são as suas principais características; b) como são selecionados e treinados esses animais, e que riscos enfrentam; c) quais são as principais características do seu binómio humano e d) se o bem-estar destes cães é uma preocupação para aqueles que com eles trabalham.

Este estudo baseou-se na realização de uma revisão sistemática da literatura existente, que permitiu identificar o Pastor Alemão, o Pastor Belga Malinois e o Labrador Retriever como as raças mais utilizadas pelas autoridades para integrar brigadas cinotécnicas, devido à sua alta capacidade de treino e eficácia. A metodologia e auxiliares de treino empregues estão alinhados com a principal função que estes animais desempenham, que de acordo com a bibliografia é a deteção de substâncias e pessoas. Mas para poderem desempenhar essas tarefas passam por um processo intenso de escrutínio, que visa preparar esses animais para o desempenho de funções muito exigentes, em condições muitas vezes desfavoráveis e perigosas, que os colocam frequentemente em risco de sofrer lesões e de ser precocemente retirados do serviço. É por isso muito importante perceber a relação que o cão tem com o seu binómio humano, o principal responsável por assegurar o bem-estar do animal ao longo da sua vida.

Esperamos com esta dissertação ter contribuído para esclarecer o papel das brigadas cinotécnicas na investigação forense, sublinhando os desafios que estes animais enfrentam ao longo da sua vida, enquanto desempenham tarefas imprescindíveis para a nossa sociedade.

**Palavras-chave:** cães de brigada cinotécnica; investigação forense; cães de deteção; treino; bem-estar; binómio humano.

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## INTRODUCTION

According to the process of domestication, dogs (*Canis familiaris*) were the first animals to be domesticated, accordingly to some authors, more than 30000 years ago. The domestic relationship between canines and humans began with the gray wolves (*Canis lupus*), when they overcame fear towards the human population and started living in a mutualism interaction that resulted in complementary hunting strategies between Paleolithic humans and wolves, that benefited from an anthropized environment. In the subsequent phase of domestication, a gradual shift took place in the interactions between humans and dogs. Dogs were increasingly chosen based on their behavioural traits, with a primary focus on providing protection and companionship to humans (Mesloh, 2003; Sousa, 2012; Da Silva & Sant'Anna, 2018; Bray et al., 2021; Tancredi & Cardinali, 2023).

Throughout the years, dogs started to work in many different types of services such as maintenance and restitution of public order, high-risk tactical intervention, explosives inactivation, search and rescue, detection of narcotics, explosives, weapons, cadaver and human remains, polycarbonates (as found in CDs and DVD's), patrol, guard and tracking missions (Morais, 2014).

This thesis aims to review the importance of working dogs in law enforcement scenarios, the positive and negative relevance they have in these types of services, as well as their own welfare and the relationship they establish with their handlers.

## LAW ENFORCEMENT WORKING DOGS

The Federal Law Enforcement Animal Protection Act of 2000, in the United States of America, defines police dogs as “[animals] employed by a federal agency (whether in the executive, legislative or judicial branch) for the principal purpose of aiding in the detection of criminal activity, enforcement of laws or apprehension of

criminal offenders". This recognition underscores the significance of dogs within law enforcement agencies (Barberi et al., 2019).

As dogs working in law enforcement scenarios may, depending on the organizational structure of each country, be associated with the military force, police force, or both, it is quite difficult distinguishing the specific circumstances mentioned in much of the consulted literature. For this reason, in this dissertation we used the term "law enforcement dogs", that is broadly known as "police dogs".

Law enforcement working dogs have been essential since around the 19<sup>th</sup> century (Pemberton, 2013; Knight & Sang, 2019), helping humans in very specific types of work. For instance, it was documented that millions of dogs were used during the first and the second World War to perform a variety of tasks, such as explosives detection or medical assistance, finding harmed soldiers and bringing them to safety, for example (Gazit et al., 2003; Mesloh, 2003; Evans et al., 2007; Sousa, 2012; Greatbatch et al., 2015; Oliveira, 2016; Gordon, 2018).

Nowadays, dogs are used by numerous governmental organizations for different purposes as there has been an increase in the need of specialized canine units, particularly those for detection and apprehension of suspects, detection of illegal substances (Sinn et al., 2010; Frank et al., 2022; Bray et al., 2021) and for civil protection, where conventional security systems have not succeeded (Tamimi & Wali, 2019). However, it is worth noting that this performance results from the interaction between the dog and its handler, following specific and intensive training allowing them to work in any necessary environment (Knight & Sang, 2019). Hence, law enforcement working dogs' performance is an interaction between the dog itself, law enforcement agents and policing.

According to Haraway, law enforcement working dogs are part of a "speciesist hierarchy" and key components to the construction of knowledge, so, dogs matter because they have had human characteristics and qualities attributed to them (Knight & Sang, 2019). Dogs and humans co-evolution through the process of domestication and breeding specific types of dogs can be seen in a "two time-space" scale. In the past, face-to-face interactions, such as hunting and tracking were present (Knight & Sang, 2019); nowadays, those interactions result of their involvement in crime control and public relations (Mesloh, 2003; Barberi et al., 2019; Sandrin et al., 2022).

The use of dogs in law enforcement enhances policing efficiency and effectiveness, as well as officer morale (Mesloh et al., 2002) due to canine units being mostly teams composed by a dog and a human part, with better range of search and safety of the handler. Canine units are quicker to clear buildings, as they are more accurate and a safer option than if an individual or team of officers attempted the same task (Mesloh et al., 2002; Barberi et al., 2019). Law enforcement working dogs can be considered multidisciplinary entities because of their wide range of work sites, such as army facilities, police agencies, airports (Sousa, 2012; Tamimi & Wali, 2019). The efficiency and effectiveness of canine units are based on the quality and type of training each dog receives, as well as their relationship with the handler (Mesloh et al., 2002).

Although canine units play a very important role in law enforcement, these special forces are cost-effective means, with skills and abilities that surpass available technology and need training to maintain their quality, efficiency, and effectiveness (Mesloh, 2006; Bray et al., 2021). In general, the presence of a law enforcement working dog unit increases the percentage of the efficiency in policing-related tasks (Mesloh, 2003; Barberi et al., 2019).

Canine units are constructed, as mentioned by Smith and colleagues (2021), through a process of objectification of the dogs' characters, bodies, abilities, and skills, to become suitable for the general purpose police dogs' function, other functions might need specific training to have efficient results.

The most used breeds for law enforcement working dogs are German Shepherd, Belgian Shepherd Malinois, Labrador Retriever, Bloodhound, Rottweiler, Doberman, Golden Retriever, Boxer, and Terrier (Sousa, 2012; Jezierski et al., 2014; Vieira, 2020). The preference for a particular breed may differ from country to country due to their specific or traditional breed choice, availability, and current opinions (Jezierski et al., 2014; Fattah & Gharib, 2020).

The importance of a law enforcement working dog is tightly linked to the role they portray and the dynamics of their relationship with their handlers. It was demonstrated that the loss of a law enforcement working dog can have a deep emotional effect on the handler but also a decreased efficiency in policing-related tasks (Barberi et al., 2019). To better understand this, we must reflect on their career

trajectory, such as recruitment, selection, training, active duty, and retirement (Knight & Sang, 2019), as this study will explain.

## ***SPECIALIZED CANINE UNITS***

The use of specialized canines has evolved from a hunting tool to a device used by many governments, law enforcement agencies, and private entities (DeGreeff et al., 2012). According to Gaub and colleagues (Sandrin et al., 2022), specialized canine units can be divided into three categories: 1) units of alternative patrol, which are general patrol duties in defined areas; 2) units for specific crime types, which are investigation-based units and 3) units of unique tactics, such as special weapons and tactics units. However, some specialized units can fall into more than one category (Sandrin et al., 2022).

Besides being able to detect scents, canine units may also be used as obedience tools and agents of force that search, track, bite and apprehend people. Therefore, they are very versatile and may be used in many kinds of situations (Sandrin et al., 2022).

So, specialized canine units can work with police forces for numerous reasons and on different tasks, such as patrol, criminal apprehension, locating missing people, tracking or trailing, cadaver recovery, and narcotics, explosives or accelerant detection (Rooney & Bradshaw, 2004; Cabral, 2011; Sousa, 2012; Cunha, 2013; Morais, 2014; Barberi et al., 2019; Antunes, 2020; Zink & Schlehr, 2020; Arcuri et al., 2022; Santariová et al., 2023). They are known to improve the results of policing tasks, either by elevating success rates and accuracy or ensuring a faster reaction of police services without decreasing quality (Barberi et al., 2019).

## ***GENERAL PURPOSE DOGS***

The primary skills that General Purpose police dogs must acquire during their training include following the handler's directions, scent tracking, searching for hidden individuals, locating specific objects, signalling the discovery of humans or objects (through barking or lying down), apprehending fleeing individuals, navigating obstacles, and mastering basic obedience, including an emergency recall. Handlers are trained to effectively manage the dogs and instruct them to perform these tasks accurately. The training philosophy primarily relies on a 'reward-based' approach, with police officers learning how to praise and reward the dogs when required. General purpose police dogs generally reside in outdoor kennels provided by the police department at the handler's residence (Smith et al., 2021).

## ***DETECTION DOGS***

Dog's noses possess about 300 million olfactory receptors, as compared to human's, 6 million receptors (Ricci et al., 2021), making them a valuable tool for crime scene investigations, mainly in sexual assault and violence cases, with the detection of bodily fluids, such as semen and blood, and locating dead bodies (Skalleberg & Bouzga, 2016). Because of this and being naturally driven to hunt, they are able to accurately detect particular scents, exceeding humans and other mechanical equipment in these tasks (DeGreeff et al., 2012).

However, detection dogs' performance may present some inaccuracies, because of handler error or poor training of the dog, which results in a false alert (Jezierski et al., 2014). Besides this, a dog's alert may be impacted by natural factors, such as the deposition of scent or fluids on different surfaces, environmental conditions (high humidity, elevated temperatures, wind and rain, for example) and exposure to other animals and organisms (Mesloh et al., 2002; Genelhoud, 2016; Skalleberg & Bouzga, 2016; Ricci et al., 2021).

Although interferences may occur, a successful performance from detection dogs needs to meet two objective measures: detection speed and detection accuracy (Fattah & Gharib, 2020). In real life scenarios detection must be quick, but sometimes, a rapid search may have the opposite effect, for example, when searching for explosives, the dog can “pull tripwires or trigger improvised explosives devices” (Jezierski et al., 2014).

Detection accuracy involves measuring correct hits, false alerts, misses and correct rejections. A perfect detection from the dog requires that no target scent remains undetected, and no other material is falsely alerted (Jezierski et al., 2014). Additionally, the faster an intervention is made, the higher are the chances of achieving successful search results (Ricci et al., 2021).

According to Gazit and collaborators (2005), detection dogs have a higher motivation to search in locations they are familiar with and have an elevated probability of a positive search, as in finding the target scent, and being rewarded for it, than to search in clean places where there is no possibility of finding the target scent (Jezierski et al., 2014). Some scents may only be detectable because they are stored in recognizable materials, for example, some explosives devices are detected because the explosive is contained in wooden or plastic boxes and the electrical ignition is usually made of graphite (Ricci et al., 2021).

Due to their highly sensitive olfactory system, dogs have been used for many detection disciplines of interest. They can be ‘*single purpose dogs*’ (Bray et al., 2021) that detect narcotics, firearms, mass storage devices, search and rescue, medical diagnoses, flammable liquid residues, explosives devices, currency and even tracking/trailing (Gazit & Terkel, 2003; DeGreeff et al., 2012; Tamimi & Wali, 2019; Antunes, 2020; DeChant et al., 2020; Bray et al., 2021). On the other hand, canines can also be ‘*dual purpose dogs*’ (Bray et al., 2021), that are more commonly chosen by law enforcement agencies and have a protection and detection purpose (Bray et al., 2021). Because of their sensitivity, detection dogs are able to overtake man-made equipment, because they can identify one odour even when it’s mixed with other odours (Ricci et al., 2021). Although detection dogs are very efficient, they are faced with physical, cultural and environmental limitations to their service (Jezierski et al., 2014; Skalleberg & Bouzga, 2016; Antunes, 2020).

In 2003, Thesen and colleagues, proposed that detection dogs have a particular three phases behaviour when they are following an olfactory clue: searching, deciding, and tracking. Sniffing time in the deciding phase was much longer than the other two phases and is considered the most difficult as the canine has to determine the direction of the track (Gazit & Terkel, 2003). After the tracking phase, whenever detection dogs find the target scents, they perform a trained response (an '*alert*') recognizable by the handler (Chaniotakis et al., 2018).

Operational detection dogs must be chosen according to three factors: 1) selection of a promising puppy; 2) efficient training and 3) continuous assessment of the dog's working performance (Martin et al., 2022). An efficient detection dog is a confident dog that makes few mistakes and is able to search an area successfully, independently, not easily distracted and do not convey fearful emotions when searching (Martin et al., 2022).

Not all performances are completely accurate, therefore errors might occur, in the detection dogs' case, they usually are from unexpected handler behaviour, inappropriate training aids, or ineffective and inconsistent training and working methods (Martin et al., 2022). These errors should be identified as soon as possible and be corrected by the handler to avoid repetition (Martin et al., 2022).

A good way of identifying performance errors is through the duration of sniffing as the shorter the duration, the more correct the response (Concha et al., 2014; DeChant et al., 2020; Martin et al., 2022). However, the sniffing rate may be reduced due to dog panting, that occurs when the dog experiences high temperature situations and tries to regulate body temperature. Dogs cannot sniff and pant simultaneously, as panting requires the air to go through the mouth instead of through the nostrils (Gazit et al., 2003; Genelhoud, 2016). Gazit & Terkel (2003) demonstrated that dogs have three patterns of panting matching the demand for respiratory evaporation: inhalation and exhalation through the nose; inhalation through the nose, exhalation through nose and mouth; and inhalation through nose and mouth and exhalation through both, consequently, limiting sniffing performance and accuracy (Gazit & Terkel, 2003).

## **SCENT DETECTION DOGS**

Canines have been used as scent detectors for thousands of years and for many different tasks (DeGreeff et al., 2012; Genelhoud, 2016). Scent detection dogs are trained to recognize and identify scents that may help link suspects to a crime scene in an investigation. Ricci et al. (2021), classified scents into three categories: primary scent category are genetically conditioned compounds that are constant regardless of environmental factors, diet, visceral and emotional state, and illness; secondary scent category are skin-derived scent compounds, which are dependent on internal and external factors; and tertiary scent category are derived from the environment, such as scents from a workplace, cosmetics, cigarette smoke, gasoline, scents of other people or domestic animals. These authors also proposed that dogs go through an odorological assessment in order to give positive results, which consists of three phases: 1) Detection of the olfactory impression; 2) Odour concentration; 3) Comparison of the olfactory trace with the scent from other people (Ricci et al., 2021). Scent detection dogs' performance also depends on olfactory acuity and canines' cognitive and learning abilities (Jezierski et al., 2014).

During an investigation, dogs can follow different types of scents, for example, when tracking down a suspect, they can follow the scent of skin flakes and disturbances of ground vegetation but, when they are recovering an object, they can search for skin oils left on the article as human scent is left anywhere a person passes or comes into contact with. Dogs can locate objects up to 48 hours after being in contact with skin oils and can identify up to ten different scents in controlled settings (Mesloh et al., 2002; Marchal et al., 2016).

Usual and current uses of scent canines are detection of drugs, explosives, accelerants, humans (alive or dead), agricultural products, currency, medical conditions, and pests (Gazit & Terkel, 2003; Jezierski et al., 2010; DeGreeff et al., 2012; Fischer-Tenhagen et al., 2017; Da Silva & Sant'Anna, 2018; Tamimi & Wali, 2019; Antunes, 2020; DeChant et al., 2020; Bray et al., 2021). Labrador Retrievers, German Shepherds and Belgian Sheperd Malinois are the most used breeds in scent detection due to their high drive and ability to train (Fattah & Gharib, 2020).

Limitations to law enforcement working dog training can interfere with their performance in real life scenarios, for example, if the dogs are trained with training aids, like jute [a type of material in protection sleeves used by trainers to protect them from canine bite], the dog may focus on the scent of the training aid, in this case, in the scent of jute, instead of the human scent when searching for a suspect (Mesloh et al., 2002).

Following this line of thought, if a suspect hides in a closed area for a longer period of time, their scent will pool in that area and intensify. But, even if they leave that area, the dog will still be drawn to the first hiding place, because the scent will be stronger there (Mesloh et al., 2002).

Besides the interferences mentioned above, such as the training method and the scent left by the suspect, scent detection dogs can also be limited by environmental factors, for example, high humidity, extreme temperatures (cold or heat) (Mesloh et al., 2002; Genelhoud, 2016), wind or rain that can cancel odorous traces (Ricci et al., 2021) making it difficult for a trained dog to find a specific scent.

Scent detection dogs are able to detect untrained scents due to similarity to the substances they are trained with, making them specialists and very sensitive to what they alert to (Jezierski et al., 2014). Some factors influence scent detection accuracy, for example, determining the quantity of target odour materials used in detection training, training in unusual locations and developing improved search tactics, results in increased proficiency and reliability in the field (Jezierski et al., 2014).

In some countries, scent lineups are considered a valid forensic technique for identification (Ferry et al., 2019). However, its use has been deemed controversial in courts, because when presented as primary evidence the only background it has is of practical experience and has no scientific support. To overcome this, lineups have started undergoing scientific analysis to prove its reliability as evidence in courts of law (Ferry et al., 2019) because it may be able to identify particular human scents in crime scenes (Marchal et al., 2016).

## **NARCOTICS DETECTION DOGS**

Narcotics detection dogs can detect drugs and psychotropic substances, such as marijuana, hashish, cocaine, heroin, LSD, methamphetamine and ecstasy, even if hidden within or mixed with other substances of vegetable origin (such as coffee, sugar) (Sousa, 2012; Ricci et al., 2021). For practical reasons, drug detection dogs are trained to detect several of the most commonly trafficked drugs and work more efficiently in a team with a human handler (Jezierski et al., 2014; Lazarowski et al., 2020).

In drug detection training, dogs are first trained to alert to odour considered “strong” or “easy” for human olfaction, in order to help handlers identify a correct alert (Jezierski et al., 2014). Marijuana and hashish are the most common drugs used for training because they are the easiest to acquire for canine training (Jezierski et al., 2014). Narcotics detection dogs’ abilities and efficacy may differ based on training method, experience, breed, gender differences, type of drug, environmental factors and search settings (Villareal et al., 2018; Fattah & Abdel-Hamid, 2020; Jantorno et al., 2020).

A correct or *active* alert is used by the dog to indicate the location of narcotics by scratching. A different alert is made by the dog sitting or lying in front of the location and is called a *passive* or *false* alert (Jezierski et al., 2014; Fattah & Gharib, 2020). When a correct indication is made, the dog is rewarded instantly with a toy and when an incorrect indication is made the handler uses vocal response only, by saying “no” (Jezierski et al., 2014; Fattah & Gharib, 2020).

Narcotics detection dogs are commonly used in airports and prisons because they are effective at scanning large amounts of people (Rooney & Bradshaw, 2004; Choi et al., 2013). The selection of narcotics detection dogs differs from organizations but only a small minority of chosen dogs can be successfully trained for this specific role, due to the difficulty of psychotropic substance detection (Choi et al., 2013).

Some drugs are easier to detect than others, according to detection time and correct indications percentage. Jezierski et al. (2014), ranked drugs from easiest to

most difficult to detect, going from marijuana, hashish, amphetamine, cocaine to heroin. Although these are the most common and used drugs to train narcotics detection dogs, the list must be regularly updated due to new drugs being continuously released (Ricci et al., 2021).

These types of detection may encounter limitations because of modern strategies used by drug traffickers, for example packing substances with fruit, chemicals, accelerant or vacuum-packed foods to make detection harder for dogs (Villareal et al., 2018).

### ***CADAVER AND HUMAN REMAINS DETECTION DOGS***

Human remains detection canines, also known as cadaver dogs or victim recovery dogs, evolved from the search and recovery discipline (DeGreeff et al., 2012). They are considered “canines specially trained to find human decomposition scent and alert their handler to its location” (Martin et al., 2020; Ricci et al., 2021).

Human remains and cadaver detection dogs are considered a special canine unit because they are not trained to detect a specific subject, they are trained to detect the scent of decomposing human remains and are able to locate whole bodies (buried or submerged), decomposed bodies, decomposition fluids, body parts, blood, tissue, hair and bones (DeGreeff et al., 2012; Ricci et al., 2021). In real life scenarios, human remains and cadaver detection canines, might have to search for a range of odours, from fresh bodies to “ancient skeletal remains” (DeGreeff et al., 2012).

Human remains and cadaver detection dogs are usually from Belgian Shepherd Malinois, German Shepherd, English Spaniel and Labrador Retriever breeds. These selected breeds are commonly known for their agility and perseverance, therefore, are great assets to this type of work. Besides these characteristics, handlers also consider dog size, fur length and muscle mass (Martin et al., 2020). Furthermore, handlers regard playfulness, curiosity, sociability, independence, and dynamism as important characteristics for detection dogs (Martin et al., 2020).

To achieve skill efficiency and efficacy, human remains and cadaver detection dogs should be trained with adequate training aids, which should be a simulation of the smell of human cadaver (Martin et al., 2020).

## **EXPLOSIVES DETECTION DOGS**

Specialized canine units can be trained to search for weapons, detonating devices and explosives to combat common and organized crimes, subversive actions and terrorist attacks; in many law enforcement operations, explosives detection occurs under severe physical conditions (Gazit & Terkel, 2003; Sousa, 2012; Vieira, 2020; Frank et al., 2022b; Rooney & Bradshaw, 2004). In explosives detection, dogs are trained to detect and identify at least twenty different types of explosive substances (Ricci et al., 2021).

Explosives detection dogs are trained to identify the scent of chemicals found in explosives (Lazarowski, Waggoner, et al., 2020). Due to their expert olfactory acuity, packaging explosives that specialized units cannot identify is very difficult (Chaniotakis et al., 2018). “*Standard*” or “*general*” explosives detection dogs are responsible to search areas within the handlers’ location and are mostly *on-leash* but can work *off-leash* (Sousa, 2012; Lazarowski, Waggoner, et al., 2020). *On-leash dogs* allows the handler to closely observe the dog’s behaviour and determine the efficacy of sniffing performance and completion of the search area. Disadvantages of *on-leash* dogs is that it puts the handler at risk and restrains the dog from searching in his full potential (Gazit et al., 2003; Sousa, 2012; Lazarowski et al., 2020).

An explosives detection dog portrays three main behavioural characteristics: detection characteristics, related to style and intensity; trainability/tractability, related to cognitive, social and behavioural characteristics to perform specific tasks; and environmental characteristics, related to dog behaviours to work efficiently at particular contexts (i.e., large places, transit stations or combat zones) (Sousa, 2012; Lazarowski, Waggoner, et al., 2020).

## **SEARCH AND RESCUE DOGS**

Search and rescue dogs are trained to locate living humans, often in wilderness or disaster settings under physically and psychologically demanding conditions (DeGreeff et al., 2012; Gordon, 2018). These canine units are commonly used in crime prevention, rescue operations and investigation activities to identify and track the path taken by a suspect or victim (Sousa, 2012; Chaniotakis et al., 2018; Bray et al., 2021; Ricci et al., 2021).

Search and rescue dogs frequently work *off-leash* and far from the handler's location but following their commands (Lazarowski et al., 2020). Although, these dogs normally work at a distance from their handlers, when searching, they maintain visual contact and bark more than *on-leash* dogs, making vocal alerts as soon as a scent target is found (Lazarowski et al., 2020).

## **WATER RESCUE DOGS**

Water rescue dogs showcase the ideal potential of training the inhibitory control, as the ability to suppress an impulsive response in favour of an alternative behaviour (Lazarowski, Krichbaum, et al., 2020). These dogs do not have a strict selection criterion, and their failure is often attributed to their handlers, that may not fulfil the high swimming standards needed. These dogs start their training as puppies and have to learn through temperamental traits or attitude. In this type of specialized canine unit Labrador and Golden Retrievers are the breeds usually selected, as they are physically and temperamentally fit for working in the water (Barrera et al., 2018).

Along with being easy to select, as there are no criteria regarding expected traits, water rescue dogs training is communication-oriented to improve their

connection with humans. On the other hand, water rescue dogs are trained in two different training stages, as D'Aniello et al. (2015) disclosed, first stage is land obedience stage where dogs learn to focus their "attention on unknown people who scream for help and wave their arms, simulating people in distress" and, second stage is the water stage where the people in distress simulates drowning (D'Aniello et al., 2015).

On account of being communication-oriented and succeed in training, dogs are able to form a deep bond and be in tune with their handlers, and have positive behaviours towards unknown people, as well as being capable of living as domestic dogs (D'Aniello et al., 2015).

Ricci et al. (2021), separated four extra categories dogs can be divided in, a) electronic storage detection dogs; b) cash detection dogs and anti-smuggling dogs; c) anti-poison, anti-poaching and apprehension dogs, and d) accelerant detection dogs, commonly known as 'arson dogs'. Some authors may include these canines in a more general form as "*scent detection dogs*".

## ***ELECTRONIC STORAGE DETECTION DOGS***

Electronic storage detection dogs are trained to sniff electronic equipment. However, little is known about this type of detection dog, as they have been implemented only after the 9/11 terrorist attacks in the United States of America (Ricci et al., 2021).

International Police Forces trained dogs to retrieve electronic equipment such as USB sticks, micro SIM cards, mobile phones, DVDs, CD-ROMs, external hard drives and memory cards. These dogs are trained to sniff the chemical component used as a thermal insulator in most electronic devices (Ricci et al., 2021; Greatbatch et al., 2015).

## ***CASH DETECTION DOGS AND ANTI-SMUGGLING DOGS***

This type of detection dog can be used against financial crimes, such as tax evasion and money laundering (Ricci et al., 2021). Labrador Retrievers are the main breed used for this type of detection as they are trained to sniff and identify hidden money by detecting the molecules contained in the ink used in banknote printing by sniffing shredded banknotes (Ricci et al., 2021). If a dog is successful in this training, they can become able to identify and discriminate different types of banknotes (Ricci et al., 2021). Law enforcement working dogs contribute to this type of detection mainly by identifying smuggled euros and United States dollars (Villareal et al., 2018).

Anti-smuggling dogs are used to combat contraband, mostly cigarette and the illicit trade of counterfeited tobacco products, as well as the smuggling of perishable food as salt, coffee, and other goods (Ricci et al., 2021).

## ***ANTI-POISON, ANTI-POACHING AND APPREHENSION DOGS***

Poison detection dogs are trained to identify toxic substances, poisoned food and food contaminated with harmful or hazardous components, for example, meatballs filled with sharp objects or dead animal remains (Ricci et al., 2021).

These detection dogs can identify poisons, weapons, ammunitions or traps and they signal their handler by pointing their muzzles in the direction of the olfactory input (Ricci et al., 2021).

Apprehension dogs are also used for patrol, usually known as canine unit and their job is to track and force offenders into submission (Ricci et al., 2021).

## **ACCELERANT DETECTION DOG (“ARSON DOGS”)**

Arson dogs are trained to sniff out traces of accelerants and flammable materials, such as gas, naphtha, butane, kerosene, among others. They can identify arsonists in a crowd and search vehicles used to transport accelerant supplies (O’Hagan & Ellis, 2021; Ricci et al., 2021).

These types of detection dogs can smell flammable substances on clothing and compare to traces found on the fire site. In fieldwork, the dogs search large areas around the fire location for either physical or chemical traces left by the arsonist (Ricci et al., 2021).

Numerous breeds can be used as ‘*arson dogs*’ but, Labrador Retrievers are the most common. Their training lasts at least three months and includes learning how to alert the handler to the presence of flammable and accelerating materials (Ricci et al., 2021). O’Hagan & Ellis (2021) also demonstrate that vapour is a restraint for accelerant detection canines as it limits and air flow, due to sources of ignition letting out a vapour which can spread and cover a room causing too much scent to fill the scene, “too much scent in a room can be just as bad as too little scent in a room” (O’Hagan & Ellis, 2021).

Accelerant detection dogs may be ordered to appear in court as an expert witness, to provide evidence on arson cases. However, evidence found by ‘*arson dogs*’ in fire investigations undergo laboratory examinations for the necessary technical-legal comparisons as their findings cannot be relied on even though their support in investigations is evaluated (O’Hagan & Ellis, 2021; Ricci et al., 2021).

## TRAINING

Becoming a police dog involves more than just training as it occupies the greatest portion of a dog's life. It is during training that canine units develop specific abilities, that allow for a partnership throughout the dogs' entire career (Smith et al., 2021; Chaniotakis et al., 2018).

Although there are a few different types of training methods, positive reinforcement, a quadrant of the *operant conditioning* learning method that is based on the premiss that a "behaviour that is rewarded is likely to be repeated" is preferred. Different rewards may be used, according to the type of training and the dogs' preferences: treats, toys or vocal encouragement are some examples (Gazit et al., 2003; Martin et al., 2020; Martin et al., 2022).

On the other hand, training methods that use aversive stimuli have a negative effect on dog welfare and on handler-canine relationship. Dogs trained with punitive techniques exhibited more stress and undesirable behaviours during training, like unwanted barking and growling. Those methods can cause pain, suffering, emotional instability and profoundly impact a dog's performance by affecting its problem-solving capabilities. In contrast, dogs trained on reward-based methods are more successful at problem-solving and do not display undesirable behaviours, showing clearly that punitive methods should never be used to train law enforcement dogs, or any dog (Fattah & Abdel-Hamid, 2020; Jantorno et al., 2020; Vieira de Castro et al., 2021).

Training schedules are usually designed around the canines' attention span and should be adapted to the dogs' behaviour. Canines engaged in training are often seen as going through an enjoyable experience, whereas, when they do not engage, an evaluation is made on whether the handlers' training skills, such as voice tone, gestures and positive reinforcement are efficient due to dogs being assessed through specific personality traits in order to engage in training. Therefore, canine training aims to provide an effective communication between handler and canine, with the intention to understand one another (Smith et al., 2021).

When dogs no longer find training enjoyable or resist participating, they are often considered unsuitable for police work, usually around one or two years of age. In such cases, they may get classified as "*failed police dogs*" and retrained for companion roles or other functions. Successful training results in a lasting working partnership between dogs and police handlers, often extending into the dogs' retirement years when they remain as companion dogs (Smith et al., 2021).

In training, the main skills dogs are taught are to follow handler instructions, track a scent, search for hidden humans, locate items, apprehend suspects and basic obedience with emergency recall and indicate when they find humans or items – usually made by lying down or barking (Smith et al., 2021). Training skills involve gaining the right sensory experiences with bite sleeves, search objects, voice pitch, leash feel, tug strength, spatial and temporal awareness, distances, durations and rhythms between objects, handlers and dogs, and which requires time, patience, and some understanding of the basic principles of learning (Choi et al., 2013; Cunha, 2013; Smith et al., 2021).

Canine performance can be influenced by several factors, such as training, familiarity with scent sources and environmental conditions (DeGreeff et al., 2012). As training evolves, training aids should become more personalized to each dog to result in a more successful canine performance (Smith et al., 2021). Similar to humans, dogs perform according to the levels expected of them, with the frequency and intensity having a significant influence on their performance, although continuous training is required to maintain performance proficiency and success (Mesloh et al., 2002).

Other authors believe that regular training or "*maintenance training*" is essential to maintain alert behaviour and olfactory performance for handler-canine teams (DeChant et al., 2020). Typically, canines are trained for one or two specific policing functions and investment is made depending on the function they are trained for (Barberi et al., 2019).

*End of session cues* are a series of stimuli that alert canines the session is coming to an end. These cues must be clear and repeated at the end of each training session to prevent the dog from associating post training events as part of the training session (Martin et al., 2020). The effectiveness and delivery of *end of session cues* can be associated with how training sessions end and how canines are returned to their

kennels (Topoleski et al., 2018). Therefore, it is crucial that handlers know when to give end of session cues, because dogs can become familiar to the timing and stop searching for odours, in anticipation of rewards (Topoleski et al., 2018).

Occasionally, training sessions can be documented for future referencing and research. In most cases, visual documentation is recommended, in the form of video or photo diaries. Documentation of training grants trainers a more profound understanding of the canine-handler relationship. Moreover, it captures data that allows trainers and handlers to see results when a training is regularly used and to record changes in canines' achievements and performances as well as handlers' confidence in training sessions (Smith et al., 2021).

### ***PARTICULAR TRAINING METHODS***

Law enforcement dogs are trained for multiple purposes, that include their role as guards, attackers and protectors through different bite training methods. While dogs have a natural instinct to protect their handlers, they are also trained to guard, intimidate and control suspects through barking and attacking on command (Smith et al., 2021).

Two particular protection and apprehension techniques are employed by law enforcement agencies, namely, *bite-and-hold* and *bark-and-hold* (also known as *circle-and-bark*). The *bite-and-hold* method involve a canine finding and restraining a suspect until instructed to release. While *bark-and-hold*, the canine prevents the suspect from moving without biting them (Meade, 2006; Knight & Sang, 2019; Barberi et al., 2019).

#### ***“BITE-AND-HOLD”***

The *bite-and-hold* is the most common method of apprehension in which the dog gives the suspect a solid bite, usually below the elbow and does not release until the handler commands (Mesloh, 2006; Smith et al., 2021). Although the dog is released under specific circumstances (defined by policy or crime severity, most times without the suspect in sight) it remains under voice control at all times and should be operated in line of sight (Mesloh, 2006).

“A well-trained police dog can be recalled at any point from the attack. Control through voice command permits the officer to call the dog off prior to or subsequent to the apprehension...” (Mesloh, 2006).

This method requires a special training of the dog, that is going to use a “full-mouth bite”, where the dog uses all its teeth to strengthen their hold on the suspect and only let go when commanded (Meade, 2006). Unfortunately, when training does not go as expected, with the dog giving multiple bites or failing to release on command, the punishments tend to be aversive, usually with a bungee cord or a shock collar (Mesloh, 2006).

Although dogs in this method are trained to maintain a firm bite hold on the suspect, to avoid re-biting (Smith et al., 2021), multiple bite rates are common due to the suspect freeing themselves from the bite, causing the dog to bite again with no specific body area as target (Meade, 2006).

A few police departments changed their training methods from “*find and bite*”, where motionless suspects were automatically bitten unless the handler called off, to “*find and bark*”, causing a reduction in the number of bite injuries but not on the severity of the injury (Meade, 2006).

### **“BARK-AND-HOLD”**

This method focuses mainly on the detection of suspects unless they move or actively resist apprehension. But, if suspects defend themselves from a law

enforcement working dog attack, by being able to arm themselves, placing the dog at risk to be injured or killed, or escaping. It has been argued that if a suspect manages to disable a canine, the officer is in a tactical disadvantage and the law enforcement agency is left with the cost of replacing a trained dog (Mesloh, 2006).

The “*bark-and-hold*” method was developed to protect the canine in the idea that it can slowdown the suspect until the handler arrived to make the arrest (Mesloh, 2006).

Although the *bark-and-hold* method is more ‘*pacific*’ than the *bite-and-hold*, it seems to have very little tolerance levels, since dogs continue to be trained to attack on the smallest movement. In fact, this method shows a higher proportion of suspects bitten than the *bite-and-hold* with statistically significant difference between both training methods (Mesloh, 2006; Sandrin et al., 2022).

## **SCHUTZHUND TRAINING**

*International Prüfungs-Ordnung* (IPO), formerly known as *Schutzhund training*, which translates to “*protection dog training*”, was developed in Germany as a method to assess German Shepherds working abilities and temperament, but currently this method includes other breeds (Barwig, 1991; Haak & Gerritsen, 2021).

This dog training method was also used to select and promote working dogs for roles in law enforcement and has three main phases: obedience, tracking and protection work. In obedience training, dogs are trained to answer to commands quickly and precisely, such as heeling, sitting, and staying; in the tracking phase, the dogs’ scent trailing abilities are analysed, and in protection training, an assessment is performed on dogs’ ability to protect their handler and obey commands under pressure (Haak & Gerritsen, 2021; Barwig, 1991).

Training dogs in the Schutzhund method has been shown to decrease bite ratios and promote the use of positive reinforcement techniques. *Schutzhund training*

involves evaluating a dog's performance in a series of intricate tasks that must occur *off-lead* and require dogs to respond to voice commands from their handlers. Succeeding in *Schutzhund training* requires extensive training and discipline. These dogs operate under the strict guidance of their handlers, without the need to make complex decisions (Mesloh, 2006; D'Aniello et al., 2015).

## **TRAINING AIDS**

To perform a specialized training, sessions need training aids. In many instances, training aids are diverse and personalized for each canine, therefore varying in cost, usefulness, and availability (Mesloh, 2006).

Some detection dogs, such as human remains and cadaver detection, need new and improved training aids that should be easily and legally obtained, non-hazardous, reusable and representative of human remains odour variety (DeGreeff et al., 2012). This is possible due to certain training aids that can create odour collection, for example (DeGreeff et al., 2012; Martin et al., 2022). Odours were collected or resembled fresh human remains, fresh canine and chicken remains, cremated human remains (*cremains*) and material containing decomposition fluid or blood (DeGreeff et al., 2012).

The Scientific Working Group on Dog and Orthogonal Detector Guidelines (SWGDOG) proposes that human remains and cadaver detection canines training should consist of scent line ups, as a recognition test, and of hidden training aids, for a comprehensive assessment (DeGreeff et al., 2012). And that human remains odours should be of varying sources and levels of decomposition as the scent changes along the process of putrefaction (DeGreeff et al., 2012).

Handlers need to be aware of their canine partner to achieve a high-quality and efficient training. They should assess every training aid, e.g., sleeves, toys or leashes, as well as the training environment, i.e., knowing where the dogs feel safer and

relaxed, and guarantee different training locations, settings and hours so that the dog experiences different situations (Smith et al., 2021).

When choosing training aids, trainers should continuously observe and experience physically how canines interacted with different equipment. Bite sleeves are usually padded fabric and leather, in order to protect the handler's hand and arm, but depending on what type of bite they are training for, different sleeves were used. A softer sleeve allows the dog to feel the flesh beneath, learning how hard to bite, whereas a stiff sleeve would promote a tougher bite to hold the target. Handlers physical experience helps them feel the bite through the sleeve and therefore analyse the dogs' behaviour. A sleeve with a jute cover gives less sensation of flesh but allows dogs to develop hold strength and is usually used for added protection (Smith et al., 2021).

According to Martin et al. (2022), there are three commonly used types of olfactory training aids, I) genuine materials – the target odour itself, this aid is highly recommended; II) pseudo-scents – synthetic aids that mimic the genuine material scent; and III) non-pseudo alternatives – dilution, encapsulation, absorption or extraction of the targeted odour (Martin et al., 2022).

Besides bite sleeves or scent sources, training aids can also be devices developed to help handlers, when a law enforcement working dog is off-leash and away from them, to evaluate if the dog is adequately sniffing through the area (Gazit et al., 2003).

Given the significant potential of training aids, further enhancements to the generic training aid creation process is needed, as it will lead to even greater improvements in the success rate (DeGreeff et al., 2012).

## **RECRUITMENT**

Law enforcement working dog recruitment can happen by three ways, since they can be acquired from: a) the public, known as '*gift dogs*'; b) acquired from in-house or c) external breeders, as law enforcement agencies often request specific breeds and of a determined age range (Knight & Sang, 2019). Canines that don't portray the required qualities for this type of work are usually rehomed or trained for a different function, but those that have the qualities receive a document, similar to a license (Morais, 2014; Knight & Sang, 2019). Dog selection is the first of many costly investments that law enforcement makes when employing dogs (Lipka et al., 2017; Barberi et al., 2019; Tiira et al., 2020). Although this occurs, canines are a valuable tool for law enforcement as it helps the industry develop and exceed performance levels (Morais, 2014; Brady et al., 2018a).

When recruiting dogs to become law enforcement working dogs, agencies can decide from two options, '*green dogs*', less expensive but untrained dogs or, more expensive pre-trained dogs. In '*green dogs*' cases, the department must find a reliable and certified academy for training, where dogs and handlers benefit from training together as a foundation for their future relationship, and deployment will take longer. When dogs are pre-trained, departments must confirm the validity of certifications and deployment is almost immediately. However, pre-trained dogs may have acquired bad habits from previous training and are very expensive (Barberi et al., 2019). Sanders (2006) classified recruited dogs into two categories, novice dogs and unsuitable or '*washed out*' dogs. Novice dogs are intelligent, self-confident, have a high drive and other physical characteristics such as their size, agility, and health. On the other hand, '*washed out*' dogs are either too "soft", demonstrating shyness and insecure traits, or too "hard", being overly aggressive and headstrong (Sanders, 2006).

For an effective recruitment, dogs are selected from specific breeders; must be a certain age gap, usually between 12 and 36 months; have had physical and temperamental evaluation; are considered trainable but shouldn't be fully trained when selected (Evans et al., 2007) and, although these are required, dog selection is not based on sex because some dogs may not have sex related characteristics (Fattah & Abdel-Hamid, 2020). Besides these, the breed of the dog is also an important decision. Agencies frequently opt for German Shepherd, Belgian Shepherd Malinois, Labrador Retriever, and Bloodhound's because each breed has different strengths and weaknesses, as well as different costs. German Shepherd, Belgian Shepherd Malinois are considered dual-purpose dogs, because they can be trained for two different goals

but, for this to be validated, agencies must pay for two trainings and two certifications, one of each for each breed (Barberi et al., 2019). Because of this asset, these two breeds are the usual choice of police departments and losing one of them represents a significant financial loss for the department (Mesloh, 2003) and crosses between these two breeds, known as Dutch Shepherds, are not commonly used in police work (Sinn et al. 2010; Lipka et al., 2017).

In order to be suitable for police work, canines need to be physically and psychologically balanced. The numerous tasks they are required to perform demands social life stability, a desire for play, an eagerness to seek out a variety of scents, some aggressive behaviours and physical energy. Dog selection must be based on genetical traits, temperament and behavioural traits, training, socialization, environmental enrichment and life experiences (Sanders, 2006; Sinn et al., 2010; Morais, 2014; Brady et al., 2018; Fattah & Abdel-Hamid, 2020; Martin et al., 2020). But one should never forget that handler and canine training are a parallel process, since both are trained for the same role (Knight & Sang, 2019). Depending on the type of activity performed and handler management, canine wellbeing and performance might be affected during training (Lazarowski et al., 2021; Tidu et al., 2021).

In general, working dogs are typically selected at two different life stages. The first selection often occurs when puppies are ready to leave their breeders, usually at around 8 weeks of age. The second phase of selection takes place during late adolescence or early adulthood. Law enforcement agencies frequently obtain young adult working dogs that are partially trained because, at this age, they already exhibit working temperament and other adult structural features that will allow them to perform and enjoy a long and healthy career (Zink & Schlehr, 2020; Martin et al., 2022).

Rejection recruitment rates are high, usually around 46-50%, due to behavioural reasons, such as anxiety, aggressiveness, or reactivity (Bjørnson, 2019; Jantorno et al., 2020; Tiira et al., 2020). Rejection consequences are elevated due to the investments made, such as time and money, and the possible stressful transitions dogs may experience by not being accurately identified for the role. These decisions are individually made, as each dog is unique (Bray et al., 2021).

Law enforcement working dogs' behaviour can be tested through behavioural tests and/or handler completed questionnaires. In behavioural tests, a set of factors are

looked for, such as character, personality, and temperament (Brady et al., 2018a). These factors should be rated through the following situations, as proposed by Brady et al. (2018a), the presence or absence of specific postures or behaviours or, subjective rating of specific behaviour within the test situation (Sinn et al., 2010; Brady et al., 2018a). Some authors suggest that, in order to have a success in training and reduce costs and handler burden, law enforcement working dogs should go through five separate subtests – social attraction, following, restraint, social dominance and elevation dominance (Choi et al., 2013).

Besides behavioural tests, these dogs are also requested to follow three key conditions: inter-rater reliability – which is how different observers describe the same individual the same way; test-retest reliability – how behavioural tests identify characteristics stable across time and context; predictive validity – in working dogs training should be predictive of successful performance (Brady et al., 2018a). Brady et al. (2018a) also stated that behavioural test must follow a positive or a negative effect. A positive effect being willingness to work, object-directed play and human directed social behavioural, whereas negative effect should be human directed aggression, sensitivity to aversive methods and approach withdraw.

Because law enforcement working dogs go through a lot of learning in a relatively short time, their memory should also be discussed. Oliveira (2016) showed that dogs can have up to three different memory types. Mechanical memory – as the one inherited from ancestors and the reason not all dogs are suitable for every function; associative memory – built from the dog's own experiences, training, and curiosity; and emotional memory – developed through socialization. According to the definitions of memory from above, it is notable that these interfere in law enforcement working dog training and the bond formed between the canine and the handler.

Although law enforcement working dogs are acquired and recruited from a very young age, predicting their future behaviour is not easy as neurological, environmental and genetical interferences occur through their development. However, some behaviour can be predicted in puppyhood although behavioural traits for successful performances are not clear (Sinn et al., 2010; Lazarowski, Waggoner et al., 2020). So, law enforcement working dog recruitment focuses on personality traits such as shyness, boldness, trainability, activity, aggression, and sociability (Tiira et al., 2020). But this process should also take into consideration canine welfare as some factors

can interfere with their working ability, such as their early environment, behaviour, cognition and preferences (Bray et al., 2021).

## **CANINE PERFORMANCE**

Besides their high purchase, training and deploying costs, law enforcement agencies may also have an interest in how their dogs behaviour will influence or predict successful performance (Sinn et al., 2010; Hall et al., 2021).

According to the type of work that is required from each recruited dog, a certain performance rate is expected from them. For example, scent detection dogs, are expected to excel in olfactory acuity but also demonstrate elevated levels of cognitive and learning abilities (Jezierski et al., 2014).

Some breeds have shown higher successful performance levels, such as German Shepherds – with more correct indications in detection service, followed by Labrador Retrievers and Terriers (Jezierski et al., 2014). Belgian Shepherd Malinois shows a higher connection between performance and behaviour (Nogueira et al., 2021).

However, breed is not the only factor that interferes with high level performance success, sex differences also demonstrated that males have shown higher trainability performance than females. On the other hand, females were easier to control, probably due to their small size and less aggressive behaviour (Rooney & Bradshaw, 2004; Fattah & Abdel-Hamid, 2020). Sexual status is also relevant, because intact (or non-castrated) dogs are significantly more trainable than neutered dogs, that may show restlessness, abnormal, and aggressive behaviour (Fattah & Abdel-Hamid, 2020).

So, a successful performance is closely linked to behaviour (Sinn et al., 2010). Some dogs become very aggressive in adulthood as a response to fear, frustration, or pain but, this type of behaviour is independent as it does not happen in every canine and may depend on specific context (Sinn et al., 2010; Brady et al., 2018a).

On the other hand, dog performance success also inflicts in canine welfare, when the qualities fit for working are not recommended or expected in companion dogs, making them not available to be kept as pets (Bray et al., 2021).

## **CANINE INJURIES**

Law enforcement working dogs can suffer numerous injuries, the most common being heat-related injuries (HRI). HRI injuries limit these specialized units by resulting in respiratory distress, lethargy, collapse, vomiting, diarrhoea, hypersalivation, ataxia, seizures, haemorrhage or coagulation problems (Benito et al., 2022). Extremely high temperatures affect both dog and handlers' health and safety (Benito et al., 2022), showing that there is a direct relation between temperature and canine performance (Royal & Taylor, 2009; Antunes, 2020; Benito et al., 2022).

Heat-related injuries that are recurring amongst law enforcement working dogs are hyperthermia (increase in body temperature above the accepted values, under exercise or elevated ambient temperature conditions) (Benito et al., 2022), heat stress (Benito et al., 2022) and heat stroke or heat exhaustion (Barberi et al., 2019). Heat stroke or heat exhaustion usually results in traumatic deaths, although it is avoidable with proper action and proper handler training. Breed, body mass and hair coat are also considered potential risk factors (Evans et al., 2007; Barberi et al., 2019).

Besides HRI injuries, law enforcement working dogs are also at risk of suffering from loss or excessive wear of the crowns of their teeth (Evans et al., 2007); infectious diseases (like canine distemper and parvovirus infection); musculoskeletal problems and hip dysplasia; otitis, blindness and deafness (Tamimi & Wali, 2019); and toxic syndromes (or *toxidromes*) (McMichael et al., 2022). Furthermore, they can suffer more tragic injuries such as hits from a vehicle and gunshot wound (Barberi et al., 2019).

Heart diseases are most common in older dogs, aged 10 years or more and its rates are still elevated because nutritional, environmental or genetic factors may play a role (Tamimi & Wali, 2019). Congestive heart failure (CHF) diagnoses can be related to

sex (male dogs are more prone to CHF symptoms than females), age and breed (Fattah & Abdel-Hamid, 2020). German Shepherds are more predisposed to the CHF disease, whereas Belgian Shepherd Malinois are more prone to most diseases than other breeds. Dogs with advanced stages of Congestive Heart Failure (CHF) cannot work because they are not able to walk and are eligible candidates for retirement (Tamimi & Wali, 2019).

Otitis is less likely to happen in straight eared dogs (as German Shepherd and Belgian Shepherd Malinois) and blindness and deafness is more expected in very old dogs. Although blindness and deafness can impair police dogs, as they are more common in older dogs, they do not impact service as dogs this age are not deployed anymore, therefore there is no limitation in these three conditions (Tamimi & Wali, 2019).

The accidental death or killing of a law enforcement dog has extensive consequences, affecting losses from three perspectives: a) the department's standpoint, there is a significant financial loss; b) for the officer involved, the death of the canine companion equates to losing a loved one, given the deep bond formed during their shared deployment; and c) it marks the tragic loss of an animal life, highlighting the potential suffering endured by a dog that did not choose to serve in law enforcement or be exposed to life-threatening situations (Barberi et al., 2019).

In addition to facing stressful situations during operations, such as loud noises, transportation, and exposure to extreme temperatures, dogs may also face the risk of being exposed to explosions or gunshot wounds. This situation can result in injuries, and dogs may also observe their own handlers or other dogs experiencing suffering, developing symptoms similar to post-traumatic stress disorder (PTSD) in humans, such as phobias and panic attacks (Tidu et al., 2021).

Besides being susceptible to injuries, dogs can inadvertently cause harm to themselves, their handlers, or even suspects. When compared to companion dog bites, law enforcement dogs have higher bite rates, with a predominant focus on the chest and upper arms, while bites to the head and neck are less common (Meade, 2006; Loder & Meixner, 2019). Canine bites often result in heightened rates of hospitalization and surgical interventions, particularly when targeting the upper arms, chest and

occasionally, the head (Meade, 2006; Mesloh, 2006). It falls upon the law enforcement agent to oversee the medical treatment of the dog bite victim (Loder & Meixner, 2019).

Both law enforcement dogs and their handlers face potential risks of injuries and casualties, given the inherent dangers associated with their roles (Barberi et al., 2019). While the shared occupational hazards are evident, it is noteworthy that dogs, in particular, are more vulnerable to injuries or even fatalities due to exposure to perilous situations, such as detecting narcotics, explosives or accelerants (Jezierski et al., 2014; Barberi et al., 2019), as departments are likely to deploy dogs in especially hazardous situations (Barberi et al., 2019). So, specialized canine units are more susceptible to diseases than domestic dogs due to the environment and working schedule they are exposed to (Tamimi & Wali, 2019). Recognizing this, there is a growing call to ensure that law enforcement working dogs receive a level of care on par with that provided for humans (McMichael et al., 2022).

## **CANINE PROTECTION STRATEGIES**

Given the vulnerability of law enforcement working dogs to injuries, various strategies have been devised to prevent such injuries.

Concerning high temperature injuries, prevention involves implementing strategies for body temperature regulation, including prioritizing hydration and utilizing cooling waistcoats (Benito et al., 2022). In addition to these measures, agencies can enhance canine safety by investing in specialized equipment, upgrading patrol cars and cruisers for improved safety, and incorporating heat alert systems. The latter serves as a protective measure, activating when a dog is in a locked vehicle by opening windows, sounding an alarm, and activating fans (Barberi et al., 2019).

But there are less obvious circumstances that can put these dogs at risk, such as malnutrition. Law enforcement dogs are engaged in strenuous endurance work, that requires a specialized diet to facilitate recovery. Tailoring their feeding needs to align with their age and workload is essential for their well-being. For older dogs, typically

around 6 or 7 years of age, comprehensive health assessments, encompassing physical examinations, radiology, and blood work, should be conducted at least every six months. Additionally, establishing a more secure and hygienic environment, coupled with an effective vaccination system, can significantly reduce the incidence of infectious diseases among these working dogs (Tamimi & Wali, 2019).

Furthermore, handlers should undergo training or engage in informative sessions to enhance their skills in managing these particularly hard-working dogs, understanding the laws related to abuse and neglect, and recognizing the responsibilities inherent in working in a dyad with a dog. This proactive approach aims to minimize fatalities and injuries among law enforcement working dogs (Barberi et al., 2019).

## RETIREMENT

Besides being a valuable tool for law enforcement, governmental and private agencies, canines have a clearly defined and delineated career trajectory. Their active service lasts for around five years (Knight & Sang, 2019), usually ending when the dog is around eight years of age (Tamimi & Wali, 2019), where working dogs 'transform' back to the status of *pets* (Knight & Sang, 2019).

The retirement of law enforcement dogs presents a significant challenge, as they may lack suitable accommodations once their serviced comes to an end. This is especially true for those canines who spent most of their lives residing in the facilities where they underwent training and carried out their duties. One of the options is to euthanise dogs that are considered unsuitable as pets (Knight & Sang, 2019), and are often seen as "*waste animals*" - making them another victim of *necropolitics*, that decides who lives and dies (Knight & Sang, 2019).

Discharging law enforcement dogs not only signifies the loss of a valuable asset for the agency, but also results in the forfeiture of considerable financial investments, encompassing purchase, training and welfare (Evans et al., 2007; Barberi et al., 2019).

The decision to discharge a dog is typically prompted by either behavioural or medical reasons. Behavioural factors may include actions hindering effective training or performance on duty, such as an aversion to sniffing, explosiveness, shyness, low drive, or inappropriate levels of aggression, rendering retraining impractical (Evans et al., 2007). On the other hand, medical reasons for discharge involve specific conditions diagnosed by a veterinarian, such as the loss or wear of canine teeth crowns, which can impact the dog's biting ability and serve as grounds for discharge (Evans et al., 2007).

The median age for discharge was around eight years, according to a study performed by Evans et al. (2007). Law enforcement working dog retirement is a very sensitive topic, often lacking the joyful transition one might associate with the conclusion of a career. Instead, these dogs, still regarded primarily as military equipment, typically end their service either confined to kennels or subjected to euthanasia. As noted by Thomas (2021b), some '*soon-to-be-retired*' dogs may embark on a final mission, assisting new law enforcement dog handlers, while others may endure up to a year in kennels before facing euthanasia (Thomas, 2021b).

## **CANINE WELFARE**

Considering all the aforementioned, it is clear that law enforcement dogs often encounter challenges that may compromise their welfare. If the animals' welfare is at risk, it can impact their ability to perform as expected, interact effectively with humans (handlers or suspects) and with the surrounding environment (Cobb et al., 2021).

According to the Article 7 of the Universal Declaration on Animal Rights (1978) "All working animals are entitled to a reasonable limitation of the duration and intensity of their work, to the necessary nourishment, and to rest". In 1991, Broom defined welfare as the "state of an animal according to its efforts to cope with the environment" (Chaniotakis et al., 2018). Later on, Mendl (2001) proposed that biological indicators can reveal an animal's condition and changes in behaviour and physical condition.

Therefore, to have adequate welfare, canines must be both physically and psychologically fit (Rooney & Bradshaw, 2004; Jantorno et al., 2020).

Thus, animal welfare can be perceived as the lived experience of an animal, shaped by positive or negative experiences with its environment, physical health, behavioural interaction and mental state (Cobb et al., 2021).

The primary responsibility for the welfare of a law enforcement dog lies with its handler, in collaboration with the agency they serve. Typically, it is the handler's role to ensure that their canine companion is placed in a suitable environment with appropriate interactions and maintains both good physical and mental health. Therefore, handlers should undergo proper training to ensure the welfare of their dogs while they are engaged in such a crucial task for the benefit of the community. Ensuring proper nutrition, physical health, and adequate rest is essential and should be regularly monitored through routine care. Special care is essential to prevent canine exposure to extremely hazardous situations, such as those encountered during drug or explosives detection, police detentions, or search and rescue tasks, a situation where their heightened sensitivity to high temperatures should be taken into consideration to prevent heat-related injuries (DeChant et al., 2020).

Considering that human attachment significantly influences a dog's performance (Lit et al., 2011; Cobb et al., 2021), training should prioritize positive reinforcement, recognized as the most effective learning method that can also strengthens the bond between dogs and handlers. Thus, through prolonged and cooperative interactions, a mutual dependency naturally evolves, resulting in the organization of their behaviour into intricate and temporally complex interactive patterns (Morais, 2014). Conversely, isolating dogs is generally deemed detrimental to their overall welfare, often leading to behavioural issues like reduced activity, increased barking, repetitive behaviours, and withdrawal (Chaniotakis et al., 2018). Such stereotypic behaviours are commonly indicators of chronic stress and poor welfare, particularly prevalent in kennelled canines due to a lack of environmental control, unpredictability and limited social contact (Nogueira et al., 2021).

To address these concerns, institutions should adopt an environmental enrichment approach that provides a variety of stimuli including toys, puzzles, physical exercise, social interaction and environmental changes. However, a stressful working

period and some stimuli may be overwhelming for canines resulting in negative performance and an increase in stereotypic behavior. Therefore, each canine should have a tailored enrichment approach based on its behavior to alleviate stress and mitigate negative outcomes. (Nogueira et al., 2021; Chaniotakis et al., 2018; Arcuri et al., 2022).

Behavioural issues stand as a significant contributor to the elevated failure rates observed in law enforcement working dogs. Nevertheless, it's important to recognize that some dogs deemed unsuccessful in one role might find suitability in other services or functions, suggesting the need for a collaborative and adaptable approach (Cobb et al., 2021). To enhance canines' welfare preventive measures must be implemented, since emotional deprivation may lead to poor learning, impaired decision-making, negative affective states, and a subsequent decline in performance.

## **OBJECTIVES**

Considering all the information regarding canine that enable humans to achieve otherwise unattainable goals, this study focuses on the crucial role played by law enforcement dogs in forensic investigation.

The primary objective of this systematic review is to thoroughly examine the significance of canine units in forensic investigations, with specific attention to the following secondary objectives:

- What functions do law enforcement dogs perform, and what are their main characteristics;
- How are these animals selected, trained and what risks do they face;
- What are the main characteristics of their handlers;
- Is animal welfare a concern for those working with law enforcement dogs.

## MATERIALS AND METHODS

To elaborate a systematic review, an extensive literature search was conducted in the following electronic databases: PubMed, EBSCOhost, ResearchGate and Google Scholar. The following equations were considered: police dogs; (police) **AND** (dogs); rescue dogs; (rescue) **AND** (dogs); military dogs; (military) **AND** (dogs); search dogs; (search) **AND** (dogs); firefighter dogs; (firefighter) **AND** (dogs); detection dogs; (detection) **AND** (dogs); sniffer dogs; (sniffer) **AND** (dogs); (police dogs) **AND** (welfare); (police dogs) **AND** (training); (police dogs) **AND** (forensic investigation); (police dogs) **AND** (crime investigation); (k9) **AND** (welfare); (k9) **AND** (training); (k9) **AND** (forensic investigation); (k9) **AND** (crime investigation); (rescue dogs) **AND** (welfare); (rescue dogs) **AND** (training); (rescue dogs) **AND** (forensic investigation); (rescue dogs) **AND** (crime investigation); (dogs) **AND** (forensic investigation); (dogs) **AND** (crime investigation); (animal research) **AND** (forensic investigation) **AND** (dogs); (cinotecnia E (investigação forense)).

To refine this research, specific criteria were established to organize and streamline the information. The research results were compiled and studies that did not meet the following inclusion criteria were excluded: a) publication between 2000 and 2023; (b) publication in English or Portuguese; (c) publication (as research article or review) in indexed scientific journals; (d) inclusion of master's or bachelor's dissertations, doctoral theses, and reviews; (e) availability of an abstract; and (f) relevance to law enforcement dogs and their role in forensic investigation.

Results not centred on law enforcement dogs working in forensic investigation were excluded. That was the case of papers that describing highly specific and technical equipment used in dog training or others that discussed particular medical conditions of handlers or dogs.

After the initial round of article selection, a total of 400 papers were identified through database search with duplicated articles ( $n = 4$ ) excluded. Subsequently, the remaining papers ( $n = 396$ ) were analysed by three independent reviewers, who classified them based on title and abstract. All reviewers concurred that 22 papers lacked a respective abstract, and 90 articles did not align with the study's objectives.

This resulted in 284 articles eligible for review. Further scrutiny led to the exclusion of 135 papers for being highly specific and technical in relation to training materials and equipment or focusing on veterinary care. Consequently, 149 articles remained for comparison, discussion, and full-text analysis. After the comprehensive review of the full texts, 75 articles were excluded, ultimately leaving 74 articles for systematic review (see figure 1).

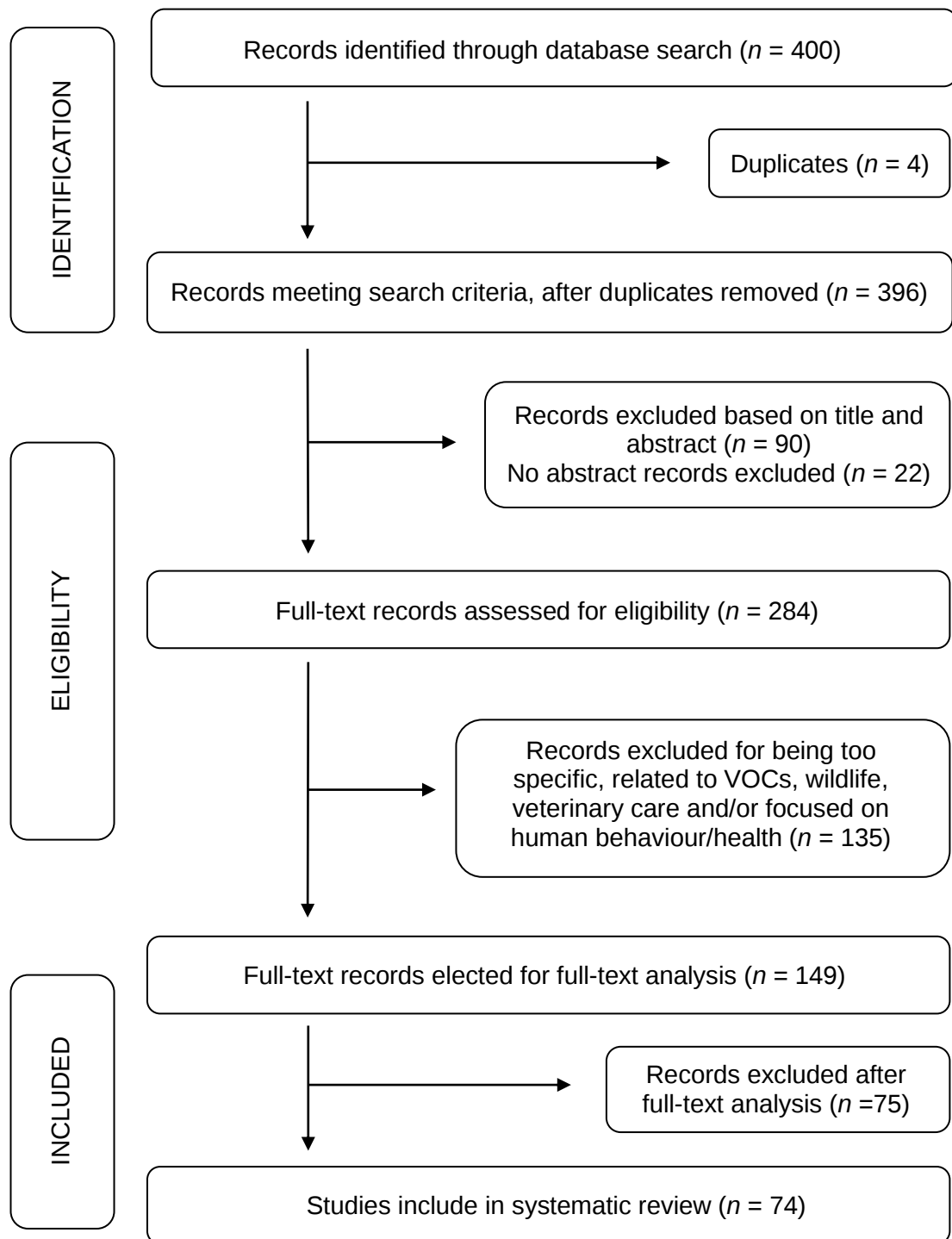


Figure 1: Flow diagram of studies selected for systematic review

## RESULTS AND DISCUSSION

The data extracted from the analysis of seventy-four (74) selected articles focusing on law enforcement dogs in forensic investigations is presented in Table 1. Each article contributes insights into the specific functions performed by these dogs, details about their breeds and sexes, and essential information concerning the selection criteria, training methods employed and training aids utilized, and efficiency evaluation. Given the inherent risks associated with the occupational demands on these dogs, comprehensive data on prevalent injuries they may encounter has also been compiled. Furthermore, the study includes information on the ratio of dogs *per* handler, the career background of handlers, and whether the articles address the welfare of these animals.

To account for potential duplications within the same article, such as the presence of multiple breeds, the final aggregated quantity or percentage may not align precisely with the total number of articles ( $n = 74$ ). However, all percentages have been calculated based on the total count of each specific data point in relation to the overall number of articles in the study.

**TABLE 1:** Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                   | Function | Breed       | Sex | Selection criteria | Training               |                    | Efficiency evaluation | Injuries              | Dogs/ Handler | Career | Welfare |
|----------------------------|----------|-------------|-----|--------------------|------------------------|--------------------|-----------------------|-----------------------|---------------|--------|---------|
|                            |          |             |     |                    | Methods                | Aids               |                       |                       |               |        |         |
| Mesloh et al. (2002)       | SD       | -           | -   | -                  | Bi-H                   | "jute" bite sleeve | TE                    | -                     | 1             | -      | -       |
| Gazit and Terkel (2003)    | SD+ED    | BM+LR       | -   | -                  | -                      | ED                 | TE                    | -                     | -             | -      | -       |
| Gazit et al. (2003)        | SD       | BM+LR       | -   | -                  | SDT                    | ED                 | -                     | -                     | -             | -      | -       |
| Mesloh (2003)              | P+DD     | -           | -   | -                  | -                      | -                  | TE                    | -                     | -             | -      | -       |
| Rooney and Bradshaw (2004) | DD       | ESS+LR      | M+F | -                  | -                      | ND+ED              | BrE                   | -                     | >1            | PO     | -       |
| Meade (2006)               | Pd       | GS+R        | -   | -                  | Bi-H (full mouth bite) | -                  | -                     | K9 bite               | 1             | PO     | WA      |
| Mesloh (2006)              | P        | GS+BM       | -   | -                  | S+Ba-H+Bi-H            | -                  | -                     | -                     | 1             | PO     | WA      |
| Sanders (2006)             | MWDs     | GS          | -   | -                  | AM+PR                  | -                  | -                     | -                     | 1             | PO     | BA      |
| Evans et al. (2007)        | MWDs     | GR+BM+LR    | M+F | selected breeders; | -                      | -                  | PurTE                 | HRI+dental conditions | -             | -      | -       |
| Garrinhas (2007)           | MWDs     | GR+LR+BM+GS | -   | -                  | IEM                    | -                  | -                     | -                     | -             | M      | -       |
| Lefebvre et al. (2007)     | MWDs     | BM          | -   | B                  | -                      | -                  | -                     | K9 Bites              | 1             | PO     | WA      |

**Note: Function:** DD = Detection Dogs; ED = Explosives Detection; MWD = Military Working Dog; P = Patrol; Pd = Police Dogs; SD = Scent Detection. **Breed:** BM = Belgian Malinois; ESS = English Springer Spaniel; GR = Golden Retrievers; GS = German Shepherd; LR = Labrador Retriever; R = Rottweilers. **Sex:** F = Female; M = Male. **Selection criteria:** B = Behavioural assessment. **Training:** AM = Aversive Methods; Bi-H = Bite-and-hold; Ba-H = Bark-and-hold; IEM = Improvement of existing methods; PR = Positive Reinforcement; S = Schutzhund; SDT = Scent Detection Test. **Training aids:** ED = Explosives detection aids; ND = Narcotics detection aids. **Efficiency evaluation:** BrE = Breed Efficiency; PurTE = Purchase Test Efficiency; TE = Training Efficiency. **Injury:** HRI = Heat-related injury. **Career:** M = Military; PO = Police Officer. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

**TABLE 1**(continued): Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                | Function | Breed         | Sex | Selection criteria | Training |      | Efficiency evaluation | Injuries             | Dogs/ Handler | Career | Welfare |
|-------------------------|----------|---------------|-----|--------------------|----------|------|-----------------------|----------------------|---------------|--------|---------|
|                         |          |               |     |                    | Methods  | Aids |                       |                      |               |        |         |
| Royal and Taylor (2009) | MWDs     | -             | -   | -                  | Bi-H     | -    | -                     | HRI; footpad injury; | -             | -      | WA      |
| Ensminger et al. (2010) | SD       | -             | -   | -                  | SDT      | -    | -                     | -                    | -             | -      | -       |
| Jezierski et al. (2010) | DD       | GS            | M+F | -                  | SDT      | SD   | TE                    | -                    | >1            | -      | -       |
| Sinn et al. (2010)      | MWDs     | GS+BM+DS      | M+F | -                  | P+SDT    | -    | -                     | -                    | -             | -      | WA      |
| Cabral (2011)           | MWDs     | -             | -   | -                  | -        | -    | -                     | -                    | -             | M      | -       |
| DeGreeff et al. (2012)  | HRD      | -             | -   | SWGDOG criteria    | -        | SD   | -                     | -                    | -             | -      | -       |
| Sousa (2012)            | SD+SAR   | GS+DS+R+LR+SS | -   | -                  | SpT      | -    | -                     | -                    | -             | M      | WA      |
| Choi et al. (2013)      | ND       | LR            | -   | B                  | -        | -    | -                     | -                    | -             | -      | BA      |
| Cunha (2013)            | MWDs     | -             | -   | -                  | PR       | -    | -                     | -                    | -             | M      | -       |
| Pemberton (2013)        | SD       | BL            | -   | -                  | -        | -    | -                     | -                    | -             | -      | -       |
| Concha et al. (2014)    | DD       | CS+LR+BC+ESS  | M+F | -                  | SDT      | -    | -                     | -                    | -             | -      | -       |

**Note:** **Function:** DD = Detection Dogs; HRD = Human Remains and Cadaver Detection; MWD = Military Working Dog; ND = Narcotics Detection; SAR = Search and Rescue; SD = Scent Detection. **Breed:** BC = Border Collie; BL = Bloodhound; BM = Belgian Malinois; CS = Cocker Spaniel; DS = Dutch Shepherd; ESS = English Springer Spaniel; GS = German Shepherd; LR = Labrador Retriever; R = Rottweilers; SS = Springer Spaniel. **Sex:** F = Female; M = Male. **Selection criteria:** B = Behavioural assessment; SWGDOG = The Scientific Working Group for Dog and Orthogonal Detector Guidelines. **Training:** Bi-H = Bite-and-hold; P = Patrol; PR = Positive Reinforcement; SDT = Scent Detection Test; SpT = Specialized training. **Efficiency evaluation:** TE = Training Efficiency. **Injury:** HRI = Heat-related injury. **Career:** M = Military. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

**TABLE 1**(continued): Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                     | Function | Breed       | Sex | Selection criteria | Training         |      | Efficiency evaluation | Injuries | Dogs/ Handler | Career | Welfare |
|------------------------------|----------|-------------|-----|--------------------|------------------|------|-----------------------|----------|---------------|--------|---------|
|                              |          |             |     |                    | Methods          | Aids |                       |          |               |        |         |
| Jeziarski et al. (2014)      | ND       | LR+GS+Te+CS | M+F | ND Proficiency     | Polish police TP | ND   | -                     | -        | 1             | PO     | -       |
| Morais (2014)                | MWDs     | -           | -   | -                  | -                | -    | -                     | -        | -             | -      | WA      |
| D'Aniello et al. (2015)      | WR       | LR+GR       | M+F | -                  | WRT              | SD   | -                     | -        | 1             | PO     | -       |
| Greatbatch et al. (2015)     | SAR      | -           | -   | -                  | -                | -    | PE                    | -        | -             | -      | -       |
| Genelhoud (2016)             | SD       | -           | -   | -                  | SDT              | SD   | -                     | -        | -             | -      | -       |
| Marchal et al. (2016)        | SD       | GS+BM+LR+R  | M+F | -                  | SDT              | SD   | -                     | -        | 1             | PO     | -       |
| Oliveira (2016)              | MWDs     | -           | -   | -                  | -                | -    | -                     | -        | -             | -      | -       |
| Skalleberg and Bouzga (2016) | SD       | -           | -   | -                  | SDT              | SD   | -                     | -        | -             | -      | -       |
| Lipka et al. (2017)          | P+SD     | GS+BM       | -   | -                  | P+TT             | -    | -                     | -        | -             | PO     | -       |
| Barrera et al. (2018)        | WR       | LR+GR       | M+F | -                  | IC               | -    | -                     | -        | -             | -      | -       |

**Note:** **Function:** MWD = Military Working Dog; ND = Narcotics Detection; P = Patrol; SAR = Search and Rescue; SD = Scent Detection; WR = Water Rescue. **Breed:** BM = Belgian Malinois; CS = Cocker Spaniel; GR = Golden Retrievers; GS = German Shepherd; LR = Labrador Retriever; R = Rottweilers; Te = Terrier. **Sex:** F = Female; M = Male. **Selection criteria:** ND = Narcotics detection. **Training:** IC = Inhibitory Control task; P = Patrol; SDT = Scent Detection Test; TT = Tracking/trailing; WRT = Water Rescue Training. **Efficiency evaluation:** PE = Performance Efficiency. **Career:** PO = Police Officer. **Welfare:** WA = Welfare Assessment.

**TABLE 1**(continued): Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                  | Function | Breed           | Sex | Selection criteria | Training |          | Efficiency evaluation | Injuries                 | Dogs/ Handler | Career | Welfare |
|---------------------------|----------|-----------------|-----|--------------------|----------|----------|-----------------------|--------------------------|---------------|--------|---------|
|                           |          |                 |     |                    | Methods  | Aids     |                       |                          |               |        |         |
| Brady et al. (2018a)      | Ass+P+DD | -               | -   | B                  | -        | -        | -                     | -                        | -             | -      | BA      |
| Brady et al. (2018b)      | MWDs     | GS+ESS+BM+cb+wc | M+F | -                  | -        | -        | -                     | -                        | -             | -      | BA      |
| Chaniotakis et al. (2018) | SAR+ED   | -               | -   | -                  | -        | -        | -                     | -                        | 1             | PO     | WA      |
| Gordon (2018)             | SAR      | -               | -   | -                  | -        | -        | -                     | -                        | -             | -      | -       |
| Jamieson et al. (2018)    | DD       | BC+LR+G         | -   | -                  | PR       | SD       | PE                    | -                        | >1            | PO     | -       |
| Topoleski et al. (2018)   | DD       | -               | -   | -                  | EOSC     | -        | TE                    | -                        | 1             | PO     | -       |
| Villareal et al. (2018)   | ND       | -               | -   | -                  | ND + ED  | -        | -                     | -                        | 1             | -      | -       |
| Barberi et al. (2019)     | ND+GP    | GS+BM+LR+BL     | -   | -                  | -        | -        | -                     | assaults; gunshot wound; | 1             | PO     | WA      |
| Bjørnson (2019)           | MWDs     | GS              | M   | -                  | -        | -        | PurTE                 | -                        | -             | -      | -       |
| Ferry et al. (2019)       | SD       | -               | -   | -                  | SDT      | SDlineup | -                     | -                        | -             | -      | -       |
| Kesici et al. (2019)      | MWDs     | -               | -   | -                  | -        | -        | -                     | -                        | 1             | PO     | -       |

**Note: Function:** Ass = Assistance dogs; DD = Detection Dogs; ED = Explosives Detection; GP = General Purpose; MWD = Military Working Dog; ND = Narcotics Detection; P = Patrol; SD = Scent Detection. **Breed:** BL = Bloodhound; BM = Belgian Malinois; cb = cross breed; ESS = English Springer Spaniel; G = Greyhound; GS = German Shepherd; LR = Labrador Retriever; wc = working collie. **Sex:** F = Female; M = Male. **Selection criteria:** B = Behavioural assessment. **Training:** ED = Explosives detection; EoSC = End of Session Cues; ND = Narcotics detection; PR = Positive Reinforcement; SDT = Scent Detection Test. **Efficiency evaluation:** PE = Performance Efficiency; PurTE = Purchase Test Efficiency; TE = Training Efficiency. **Career:** M = Military; PO = Police Officer. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

**TABLE 1**(continued): Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                             | Function | Breed             | Sex | Selection criteria | Training           |      | Efficiency evaluation | Injuries              | Dogs/ Handler | Career | Welfare |
|--------------------------------------|----------|-------------------|-----|--------------------|--------------------|------|-----------------------|-----------------------|---------------|--------|---------|
|                                      |          |                   |     |                    | Methods            | Aids |                       |                       |               |        |         |
| Knight and Sang (2019)               | Pd       | R+DP+GS+BM        | -   | B                  | Bi-H+Ba-H          | -    | -                     | -                     | 1             | PO     | WA      |
| Loder and Meixner (2019)             | Pd+MW Ds | -                 | -   | -                  | -                  | -    | -                     | K9 bite               | -             | -      | WA      |
| Tamimi and Wali (2019)               | MWDs     | GS+BM+LR+DS+CS+He | M+F | -                  | -                  | -    | -                     | zoonotic diseases+CHF | -             | -      | WA      |
| Antunes (2020)                       | MWDs     | GS+BM             | -   | -                  | -                  | -    | -                     | -                     | -             | -      | -       |
| DeChant et al. (2020)                | DD       | -                 | -   | -                  | -                  | -    | -                     | -                     | >1            | PO     | -       |
| Fattah and Abdel-Hamid (2020)        | ND       | GS                | M+F | B                  | SDT                | -    | -                     | -                     | 1             | PO     | WA      |
| Fattah and Gharib (2020)             | ND       | GS+BM+LR+R        | -   | -                  | Egyptian police TP | ND   | -                     | -                     | 1             | PO     | -       |
| Jantorno et al. (2020)               | ND       | -                 | -   | -                  | AM                 | -    | -                     | -                     | -             | -      | WA      |
| Lazarowski, Krichbaum, et al. (2020) | DD       | LR+cb             | M+F | CT                 | -                  | -    | TE                    | -                     | -             | -      | -       |
| Lazarowski, Thompson, et al. (2020)  | SAR+ED   | GS+BM+LR          | M+F | -                  | OCT+UT             | -    | TAE                   | -                     | >1            | PO     | -       |
| Lazarowski, Waggoner, et al. (2020)  | ED       | -                 | -   | C-BARQ             | -                  | -    | -                     | -                     | -             | -      | BA      |

**Note: Function:** DD = Detection Dogs; ED = Explosives Detection; MWD = Military Working Dog; ND = Narcotics Detection; Pd = Police Dogs; SAR = Search and Rescue. **Breed:** BM = Belgian Malinois; cb = cross breed; CS = Cocker Spaniel; DP = Doberman Pinscher; DS = Dutch Shepherd; GS = German Shepherd; He = Herder; LR = Labrador Retriever; R = Rottweilers. **Sex:** F = Female; M = Male. **Selection criteria:** B = Behavioural assessment; C-BARQ = Canine Behavioral Assessment and Research Questionnaire; CT = Cognitive tests. **Training:** AM = Aversive Methods; Bi-H = Bite-and-hold; Ba-H = Bark-and-hold, OCT = Object-Choice Task; SDT = Scent Detection Test; TP = Training protocol; UT = Unsolvability Task. **Training aids:** ND = Narcotics detection. **Efficiency evaluation:** TAE = Training Aids Effectiveness; TE = Training Efficiency. **Injuries:** CHF = Congestive Heart Failure. **Career:** PO = Police Officer. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

**TABLE 1**(continued): Summary of law enforcement dog articles reviewed (continues next page)

| Study ID                 | Function       | Breed            | Sex | Selection criteria | Training |      | Efficiency evaluation | Injuries | Dogs/ Handler | Career | Welfare |
|--------------------------|----------------|------------------|-----|--------------------|----------|------|-----------------------|----------|---------------|--------|---------|
|                          |                |                  |     |                    | Methods  | Aids |                       |          |               |        |         |
| Martin et al. (2020)     | HRD            | -                | -   | B                  | -        | -    | -                     | -        | 1             | PO     | -       |
| Tiira et al. (2020)      | ED             | GS+BM+ESS+DS     | M+F | -                  | -        | -    | -                     | -        | 1             | PO     | BA      |
| Vieira (2020)            | DD+P           | GS+BM+DS+R+LR+CS | -   | -                  | BaST     | -    | -                     | -        | -             | M      | -       |
| Zink and Schlehr (2020)  | MWDs+Pd+SAR+DD | GS+BM+LR         | -   | -                  | -        | -    | BrE                   | -        | -             | -      | -       |
| Bray et al. (2021)       | P+DD+Ass       | -                | -   | B                  | DuP      | -    | -                     | -        | -             | PO     | WA      |
| Cobb et al. (2021)       | MWDs           | -                | -   | -                  | PR       | -    | -                     | -        | -             | -      | WA      |
| Hall et al. (2021)       | App+DD+Ass     | -                | -   | -                  | -        | -    | -                     | -        | -             | -      | -       |
| Lazarowski et al. (2021) | DD             | LR+cb            | M+F | B                  | -        | -    | -                     | -        | -             | -      | -       |
| Nogueira et al. (2021)   | SD+P           | BM               | -   | -                  | -        | -    | TAE                   | -        | -             | -      | -       |
| Ricci et al. (2021)      | AF             | -                | -   | -                  | -        | -    | -                     | -        | -             | -      | -       |
| Smith et al. (2021)      | GP             | GS+BM            | F   | -                  | PR       | -    | TAE                   | -        | 1             | PO     | -       |

**Note: Function:** AF = ALL FUNCTIONS; APP = Apprehension; Ass = Assistance dogs; DD = Detection Dogs; ED = Explosives Detection; GP = General Purpose; HRD = Human Remains and Cadaver Detection; MWD = Military Working Dog; P = Patrol; Pd = Police Dogs; SAR = Search and Rescue; SD = Scent Detection. **Breed:** BM = Belgian Malinois; cb = cross breed; CS = Cocker Spaniel; DS = Dutch Shepherd; ESS = English Springer Spaniel; GS = German Shepherd; LR = Labrador Retriever; R = Rottweilers. **Sex:** F = Female; M = Male. **Selection criteria:** B = Behavioural assessment. **Training:** BaST = Basic and specific training; DuP = Dual-purpose dog training; PR = Positive Reinforcement. **Efficiency evaluation:** BrE = Breed Efficiency; TAE = Training Aids Effectiveness. **Career:** M = Military; PO = Police Officer. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

**TABLE 1** (continued): Summary of law enforcement dog articles reviewed

| Study ID                       | Function | Breed      | Sex | Selection criteria | Training   |      | Efficiency evaluation | Injuries | Dogs/ Handler | Career | Welfare |
|--------------------------------|----------|------------|-----|--------------------|------------|------|-----------------------|----------|---------------|--------|---------|
|                                |          |            |     |                    | Methods    | Aids |                       |          |               |        |         |
| Tidu et al. (2021)             | MWDs     | GS+BM      | -   | -                  | BaT        | -    | -                     | -        | -             | PO     | BA      |
| Thomas (2021)                  | MWDs     | -          | -   | -                  | -          | -    | -                     | -        | -             | -      | WA      |
| Vieira De Castro et al. (2021) | MWDs+Pd  | -          | -   | -                  | MM+AL      | -    | TAE                   | -        | -             | -      | -       |
| Arcuri et al. (2022)           | MWDs     | GS+BM+DP+R | M   | -                  | -          | -    | -                     | -        | -             | -      | WA      |
| Benito et al. (2022)           | MWDs+SD  | GS+BM      | M+F | -                  | Field test | -    | TAE                   | HRI      | 1             | PO     | -       |
| Martin et al. (2022)           | DD+ND    | SS+BM+GS   | M+F | -                  | SDT        | -    | PE                    | -        | 1             | PO     | -       |
| Sandrin et al. (2022)          | MWDs     | GS         | -   | -                  | -          | -    | -                     | -        | -             | PO     | -       |
| Schoon (2022)                  | SD       | BL         | -   | SWGDOG criteria    | TT         | -    | -                     | -        | -             | -      | -       |
| Santariová et al. (2023)       | SD       | GS+BM      | -   | -                  | SDT        | -    | PE                    | -        | 1             | PO     | -       |

**Note:** **Function:** DD = Detection Dogs; MWD = Military Working Dog; ND = Narcotics Detection; Pd = Police Dogs; SD = Scent Detection. **Breed:** BL = Bloodhound; BM = Belgian Malinois; DP = Doberman Pinscher; GS = German Shepherd; R = Rottweilers; SS = Springer Spaniel. **Sex:** F = Female; M = Male. **Selection criteria:** SWGDOG = The Scientific Working Group for Dog and Orthogonal Detector Guidelines **Training:** AL = Associative Learning; BaT = Basic training; MM = Mixed Methods; SDT = Scent Detection Test; TT = Tracking/trailing. **Efficiency evaluation:** PE = Performance Efficiency; TAE = Training Aids Effectiveness. **Career:** PO = Police Officer. **Welfare:** BA = Behaviour assessment; WA = Welfare Assessment.

All articles ( $n = 74$ ) included in table 1, refer that law enforcement working dogs may perform several different functions. The majority of publications revised focus on military working dogs (MWDs;  $n = 25$  articles; 33,78%), without specifying the dogs' function, generating this rather imprecise information. Next, the most reported function is that of detection dogs (DD;  $n = 16$ ; 21,6%), with the same percentage as scent detection (SD;  $n = 16$ ; 21.6%) (see Figure 2). Following these, there are 6 other functions related to the detection of substances or individuals: narcotics detection (ND;  $n = 9$ ; 12.2%), search and rescue (SAR;  $n = 7$ ; 9.45%), explosives detection (ED;  $n = 6$ ; 8.1%), human remains detection (HRD) and water rescue (WR) (both  $n = 3$ ; 4.05%), and apprehension (App;  $n = 2$ ; 2.7%).

In reality, the only represented functions that are not related to detection are patrol dogs (P;  $n = 8$ ; 10.81%), police dogs (Pd;  $n = 6$ ; 8.1%), and general-purpose dogs that fulfil several roles as law enforcement agents (GP;  $n = 3$ ; 4.05%). Besides this, one article (AF "all functions";  $n = 1$ ; 1,35%) mentioned every function written on table 1 with the addition of four functions mentioned in this review, such as Electronic Storage Detection (ESD), Cash Detection (CD), Anti-smuggling (AS), Anti-poison (AP), Anti-poaching (Apo) and Accelerant Detection (AD), also known as "arson dogs". This information was added to each function separately, therefore, the mention on the graph for this function only serves as a visual representation of the four 'extra' functions mentioned in this review, as each of them accounts for 1,35%.

It is also noteworthy that despite the focus of this dissertation being on law enforcement dogs, other aspects have emerged. Four articles mentioned assistance dogs (ASS;  $n = 4$ ; 5,4%) an irrelevant information for this study. This column doesn't show any not applicable (-) information as this would conflict with the selection criteria created for this study, meaning that if there is no information about the type of function the dog performs, the article has no relevance for this review as it wouldn't present desired information.

So, considering this information, it seems that the majority of law enforcement dogs are performing detection functions, primarily relying on their sense of smell, whether it be detecting illicit substances or individuals.

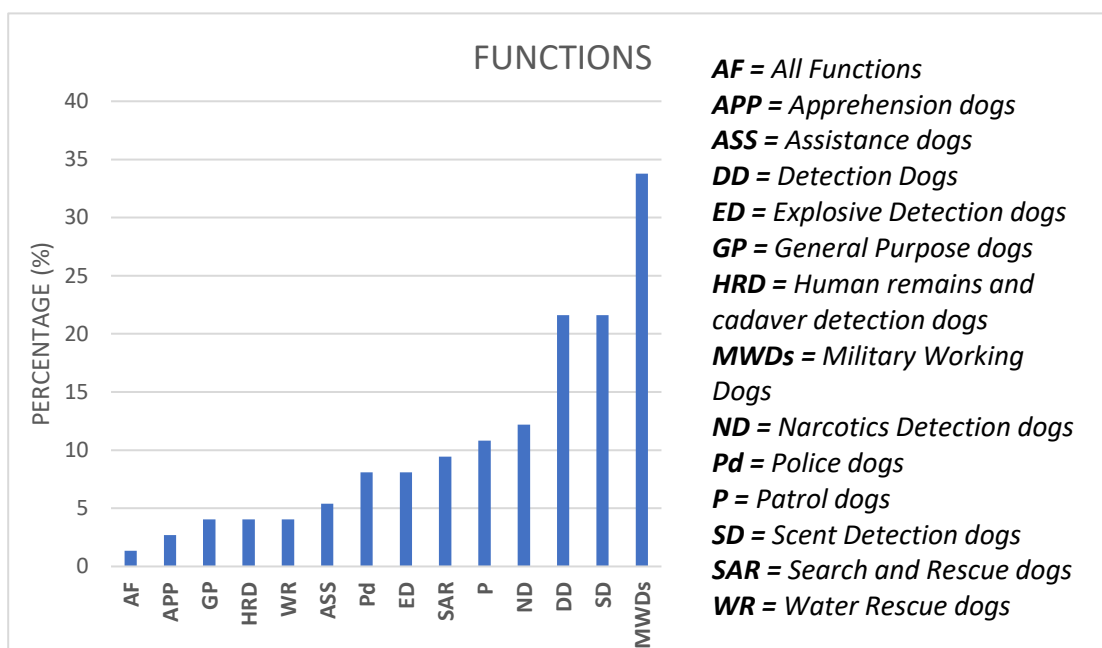


Figure 2 – The percentage of articles that mentioned different law enforcement dog function.

According to the information gathered from the graph above and table 1, detection work is the main function performed by law enforcement dogs. This function involves scent detection, narcotics detection, explosives detection, human remains detection, search and rescue and water rescue which are valuable services for forensic investigations as evidence found by law enforcement dogs can be used in forensic trials, with the assistance of lineups. However, the use of law enforcement dog evidence is decreasing because it is not considered accurate and should not be taken in as principal evidence, besides being thoroughly labeled, described, handled and safeguarded similar to non-canine evidence (Ferry et al., 2019). Furthermore, besides detection work being relevant for forensic investigations, search and rescue functions are an important use of law enforcement dogs in disaster situations and victim recovery.

Regarding the physical characteristics of these dogs, it was found that the breeds most used for law enforcement work were the German Shepherd (GS;  $n=29$ ; 39,18%), Belgian Malinois (BM;  $n=26$ ; 35,13%) and Labrador Retriever (LR;  $n=21$ ; 28,37%) (see Figure 3). They seem to have a notable success, probably due to their cognitive abilities and behavioural traits. However, other breeds are also represented in the consulted bibliography, such as Rottweilers (R;  $n=7$ ; 9,45%), Dutch Shepherd (DS;  $n=5$ ; 6,75%) and Cocker Spaniel (CS;  $n=4$ ; 5,4%). Interestingly, 40,54% ([-];  $n=30$ ) of articles had no information regarding the dogs'

breed, probably because this was not a criterion they considered relevant for the selection of animals for this type of work.

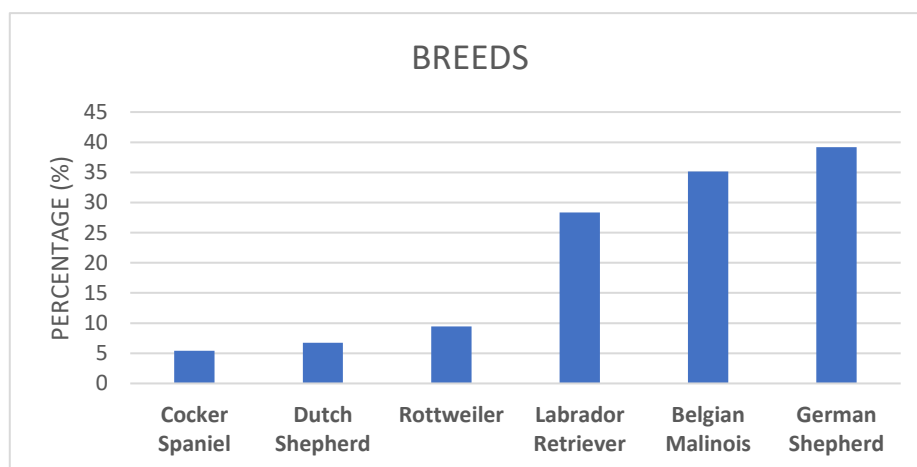


Figure 3 – The percentage of articles that mentioned law enforcement dog breed.

While law enforcement agencies show a preference for larger breeds, it is worth mentioning that, although not common, in some agencies, Golden Retrievers and Beagles are chosen for detection work, due to their olfactory capacity. From the information retrieved, German Shepherds and Belgian Malinois are the preferred breeds for their capacities, which are widely recognized, their performance and behavioural characteristics.

Concerning sex differences, most articles ([-];  $n = 53$ ; 71,62%) did not provide information about the dogs' sex. Only a small number of articles mentioned the use of males (M;  $n = 2$ ; 2,7%), females (F;  $n = 1$ ; 1,35%) or both (M+F;  $n = 18$ ; 24,32%), male and female dogs (see figure 4).

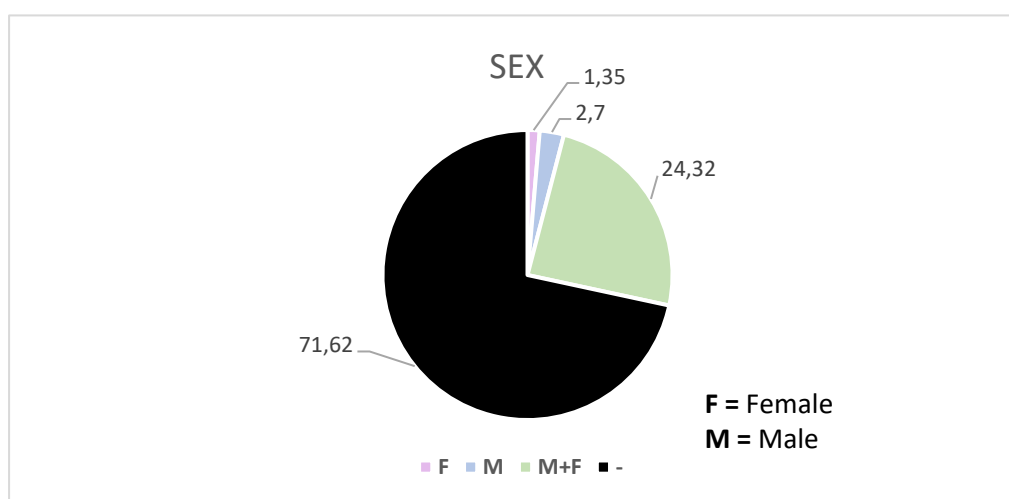


Figure 4 – The percentage of articles that referred the law enforcement dogs' sex.

Limited information exists on the distinctions between sexes, as there seems to be no established preference for males or females in working dog scenarios, and this does not appear to significantly impact performance success.

Some authors suggest that females are perceived as easier to manipulate and more manageable, while males are considered more aggressive and trainable (Rooney & Bradshaw, 2004; Fattah & Abdel-Hamid, 2020; Santariová, 2023).

Institutions may obtain dogs for this purpose from public gifts, institutional or outside breeders. However, outside breeders may be breeding out needed characteristics of dogs, making them less valuable for police and military work (Sanders, 2006). Law enforcement working dogs are usually selected through some predefined criteria, such as breed or age range. However, it is likely that behavioural traits will be more involved in the selection of puppies and their maintenance in training programs to develop new law enforcement working dogs. Among the articles consulted in this systematic review, eight mentioned this behavioural assessment (B;  $n = 8$ ; 10.81%, see table 1), and another one used "The Canine Behavioural Assessment and Research Questionnaire" (C-BARQ;  $n = 1$ ; 1.35%, see table 1).

Additionally, these specific dogs may be selected based on particular criteria, that may include a cognitive test (CT;  $n = 1$ ; 1.35%, see table 1) or the compliance with guidelines from organizations like the Scientific Working Group for Dog and Orthogonal Detector Guidelines (SWGDOG,  $n = 2$ , 2.7%, see table 1). This group aims to establish best practice guidelines for detection canines, seeking to improve their performance and reliability. It is also notable that the selection criteria information was scarce throughout the selected articles, with 83.78% of them not providing any data ([-];  $n = 62$ ).

Although, law enforcement agencies follow criteria, but predicting future adult behaviour in puppies is not straightforward as during the dogs' development many factors influence their behaviour, like time spent with the mother (*nurture*), their individual characteristics (*nature*), the environment they are set in, and types of training or tests they are put through. Thus, most tests rely on behavioural assessment in order to get clearer prediction results.

Examining the training process of animals destined to become law enforcement dogs offers valuable insights into their ultimate function and welfare. The predominant training approach involves scent detection tests (SDT;  $n = 12$ ; 16.21%) as illustrated in Figure 5, often complemented by lineups during court trials. This training methodology aligns with the prevailing functions assigned to these working dogs, underscoring their primary role in forensic investigations.

The following are training methods that are more important for patrol and police dogs: the bite and hold (Bi-H;  $n = 5$ ; 6.75%) and the bark and hold method (Ba-H;  $n = 2$ ; 2.7%), that had values comparable to tracking/trailing (TT;  $n = 2$ ; 2.7%). Only individual articles mentioned the use of specific training methods, like the schutzhund training (S;  $n = 1$ ; 1.35%), the Egyptian police training protocol ( $n = 1$ ; 1.35%), the Polish police training protocol ( $n = 1$ ; 1.35%), the dual purpose training (DP;  $n = 1$ ; 1.35%) and the end of session cues (EoSC;  $n = 1$ ; 1.35%) (see Figure 5). However, little information was provided within the articles about how these types of training protocols interfere with canine performance and their welfare.

In this regard, it was possible to verify that some of these training sessions were developed according to the principles expressed in operant conditioning, namely positive reinforcement (PR;  $n = 5$ ; 6.75%). However, two articles reveal the use of aversive methods (AM;  $n = 2$ ; 2.7%), which jeopardizes not only the handler-dog bond but primarily the welfare of the animal. So, more information is needed regarding the welfare provided to animals in these training sessions.

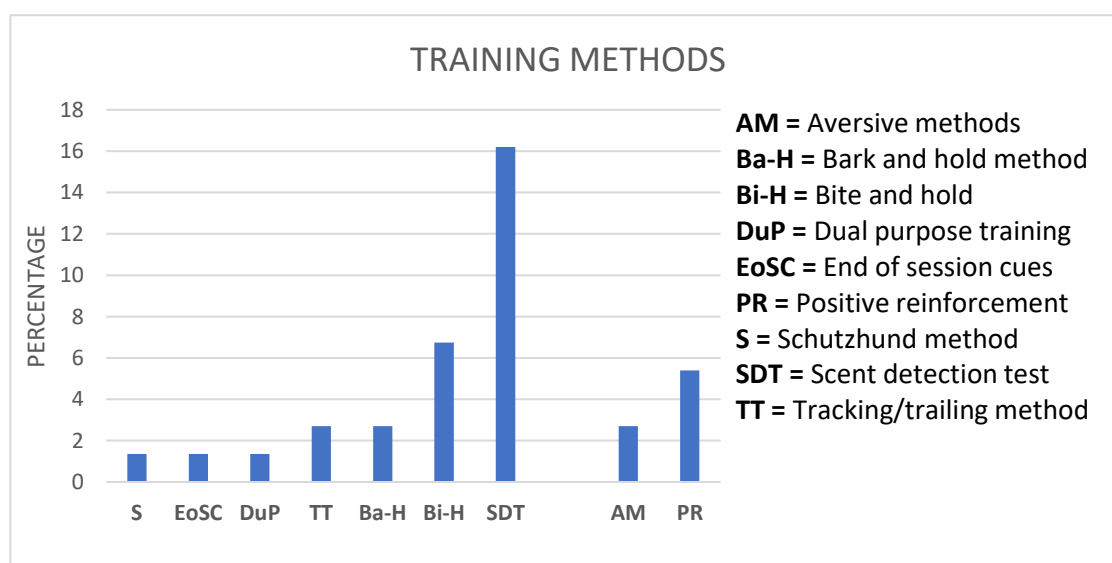


Figure 5 – The percentage of articles that mentioned law enforcement dogs' training methods.

In this scope, the efficacy of dog training is highly dependent on the utilization of different training aids. Those mentioned are for scent detection (SD;  $n = 8$ ; 10,81%), explosives detection (ED;  $n = 3$ ; 4,05%), narcotics detection (ND;  $n = 3$ ; 4,05%) and one mention ( $n = 1$ ; 1,35%) for “jute” bite sleeve (see figure 6). As the main function performed by law enforcement dogs and the predominant training method is scent detection related, the most used training aid is, therefore, scent detection related.

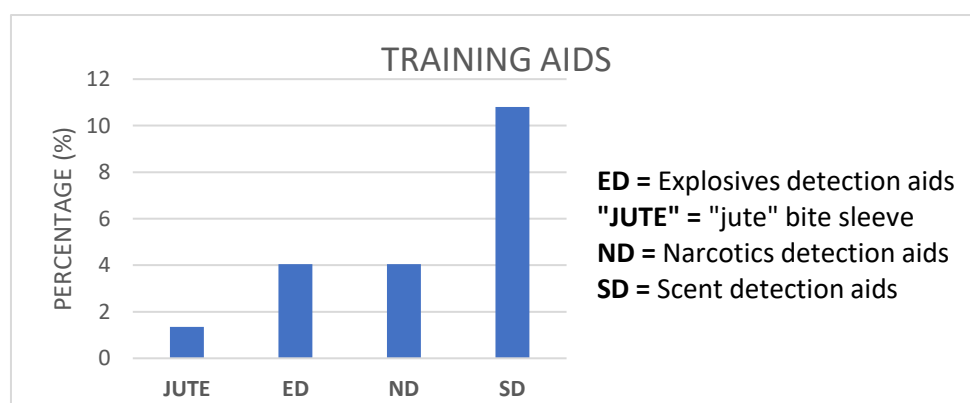


Figure 6 – The percentage of articles mentioning training aids for the training of law enforcement dogs.

Training aids can take many forms and should be adapted to each dog's specific needs as their training progresses. These include items such as leashes, protective sleeves, toys, scent pads, glass jars, and food-based rewards.

As one might expect, these training aids are effectively contributing to the efficient training of law enforcement dogs, which will predominantly perform functions associated with scent detection.

Considering the material and human investment involved in the entire training of a law enforcement dog, it is common for the literature to address the evaluation of various parameters that may influence the final performance these animals can achieve. In the selection phase, the impact of the animals' origin (donations, acquisition from external breeders, or internal breeding) was assessed in the purchase efficiency test (PurTE;  $n = 2$ , 2.7%), while the relevance of selecting a specific breed was evaluated by breed efficiency (BrE;  $n = 2$ , 2.7%).

Regarding the effectiveness of training in the final output, several articles focused on training aids efficiency (TAE;  $n = 5$ , 6.75%) and, in a more comprehensive way, on training efficiency (TE;  $n = 6$ , 8.1%). The most comprehensive parameter reflecting the success of this entire investment is expressed by performance efficiency (PE;  $n = 4$ , 5.4%) (see Figure 7), whose importance is not fully reflected in the number of articles in which it appears.



Figure 7 - The percentage of articles that address the efficiency of law enforcement dogs' selection, training and performance.

While canine bites ( $n = 3$ ; 4,05%, see table 1) are a noteworthy concern for law enforcement agencies, it is important to recognize that these working dogs are susceptible to a range of injuries. Among these, heat-related injuries (HRI;  $n = 3$ ; 4,05%), are the most prevalent, occurring when these dogs operate in extreme weather conditions for extended periods. Additionally, in challenging environments or when navigating uncertain terrain, footpad injuries ( $n = 1$ ; 1.35%) may also occur. But being exposed to the environment doesn't just mean suffering damage caused by the weather; these animals are much more exposed to intoxications, infections (which can be zoonotic) ( $n = 1$ , 1,35%), and even to violent situations, where interaction with an individual can result in an injury caused by a firearm ( $n = 1$ , 1,35%) (see Figure 8).

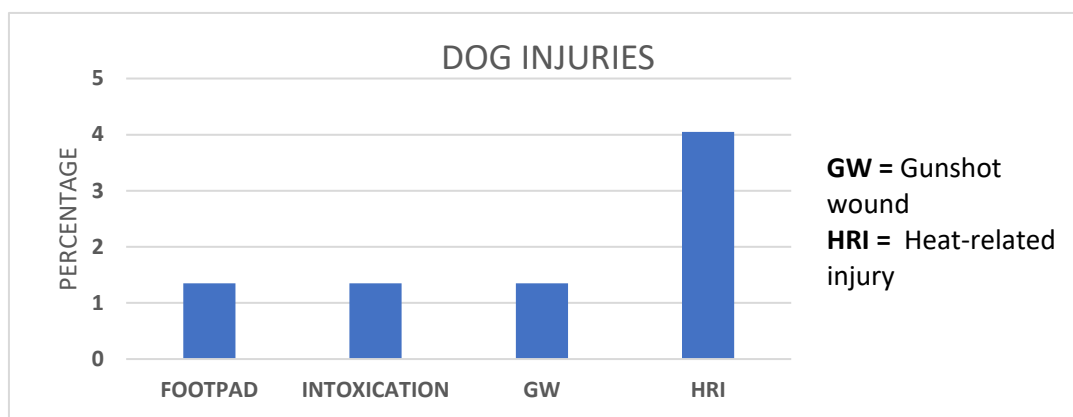


Figure 8 – The graph shows the percentage of articles that mentioned types of injuries law enforcement dogs may suffer.

Dogs are more sensitive than humans are to heat, therefore it is a great concern when these animals work in extreme weather conditions, which may lead to heat exhaustion or heat stroke, for example. One way to control these incidents is to invest in heat systems in law enforcement vehicles, which may consist in alarms when a certain temperature is reached, cooling vests, and ventilation (Barberi et al., 2019; Benito et al., 2022).

But beyond the increased risk of injury, law enforcement dogs also face various health conditions that jeopardize their ability to perform their duties effectively. This includes conditions such as congestive heart failure and osteoarticular pathologies. Whether due to an injury or a debilitating chronic illness, medical circumstances will certainly be a reason for these animals to retire early, in parallel with behavioural causes (Evans et al., 2007).

The retirement of law enforcement dogs poses a significant challenge, as they may lack suitable accommodations once their service comes to an end, largely depending on the proximity they have with their handler.

In the literature consulted for this review, it was possible to ascertain that there were handlers responsible for only one dog (1,  $n = 22$ , 29.72%), while others would be responsible for multiple dogs ( $>1$ ,  $n = 5$ , 6.75%). However, articles where this information is not provided predominate ((-),  $n = 47$ , 63.51%), making it impossible to determine whether the animals live on-site where they work or have a closer connection with their handler (see figure 9).

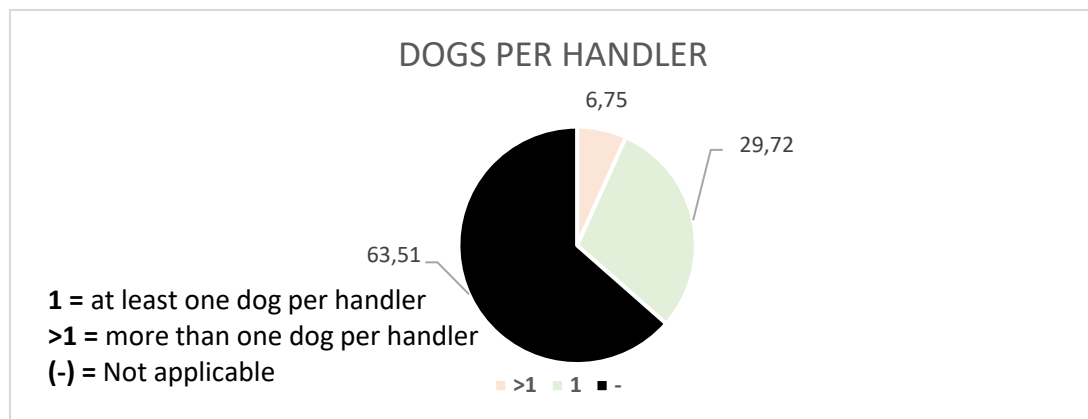


Figure 9 –The percentage of articles that stated the number of canines under handlers\* responsibility.

Only 17,56% of articles ( $n = 13$ ) acknowledge a positive relationship between handlers and canines, and minimal information is available regarding the dogs' living arrangements, whether in institutional kennels or the handlers' residences (see Table 1). This lack of data directly correlates with canine welfare concerns. As noted by Lefebvre et al. (2007), some handlers bring their canines home with the intention of improving their dogs' welfare and fostering a stronger bond, whereas others do so for financial incentives, seeking monthly indemnity.

Handlers that decided to leave their dogs at the kennel explained that it was because of either material problems and financial difficulties (such as inappropriate handler housing, expensive infrastructure, insufficient indemnity) or human problems (such as lack of interest in taking the dog home, or disagreement between the handlers family or neighbourhood). Eventually, the handler doesn't want to take the animal home because its behaviour may cause problems, the dog may bark all the time or bite, being considered a potential hazard (Lefebvre et al., 2007).

In the consulted articles, it was possible to observe that most handlers were police officers (PO,  $n = 28$ ; 37.83%), followed by military personnel (M,  $n = 5$ ; 6.75%). However, the most frequent scenario was the absence of this information in the articles ([-];  $n = 41$ ) (see Figure 10). This information may be relevant to explain why police dogs are often called military working dogs, and vice-versa. The fact is that police and military dogs share many functions in forensic investigation, making it easy to generalize and assume that they are always police dogs, as previously stated by the Poliisi Police University College (*Police Dogs - Police University College*).

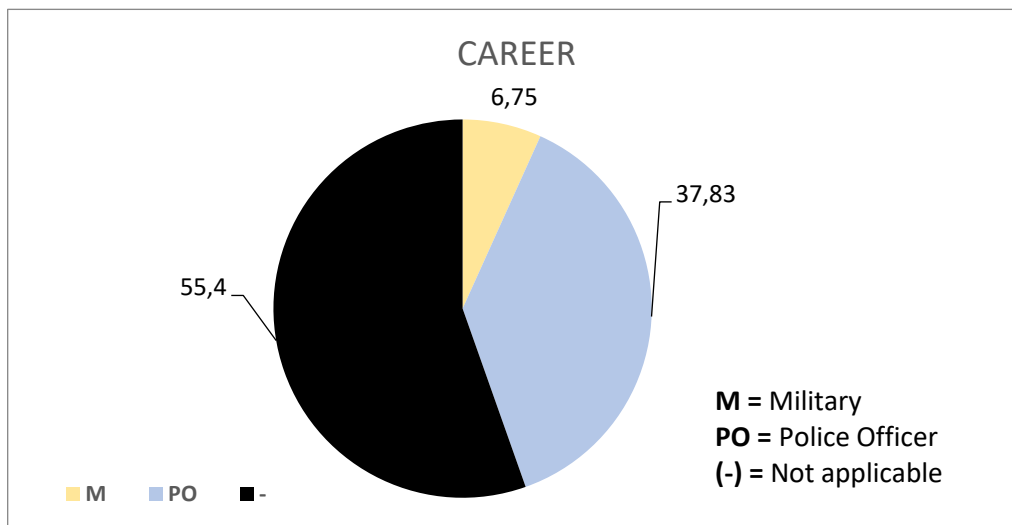
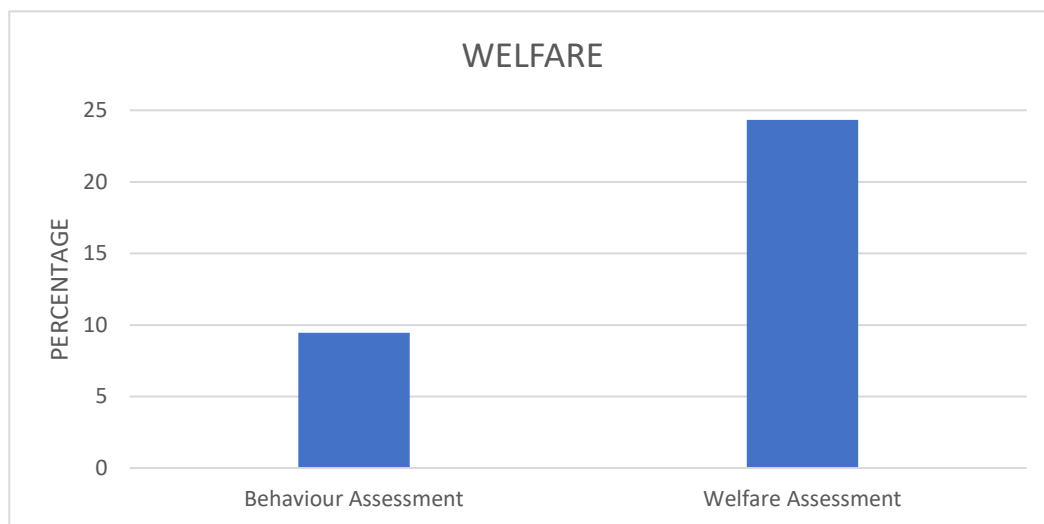


Figure 10 – The percentage of articles that indicate the career of the law enforcement dog handler.

But regardless of whether it is police officer or military personnel, or whether the dog lives in a kennel at the institution or resides with the handler, it is always crucial for the welfare of the dog to have a highly positive relationship with the handler, with whom they spend most of their time. The handler should be aware that allowing the dog to have leisure moments (engaging in sports, going for walks, playing, interacting with other animals and people, etc.) is very important and has a tremendous impact on their well-being.

Law enforcement dogs play a crucial role in our society, enabling the detection of substances that serve as evidence of crimes or are illicit, locating missing persons or suspects (including human remains), and serving as a defence or attack weapon for their human counterparts. To achieve this performance, these dogs undergo intensive training that, when successful, allows them to work under highly demanding conditions for several years. This unusually challenging journey has many moments that could compromise the well-being of these animals. Does the bibliography reflect any concern for the welfare of law enforcement working dogs?

As depicted in Figure 11, approximately one-third of the selected articles mention behaviour assessment (BA;  $n = 7$ ; 9.45%) or welfare assessment (WA;  $n = 18$ ; 24.32%) of law enforcement dogs. These are two highly relevant types of evaluation, indicative of the desire to understand whether the animals, at the time of assessment, exhibited an appropriate behaviour or if this parameter was altered, thereby also impacting the broader assessment of their welfare.



*Figure 11 – The graph represents the percentage of mentioned canine welfare assessment on reviewed articles.*

Welfare assessment includes health and veterinary care, with regular check-ups, nutrition, housing and living conditions, training methods, assessing the techniques used regarding canine and handler relationship, working conditions and retirement and transition planning. Helping identify areas of improvement while keeping their wellbeing. These assessments are designed to monitor various aspects of the dogs' physical and mental health, living conditions, and overall quality of life. The goal is to ensure that these dogs are treated ethically and provided with the care they need to success in their performances.

## CONCLUSION

Law enforcement working dogs are very useful, valuable, and multifaceted tools for law enforcement agencies, being an asset in forensic investigation.

To learn more about forensic canine units, in this master's dissertation in Forensic Medicine at ICBAS, we decided to conduct a systematic review on the subject. After a thorough evaluation of articles available on major online search engines, it was possible to select seventy-four articles based on well-defined criteria. These papers served as the foundation for constructing a table containing most of the information we sought to obtain on this topic.

From the analysis of the table, it was possible to understand that the majority of law enforcement dogs are performing detection functions, primarily leveraging their sense of smell, whether it involves detecting illicit substances or individuals.

To undertake these tasks, a preference appears to exist for breeds such as the German Shepherd and Belgian Malinois, widely acknowledged for their performance and behavioural characteristics. Limited information exists on the distinctions between sexes, as there appears to be no established preference for males or females in these working scenarios, a situation that does not impact the overall performance.

The training process of animals destined to become law enforcement dogs offers valuable insights into their ultimate function and welfare. The predominant training approach involves scent detection tests, a training methodology (and training aids) that aligns with the prevailing functions assigned to these working dogs, underscoring their primary role in forensic investigations.

Given the substantial investment required for a law enforcement dog, it is plausible that the entire process undergoes scrutiny, with training effectiveness and performance efficiency emerging as two of the most frequently evaluated parameters.

But all that intensive training is necessary to prepare dogs for a highly demanding work, exposing them to potentially strenuous conditions that may lead to

injuries. Among these, heat-related injuries are the most prevalent, occurring when these dogs operate in extreme weather conditions for extended periods. But it's not all, because these animals are also exposed to intoxications, infections (potentially zoonotic) and even to violent situations, that may result in serious injuries.

With such demanding life paths, one might think that all law enforcement dogs would have the opportunity to rest in the company of their handler, living with them. Unfortunately, most of the articles we consulted do not address this issue, making it impossible to determine whether most dogs live in kennels or in the homes of their handlers.

However, it is recognized that a positive relationship typically develops between handlers (mainly police officers, but may also be military personnel) and dogs, contributing to the animals' welfare. About one-third of the selected articles addressed the behaviour or welfare assessment of law enforcement dogs, indicating that the well-being of these animals may be often at risk.

Thus, this dissertation underlines that further advances are needed to comprehend the complexities of law enforcement working dogs. Exploring their behavioural evolution from puppies to adulthood, the transformations, influences and effect it brings to their lives. Furthermore, this advances should extend to their welfare during active service and retirement process, exploring the possibilities to enhance their post-service quality of life.

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