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Health management and pruritic behaviour
in New Zealand working dogs

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Abstract

Pruritus is the most common sign of skin diseases, which is a common problem in working dogs. This sign can be observed by the handler, but it is often not reported to veterinarians. As a result, the skin problem progresses to a severe condition and requires high-cost care. This makes it difficult to find a new owner after the retirement of working dogs. This thesis aims to provide information on health management and pruritic behaviour in New Zealand working dogs.

The data used in this thesis was derived from a cross-sectional survey conducted between October 2018 and June 2021. The data was collected from the handler-reported questionnaire and the physical examination by two veterinarians. The questionnaire asked about the health management and the pruritic behaviour in working dogs. The severity of pruritus and the skin lesions were recorded during physical examination. The survey data included 340 responses from 252 working dogs' handlers.

The first research chapter described the population features, health management and frequency of pruritic behaviour of 252 working dogs. Police dogs were the major population of working dogs (83%), and German Shepherd were the most common breed of working dogs (80.2%). The median age and body weight were 2.9 years and 32 kg, respectively. Most working dogs spent most of time outdoors (66%). Seventy-two percent of working dogs received flea and worm prevention, but only 26% received vaccination in the last six months. Most of the working dogs were fed with dry food (84%) and received treats at least a few times a year (73%). Ninety-five percent and sixty-nine percent of working dogs were bathed and received ear cleaning at least a few times a year, respectively. The most common pruritic behaviour was head shaking (72.2%), followed by facial rubbing (62.3%), paw licking (46.4%), eye rubbing (39.5%), and leg licking behaviour (39.3%), which working dogs exhibited at least a few times a year. Seventy-five percent of working dogs exhibited sneezing, and 45% showed signs of conjunctivitis at least a few times a year.

The second research chapter assessed the level of pruritus using the PVAS and evaluated the skin lesions using CADESI-04 in working dogs. Moreover, this chapter investigated the association of each pruritic behaviour, the level of pruritus, and the presence of skin lesions. Twenty-seven dogs whose handlers completed the questionnaire on the same day as the physical examination were included in this chapter. Seven dogs exhibited an

abnormal level of pruritus, and six dogs presented with skin lesions. Dogs older than four years were 7.9 times more likely to exhibit an abnormal level of pruritus compared to younger dogs ($p = 0.0297$). The level of pruritus was not associated with the presence of skin lesions. In addition, there was no significant association between pruritic behaviour and the level of pruritus or the presence of skin lesions.

This thesis provides baseline information on health management, pruritic behaviour, intensity of pruritus, and the prevalence of skin lesions in working dogs. Further research should investigate the underlying skin problems and the risk factors of pruritic behaviour in working dogs.

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Ethical statement

This study uses existing data collected between October 2018 and July 2021. The data collection process did not involve any veterinary procedures that required animal ethics approval. No information that could identify individuals was included in this survey. The survey was therefore deemed to be low risk, and no human ethics approval was needed.

Abbreviations

CADESI – 04 = The Canine Atopic Dermatitis Extent and Severity Index-04 (CADESI-04)

CI = Confidence interval

IQR = Interquartile range

LRT = Likelihood ratio test

OR = Odd ratio

PVAS = Pruritus Visual Analog Scale

SE = Standard error

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Introduction

In New Zealand, many departments employed working dogs to help in their duties, improve the function of the department and maintain public safety (Aviation Security Service; Department of corrections; New Zealand customs service; New Zealand Police, 2022). Working dogs are generally divided into two types based on their roles (New Zealand Police, 2022). Patrol dogs assist with tracking and searching operations, suspect apprehension, and the detection of illegal substances. Detector dogs are primarily used to identify illegal items or substances. Given the wide range of tasks and the high energy demands of their work, the performance of working dogs depends on both their physical and mental health (Farr et al., 2021a). When dogs are healthy, they are more alert, responsive, and able to perform complex tasks effectively.

Health management is a crucial part of maintaining the health and welfare of working dogs as well as ensuring they are ready for work. In New Zealand, working dogs spend 24 hours a day with their handler, who is responsible for the health care and welfare management of working dogs (New Zealand Police, 2022). Handlers should provide working dogs with regular vaccinations, as well as worm and parasite control (Otto et al., 2021). This practice can protect the dogs from infectious agents and illness. In addition, working dogs must be fed a balanced and complete diet and require appropriate energy to support their physical activities and overall well-being. Grooming practices are also essential, as they help to maintain the skin barrier and remove allergens or chemical substances on the body. When health management is done properly, the overall health and welfare of working dogs can be maintained. Investigating current health management practices may improve our understanding of routine care provided by handlers and help to develop the appropriate health care strategies.

Working dogs are required to work in a wide range of environments, from well-maintained buildings to disaster or high-risk areas. This type of work condition increases the risk of injury and illness (Otto et al., 2021). Many studies have reported health problems in groups of working dogs, but mostly focused on dogs deployed in disaster areas (Fox et al., 2008; Gordon, 2012; Slensky et al., 2004) or relied on data from medical records (Park et al., 2023; Takara & Harrell, 2014; Tamimi & Wali, 2019). As a result, the overall health status of the general working dog population remains unclear. Moreover, previous studies of health problems mainly focused on the diseases that adversely affect their performance (Andrews et

al., 2018; Parr & Otto, 2013). Consequently, health problems that do not affect work performance are often underreported.

Previous studies reported that the most common health problems in working dogs are associated with the musculoskeletal, gastrointestinal, and dermatological systems (Park et al., 2023; Takara & Harrell, 2014; Tamimi & Wali, 2019). However, most research has focused on musculoskeletal and gastrointestinal issues, as these problems can significantly reduce performance and lead to early retirement or euthanasia (Evans et al., 2007; Moore et al., 2001; Worth et al., 2013). In New Zealand, previous research on working dogs primarily focused on musculoskeletal conditions (Baltzer et al., 2019; Worth et al., 2013). Dermatological problems have been observed during the physical examination of police dogs (V. Erceg, personal communication, November 7, 2024), but no published data currently exists. The skin problem can progress to severe skin disease, which may distract dogs from work and affect their trainability. Therefore, it is important to investigate skin disease in New Zealand working dogs, as this could provide baseline information for developing health management and preventive strategies.

Given the importance of health management of New Zealand working dogs. This thesis aims to investigate the current health practices of working dogs. Moreover, this thesis will evaluate the clinical signs of skin problems. The findings could serve as baseline information and provide a foundation for future studies. This thesis is divided into three chapters.

Chapter 1 will provide a review of previous literature on general information of working dogs, including population features, health management, and common health problems. It also provides the background information on pruritic skin conditions and risk factors for skin disease in dogs.

Chapter 2 will investigate the specific health management practices in New Zealand working dogs, with a focus on preventive medicine, feeding routines, and skin/ear management. Moreover, this chapter will evaluate the frequency of the pruritic behaviour and the clinical signs of allergic problems in working dogs.

Chapter 3 will evaluate the pruritic score and the presence of skin lesions in working dogs. In addition, this chapter explores the relationship between the presence of pruritic behaviour, the level of pruritus, and the presence of skin lesions.

Chapter 1 Literature review

1.1 Introduction

Working dogs play an important role in assisting the duties of New Zealand government organisations and maintaining public security (Aviation Security Service, n.d.; Department of corrections, n.d.; New Zealand customs service, n.d.; New Zealand Police, 2022). These working dogs are divided into two groups. Patrol dogs are used for tracking, searching, and apprehending suspects, while detector dogs are employed to detect illegal substances or objects (New Zealand Police, 2022). In New Zealand, the breed of working dogs varies depending on the type of work. German Shepherds are used for patrol work, while various breeds are employed as detector dogs.

Working dogs must have both good mental and physical health to ensure that they can work effectively (Farr et al., 2021a). Health management is therefore an essential part for working dogs. In New Zealand, the handlers have 24-hour responsibility for the health and welfare of their dogs (New Zealand Police, 2022). Handlers are responsible for providing working dogs with adequate nutrition, supplementation, vaccination, and parasite prevention as part of their health management (Otto et al., 2021). Preventive medicine regimens vary depending on the type of working dogs, regional disease and the area where they work. Working dogs should receive adequate energy to maintain their energy level and support muscular function (Cline et al., 2021; Hill, 1998; Hill et al., 2000). Effective health management and husbandry practices can support the welfare and operational efficiency of working dogs.

Working dogs are at high risk of illness and injury because their work involves sprinting, jumping over obstacles, and walking on unstable or sharp surfaces. Previous studies have explored the health problems of working dog population (Duhaime et al., 1998; Fox et al., 2008; Gordon, 2012). However, these studies mainly focused on dogs after employment, which can contribute to the high prevalence of work-related illnesses. Two other studies focused on the health problems that cause euthanasia or loss of work (Moore et al., 2001; Worth et al., 2013). The health problems observed in the overall working dog population may differ from those reported in retired working dogs. Further investigation of additional health problems is needed to better understand their occurrence in the working dog population.

Skin diseases are commonly reported in both companion and working dogs, but the prevalence differs depending on the type of work and the method of data collection (Hill et al., 2006; Park et al., 2023; Tamimi & Wali, 2019). Risk factors of skin disease have been reported

in previous studies, including genetics, diet, environment, and health management (Favrot et al., 2010; Meury et al., 2011; Olivry & Mueller, 2019). All these studies focused on companion dogs with specific skin diseases, such as atopic dermatitis and food hypersensitivity. One literature proposed that work-related stress can induce dermatological problems in working dogs (Rooney et al., 2009). However, the underlying mechanisms of stress-related skin problems remain under-investigated. This makes it difficult to understand how work and environmental factors affect skin health in a group of working dogs. Understanding risk factors could help veterinarians and handlers develop preventive strategies for skin diseases in this group.

Pruritus is the most common sign of skin problems (Hill et al., 2006). This sign can disrupt the skin barrier and progress to more severe skin diseases (Coatesworth., 2019; Haubenhofner, 2009; Rooney et al., 2009). The pruritic behaviour also significantly affects the quality of life, trainability, and work performance of working dogs (Harvey et al., 2019). The severity of pruritus can be assessed using the scoring system: the pruritus Visual Analog Scale (PVAS) (Hill et al., 2007) and a verbal numeric scale (VNS) (Strzok et al., 2022). However, both systems rely on the owner's perception, which can be influenced by what they perceive as normal behaviour. Pruritic behaviours have been observed in dogs both with and without skin disease, but the location and frequency differ depending on the breed and underlying conditions (Stetina et al., 2015; Webb Milum et al., 2018). To our knowledge, there are no published data on the prevalence of pruritus and the frequency of pruritic behaviour in working dogs.

This literature review aims to provide an overview of the working dogs population, general health management, and common health issues in working dogs, including gastrointestinal, musculoskeletal, and dermatological problems. Moreover, this review describes methods for evaluating pruritic behaviour and factors associated with pruritus in dogs. Furthermore, the review identifies gaps in current knowledge and highlights areas where further research is needed for working dogs.

1.2 Population features of working dogs

1.2.1 Working dogs

Dogs are the first domesticated animals and fulfil various important roles for humans, such as hunting, guarding, and companionship (Vonholdt & Driscoll, 2016). In New Zealand, many sectors use working dogs to assist their duties, such as farm working dogs, working dogs for public service, and assistance dogs for people with disabilities. For this thesis,

working dogs refer to dogs that work with government organisations to carry out essential tasks and support the public services and national safety. These working dogs are generally divided into two main groups based on type of work; patrol dogs (also known as general purpose dogs) and detector dogs (New Zealand Police, 2022). The particular group of dogs employed by each organisation depends on the operational demands of their duties

The New Zealand Police employ both patrol and detector dogs, commonly referred to as police dogs. All police dogs must complete a course of instruction at the Police Dog Training Centre before starting operational work (New Zealand Police, 2022). Patrol police dogs are primarily used for tracking, searching, and apprehending suspects and violent offenders. The patrol dogs are trained for secondary roles, including tactical operations, search and rescue, victim recovery, and narcotic detection. The patrol police dogs account for 90% of the overall police capability. The New Zealand police also used detector dogs to detect illegal substances or objects. The detection police dogs are divided into four main groups: narcotic detection, currency detection, firearm detection, and explosive detection. Each subgroup needs to undergo specific training before operation. Currently, the police department employs 130 operational units, and these dogs respond to over 30,000 cases a year (New Zealand Police).

Many government organisations in New Zealand employ detector dogs to support their duties, particularly in identifying specific substances. For example, the Aviation Security Service uses Explosive Detector Dogs (EDD) to identify explosives or explosive materials in vehicles, car parks, buildings, airport facilities, and aircraft (Aviation Security Service, n.d.). The EDD dogs also detect illegal items from the foot patrols around the airport to enhance overall airport security. Currently, the Aviation Security Service employs more than 30 dogs, stationed at major airports including Auckland, Wellington, Christchurch, and Queenstown. Similarly, the New Zealand Customs Service uses detector dogs to locate items such as illegal drugs, firearms, and undeclared cash crossing the country's borders (New Zealand customs service, n.d.). The custom dogs are trained to search for prohibited or undeclared items in freight, cargo, packages, mail, and luggage. The Department of Corrections also employs detector dogs to search visitors, vehicles, and prison facilities for illicit substances, including drugs, cellphones, and tobacco products (Department of corrections, n.d.). Working dog teams from a specific department can support other departments when required (New Zealand Police, 2022). Taken together, these highlight the central role of detector dogs in maintaining security across different public service sectors in New Zealand.

1.2.2 Breeds

According to the New Zealand Police, all patrol police dogs are German Shepherds (New Zealand Police, 2022). German Shepherds are preferred by police officers due to their high prey drive and trainability, which enable them to learn a wide range of police tasks. Two studies have examined the breeds of New Zealand working dogs. Baltzer et al. (2019) reported that 96% of active police working dogs were German Shepherds, with only 4% being Labrador Retrievers or crossbreeds. However, Baltzer's study focused on orthopaedic issues, which may have introduced bias. German Shepherd dogs, a breed at higher risk for orthopaedic diseases, were more likely to be included in the study. Another study by Worth et al. (2013) examined only German Shepherds in study on causes of retirement and euthanasia in police dogs. Both studies included only police dogs, providing limited information on the overall working dog population or the breeds used by other government organisations, leaving the current breed distribution in New Zealand largely unknown.

Various breeds, such as Labrador Retrievers, Springer Spaniels, and crossbreeds were used as detector dogs across New Zealand organisations (Aviation Security Service, n.d.; Department of corrections, n.d.; New Zealand customs service, n.d.; New Zealand Police, 2022). A similar pattern has been reported in the United Kingdom, where English Springer Spaniels are the most common detector dogs, followed by Labrador Retrievers, crossbreeds, and Border Collies (Rooney & Bradshaw, 2004). Several studies have compared the performance of different detector dog breeds. German Shepherds had the fewest false alerts and completed searches faster than Labradors, Terriers, and English Cocker Spaniels (Jezierski et al., 2014). In contrast, a study in Poland reported that drug-detecting Labradors have a better sense of smell than German Shepherds (Adamkiewicz et al., 2013). However, all these studies evaluated dogs performing different detection roles, and performance may be influenced by training methods and work environment. Nevertheless, there is no published information explaining why New Zealand organisations specifically select Labradors and other breeds for detection work.

1.2.3 Sex

Many studies have reported that male dogs are predominantly used in police and military work, with their representation ranging from 60% to 95% (Harroun-White et al., 2024; Park et al., 2023; Parr & Otto, 2013; Tamimi & Wali, 2019). Tamimi and Wali (2019) noted that

male dogs are preferred for their higher levels of aggressiveness, whereas female dogs are less commonly selected, as they may distract male dogs. Parr and Otto (2013), Tamimi and Wali (2019), and Harroun-White et al. (2024) collected information from medical records, which did not represent the overall working dog population, as the data of healthy dogs may be missing. As a result, these studies may not accurately reflect the sex distribution across the entire working dogs population.

There is evidence of a preference for male dogs among New Zealand police working dogs; however, the reported proportion of males varies depending on the criteria used to select enrolled dogs. Worth et al. (2013) focused on retired German Shepherds and reported that 97% were male. While a recent study by Baltzer et al. (2019) included dogs on active duty and breeding/active duties, found that 80% were male. This suggests that the New Zealand Police may retain more female dogs for breeding purposes. However, these two studies focused only on dogs with the New Zealand Police, leaving a gap in research regarding the sex distribution of working dogs in other organisations.

Previous research reported that the New Zealand police commonly deployed intact male dogs (111 out of 152) for police work, followed by spayed females (16 out of 152) (Baltzer et al., 2019). This trend aligned with reports in the other countries (Park et al., 2023; Tamimi & Wali, 2019). The preference for intact males may be due to the handler's perception that male dogs exhibited higher aggressiveness compared to female dogs. However, both Tamimi and Wali (2019) and Park et al. (2023) relied on the medical records, which may have overrepresented male working dogs due to sex-related health problems. One study explored the age at euthanasia of working dogs and found that neutered male dogs lived longer than intact males (Moore et al., 2001). Another study reported that intact male dogs are at a higher risk of early retirement due to behavioural problems (Evans et al., 2007). However, both Moore et al. (2001) and Evans et al. (2007) focused on diseases that affected their performance, which may underrepresent mild to moderate conditions. Future research is needed on the sex distribution of working dogs and the reasons for neutering. Moreover, investigating the effect of neuter status on performance could help determine whether working dogs should be spayed or neutered.

1.2.4 Age

A previous study in New Zealand reported that the average age of police working dogs on active duty was 3.2 ± 2.4 years (Baltzer et al., 2019), while the average age of retirement of

New Zealand police dogs was 7 ± 2.6 years (Worth et al., 2013). The average age of New Zealand police dogs was lower than that of Iraqi police dogs, which was 4.6 ± 3 years (Tamimi & Wali, 2019). Another study in Korean military working dogs using the medical record reported an average age of 6 ± 3 years, with 24% of the dogs being over 10 years old and still active as military working dogs (Park et al., 2023). Tamimi and Wali (2019) and Park et al. (2023) used data obtained from medical records, while Baltzer et al. (2019) surveyed in the general population. These discrepancies highlight that the result may be influenced by how the data was collected and the source of the data. For example, older dogs may be overrepresented in hospital-based studies due to their higher risk of health problems and the need for veterinary care. Moreover, the differences in countries' policies may contribute to the differences in age on duty or retirement age of working dogs. To obtain accurate information about age distribution, data should be collected from the entire population rather than hospital-based samples.

The age of working dogs is related to both health problems and work performance. A previous study by Park et al. (2023) reported that senior dogs had a higher incidence of degenerative disease, whereas younger dogs more frequently experienced gastrointestinal, dental, and ear or skin diseases. A study by Baltzer et al. (2019) reported that police dogs begin to show signs of lameness or fatigue after work or exercise at 2-5 years old, and the severity of clinical signs increases until it significantly affects workability at 5 years or older. In New Zealand, many police dogs fail to reach retirement age due to severe health issues, die, are killed, or are euthanised before retirement. Among retired dogs, 65% were retired due to an inability to perform their duties, primarily caused by musculoskeletal problems (Worth et al., 2013). However, a study by Worth et al. (2013) included only retired German Shepherds without comparison with other breeds. Although Baltzer's study reported that age is related to orthopaedic diseases, they did not investigate whether age affects other health issues or contributes to specific medical conditions in working dogs. A study by Park et al. (2023) recruited only dogs that experienced medical events. This highlights a gap in understanding the broader impact of ageing on the overall health and performance of working dogs, which is crucial for applying appropriate health management strategies at different life stages.

1.3 Health Management

1.3.1 Preventive medicine

Vaccination and parasite prevention are important to maintain the health and welfare of working dogs. Working dogs may be required to work in contaminated areas and contact with other animals, which can increase the risk of exposure to a variety of pathogens and infectious agents that could compromise their health and performance (Jarrett et al., 2022; Murphy et al., 2003). Therefore, working dogs should be provided with the appropriate vaccination, deworming, and parasitic control (Otto et al., 2021).

According to the 2024 guideline for the vaccination of dogs and cats provided by the World Small Animal Veterinary Association (WSAVA), dogs should receive core vaccines against canine distemper virus (CDV), adenovirus (CAV), and canine parvovirus (CPV) (Squires et al., 2024). The initial vaccination for CPV, CDV, and CAV is recommended at 6 to 8 weeks of age, followed by boosters every 2 to 4 weeks until the dog is at least 16 weeks of age. Revaccination should be done at 3 years of age, then every 3 years. In Leptospirosis-endemic areas, the first Leptospirosis vaccine should be given at 8 weeks of age, followed by a second dose at 2 to 4 weeks later, and then boosted annually. When administering the vaccine against Leptospirosis, the vaccination serogroups should match the endemic serogroups.

Leptospirosis has been reported in a group of search and rescue dogs in Haiti (Gordon, 2012). Five of eight dogs were seropositive after deployment at the earthquake site. This suggests that working dogs are susceptible to *Leptospira spp* infection. In New Zealand, approximately 15% of dogs were seropositive to at least one leptospirosis serovar (Harland et al., 2013; O'Keefe et al., 2002). Study by Harland et al. (2013) reported that working farm dogs are at high risk of exposure to *Leptospira* serovar *hardjo*. However, another study investigated the disease in working farm dogs using medical records reported that only five of 2,198 visits (0.2%) were suspected to be leptospiral infection (Cave et al., 2014). The lower prevalence in Cave's study may be because *Leptospira spp.* did not cause severe clinical signs in working dogs, resulting in limited concern from their owners. This suggests that although leptospirosis occurs in working dogs, prevalence estimates can be influenced by the data source used. Leptospirosis vaccination should be considered in working dogs to reduce the severity of clinical signs and to ensure their health and welfare.

The parasitic prevention is essential for working dogs because they often travel, work in natural environments, and live in close quarters with other dogs in kennels (Otto et al., 2021).

Cutaneous parasites were reported in 23 of 2,214 New Zealand working farm dogs presented at rural veterinary clinics over a 12-month period (Cave et al., 2009). These parasites can serve as vectors for contagious pathogens, increasing the risk of infectious disease in both handlers and other dogs (Marendy et al., 2020). However, Cave's findings may underestimate the prevalence of ectoparasites, as dogs with mild infestations are often not brought to veterinary clinics because owners do not consider them a problem. Another study by O'Connell et al. (2019) reported that intestinal parasites were present in the faeces of 40% of New Zealand working farm dogs, despite most owners administering anthelmintic treatments every three months. This suggests the need to consider factors such as the type of parasite, drug choice, dosage, and treatment methods for effective control. Similar concerns have been reported in police dogs in Iraq and Egypt, where approximately 7% of dogs were infected with intestinal parasites (Ahmed et al., 2014; Tamimi & Wali, 2019). Taken together, parasitic control should be considered for working dogs. Evaluating the parasitic prevention program would help veterinarians determine whether the current practice is appropriate.

1.3.2 Diet and supplements

1.3.2.1 Nutritional requirements

Working dogs should be fed an appropriate, complete, and balanced diet to maintain overall health and prevent future complications. According to the American Hospital Animal Association (AAHA) recommendation, working dogs require a higher caloric intake than companion dogs (Cline et al., 2021). Previous research in search and rescue dogs found that 20% of the dogs experienced weight loss during deployment, despite handlers increasing both the quantity and frequency of feedings (Gordon, 2015). However, Gordon (2015) included 30 dogs worked an average of four shifts, with each shift lasting approximately 7.7 hours. Therefore, these results may not apply to working dogs in other situations. Another study suggested that dogs who exercise for 30-120 minutes per day should be fed a moderate percentage of protein and carbohydrate and a high percentage of fat (Wakshlag & Shmalberg, 2014). The high-fat diets serve as the main energy source during exercise, conserve glycogen and maintain high-intensity exercise. Therefore, it is important to ensure that police dogs receive appropriate nutrition based on their body weight (BW), activity levels and the nature of their work.

Previous research investigated the minimum energy requirement of working dogs. A study in military dogs 12 months of age found that the average energy supply for dogs trained for obedience work and protection work was 144 kilocalories per kilogram bodyweight^{0.75}

(kcal/kg BW^{0.75}) (Schäfer & Hankel, 2020). An energy requirement for sprinting Greyhounds, which raced twice weekly and exercised for 15 minutes twice daily, was 155 ± 9 kcal/ kg BW^{0.75} per day (Hill et al., 2000). In contrast, long-distance sled dogs require resting energy at 215 kcal/ kg BW^{0.75} per day and may increase to 1003 kcal/ kg BW^{0.75} during the 70-hour race in extremely low temperatures (Hill, 1998; Hinchcliff et al., 1997). The retrospective study of 20 detection canines found that the energy consumption was 136 ± 38 kcal/ kg BW^{0.75} (Mullis et al., 2015). However, these studies were conducted in different locations with varying temperatures and different activity levels, resulting in differences in energy consumption. Furthermore, Schäfer and Hankel (2020) focused on growing dogs, while Hill et al. (2000) and (Mullis et al., 2015) evaluated energy requirement in adult dogs, whose energy requirements differ from those of young animals. Therefore, to appropriately assess energy requirements, factors such as age, type of work, exercise intensity, and work schedule should be considered.

In addition, several factors should be considered when feeding working dogs. A large volume of diets should be avoided because it can increase the risk of gastric dilation and volvulus in dogs; the major cause of euthanasia in police dogs (Raghavan et al., 2004; Worth et al., 2013). Moreover, ingestion of bones can lead to constipation (Cave et al., 2009). In addition, restricting feed intake by 20–30% before the day of competition has been recommended to reduce faecal bulk (Wakshlag & Shmalberg, 2014). Therefore, the amount of food and the feeding schedule should be considered in working dogs.

In New Zealand, police departments provide guideline for diet selection for police dogs (New Zealand Police, 2022). Police dogs should be fed with complete and balanced diets that meet the standard of the Association of American Feed Control Officials (AAFCO) or are approved by the National Coordinator of Police Dogs (New Zealand Police, 2022). The police department also supported a biscuit diet for their working dogs. However, the information on food ingredients, the amount of food, and the feeding schedule is still undetermined. This information can help veterinarians assess the energy intake of these dogs and ensure appropriate feeding practices, reducing the risk of health problems.

1.3.2.2 Supplementation

Nutritional supplements are essential for maintaining the overall health, performance, and well-being of working dogs. Calcium and phosphorus are important minerals to maintain bone health, especially for large or giant breed dogs (Główny et al., 2024). Working dogs that fed a meat-based diet, which has a higher percentage of phosphorus, can result in secondary

hypocalcaemia, changes of bone mineral matter, bone demineralisation and can progress to metabolic bone disease and affect their work performance (Howard & Allen, 2008). Therefore, working dogs on a meat-based diet should receive optimal levels of calcium and phosphorus to maintain musculoskeletal health (Wakshlag & Shmalberg, 2014). Two studies reported that providing omega-3 fatty acids can improve weight bearing, increase range of motion, and reduce lameness (Kumpanart Soontornwipart & Techaarpornku, 2014; Roush et al., 2010). However, both Soontornwipart et al. (2015) and Roush et al. (2010) focused in companion dogs diagnosed with osteoarthritis. The effects of fatty acid supplementation on the bone health of healthy dogs might differ. Another study found that commercial fatty acids can improve the skin and hair coat quality in dogs with poor hair coats (Combarros et al., 2020). Combarros's study included only two hound breeds, leaving an unknown effect in other breeds. Future research should focus of impact of supplement on overall health and performance of working dogs. This knowledge could help veterinarians and handlers develop healthcare strategies to maintain health and improve operational efficiency of working dogs.

1.3.3 Grooming

Regular grooming is essential for working dogs as it helps to maintain coat and skin health, which acts as a barrier to protect against chemical agents, reduce the absorption of toxic environmental substances, and prevent skin injuries during work (Jarrett et al., 2022). Working dogs are often employed in challenging environments where they may be exposed to chemical agents or toxins that can impact their overall health (Llera & Volmer, 2006; Murphy et al., 2003; Parr & Otto, 2013). For example, Parr and Otto (2013) reported that 2.2% of working dogs were exposed to toxins during their duties. Furthermore, a previous research on search and rescue dogs employed in the 9/11 World Trade Centre terrorist attack reported that 81% of dogs exposed to at least one environmental toxin (Fox et al., 2008). In another study, detector dogs can be exposed to hydrocarbons at drug manufacture sites, which can result in irritation of the respiratory tract, conjunctiva, and integumentary system (Llera & Volmer, 2006; Murphy et al., 2003). Therefore, washing the skin after work sessions is important to remove chemical substances before they penetrate, reducing the risk of illness from environmental exposure.

Grooming and bathing are important factors to prevent skin problems in working dogs. One study in search and rescue dogs suggested that bathing/washing before and after employment in contaminated areas can reduce the number of dermatitis cases (Gordon, 2012). Moreover, bathing can help to manage erythema in dogs, especially those that develop skin irritation quickly after search activities (Fox et al., 2008). These symptoms usually improve

within three to five days after washing. However, these two studies focused on search and rescue dogs after employment, which pose a higher risk of exposure to chemical substances . There is a gap in understanding the benefits of regular bathing on the skin health of working dogs.

A previous study found that too frequent bathing is a risk factor for canine atopic dermatitis, likely due to the removal of sebum, affecting the epidermal lipid layer, thus compromising skin barrier function (Meury et al., 2011). Another study by Babić et al. (2020) evaluated a correlation between bathing frequency and the location of skin lesions in dogs with atopic dermatitis. Dogs bathed 1–4 times per month tended to have skin changes on the legs or paw area, while those bathed 1–5 times per year showed lesions on the abdomen, chest, or axillae area. Since both studies by Babić et al. (2020) and Meury et al. (2011) included only dogs with atopic dermatitis, which requires bathing as a part of treatment. Therefore, the results of bathing frequency on skin change may differ in healthy dogs. Additionally, 25 of 50 dogs in Babić’s study had concurrent skin infections, which could cause lesions to appear anywhere on the body regardless of bathing frequency. A recent study in healthy dogs by Discepolo et al. (2023) found that daily bathing can decrease the diversity and abundance of skin microbiota and negatively impact the dermatological health of dogs. Therefore, it can be assumed that excessive bathing in healthy working dogs could disrupt the skin barrier, potentially leading to dryness, irritation, or increased susceptibility to other dermatologic issues. A study by Discepolo et al. (2023) used dilute dish detergent, which might have different ingredients and pH from dogs’ shampoo, and they did not investigate the change in skin health. Taken together, bathing provides both advantages and disadvantages for working dogs. It is important to evaluate the frequency of bathing in working dogs and investigate the effect of bathing on the skin health of these working dogs.

1.3.4 Housing

Proper housing is essential to ensure safety of working dogs and people who approach them. One study suspected that working dogs are usually in a kennel when they are not on duty (Arcuri et al., 2022). Similarly, two previous studies that investigated intestinal parasites in police dogs reported that the dogs were kept in individual cages (Ahmed et al., 2014; Jenan et al., 2015). This housing practice contrasts with companion dogs, which usually live in a home environment and often share space with humans or other animals. However, the kennel descriptions in those two studies were provided only in the materials and methods sections, which may reflect temporary housing for research purposes rather than their usual living

conditions. In the UK, working dogs are housed in individual areas with a wooden kennel placed centrally (Gaines et al., 2008). These kennels are unheated but include bedding. However, housing practices in New Zealand may differ due to variations in the welfare policies, organisation guidelines, and climate conditions.

In New Zealand, previous studies on housing practices focused on working farm dogs (Isaksen et al., 2020; Jerram, 2013; O'Connell et al., 2019). A study in the Manawatu region reported that 96% of working dogs had individual shelters attached to a run area, either with a cage or chain, while 3% lived in shelters not specifically built for working dogs (Jerram, 2013). Another study by Isaksen et al. (2020) investigated the bedding and the construction of kennel in 641 working farm dogs in the South Island. They found that 72% of working farm dogs were housed in individual elevated boxes with cage runs, while 26% were kept in kennels with chains. Another study investigated floor design and cleaning practice of kennel of working farm dogs in the North Island (O'Connell et al., 2019). However, detailed descriptions of kennel structures were not provided in O'Connell's study. Taken together, the housing practices for working farm dogs in New Zealand may vary depending on geographic location, climate, and owner preferences.

In contrast to the housing practice of working farm dogs, the housing of working dogs employed by government organisations is guided by formal policies (New Zealand Police, 2022). These regulations make housing practices more standardised. New Zealand working dogs live at home with their handlers and go to work with them. At a working dogs base, each dog is provided with an individual kennel attached to a cage run area (New Zealand Police, 2024). When not training or on operations, working dogs are usually kept in their kennels. At home, working dogs must be supervised by their handler or an approved person, and should primarily be kept in a secure kennel when unsupervised (New Zealand Police, 2022). The design of police dogs home kennel must be approved by the National Co-ordinator: Police Dogs or the officer in charge of the dog section. The kennel must be attached to a secure run area to prevent dogs from going out. In addition, the kennel must comply Code of Welfare for dogs issued by the New Zealand government (National Animal Welfare Advisory Committee, 2018). The kennel size should be sufficient for dogs to stand, turn, and lie naturally. It should offer shelter from extreme temperatures and include soft bedding. Clean water must always be available, with a separate toileting area away from the resting space, and waste must not accumulate. Although the guidelines on housing exist, the actual housing practices for working dogs in New Zealand remain unclear. Therefore, it is essential to investigate current housing

conditions to determine whether they follow the guidelines and to assess the welfare of the working dogs.

1.4 Health problems of working dogs

As previously stated, working dogs perform a wide range of duties in different environments, which can increase the risk of health problems. This section focuses on common diseases in working dogs, categorised by affected body systems.

1.4.1 Gastrointestinal problems

Gastrointestinal problems have been described as a common health problem in police dogs, with a prevalence range from 10.6% to 28.3% depending on the source of data and diagnostic methods (Alves et al., 2021; Parr & Otto, 2013; Tamimi & Wali, 2019). Gastrointestinal problems are significant problems that affect performance and can lead to euthanasia/retirement (Moore et al., 2001; Worth et al., 2013). Gastrointestinal problems have also been reported in military dogs, sled dogs and working farm dogs (Cave et al., 2009; Hendriks et al., 2012; Hill, 1998; McKenzie et al., 2010; Park et al., 2023), but the definitive diagnoses reported differed among studies. A previous study found that German Shepherd dogs are predisposed to gastrointestinal problems such as inflammatory bowel disease and exocrine pancreatic insufficiency (O'Neill et al., 2017). O'Neill's study investigated the disease pattern in companion German Shepherd dogs, which may not reflect the patterns observed in working German Shepherd. Studies by Worth et al. (2013) and Moore et al. (2001) focused on retired dogs, which did not represent the general population of working dogs, and they excluded dogs with mild to moderate gastrointestinal disorders that did not result in death/retirement. Therefore, there is a gap in the common gastrointestinal signs in New Zealand working dogs.

The aetiology of gastrointestinal signs in working dogs has been proposed in previous studies. A study in nine hunting dogs found that the intense exercise during hunting season can disrupt intestinal microbiota by producing oxidative stress (Belà et al., 2024; Zannoni et al., 2020). Alterations in intestinal microbiota increase the risk of intestinal barrier disruption, allowing pathogens to enter the intestinal lumen and trigger an inflammatory response (Belà et al., 2024). Moreover, prolonged exercise in sled dogs can induce the release of endotoxin and neuropeptides that reduce colonic motility and result in diarrhoea and hematochezia (Hill, 1998; McKenzie et al., 2010). However, McKenzie et al. (2010) focused on specific pathogens, which makes it difficult to conclude that exercise is the only factor that induces diarrhoea in sled dogs.

A previous study in 188 Portuguese police dogs fed with the same diet, reported the prevalence of diarrhoea was 10.6% at the time of survey, and it was associated with the level of activity and food intake per body weight ratio (Alves et al., 2021). Moreover, 12% of Portuguese police dogs showed an increase in defecation frequency, more than three times per day. However, Alves et al. (2021) did not investigate the cause of diarrhoea and concurrent gastrointestinal signs, leaving a gap in the underlying cause of these problems. Moreover, Alves et al. (2021) classified the activity level based on handler descriptions, which may be influenced by the perception of the handler.

Diets have been reported as a potential cause for gastrointestinal disorders in dogs with food hypersensitivity or food intolerance (Possebom et al., 2022). Commonly reported sources of food allergens include beef, dairy products, chicken, and wheat (Mueller et al., 2016). Dogs with adverse food reactions can exhibit both pruritus and gastrointestinal signs. The common clinical signs in dogs with food hypersensitivity include the presence of blood or mucus in faeces, tenesmus (Paterson, 1995), defecation more than four times per day (Johansen et al., 2017), a change in faecal consistency, constipation and flatulence (Loeffler et al., 2004). Change in elimination habit, urgency defecation or inappropriate elimination without diarrhoea can occur in dogs with gastrointestinal problems (Sherding, 2003). Other clinical gastrointestinal signs included vomiting, diarrhoea, and flatulence (Possebom et al., 2022). However, some dogs may not show obvious signs of gastrointestinal disorders, but they might display symptoms of grass ingestion during episodes of abdominal discomfort (Tams, 2003). Intermittent vomiting, borborygmus, and abdominal discomfort have been reported in dogs with gastrointestinal disorders (Hardy & Gajanayake, 2022; Matricoti & Noli, 2018). However, most of the studies on diet-related gastrointestinal signs included only dogs diagnosed with adverse food reactions without making comparisons to other diseases. It is important to note that similar gastrointestinal signs can also be observed in healthy dogs that are not allergic to food.

Three studies agreed that the intestinal parasite is a common cause of gastrointestinal issues in working dogs (Ahmed et al., 2014; Jenan et al., 2015; Tamimi & Wali, 2019). Tamimi and Wali (2019) used data from medical records, though some dogs with subclinical gastrointestinal signs of parasitic infections may have been missed. Jenan et al. (2015) focused on zoonotic intestinal parasites such as *Toxocara* spp., *Isospora* spp., and *Sarcocystis* spp. without investigating other intestinal parasites. Another study by Ahmed et al. (2014) reported that only 7.5% of Egyptian police dogs were found to have gastrointestinal parasites. The difference in gastrointestinal parasites reported in these two studies may be influenced by the

management, use of antiparasitic drugs, and geographical location. Two other studies discussed parasites in working farm dogs. Pattison et al. (2024) found that less than five percent of Australian working farm dogs have gastrointestinal parasites. In contrast, a study in New Zealand reported that 40% of working farm dogs have intestinal parasites in the faecal samples (O'Connell et al., 2019). This suggests that the prevalence of intestinal parasites varies by region. However, the high prevalence of O'Connell's report may be due to differences in diagnostic methods. Pattison's study relied on handler reports, while O'Connell's study used a laboratory to identify the faecal parasite. This highlights the potential influence of diagnostic techniques on the prevalence reported. There is a need to evaluate the parasitic infection as well as identify the risk factors of parasitic infection in working dogs.

Previous studies of New Zealand working dogs by Worth et al. (2013) and O'Connell et al. (2019) suggested the need for attention to gastrointestinal problems in this country. However, Worth's study focused solely on retired police dogs, which did not represent the general population of working dogs. It excluded working dogs with mild to moderate gastrointestinal disorders that did not result in death. Furthermore, both Worth's and O'Connell's studies did not investigate specific gastrointestinal signs. Therefore, the prevalence of mild gastrointestinal disorders and gastrointestinal signs in police dogs is unknown. Research on specific gastrointestinal signs is needed to aid in early diagnosis and improve the health of working dogs.

1.4.2 Musculoskeletal problem

Working dogs usually work in dangerous areas, running and jumping to apprehend suspects, which can increase the risk of musculoskeletal injury. The prevalence of musculoskeletal problems in police dogs is around nine percent during 3-year period (Tamimi & Wali, 2019). The prevalence of musculoskeletal problems in military working dogs varies among previous literature, ranging from 12.12% to 22% (Mey et al., 2020; Park et al., 2023; Takara & Harrell, 2014). Although these three studies use the data from medical records, they collected and categorised data differently. Takara and Harrell (2014) focused on the non-combat-related injury. In contrast, Mey et al. (2020) collected data from the dogs' first deployment on a combat mission. Therefore, the reported prevalence may be influenced by differences in data collection methods and the characteristics of the sample populations.

Musculoskeletal condition can lead to prolonged pain and inability to move, and negatively affect animal welfare (O'Neill et al., 2017). Over time, these problems gradually

reduce quality of life, leading to early retirement, and eventually to the decision to euthanise (Moore et al., 2001). Dogs with musculoskeletal problems may become aggressive when approached, which can negatively affect their trainability and handling (Amat et al., 2024). Sixty-nine percent of New Zealand police dogs were retired due to degenerative musculoskeletal problems (Worth et al., 2013). Similarly, degenerative joint disease was a common cause of death or euthanasia in 19.2% of United States military dogs (Moore et al., 2001). Studies by Worth et al. (2013) and Moore et al. (2001) focus on retired working dogs, which did not represent the prevalence of musculoskeletal problems in the general working dog population. Moore et al. (2001) and Worth et al. (2013) used data from medical records, which can provide higher reliability than surveys from handlers. However, the use of medical records can introduce bias because dogs with minor illnesses that do not affect their performance may not be presented to a veterinarian, which may underrepresent the true prevalence.

The risk factors associated with musculoskeletal problems in military dogs included age (more than 80 months), duty (explosive detector and special search), and breed (Labrador retrievers) (Mey et al., 2020). Golden retrievers, a common breed for detection work, were reported to have a higher risk of cruciate rupture, while German shepherd dogs have a higher risk for hip and elbow dysplasia (Anderson et al., 2020). Although risk factors specific to working dogs have not been documented, it can be assumed that they may face similar risks to military dogs due to the overlap in breed and their roles.

The survey of health problems in New Zealand working farm dogs reported that 42% of sheepdogs had musculoskeletal abnormalities (Isaksen et al., 2020). This finding contrasts with an earlier study based on medical records of New Zealand working farm dogs, which found that only 12% of working farm dogs had either traumatic or non-traumatic musculoskeletal problems (Cave et al., 2009). The study by Isaksen et al. (2020) documented all abnormalities found in working farm dogs recorded by veterinarians during physical examination, even those unnoticed by owners or not affecting their ability or quality of life. In contrast, the study by Cave et al. (2009) used medical records that focused on issues that were severe enough for owners to seek veterinary care. Moreover, Cave's study reported only the two most serious diagnoses, less severe diseases but currently presented conditions may have been overlooked. This highlights the limitation of using medical records, as they may not capture the full range of health issues encountered by working dogs. Many conditions may be unreported because they are not severe enough for owners to seek veterinary care, or owners may not perceive them as significant enough to warrant attention.

1.4.3 Dermatological problem

Dermatological problems are one of the common cases seen in veterinary practice with the prevalence more than 20% over the past three decades (Evans et al., 1974; Hill et al., 2006; Wiles et al., 2017). In New Zealand, dermatological problems in police dogs have not been systematically studied, although physical examinations indicated that they occurred and represented a notable concern (V. Erceg, personal communication, November 7, 2024). In comparison, the prevalence of dermatological problems has been reported as approximately 8% in Iraqi police dogs (Tamimi & Wali, 2019) and 11-25% in military working dogs (Park et al., 2023; Takara & Harrell, 2014). All studies in companion and working dogs used data from medical records, which can provide higher reliability than surveys from handlers. However, it can introduce bias as dogs with mild skin disease that did not impact their performance may not be prioritised by the handlers for veterinary care. Surveying owners directly about dermatological issues may provide a broader assessment of these conditions.

Dermatological problems affect both trainability and work-life longevity of working dogs. Harvey et al. (2019) focused on retriever dogs, which are predisposed to canine atopic dermatitis (CAD). They reported that retriever dogs with atopic dermatitis are more likely to exhibit problematic behaviour such as mounting, hyperactivity/restlessness, leash pulling, grooming, and repetitive behaviour. However, the study by Harvey et al. (2019) neither examined the underlying reasons for problematic behaviour nor investigated current management practices that affect normal behaviour. A study in working guide dogs in the United Kingdom reported that skin problems can reduce work-life longevity by approximately five years due to the difficulty of treatment (Caron-Lormier et al., 2016). In comparison, less than five percent of working dogs were lost from service due to dermatological problems (Evans et al., 2007; Moore et al., 2001). The study by Caron-Lormier et al. (2016) included only guide dogs. Therefore, the results of other groups of working dogs may differ. Studies by Evans et al. (2007) and Moore et al. (2001) did not specify the reasons or medical diagnoses for the retirement of dogs with dermatological conditions. Some dogs may have concurrent systemic diseases that limit their quality of life. Research on impacts of dermatological problems in different working dog groups and those without other systemic disease is needed.

The most common dermatological problems reported in working dogs included irritation from contaminated environments during the working period, inflammatory skin diseases, infectious skin problems, atopic dermatitis, otitis externa, and skin wounds (Duhaime et al., 1998; Fox et al., 2008; Gordon, 2012; Takara & Harrell, 2014; Tamimi & Wali, 2019). The

studies in working dogs relied on medical records and overlooked mild or moderate cases in dogs that did not receive veterinary care. It should be noted that Takara and Harrell (2014) excluded only dogs that returned for the same clinical reason within a 14 days. As a result, patients with chronic conditions requiring prolonged treatment may appear more frequently in the dataset compared to those with acute disease. Two studies by Fox et al. (2008) and Duhaime et al. (1998) investigated dogs after deployment, which may increase the risk of disease and result in a higher prevalence of diseases compared to dogs in normal conditions. A study from Gordon (2012) involved surveys conducted 7 to 12 months after the deployment, which may not accurately represent the conditions immediately following deployment. None of these studies investigated general health in normal situations.

The research on dermatological problems in New Zealand has been carried out in working farm dogs and companion dogs. Forty-two percent of working farm dogs (272 from 641) exhibited abnormal skin conditions such as calluses, scars, lacerations, inflammation, masses, alopecia, and infections on the physical examination (Isaksen et al., 2020). Calluses were noted as the most common skin lesion reported in working farm dogs, which might be associated with poor bedding. This finding contrasts with an earlier study by Cave et al. (2009), which analysed data from 2,214 veterinary visits and categorised cases into non-traumatic and traumatic diseases. Of the 2,214 visits, non-traumatic skin conditions accounted for 149 cases, including abscesses, cutaneous parasites, otitis externa, pododermatitis, suspected atopic dermatitis, and generalised pruritus. However, Cave's study did not investigate traumatic skin conditions, such as wounds and healed scars, which can explain the lower number of cases compared to the study by Isaksen et al. (2020). Moreover, Cave's study relied on medical data, which may underrepresent mild or moderate skin problems. Another study in New Zealand companion dogs reported that skin disease was a common reason for clinic visits, accounting for 11% of clinical cases (Muellner et al., 2016). However, Muellner's study was limited to two veterinary practices and not all cases were fully documented in veterinary records. These three studies supported that dermatological disease is one of the common problems faced by both companion and working farm dogs in New Zealand, but the results were influenced by the data collection method and the source of the sample. Future study on skin problems in working dogs would help veterinarians and handlers to understand this problem and establish preventive strategies for skin disease.

1.5 Evaluation of dermatological problems

1.5.1 Definition of pruritus

Pruritus, an unpleasant sensation that triggers a desire to scratch (Metz et al., 2011), is the most common clinical sign in dogs with skin disease (Akter et al., 2018; Hill et al., 2006; Khoshnegah et al., 2013). This sensation is an important part of the defence mechanism to remove damaging or harmful substances from the epidermis. Pruritus is divided into acute and chronic pruritus. In acute pruritus, an irritation of the skin stimulates local cells to release pruritogenic substances that can induce the release of inflammatory cytokines and trigger pruritic behaviour (Metz et al., 2011; Sauvé, 2023). Chronic pruritus is the pruritus that lasts longer than six weeks, often associated with underlying systemic conditions, characterised by the continuous release of pruritogenic mediators (Sauvé, 2023). However, the pathological event of chronic itch is not fully understood.

1.5.2 Evaluation of pruritus

Measurement of the severity of pruritus in dogs is subjective and can be influenced by the owner's perception. In general practice, the assessment of the intensity of pruritus is important to help veterinarians make a diagnosis and monitor the response to treatment. One method to assess the intensity of pruritus is the use of the validated pruritic score, PVAS (Hill et al., 2007; Rybníček et al., 2009). The PVAS consists of the vertical line with a numerical scale from 0 to 10 and the descriptors indicating levels of severity, frequency of pruritic behaviour, and the change of normal behaviour. The PVAS allows the owner to select the point that represents the severity of their dog's pruritus from zero to ten. The score of zero is "Normal dogs – I don't think itching is a problem", and a score of ten means "Extremely severe itching/ almost continuous" (Figure 1.1). Rybníček et al., (2009) set up the cut - off value of the PVAS of 1.9 to differentiate between normal dogs and dogs with skin disease. Dogs with PVAS between 0 and 1.9 are defined as having a "normal" level of pruritus, which most owners would not seek veterinary attention. At this PVAS cut-off at 1.9, the scale demonstrated high sensitivity (92%) and specificity (94%) to differentiate dogs with normal and abnormal levels of pruritus.

Because the PVAS scoring system relies on the owner's perception, it may not accurately reflect pruritic behaviour exhibited by dogs. For instance, some owners may interpret mild or pruritic behaviour as normal grooming, leading to underreporting of itchiness. A previous study by Young et al. (2019) determined the agreement between changes in PVAS at follow-up and the owners' perceptions of improvement of their pet's pruritus. This study found that providing

owners with the previous PVAS more accurately captures their perception of improvement of their dog's itch level at the follow-up visit. Without the previous score, the PVAS score may not accurately reflect the dog's pruritus level. However, providing clear and consistent instructions on how to use the PVAS at a first-time visit, particularly by defining which behaviours qualify as pruritus, may help owners to understand and accurately rate their dog's level of pruritus.

Two studies determined the association between PVAS and pruritic behaviour with Stetina et al. (2015) focused on healthy dogs without skin and systemic diseases, whereas Webb Milum et al. (2018) focused on English bulldogs with a history of skin problems. In healthy dogs, the PVAS was positively related to the frequency of paws licking/chewing, facial/muzzle rubbing, head shaking and sneezing behaviour (Stetina et al., 2015). Webb's study found that dogs with skin disease showed higher PVAS than dogs without skin disease. By contrast, dogs with skin conditions had higher PVAS scores but showed lower frequencies of sneezing, head shaking, and paw licking than those without skin disease. These differences suggest that pruritic behaviour may vary with breed, general health, and the presence of skin conditions. A study by Stetina et al. (2015) included various breeds, making it hard to conclude breed-specific behaviour. However, this study provided useful owner-reported behaviours for identifying pruritus even in dogs without skin disease. In comparison, a study by Webb Milum et al. (2018) focused on companion English Bulldogs with some dogs currently on anti-pruritic medication, which can decrease the PVAS and suppress pruritic behaviour. Despite these limitations, both studies highlighted the association between PVAS and the frequency of pruritic behaviours in dogs with and without skin problems.

Another validated scale for assessment of canine pruritus is a verbal numeric scale (VNS), with a score range from 0 (no itch) to 10 (extremely itch) (Strzok et al., 2022). In this method, the instructor describes the pruritic behaviour verbally, including scratching, biting, licking, chewing, nibbling, or rubbing, and asks the owners to rate their dog's level of pruritus verbally. Therefore, clients can be interviewed over the telephone, which is suitable for the owner who is unable to complete the PVAS. A study by Young et al. (2019) reported a good correlation between the VNS and the PVAS scoring system, suggesting that VNS can effectively replace the PVAS when the owners are physically unable to fill out the PVAS. However, Strzok et al. (2022) reported that most owners preferred PVAS over VNS because of the visual aspect of the PVAS and detailed descriptions of itching behaviour that make ratings easier.

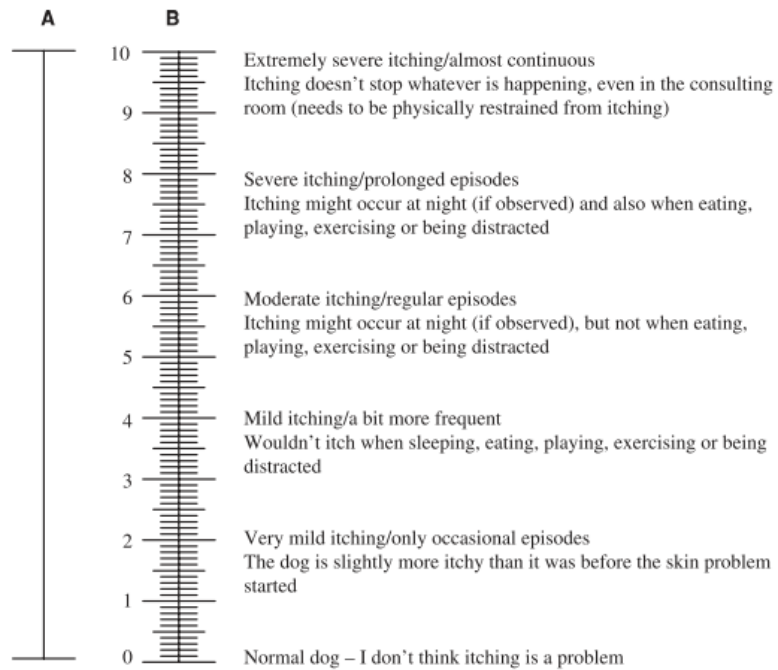


Figure 1.1 The pruritic visual analog scale validated by Rybníček et al. (2009). Both scales had the same descriptors down the right side, but version A had a traditional visual analogue scale down the left side, whereas version B had a numbered and graduated visual analogue scale.

1.5.3 Evaluation of the severity of skin lesions

In dogs with atopic dermatitis, two validated scoring systems are currently used to grade the severity of skin lesions; the Canine Atopic Dermatitis Extent and Severity Index 4th iteration (CADESI-04) (Olivry et al., 2014) and the Canine Atopic Dermatitis Lesion Index (CADLI) (Cho et al., 2022). The CADESI-04 is used to evaluate three lesions, including erythema, lichenification, and alopecia/excoriations at 20 different body areas on a four-point severity scale for each lesion, consisting of none (score 0), mild (score 1), moderate (score 2) and severe (score 3). The investigator then gave a score based on the severity of each location. The maximum CADESI-04 score was 180 (3 lesions x 20 body areas x 3 score). Dogs with scores of CADESI-04 less than ten were categorised as normal dogs or canine atopic dermatitis remission. The benchmarks for mild, moderate, and severe canine atopic dermatitis were 10, 35 and 60, respectively.

Another validated scale for canine atopic dermatitis is the Canine Atopic Dermatitis Lesion Index (CADLI) (Plant et al., 2012), which scores range from 0 (none) to 5 (severe extensive lesions) and a total score of 25 points. The CADLI evaluation base on the severity of six lesions in five areas of the body, including the head and pinnae, forefeet, hind feet, ventral thorax and axillae, and ventral abdomen and inguinal area. These six lesions were grouped into two groups: erythema/excoriations/erosions and alopecia/lichenification/hyperpigmentation. This grouping can induce the misinterpretation of severity. For example, dogs with severe erythema and excoriation may get the same score as dogs that have severe erythema without excoriation.

When comparing CADLI and CADESI-04 for assessing the lesion severity, CADLI has some limitations due to grouping lesions. First, the score is higher even though there is only one severe lesion in the group. Second, mild or moderate lesions might be underreported. For example, the severity of the lesion at the pinnae may be underreported if dogs have more severe lesions on the head because it primarily focuses on the more severe area. Therefore, for a first-time visit, CADESI-04 is more suitable than CADLI because it evaluates lesions individually, preventing the overestimation of severity. CADESI-04 allows veterinarians to assess the severity of each lesion in different parts of the body, making it an appropriate tool to evaluate the full range of severity of lesions.

1.5.4 Pruritic behaviour

There are various pruritic behaviours that exhibited by pruritic dogs. Metz et al. (2011) reported that scratching, the act of using nails or claws to rub or scrape the skin, is one of the signs of pruritus. Three other studies investigated the pruritic behaviour in dogs. Griffies et al. (2018) investigated only the head shaking and scratching behaviour as pruritus in dogs. Two other studies investigated pruritic signs after the challenge of pruritogenic substances (Blubaugh et al., 2020; Carr et al., 2009). The pruritic behaviour observed by Blubaugh et al. (2020) included licking, biting/chewing, scratching, head shaking, scooting, rolling, pawing, and tail chasing. Another study by Carr et al. (2009) evaluated four pruritic behaviours, including scratching, licking, chewing, rubbing or rolling. Although these two studies investigated pruritic signs after the injection of pruritogenic substances, it can be proposed that naturally pruritic dogs would exhibit the same behaviour. Asking about these pruritic signs in dogs can help veterinarians identify pruritic dogs with possible skin disease.

Previous studies found that the location of pruritus varied depending on dermatological problems. A study by Favrot et al. (2010) suggested that lesions on the feet, axillae, and ear pinnae were strongly associated with CAD, whereas dogs with lesions on ear margins and the dorsolumbar were considered non-CAD. This finding was supported by previous studies in atopic dogs, which reported that paws were the most common area of pruritus, followed by axillae, ventral chest, and face (Bruet et al., 2012; Graham et al., 2019). In contrast, Ferreira et al. (2023) noted that the ears were the most affected area in dogs diagnosed with CAD. However, 70% of dogs in Ferreira's study had concurrent otitis that could increase the percentage of ear involvement. The studies by Favrot et al. (2010), Graham et al. (2019), and Ferreira et al. (2023) only included dogs with atopic dermatitis and did not compare them with dogs having other skin diseases. It remains unclear whether such patterns are truly characteristic of CAD or can also be found in dogs with other skin diseases. Future research should include comparison groups and control for concurrent conditions to clarify lesion distribution and improve pruritus diagnosis.

Two studies investigated clinical signs of perianal pruritus in dogs. Maina et al. (2014) included dogs with any skin condition but excluded dogs with anal sac disease, while Bruet et al. (2012) included dogs with allergic skin conditions. Maina et al. (2014) reported that the frequency of perianal pruritus in dogs with adverse food reactions and/or CAD was higher than dogs with other skin problems. Bruet et al. (2012) found that dogs with flea bite allergy exhibited showed higher frequency of perianal pruritus than atopic dogs. The differences between these two studies might be due to the differences in survey questions and selection criteria. Moreover, Maina et al. (2014) focused on perianal pruritus in atopic dogs and asked about perianal behaviours such as scooting and tail chewing. In contrast, Bruet's study reported all signs of pruritus, which might have led owners to overlook the perianal area specifically. These two studies, however, only focused on whether symptoms of pruritus are present, without determining the severity or frequency of pruritic behaviour. As a result, the difference in severity of perianal pruritus across different skin diseases is undetermined.

Pruritic behaviour can be observed in healthy dogs without dermatological conditions. Stetina et al. (2015) investigated the frequency of pruritic behaviour in dogs without skin problems and found that healthy dogs can exhibit signs of pruritic behaviour such as paw licking/chewing, facial/muzzle rubbing, and head shaking, with varying frequencies. The frequency of pruritus was correlated with the PVAS score. This finding suggested that asking owners about these behaviours can help detect pruritic dogs even no skin lesions and improve

the accuracy of PVAS assessments by reducing the influence of owner perception. However, no studies have compared the frequency of pruritic behaviours in dogs with skin disease versus healthy dogs. Further research is needed to determine pruritic behaviours, their locations, and frequencies in the overall population and to compare patterns between dogs with and without skin problems.

1.6 Factors associated with dermatological problems in working dogs

1.6.1 Stress-related factors

Stress has been identified as a factor associated with dermatological problems in working dogs. Arcuri et al. (2022) reported that working dogs exhibited higher cortisol levels even in resting period, which were associated with prolonged stress exposure. Similarly, another study found that animal-assisted therapy dogs showed a high level of cortisol after work session, indicating work-related stress (Haubehofer, 2009). Stress can also affect the learning ability of working dogs and induce unpleasant behaviour (Rooney et al., 2009). Dogs that experienced long-term stress may show signs of self-mutilation, such as scratching or licking part of their body to relieve anxiety. This behaviour led to hair loss, skin thickening, and skin damage in the areas they groom most frequently, increasing the susceptibility to secondary skin infections (Coatesworth., 2019; Rooney et al., 2009). Although studies by Arcuri et al. (2022) and Haubehofer (2009) focused on military dogs and animal-assist therapy dogs, it can be inferred that working dogs may also experience stress from work and can exhibit signs of problematic behaviour. However, no studies have established a link between work-related stress and skin disease in these dogs. The research is needed to investigate whether signs of unpleasant behaviour in working dogs are associated with their roles and responsibilities, how these behaviours differ from those observed in companion dogs, and its association with the development of skin disease.

1.6.2 Breed factors

German Shepherds and Labrador retrievers are the most common breeds employed as working dogs. These two breeds are more represent with dermatological problems (Favrot et al., 2010). However, Favrot et al. (2010) focused on allergic skin diseases. Therefore, it hard to conclude that whether these two breeds are predisposing to other skin disease or not. A cohort study on disease patterns in the German Shepherd population revealed that skin disorders had the highest annual incidence rate compared with other diseases, and itching was the most frequently diagnosed condition (Vilson et al., 2013). The skin problems in German Shepherds

are usually severe and increase the risk of death/euthanasia. Moreover, a study by Wisselink et al. (1989) suggested that German Shepherds may have genetically inherited pyoderma, multiple deep skin lesions with bacterial colonisation. This group of German Shepherds presented signs of pruritus, alopecia, and ulceration, initially from the lumbosacral area, and can become generalised lesions. It should be noted that the study by Vilson et al. (2013) used insurance data, which tend to have more frequent veterinary visits, resulting in more documented health issues.

Two studies in Europe agreed that German Shepherds are predisposed to canine atopic dermatitis (Nødtvedt et al., 2006; Picco et al., 2008a). In contrast, a previous study in Australia investigated the breeds at risk for developing CAD and found that German Shepherds are not at risk of developing CAD (Mazrier et al., 2016). These three studies highlight that the development of skin disease may be influenced by geographic region rather than breed alone. A study in police working dogs by Takara and Harrell (2014) reported that working German Shepherds might be affected by CAD. However, this study included both German Shepherds and Belgian Malinois, making it difficult to determine whether German Shepherds are at a higher risk for developing atopic dermatitis compared to other working dogs breeds. No studies on skin problems in German Shepherds have been reported in New Zealand, highlighting the need to determine the prevalence of skin problems and investigate if New Zealand German Shepherds are at risk of developing skin diseases. This information is valuable for breeding practices to enhance the health of working dogs.

A study on guide dogs reported that Labrador retrievers have a strong genetic component for the development of canine atopic dermatitis (Shaw et al., 2004). This relates to a previous study by Nødtvedt et al. (2006), which reported that Labrador retrievers are one of the most reported breeds for insurance claims for canine atopic dermatitis, highlighting their susceptibility to these skin conditions. Labrador retrievers are also a breed at risk of developing canine atopic dermatitis in one study in Australia (Mazrier et al., 2016). Nødtvedt's study recorded the number of diagnoses per claim; canine atopic dermatitis, which is a chronic disease, requires long-term treatment, which may have a high incidence rate in this study. A study by Shaw et al. (2004) included dogs with recurrent pyoderma or traumatic dermatitis, making it hard to conclude whether these dogs truly had canine atopic dermatitis. Previous studies in companion Labrador retrievers by Shaw et al. (2004) and Nødtvedt et al. (2006) confirmed that Labrador retrievers have a higher risk of developing canine atopic dermatitis. Therefore, it can be assumed that working Labrador retrievers may be predisposed to various skin problems.

Further investigation is needed to determine whether working Labradors have a higher risk of developing skin diseases and if their prevalence is greater than in companion Labradors.

1.6.3 Environmental factors

Environmental factors can affect the development of skin problems and can cause pruritic behaviour. A study by Stetina et al. (2015) found that a number of walks per day were positively correlated with pruritic behaviour, such as paw licking/chewing, head shaking behaviour in healthy dogs. This suggests that dogs that spend more time outdoors are more likely to be exposed to environmental allergens that induce pruritus. Other environmental risk factors of canine atopic dermatitis have been reported in previous studies, including living in urban areas (Nødtvedt et al., 2006), adoption at 8-12 weeks of age, and living in a house without other animals (Meury et al., 2011). Both Nødtvedt et al. (2006) and Meury et al. (2011) focused on atopic dogs, it still unknown if this factor can cause pruritus in the general population of working dogs. Moreover, Meury's study focused on retriever breeds, which predisposed to the development of canine atopic dermatitis. Therefore, it cannot conclude that these factors affected breed that not predisposed to canine atopic dermatitis. Study by Nødtvedt et al. (2006) and Meury et al. (2011) based on European environments, which differ from New Zealand. Research on the effect of environmental conditions on the development of skin disease in New Zealand dogs can enhance the understanding of risk factors for this problem and help in developing preventive methods.

One study in military dogs by Takara and Harrell (2014) suggested that military dogs that work or stay in a humid kennel have a higher risk of developing otitis externa and dermatitis compared to those who live in dry kennel. This was supported by a recent consensus, which suggested that warmth and humidity can influence the abundance of *Malassezia sp.* on the skin and can result in skin infection or otitis (Bond et al., 2020). The onset of pruritic signs for dogs with *Malassezia* dermatitis is the summer or humid months and persists to winter. However, Takara & Harrell (2014) neither determined other environmental factors nor investigated the underlying dermatological problems, such as atopic dermatitis or endocrine disease, which are considered as common causes of dermatitis. Moreover, existing research has been conducted in Europe, which may not be fully applicable to New Zealand. This highlights the need to investigate the environmental management of New Zealand working dogs and its potential impact on dermatological problems, which can help veterinarians and handlers manage their environment to prevent skin problems in working dogs.

1.6.4 Dietary factors

Diets can induce pruritic in dogs by initiating a specific immune response (White, 1986). White (1986) described the concept of food hypersensitivity in dogs, which cases with symptoms of pruritus or itching were successfully resolved after dietary restrictions. The hypersensitivity might be developed from genetic predisposing, dysbiosis of the intestinal microbiome, change of intestinal permeability, and specific immune response to food allergens (Jackson, 2023; Sherding, 2003). The reported prevalence of cutaneous adverse food reactions varies depending on the group studied, ranging from 12–14% in dogs with dermatological signs (Proverbio et al., 2010; Shimakura & Kawano, 2021), 9–40% in dogs with pruritic signs, and 9–50% in dogs with atopic dermatitis (Olivry & Mueller, 2017). However, the prevalence in the overall dog population remains unknown. Studies on the prevalence of food hypersensitivity typically rely on veterinary medical records and require restrictive diets for diagnosis. This approach can overlook cases where dogs experience symptoms but have not been presented to a veterinarian for evaluation. Moreover, it excludes cases where owners are unable to complete the diet restriction trial. Consequently, the prevalence of food hypersensitivity may be underestimated and the prevalence in overall population remains unknown.

Unlike dogs with general skin problems, dogs with food hypersensitivity show signs of gastrointestinal problems as well as pruritus. Reported gastrointestinal included increase in bowel movements, the presence of faecal mucus, hematochezia, tenesmus (Paterson, 1995), an increase in defecation frequency (more than four times per day) (Johansen et al., 2017), changes in faecal consistency, constipation, flatulence (Loeffler et al., 2004), vomiting, diarrhoea (Possebom et al., 2022), changes in elimination habits, urgency defecation or inappropriate elimination without diarrhoea (Sherding, 2003). Tams (2003) reported that some dogs may not show obvious signs of gastrointestinal disorders, but display symptoms of grass ingestion during episodes of abdominal discomfort (Tams, 2003). Two studies by Johansen et al. (2017) and Loeffler et al. (2004) conducted in dogs referred to dermatology clinics. This may lead to underreport of gastrointestinal signs, as some owners might focus primarily on skin issues. Moreover, neither of the two studies investigated other systemic diseases, which can induce gastrointestinal signs. It should be noted that gastrointestinal symptoms can occur in dogs with various gastrointestinal diseases and not specific to adverse food reactions.

Many protein sources have been reported to induce allergic reactions in dogs. Beef, dairy products, chicken, and wheat are among the most common (Mueller et al., 2016). However, the review by Mueller et al. (2016) included only articles from Australia, Europe, and

North America. Therefore, it cannot be assumed that dogs in other countries are allergic to these sources of protein. Furthermore, cross-reactivity between allergens from different food sources is a significant concern (Olivry, O'Malley, et al., 2022; Olivry, Pucheu-Haston, et al., 2022). For example, research had identified that chicken antigens exhibit some overlap with antigens found in fish and mammalian meats (Olivry, Pucheu-Haston, et al., 2022). Therefore, there is theoretical potential that dogs allergic to chicken also show allergic reactions to other animal proteins. All existing research have focused on diets typically given to companion animals, which may differ from diets of working dogs, especially the quality of the ingredients. Consequently, the risk of hypersensitivity to specific protein types may vary between working and companion dogs. Further research is needed to investigate the dietary practices in working dogs and assess their potential impact on gastrointestinal and dermatological issues.

Stetina et al. (2015) evaluated the pruritic behaviour in healthy dogs without skin or systemic diseases and found that diets were positively related with pruritic behaviour such as paw licking, facial rubbing, head shaking, and sneezing. The ingestion of treats was linked to increased gastrointestinal disturbances such as flatulence, borborygmi, and vomiting. Consumption of a raw diet was associated with a higher frequency of defecation but lower incidences of flatulence. However, this study did not examine the specific ingredients in diets or treats, so it cannot be concluded that treats directly increase the severity of pruritus without investigating their composition. Future research should therefore investigate the effects of specific dietary components and treats in working dogs and assess the potential relationship between gastrointestinal and dermatological signs in this population.

1.7 Conclusion

This literature review provided an overview of the population features and general health management of working dogs and summarised the common health problems affecting this population. While previous research on health problems in this population has largely relied on medical records, which provide reliable information, it may overlook mild conditions that do not affect work performance. This research aims to collect data from handlers to describe health management practices and the occurrence of pruritic behaviours in working dogs. By using handler-reported data, this study can report pruritic behaviours in overall population. This information can help veterinarians better understand pruritic behaviours and early diagnosis of pruritus in working dogs.

Chapter 2 Population features, health management and pruritic behaviours of New Zealand working dogs

2.1 Abstract

Background: Working dogs play a crucial role in maintaining public safety in New Zealand. However, there are no published data on populational features, health management practice, pruritic behaviour, and signs of allergic problems in these working dogs.

Objectives: To describe population features, health management practices, the frequency of pruritic behaviours, and the frequency of clinical signs of allergy in New Zealand working dogs.

Methods: The questionnaire was distributed to working dogs' handlers across New Zealand. The questionnaire covered the health management, feeding practices, the frequency of pruritic behaviours, and the frequency of allergic signs in working dogs. The available responses about the frequency of pruritic behaviours and allergic signs range from multiple times daily to a few times a year. The continuous variables were reported as median and interquartile range (IQR). The categorical variables were reported as the number of dogs, percentage, and 95% confidence interval (95% CI).

Results: Two hundred fifty-two dogs were eligible for this study. The percentage of male and female working dogs were 56.7% and 43.3%, respectively. The median age of enrolled dogs was 2.95 years (IQR 1.6 – 5.0), and the median body weight was 32 kg (IQR = 27.0 – 36.0). German Shepherd was the most common breed of working dogs (80.2%). Eighty-three percent of dogs worked for the New Zealand Police. Sixty-six percent of working dogs spent most of time outdoor (165 of 250). Seventy-two percent of dogs received flea and worm prevention (180 of 250), and 26% received vaccination in the last six months (26 of 250). Eighty-four percent of dogs were fed with dry food (210 of 250) and forty-three percent received dog treats at least a few times a year (109 of 250). Ninety-five percent of dogs were bathed, and sixty-nine percent got ear cleaning at least once a year. Ninety percent of working dogs exhibited at least one pruritic behaviour (224 of 252) at least a few times a year. The most common reported behaviour was head shaking (72.2%), followed by facial rubbing (62.3%), paw licking (46.4%), eye rubbing (39.5%), and leg licking behaviour (39.3%), which were exhibited a few times a

year or more. Seventy-five percent of dogs exhibited sneezing, and 45% showed signs of conjunctivitis at least a few times a year.

Conclusion: This study provided baseline information on the population features and health management practices of New Zealand working dogs. Moreover, this study reported the frequency of pruritic behaviours and clinical signs of allergy in New Zealand working dogs. This finding can help veterinarians understand the current management and pruritic behaviour of New Zealand working dogs.

2.2 Background

In New Zealand, many organisations employ working dogs to help in public service and improve the functions, duties, and power of the organisation. Working dogs were divided into two main types: patrol and detector dogs. Patrol dogs are primarily used for tracking, searching, and apprehending suspects and violent offenders, while detector dogs are employed to detect illegal substances or objects (New Zealand Police, 2022). The New Zealand Police employs working dogs for both patrol and detector works (New Zealand Police, 2022). The New Zealand Customs Service and the Department of Corrections employ working dogs for the detection of illegal substances (Department of corrections, n.d.; New Zealand customs service, n.d.). The Aviation Security Service only employs explosive detector dogs (Aviation Security Service, n.d.). German shepherd is the only breed employed for patrol work while Labrador retrievers, cocker spaniel, other common retrievers, and crossbreed are used for detection work across all organisation (Aviation Security Service, n.d.; Department of corrections, n.d.; New Zealand customs service, n.d.; New Zealand Police, 2022). These working dogs must complete a training course before the operation. In addition, dogs from specific organisation can work with other organisations when required.

The health management is an important part to maintain the health and welfare of working dogs. The working dogs should be provided adequate nutrition, supplementation, vaccination and parasitic prevention as parts of health management (Otto et al., 2021). In New Zealand, working dogs live with their handlers 24 hours a day, both during operations and while off-duty at home (New Zealand Police). These dogs must be always supervised by their handlers or an approved person to ensure both public safety and the safety of the animals. Although the health management of police dogs was covered by police policies (New Zealand Police, 2022), it still unclear how individual handlers across all organisations have done in practice. Furthermore, specific health management practices by handlers including preventive medicine,

feeding practices and skin health management of New Zealand working dogs have not been investigated.

Dermatological problems are one of common health issues that have been reported in working dogs (Fox et al., 2008; Tamimi & Wali, 2019). Fox et al. (2008) examined both acute injuries/illnesses and long-term health outcomes in police dogs deployed after the 9/11 terrorist attack disaster. Therefore, Fox's study cannot represent the dermatological health of general working dogs, especially those not working in disaster areas. Tamimi and Wali (2019) surveyed health problems of police dogs in referral hospitals using medical records. It is possible that dogs with mild skin problems were not brought to the hospital, resulting in the underrepresentation of dogs with mild skin problems. In New Zealand, skin problems were noticed in police dogs during routine examination, but the handlers did not report to veterinarians (V. Erceg, personal communication, November 7, 2024). It might be because the handler perceived that it was a mild condition that did not affect performance. However, mild skin problems can progress to severe skin conditions, requiring long-term treatment. Consequently, it is difficult to find a new owner for the dog after retirement because of long-term management and high cost for a new owner (V. Erceg, personal communication, November 7, 2024). Therefore, investigating signs of dermatological problems in working dogs may help veterinarians better understand the status of these underreported conditions.

Pruritus, an unpleasant sensation that triggers a desire to scratch, is the most reported sign in dogs with dermatological problems (Akter et al., 2018; Hill et al., 2006; Khoshnegah et al., 2013). Pruritic dogs usually showed pruritic behaviours, including scratching, licking, chewing, and rubbing in different parts of the body (Banovic et al., 2019; Griffies et al., 2018). Pruritus can lead to the development of severe skin problems or chronic pruritus, which negatively affect the trainability and performance of working dogs by interrupting their focus and causing distractions (Harvey et al., 2019). A previous study evaluated the frequency of pruritic behaviour in a specific group of dogs, with Stetina et al. (2015) focused in 314 healthy dogs without a history of skin or systemic disease and normal skin appearance on physical examination. In contrast, Webb Milum et al. (2018) examined the frequency of pruritic behaviour in 34 English bulldogs with abnormal skin appearance. However, the frequency of pruritic behaviours in the general population of working dogs has not been investigated.

The first aim of this study is to describe the population features of New Zealand working dogs. The second aim is to investigate health management of working dogs, including preventive medicine, feeding practice, and skin and ear management. The third aim is to

determine the frequency of the pruritic behaviours and the clinical signs of allergy in working dogs.

2.3 Materials and methods

2.3.1 Data collection

This thesis used a data set that was collected from the handlers of working dogs across New Zealand between October 2018 and July 2021. The data collection was divided into two rounds: a first survey, starting from October 2018, and a second survey, starting from June 2019.

2.3.1.1 First survey

2.3.1.1.1 The questionnaire

The first questionnaire was designed to explore the signalment of working dogs, health management, health problems, pruritic behaviours, and gastrointestinal signs of New Zealand working dogs. Some questions in the first questionnaire were identical to those used in a previous study (Stetina et al., 2015). The questionnaire was uploaded into SurveyMonkey, an online survey tool (SurveyMonkey Inc.). The online questionnaire was initially sent to the police dogs section supervisor (District Officer in Charge of Dog Section) via e-mail. Then, the police dogs section supervisor distributed the questionnaire to police dogs' handlers across New Zealand. The first questionnaire included nine sections with 71 questions as follows (see Appendix 1):

1. Dogs' signalments (five questions): name and identification number (ID), age, breed, sex, and weight.
2. History and health management (21 questions): medical problems in the previous 6 months, preventive medicine, current supplements, frequency of elimination, length of ownership, environment, observation hours change in appetite, type and brand of diet and treats, number of meals per day, weight change in previous three months, duration of current diet, urination and defecation location, and frequency of toileting.
3. Gastrointestinal problems and the frequency of gastrointestinal signs (17 questions): faecal consistency, change of faecal consistency, hematochezia and blood characteristic, bowel movement per day, change in bowel movement, melena, faecal mucus, flatulence, belching, borborygmi, abdominal cramp, tenesmus, grass digestion, grass vomiting, regurgitation, and vomiting.

Faecal consistency was assessed using The WALTHAM™ Faeces Scoring System (Moxham, 2001), a 5-point numerical scale ranging from 1 (dry, crumble faeces) to 5 (watery stool) along with the picture of faecal of each score (see Appendix 5).

4. Frequency of pruritic behaviours (eight questions): eye rubbing, muzzle/face rubbing, paw licking, front legs licking, head shaking, tail licking/chewing, back chewing/rubbing/licking, and scooting.
5. Questions related to perianal pruritus (three questions): Anal gland expression, history of anal problems, and how long the scooting resolve after anal expression.
6. Frequency of allergic signs (two questions): sneezing and eye discharge/conjunctivitis.
7. Ear problems and managements (six questions): history of ear problems, frequency of ear cleaning, ear cleaning method, reason for ear cleaning, ear cleanser application, and where the handler learned to clean the dogs' ears.
8. Skin health and managements (seven questions): frequency of bathing, type of shampoo, who recommended bathing for the dog, frequency of paw washing, reasons for washing the paws, intensity of body odour and dominant body odour.
9. Sign of repetitive behaviours and how easy it is to distract them from the behaviours (two questions).

The format of the questionnaire included both closed and open-text questions. Some of the closed questions allow the handlers to select multiple answers, including an "Other" option. If "Other" was selected, handlers were asked to provide additional details in an open-text field. For the yes/no questions, if a handler selected "Yes," they were asked to describe their response further in an open-text field.

2.3.1.1.2 Physical examination

Handlers have an option to complete the questionnaire independently. However, those with more availability were encouraged to visit a dermatological veterinary clinic in Auckland or Wellington on a specific date for a physical examination. Two veterinary dermatologists involved in physical examination and obtained two additional points of information from handlers, including the Pruritus Visual Analog Scale (PVAS) (Rybníček et al., 2009) and the Canine Dermatitis Extent and Severity Index (CADESI-04) (Olivry et al., 2014).

The first was the PVAS, a chart of numerical scale from 0 - 10 combined with the description of behaviour (see Appendix 3). During physical examination, the veterinarian showed the scale of PVAS to the handler. The handler was asked to select the point on the

scale that best describes the level of pruritus of dogs. The PVAS score of 0 means “normal dogs – I don’t think pruritus is a problem”, and the PVAS score of 10 was “Extremely severe itching/almost continuous”. Then the veterinarian determines the numerical score from the selected points.

Secondly, the veterinarian evaluated the severity of skin lesions using the published validated scale of CADESI-04. The three skin lesions in 20 body sites were examined. In each body site, three skin lesions, including erythema, alopecia, and lichenification/excoriation were evaluated. Then, the veterinarian compared the skin lesion with the CADESI-04 guideline and recorded a score for each lesion on each body site, ranging from 0 (none) to 3 (severe). Therefore, the maximum score of CADESI-04 was three lesions x severity score of 3 x 20 body sites = 180. Then the veterinarian noted the score of each dog on the scoring paper (see Appendix 4).

2.3.1.2 Second survey

2.3.1.2.1 *The questionnaire*

To reduce response time and simplify the process for handlers, a second questionnaire was developed from the first questionnaire by focusing on pruritic behaviour and gastrointestinal signs. This second survey was sent to the working dogs’ handler of the New Zealand police who completed the first survey. Therefore, only police dogs were included in second survey. The questionnaire was uploaded online via Qualtrics, an online survey tool (Qualtrics, 2018). Moreover, this second questionnaire was also printed as a hard copy for handlers to complete at the clinic after physical examination.

The second questionnaire is a shorter version of the first questionnaire, includes only 21 questions as follows (see Appendix 2):

1. Signalment of dogs (two questions): name and ID number.
2. The frequency of gastrointestinal signs (nine questions): bowel movement, score, faecal mucus, belching, flatulence, barborygmi, tenesmus, grass eating, and grass vomiting.
3. The frequency of pruritic signs (eight questions): eye rubbing, muzzle/face rubbing, paw licking, front legs licking, head shaking, tail base licking/chewing, and back chewing/rubbing/licking, scooting.
4. The frequency of allergic signs (two questions): sneezing and eye discharge/conjunctivitis.

2.3.1.2.2 Physical examination

In the second survey, police dog handlers were asked to bring their dogs to a veterinary dermatologist in Auckland or Wellington for a physical examination on one of the following dates: 5, 6, or 10 June 2019, or 18, 19, or 22 November 2019, depending on their availability. During the veterinarian visit, two veterinarians asked the handler to select the severity of pruritic behaviour using the PVAS score. Moreover, the CADESI-04 of each dog was recorded by a veterinarian. Handlers were required to complete a hard copy of the questionnaire on the same day as the physical examination. For handlers who were unable to complete the survey at the clinic, the identical short questionnaire was available online via the Qualtrics platform, and the link was sent to their email addresses.

2.3.2 Data management

2.3.2.1 Data entry and data cleaning

The original data from the questionnaire was exported from SurveyMonkey and Qualtrics to Excel® spreadsheet [version 2504](Microsoft Corporation). The answer from the hard copy was manually entered into the Excel® spreadsheet. The PVAS and CADESI-04 scores of each dog were manually transferred from the scoring sheet to the Excel® spreadsheet.

The first and second survey data were combined into one datasheet. Then, the original dataset was cleaned by one technician without checking by other people. The data cleaning process by the technician consists of the following steps:

Recording of the survey completion number: For dogs with the same name and identification number (ID) who completed survey multiple times, the completion number was recorded as follows: if a handler completed the survey for the first time, it was marked as 1; if completed a second time, it was marked as 2; and if completed a third time, it was marked as 3, and so on.

Organisation: some handlers provided only the dog's name and ID, some handlers provided the name of organisation. If the handler did not provide the organisation, then the organisation was identified using the name and ID record for the police dogs. If the organisation could not be found, the organisation was recorded as "unknown", which may include working dogs that are used for breeding.

Breeds: there are many different of latter in this open-text box. Each answer was coded into larger categories. For example, GS, G/S, GSD were recoded to German Shepherd. Lab,

black Labrador were grouped as Labrador retrievers. Huntaway x, GSP lab x, x breed, and cross breed were grouped as cross breed. One German Short Haired Pointer was not further grouped.

Age: some handlers provide only age, while some handlers provide only date of birth. If the handler provides the date of birth, then age was calculated based on the difference between the date of birth and the date of survey completion. If only the age was provided, it was reported as given by the handler.

Medicine in the previous six months; some handlers provided the commercial names of the medications, while others listed the types of medications. Each answer was manually investigated and categorised into specific groups: vaccinations, flea and worm prevention, and other. The “other” categories included antibiotics, anti-inflammatory medications, and anti-pruritic treatments.

Supplements: if the handler provided the answer regarding supplement type, such as omega, flax seed oil, canola oil, then the answer was recoded as “yes”; if they answered as none, n/a, the answer was recoded to “no”.

Food brand: there are many different latter provided by the handler. If the handler provided the brand’s name, the food’s brand was then recorded as the brand’s name. If the handler did not provide the brand’s name, the answer was recorded as “other”.

Food formula: there were many different labels provided by the handlers. These labels were grouped into broader categories based on the formula type. For example, Trial 430 and Endurance were recorded under "Endurance/Energy/Performance". Formula reported as Maxi Adult, Senior, and Maxi Adult were grouped under "Age". Formulas related to specific health problems, such as Daily Care Sensitive Skin, Vitamin-Rich Fish, Hypoallergenic, and Hill’s ZD, were categorised as "Prescription". Breed-specific formulas, such as Royal Canin German Shepherd or Labrador formulas, were recorded under "Breed". If the formula was not specified, it was categorised as "other".

Health problems: the health problems reported by the handler were categorised according to the affected system. For example, dermatitis, redness, otitis, eye infection, and allergy were categorised as “skin problems”. Bone fracture, hip dysplasia, and joint disease were categorised as “orthopaedic disease”. Diarrhoea and vomiting were categorised as “gastrointestinal problems”.

The frequency that dogs can access to the elimination area: the opened - ended text answer varied among handlers, with some handlers provided specific numbers per day (e.g., 3

times/day, 5-6 times/day) while others gave general frequency descriptions (e.g., hourly, several times). These responses were manually grouped into categories based on the number of times per day: 2-3 times per day, 4-6 times per day, 7-12 times per day, 12-24 times per day. If the handler did not specify the frequency, the answer was categorised as unknown. The original answer of unknown frequency including “at selected time during the day”, “only when let him”, “when let out”, and “he live in the run area but toilet rarely”.

Please note that some of the open-text responses were left uncategorised and retained in their original format until further investigation.

2.3.2.2 Identification of repeated response

The cleaned dataset consisted of 340 responses from both the first and second surveys. Some handlers completed the survey multiple times for the same dog. For this chapter, only the first completed survey for each working dog was included. Firstly, the dataset was reviewed to differentiate between the first and second surveys, identified by the distribution platform used. This dataset included 272 responses from the first survey, distributed via SurveyMonkey, and 68 responses from the second survey, distributed via Qualtrics and hard copy. Secondly, we identify the first-time response for each dog using the survey completion number. We identified 250 responses from the first survey and two responses from the second survey as first-time responses for each dog. Therefore, a total of 252 responses were identified as first-time responses of each working dog, which were eligible for analysis in this chapter (Figure 2.1).

2.3.3 Data analysis

2.3.3.1 Data categorisation for analysis

The screened dataset included 252 dogs defined as the first-time responses. Specifically, the data of 250 dogs from the first survey and two dogs from the second survey. Therefore, the data on population features were derived from a full sample of 252 dogs, data on health management were derived from 250 dogs whose handler completed the first survey, while the data on pruritic behaviour and allergic signs were derived from 252 dogs whose handler completed either the first or second survey for the first time.

For descriptive analysis, the variables were grouped as follows:

Organisation

The organisation was originally recorded as “police”, “correction”, “aviation”, “custom” and “unknown”. The organisation was further classified to “police”, which referred to dogs that work with the New Zealand Police, and “other”, which refers to dogs that did not work with the New Zealand Police.

Age

The continuous variable of age was categorised according to the 2019 AAHA Canine Life Stage Guidelines (Creevy et al., 2019). Dogs aged 0 to 9 months were classified as “puppy”, those between 9 and 48 months were classified as “young adults”, age between 48 and 108 months were classified as “mature adults”, and working dogs older than 108 months were classified as “senior”.

Change of body weight

The categorised responses regarding the change of body weight were categorised into larger groups. If the handler selected “unsure amount of weight gain”, “weight gain of less than 1.5 kg”, and “weight gain of more than 1.5 kg”, the answer was categorised as “weight gain”. If the handler selected “unsure amount of weight loss”, “weight loss less than 1.5 kg”, and “weight loss more than 1.5 kg”, the answer was classified as “weight loss”.

Inappropriate elimination behaviour

The open-text responses regarding inappropriate elimination were manually investigated and categorised into the following categories (Beaver, 2009): confinement (includes dogs eliminated in confined spaces such as kennels or crates, often due to being left for too long without access to the outdoors), work or training environment (reported as a dog that eliminated during work, tracking, or training due to any reasons), house soiling (refers to dogs eliminated in house where they were not allowed), incomplete elimination (where dogs did not have sufficient time to fully eliminate during designated toilet breaks), and other (response that didn’t fit into any categories or less common).

2.3.3.2 Data analysis

All data analysis in this chapter was carried out using RStudio [version 4.1.1] (R Core Team, 2024). The continuous variable was reported as median and interquartile range (IQR). The categorical variables were reported as the number of dogs, percentage, and 95%

confidence interval (95% CI). The figure in this chapter was created using ggplot2 (Wickham, 2016), except Figure 2.1 was created using Microsoft PowerPoint [version 2504].

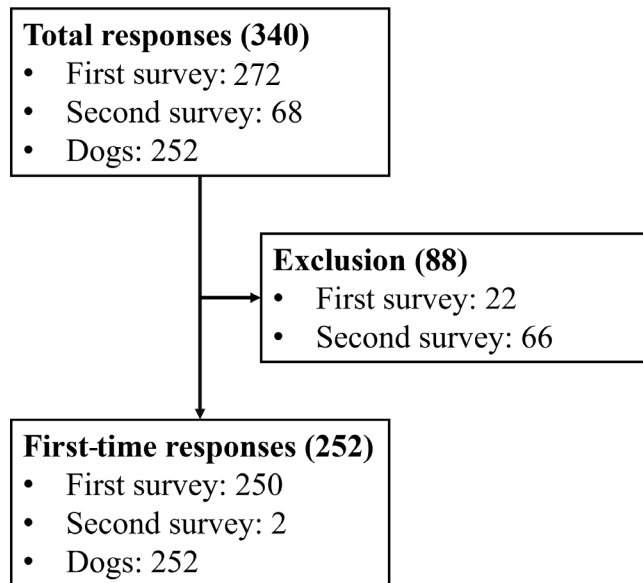


Figure 2.1 Data screening process. A total of 340 questionnaires were collected: 272 from the first survey and 68 from the second survey. For this chapter, only first-time responses were included. Twenty-two responses from the first survey and 66 from the second survey were excluded because they were not the first-time response for a dog. Therefore, 252 first-time responses from 252 dogs were included in this chapter, consisting of 250 from the first survey and 2 from the second survey.

2.4 Result

2.4.1 Populational features

Table 2.1 shows the number and percentage of 252 working dogs stratified by age group, neuter status, organisation, and breed. A total of 252 dogs were included in this study, with 210 dogs worked with the New Zealand Police and 42 dogs from other organisations that sometimes work with police dogs. Of the 210 police dogs, 202 were German Shepherds, six were Labradors, and one each was a Spaniel and a crossbreed. The age of enrolled dogs is a right-skewed distribution, ranged from 2 months to 12 years old, with a median of 2.95 years (IQR 1.58 – 5.03). The majority of dogs were male (56.7%, 95% CI = 50.6 – 62.9) and 43.3% were females (95% CI = 37.1 – 49.4). The median body weight of enrolled dogs was 32 kg (IQR = 27 - 36). The distribution of body weight is shown in Figure 2.2.

Table 2.2 shows the number and percentage (with 95% CI) of working dogs stratified by the time that the handler had the dogs and where the dogs spent most of their time in a day.

Table 2.1 The number and percentage (with 95% CI) of enrolled dogs stratified by age, neuter status, breed, and organisation. The other organisation was a group of dogs that did not work for the New Zealand police. Data was collected from 252 working dogs.

Categories	Number of dogs (n = 252)	% (95% CI)
Age		
Puppy	26	10.3 (6.6 - 14.1)
Young adult	136	54.0 (47.8 - 60.1)
Mature	84	33.3(27.5 - 39.2)
Senior	6	2.4 (0.5 - 4.3)
Neuter status		
Female, intact	62	24.6 (19.3 - 29.9)
Female, spayed	47	18.7 (13.8 - 23.5)
Male, intact	122	48.4 (42.2 - 54.6)
Male, neutered	21	8.3 (4.9 - 11.7)
Breed		
German Shepherd	202	80.2 (75.2 - 85.1)
Labrador retrievers	23	9.1 (5.6 - 12.7)
Crossbreed	21	8.3 (4.9 - 11.7)
Spaniel	5	2.0 (0.3 - 3.7)
German Short-Haired Pointer	1	0.4 (0 - 1.2)
Organisation		
The New Zealand Police	210	83.3 (78.7 – 21.3)
Other	42	16.7 (12.1 – 21.3)

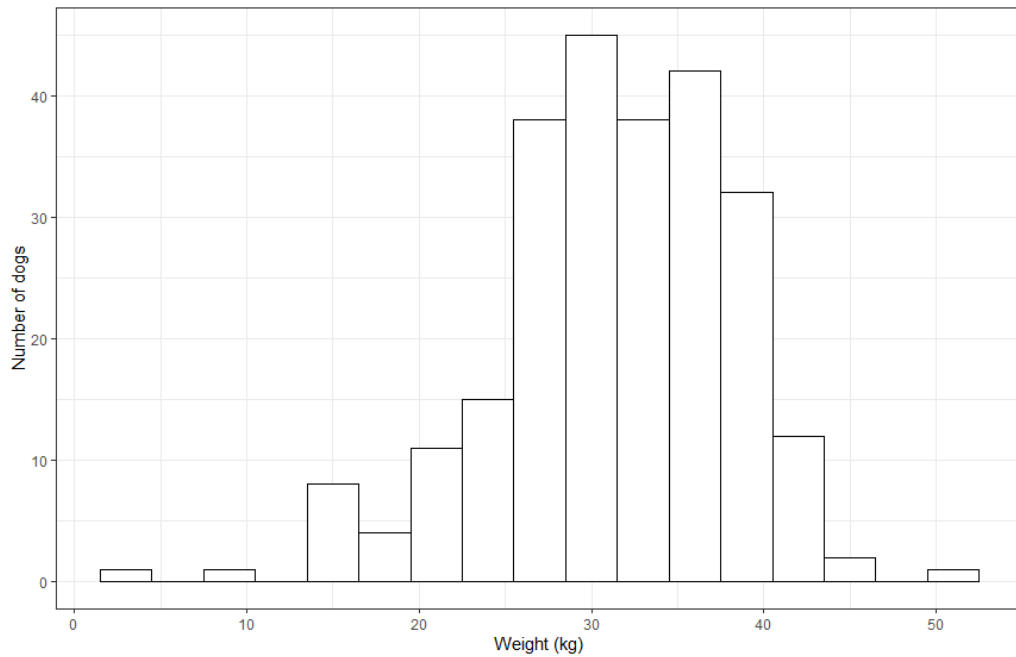


Figure 2.2. The distribution of body weight (kg) of 250 working dogs.

Table 2.2 The number and percentage (with 95% CI) of working dogs stratified by the time that the handler had the dogs and the location where the dogs spent most of their time in a day. Data was collected from 250 working dogs.

Categories	Number of dogs (n = 250)	% (95% CI)
Duration the handler had the dogs		
Less than 3 months	24	9.6 (5.9 - 13.3)
Less than 6 months	29	11.6 (7.6 - 15.6)
6-12 months	46	18.4 (13.6 - 23.2)
1-3 years	101	40.4 (34.3 - 46.5)
4-6 years	39	15.6 (11.1 - 20.1)
Greater than 6 years	11	4.4 (1.9 - 6.9)
Location		
Exclusively indoors	1	0.4 (0 - 1.2)
Mostly indoors	16	6.4 (3.4 - 9.4)
Equal time indoors and outdoors	68	27.2 (21.7 - 32.7)
Mostly outdoors	128	51.2 (45.0 - 57.4)
Exclusively outdoors	37	14.8 (10.4 - 19.2)

2.4.2 General management

2.4.2.1 Medication and supplement

Table 2.3 summarizes the type of medication that working dogs received in the previous six months and how the handler gave the medicine. The “other medication” included antibiotics, anti-inflammatory medications, and anti-pruritic treatments. Twenty-eight of 250 dogs (11.2%, 95% CI = 7.3 – 15.1) received supplements such as fish oil, joint, and skin supplements.

Table 2.3 The number and percentage (with 95% CI) of working dogs stratified by type of medication received in the previous six months and how the handler gave medication to working dogs. “Other medication” included antibiotics, anti-inflammatory medications, and anti-pruritic treatments. Data was collected from 250 working dogs. The percentage does not add up to 100% because some dogs received more than one type of medicine.

Categories	Number of dogs (n = 250)	% (95% CI)
Medication in the last 6 months		
Flea & worm prevention	180	72.0 (66.4 – 77.6)
Vaccination	26	10.4 (6.6 – 14.2)
Other medication	82	32.8 (27.0 – 38.6)
None	2	0.8 (0 – 1.9)
How medicine given		
Dog’s food/meal	123	49.2 (43.0 – 55.4)
No medicine given	80	32.0 (26.2 – 37.8)
Treats/pill pocket	22	8.8 (5.3 – 12.3)
Human food	14	5.6 (2.7 – 8.5)
Not with food or water	10	4.0 (1.6 – 6.4)
Water	1	0.4 (0 – 1.2)

2.4.2.2 Diet and treats

Table 2.4 shows the number and percentage (with 95% CI) of working dogs stratified by type of diet, number of daily meals, and how long they were fed with the current diet. The diet types fed fewer than five dogs were combined and listed as “other combinations,” including dry/food combined with dog roll, raw diet and dehydrated, frozen, and home-prepared diet.

The handlers were asked to provide the food brand and formula of the diet they fed their dogs. Of 252 dogs, 213 dogs were fed with Royal Canin (85.2, 95% CI = 80.8 - 89.6), 16 dogs were fed with Eukanuba (6.4%, 95% CI = 0.5 - 4.3), six dogs were fed with Hills (2.4%, 95% CI = 0.5 - 4.3), four dogs were fed with Blackhawk (1.6%, 95% CI = 0 - 3.2). Eleven handlers fed with other brands. For the feed formula, 88 dogs (35.2%, 95% CI = 29.3 - 41.1) were provided an Endurance/Energy/Performance formula. A total of 80 dogs (32.0%, 95% CI = 26.2 - 37.8) were fed based on age, 18 dogs were fed a prescription diet (7.2%, 95% CI = 4.0 - 10.4), and 18 dogs were fed a breed-specific formula (7.2%, 95% CI = 4.0 - 10.4). The remaining 46 dogs were fed other formulas.

Of 250 dogs, 11 dogs (4.4%, 95% CI = 2.3-8.0) accessed food from external sources, such as neighbours, postmen, or even cat food. In addition, the handler of 23 dogs reported that sometimes they gave another diet, such as sausage, leftover food, milk, vegetables, chicken, raw meat, and training treats combined with the regular diet. This introduces challenges in identifying the specific ingredients and assessing the quality of the food consumed by these dogs.

Table 2.5 summarizes the types of treats and how many times dogs received treats. Of 174 handlers who provided treats for dogs, 54 handlers gave information regarding the type of treats, such as sausage (18 dogs), animal products (11 dogs), commercial products (17 dogs), and homemade vegetable mix with meat (8 dogs). Three handlers mentioned they occasionally treat or just treat for training purposes. Four handlers who initially indicated that they gave treats later contradicted this by stating that they never actually treat dogs when asked about the frequency. Moreover, 14 of 76 handlers who initially reported not feeding treats later provided information about how often they give treats to their dogs. This contradiction makes it unclear whether these dogs were given treats or not, and it is difficult to calculate the true number of dogs that regularly receive treats.

Table 2.4 The number and percentage (with 95% CI) of working dogs stratified by type of diet, number of daily meals, and how long they were fed with current diet. Data was collected from 250 working dogs. The diet types fed less than five dogs were combined and listed as “other combinations”.

Categories	Number of dogs (n = 250)	% (95% CI)
Diet		
Dry food/biscuits only	210	84.0 (79.5 - 88.5)
Dry food/biscuits and other	12	4.8 (2.2 - 7.4)
Dry food/biscuits and dog roll	10	4.0 (1.6 - 6.4)
Canned/pouches/sachets and dry food/biscuits	8	3.2 (1.0 - 5.4)
Other combination	10	4.0 (1.6 - 6.4)
Number of meals per day		
3 times/day	9	3.6 (1.3 – 5.9)
2 times/day	137	54.8 (48.6 - 61)
1 time/day	103	41.2 (35.1 – 47.3)
Always	1	0.4 (0 – 1.2)
Time that dogs feed with current diet		
Less than 1 month	14	5.6 (2.7 – 8.5)
1 – 3 months	30	12.0 (8.0 – 16.0)
3 – 12 months	97	38.8 (32.8 – 44.8)
1 – 2 years	64	25.6 (20.2 – 31.0)
More than 2 years	45	18.0 (13.2 – 22.8)

Table 2.5 The number and percentage (with 95% CI) of working dogs stratified by type of treats and frequency of treats given by the handlers. Data was collected from 250 working dogs. The percentage of types of treats is not added up to 100% because some dogs received more than one type of treat.

Categories	Number of dogs (n = 250)	% (95% CI)
Type of treats		
Dog treats	109	43.6 (37.5 – 49.7)
Meat	104	41.6 (35.5 - 47.7)
Fruits/vegetables	29	11.6(7.6 – 15.6)
Dairy/egg	15	6.0 (3.1 - 8.9)
Carbohydrates	9	3.6(1.3 - 5.9)
Other	2	0.8 (0 – 1.9)
Not give treats	76	30.4 (24.7 – 36.1)
Frequency of treats		
More than 3 times/day	22	8.8 (5.3 – 12.3)
1-2 times/day	39	15.6 (11.1 – 20.1)
A few times a week	57	22.8 (17.6 – 28.0)
A few times a month	43	17.2 (12.5 – 21.9)
A few times a year	23	9.2 (5.6 – 12.8)
Never	66	26.4 (20.9 – 31.9)

2.4.2.3 Defecation and urination location

The handlers were asked about the place where dogs had eliminated in the past three months. The handlers were allowed to select multiple options for the elimination location. The number and percentage (with 95% CI) of working dogs stratified by urination location and defecation location are shown in Table 2.6. Other urination areas included three dogs urinated in van, one dog from aviation service urinated at airport, one dog urinated when excited. Six dogs that urinated outside also urinate either while working or at the workplace. Other defecation locations included three dogs defecated in a van, four dogs defecated inside a house, four dogs defecated in a crate and one dog used to defecate in the examination room at the veterinary clinic. Ten of 203 handlers who reported their dogs defecated outside also reported that their dogs defecated either during work or at the workplace.

The data on how often the working dogs have access to the elimination area in a day is available for 248 working dogs. Thirty-three dogs (13.3%, 95% CI = 9.1–17.5) accessed to eliminated area 2–3 times per day, 168 dogs (67.7%, 95% CI: 61.9–73.6) accessed to eliminated area 4–6 times daily, 32 dogs (12.9%, 95% CI = 8.7–17.1) accessed to eliminated area 7–12 times per day, while 11 dogs (4.4%, 95% CI=1.9–7.0) accessed to eliminated area more than 12 times per day. Four handlers (1.6%, 95% CI = 0 – 3.2) give the text-response including “When let out /on command”, “He lives in a run area but only toilets in it very rarely”, “When I let him out of his kennel, I run him time vary”, and “At selected times during the day”.

The handlers were asked if their dogs had urinated or defecated in an inappropriate area. Sixty-three dogs (25.2%, 95% CI = 19.8–30.6) were reported to eliminate in the inappropriate area or during work in the previous three months. Of these 63 dogs, two dogs eliminated in the car (3.2%, 95% CI = 0–7.5), nine dogs eliminated in their confinement area (14.3%, 95% CI = 5.6–22.9), one dog urinated when excited (1.6%, 95% CI = 0–4.7), three dogs urinated in the house (4.8%, 95% CI = 0–10.0), one dog urinated in the run area (1.6%, 95% CI = 0–4.7), and eight dogs had incomplete elimination during toilet breaks (12.7%, 95% CI = 4.5–20.9). Additionally, four dogs eliminated in the kennel (6.3%, 95% CI = 0.3–12.4), three dogs outside (4.8%, 95% CI = 0–10.0), ten dogs urinated during work or training (15.9%, 95% CI = 6.8–24.9), and 14 handlers provided information on frequency without specifying the location (27%, 95% CI = 16–37.9). Five handlers did not provide further details about this data.

2.4.3 Skin health management

2.4.3.1 Bathing

Table 2.7 shows the number and percentage (with 95% CI) of working dogs stratified by bathing frequency and type of product used for bathing. It should be noted that three dogs with a history of skin disease were never bathed. Handlers were also asked if they washed their dogs' paws outside of regular bath times. Only 44 handlers (18%, 95% CI = 13.2 – 22.7) reported to wash their dogs' paws separately from bathing. The primary reason for paw washing was to remove dirt or mud from paws.

Table 2.6 The number and percentage (with 95% CI) of working dogs stratified by location of urination and defecation during the previous three months. Data was collected from 250 dogs. The percentage does not add up to 100% because some dogs eliminated more than one area.

Categories	Number of dogs (n = 250)	% (95% CI)
Urination location		
Outside - on the property	238	95.2 (92.6 – 97.8)
Outside - off property	205	82.0 (77.2 – 86.8)
Run area	34	13.6 (9.4 – 17.8)
In a kennel	12	4.8(2.2 – 7.4)
Inside house	11	4.4 (1.9 – 6.9)
In a crate	5	2.0 (0.2 – 3.7)
Other	6	2.4 (0.5 – 4.3)
Defecation location		
Outside - on the property	238	95.2 (92.6 – 97.8)
Outside - off property	203	81.2 (76.4 – 86.0)
Run area	32	12.8 (8.7 – 16.9)
In a kennel	18	7.2 (4.0 – 10.4)
Other	12	4.8 (2.2 – 7.4)

The most common reason for bathing was routine maintenance and grooming, which was selected 175 times (69.4%, 95% CI = 63.8 – 75.1). This was followed by bathing to address unacceptable body odour, reported 68 times (27%, 95% CI = 21.5– 32.5), bathing for routine

care was mentioned 45 times (17.9%, 95% CI = 13.1 – 22.6), while bathing to relieve itching was mentioned 19 times (7.5%, 95% CI = 4.3 – 10.8). Bathing to resolve skin inflammation, dry or seborrhoea skin problems was the least common reason, mentioned only 13 times (5.2%, 95% CI = 2.4 – 7.9).

Of 250 handlers, only 77 indicated that they were advised to bathe their dogs. Of 77 handlers, 35 handlers (13.9%, 95% CI = 9.6 - 18.2) reported that the advice come from veterinarian, nine handlers were recommended by breeder (3.6%, 95% CI = 1.3 – 5.9), while 33 handlers (12.3%, 95% CI = 8.2 – 16.4) were recommend by other sources such as staff at dog training centre, New Zealand police dogs staff, police dogs manual, groomer, and social media.

Table 2.7 The number and percentage (with 95% CI) of working dogs stratified by frequency of bathing and what they used to bath their dogs. Data was collected from 250 working dogs. The total percentage of bathing products does not add up to 100% because some handlers select more than one product. The product was used by less than five handlers were classified as “other”.

Categories	Number of dogs (n = 250)	% (95% CI)
Frequency of bathing		
Never, because not needed	12	4.8 (2.2 - 7.4)
Multiple times a week	2	0.8 (0 – 1.9)
Once weekly	10	4.0 (1.6 - 6.4)
Multiple times a month	15	6.0 (3.1 - 8.9)
Once a month	62	24.8 (19.4 - 30.2)
Once every 2 months	50	20.0 (15.0 – 25.0)
Once every 3 months	49	19.6 (14.7 - 24.5)
Twice a year	38	15.2 (10.7 - 19.7)
Once a year	12	4.8 (2.2 - 7.4)
Bathing products		
Non-medicated pet shampoo	169	67.6 (61.8 – 73.4)
Medicated pet shampoo	54	21.6 (16.5 – 26.7)
Water	43	17.2 (12.5 – 21.9)
Other	4	1.6 (0 – 3.2)

2.4.3.2 Ear cleaning

Table 2.8 shows the number and percentage of working dogs stratified by frequency of ear cleaning and reason for ear cleaning. The handlers were allowed to select multiple reasons for ear cleaning. Three handlers reported that they never clean their dogs' ears, but selected reasons such as grooming purposes or cleaning when the ears are dirty or have a bad smell. Additionally, 12 handlers indicated that they clean their dogs' ears less than once a year, but answered that they do not clean their dogs' ears when asked the reason for ear cleaning.

The data on the method for ear cleaning was available for 250 dogs. Ninety-one handlers (36.4%, 95% CI = 30.4 - 42.2) did not clean their dogs' ears. Seventy-seven handlers (30.8%, 95% CI = 25.1 - 36.5) cleaned an ear opening by using a dry wipe, while 43 handlers (17.2%, 95% CI = 12.5 - 21.9) applied ear cleaner to a wipe to clean the ear opening. Thirty-six handlers (14.4%, 95% CI = 10.0 - 18.8) applied ear cleaner directly into the ear canal. Three handlers (1.2%, 95% CI = 0.0–2.5) used cotton-tip applicators for ear cleaning.

Table 2.8 The number and percentage of working dogs stratified by frequency of ear cleaning and reasons for ear cleaning. Data was collected from 252 working dogs. The total percentage of reasons for cleaning does not add up to 100% because some handlers cleaned their dogs' ear for many reasons.

Categories	Number of dogs (n = 252)	% (95% CI)
Ear cleaning frequency		
Daily	2	0.8 (0 – 1.9)
A few times a week	6	2.4 (0.5 - 4.3)
Once weekly	16	6.3 (3.3 - 9.4)
A few times a month	16	6.3 (3.3 - 9.4)
Once monthly	26	10.3 (6.6 - 14.1)
A few times a year	61	24.2 (18.9 - 29.5)
Less than once a year	48	19.0 (14.2 - 23.9)
Never	77	30.6 (24.9 - 36.2)
Reason for ear cleaning		
Do not clean ears	92	36.5 (30.6 - 42.5)
Routine management/ grooming purposes	91	36.1 (30.2 – 42.0)

Get dirty/bad smell	61	24.2 (18.9 - 29.5)
Vet recommendation for routine care	22	8.7 (5.2 - 12.2)
Relief ear problems	20	7.9 (4.6 - 11.3)
Vet recommendation for ear problems	19	7.5 (4.3 - 10.8)
After swimming	17	6.7 (3.6 - 9.8)

2.4.3.3 Anal gland expression

Table 2.9 summarises the frequency of anal gland expression in 250 working dogs. Only three of the 250 dogs have a history of treatment for anal gland problems, such as an anal gland infection, rupture, or abscess in the past.

Table 2.9 The number and percentage (with 95% CI) of working dogs stratified by anal gland expression frequency. Data was collected from 250 working dogs.

Frequency of anal gland expression	Number of dogs (n = 250)	% (95% CI)
Every 2 weeks	1	0.4 (0 - 1.2)
Every 1 month	3	1.2 (0 - 2.5)
Every 2 months	3	1.2 (0 - 2.5)
Every 3 months	3	1.2 (0 - 2.5)
Twice a year	7	2.8 (0.8 - 4.8)
Once a year	18	7.2 (4.0 - 10.4)
Never	215	86.0 (81.7 - 90.3)

2.4.4 Health problems

2.4.4.1 History of weight change and appetite in the previous three months

The handlers were asked about the changes in the dog's weight and appetite over the previous three months. The change of appetite and weight change were assessed together to evaluate the possible nutritional problems. A total of 225 out of 250 dogs (90%, 95% CI = 86.3–93.7) showed no change in appetite, 21 dogs (8.4%, 95% CI = 5.0–11.8) showed an increased in appetite, and four dogs (1.6%, 95% CI = 0–3.2) showed a decreased in appetite in the previous three months. Of 225 dogs showed no change in appetite, 138 dogs (61.3%) had no

change in weight, and six handlers (2.7%) were unsure about weight changes. Moreover, 36 dogs (16.0%) had increased weight, while 13 dogs (5.8%) had weight loss over three months.

2.4.4.2 History of skin, ear, and eye problems in the previous six months

The handlers were asked to provide data on the health problems of dogs in the previous six months. There were 70 out of 252 dogs (52%) had a history of skin problems. Among 70 dogs with skin issues, 48 out of 70 (19%) had only skin-related problems, while 22 of 70 (8.7%) had skin disease concurrent with other health issues such as orthopaedic, gastrointestinal, or other problems.

2.4.4.3 Ear problems

Table 2.10 summarises the ear problems in 252 working dogs. Of the 23 dogs with ear infections, 12 dogs received home treatment, while 11 dogs required veterinary treatment. The other ear problems included one dog with dry tips of the ears, three dogs with a history of ear infections, four dogs with a history of itchiness, one dog developed ear problems after swimming, two dogs with a history of ear problems in the past, and one dog with hair in the ear canal.

Table 2.10 The number and percentage (with 95% CI) of working dogs stratified by ear problems reported by the handlers. Data was collected from 252 working dogs.

Ear problem	Number of dogs (n = 252)	% (95% CI)
No problem	179	71.0 (65.4 - 76.6)
Dirty	22	8.8 (5.2 - 12.2)
Itchy, head shaking, ear rubbing/scratching	14	5.6 (2.7 - 8.4)
Infection	23	9.1 (5.6 - 12.7)
Odour/smell	2	0.8 (0 - 1.9)
Other	12	4.8 (2.1 - 7.4)

2.4.4.4 Body odour

Table 2.11 summarises the perception of the handler of the dogs' body odour and the dominant body odour types. Thirty-six handlers reported that their dogs have other dominant body odours, including 26 dogs that had dog smell, and three dogs were described as having

urine odour. Several other odours were reported, each affecting a single dog, including a rancid smell, grass smell, farm creek smell, fur smell, and sweaty smell.

Table 2.11 The number and percentage (with 95% CI) of working dogs stratified by strength of body odour and the dominant body odour perceived by the handlers. Data was collected from 250 working dogs.

Categories	Number of dogs (n = 250)	% (95% CI)
Strength of odour		
Mild	67	26.8 (21.3 - 32.3)
Not detectable	79	31.6 (25.8 - 37.4)
pleasant/inoffensive	99	39.6 (33.5 - 45.7)
Strong	5	2.0 (0.3 - 3.7)
Main body odour		
No	142	56.8 (50.7 - 62.9)
Musty	37	14.8 (10.4 - 19.2)
Dusty old house	18	7.2 (4.0 - 10.4)
Corn chips	9	3.6 (1.3 - 5.9)
Yeasty	8	3.2 (1.0 - 5.4)
Other	36	12.8 (8.7 - 16.9)

2.4.4.5 Pruritic behaviours

The handlers of 252 working dogs were asked to report the frequency of pruritic behaviour, ranging from multiple times a day to a few times a year. This study found 224 dogs (88.9%, 95% CI = 85.0 – 92.8) exhibited at least one pruritic behaviour at least a few times a year. Of these 252 dogs, 182 dogs (72.2%, 95% CI = 66.7 – 77.8) exhibited head shaking behaviour, 157 dogs (62.3%, 95% CI = 56.3-68.3) exhibited facial or muzzle rubbing, 117 dogs (46.4%, 95% CI = 40.3-52.6) showed paws licking/chewing, 115 dogs (45.6%, 95% CI = 39.5 – 51.8) showed signs of eye rubbing, Additionally, 99 dogs (39.3%, 95% CI = 33.3 – 45.3) licked their legs, and 33 dogs (13.1%, 95% CI = 8.9-17.3) demonstrated scooting behaviour at least a few time a year.

Of 33 dogs exhibited scooting behaviour, 18 dogs never got anal gland expression, 14 dogs got anal gland expression, and one handler did not provide information on anal gland expression. Among the 14 dogs with a history of anal gland expression, the reported improvements in scooting behaviour were as follows: two dogs improved within three days, one dog improved within 1–2 weeks, one dog improved within 2–4 weeks, one dog improved within 1–2 months, five dogs improved after two months, and one dog showed no improvement. Three handlers reported that their dogs had anal gland expression but gave inconsistent responses, indicating that their dogs did not receive anal gland expression and/or did not show scooting behaviour when asked about improvement.

The frequency of tail biting and back rubbing behaviour was available for 250 dogs, with 129 dogs (51.6%, 95% CI = 45.4 – 57.8) showed tail biting behaviour at least a few times a year and 92 dogs (36.8%, 95% CI = 30.8 – 42.8) exhibited back rubbing at least a few times a year. The frequency of each pruritic behaviour is shown in Table 2.12 and 2.13

Table 2.12 The number and percentage (with 95% CI) of working dogs stratified by the frequency of eye rubbing, facial/muzzle rubbing, conjunctivitis, paw chewing/licking, leg chewing, head shaking, sneezing, and scooting. Data was collected from 252 working dogs.

Pruritic behaviour	Frequency	Number of dogs (n = 252)	95% CI
Eye rubbing	> 3 times/day	1	0.4 (0 – 1.2)
	1-2 times/day	9	3.6 (1.3 - 5.9)
	A few times a week	7	2.8 (0.7 - 4.8)
	A few times a month	24	9.5 (5.9 – 13.1)
	A few times a year	74	29.4 (23.7 – 35.0)
	Never	137	54.4 (48.2 – 60.5)
Facial/muzzle rubbing	> 3 times/day	0	0
	1-2 times/day	11	4.4 (1.8 - 6.9)
	A few times a week	25	9.9 (6.2 - 13.6)
	A few times a month	44	17.5 (12.8 - 22.1)
	A few times a year	77	30.6 (24.9 - 36.2)
	Never	95	37.7 (31.7 - 43.7)
Paw licking/chewing	> 3 times/day	3	1.2 (0 – 2.5)
	1-2 times/day	14	5.6 (2.7 - 8.4)
	A few times a week	23	9.1 (5.6 - 12.7)
	A few times a month	24	9.5 (5.9 - 13.1)
	A few times a year	53	21.0 (16.0 - 26.1)
	Never	135	53.6 (47.4 - 59.7)
Leg licking/chewing	> 3 times/day	0	0
	1-2 times/day	10	4.0 (1.6 - 6.4)
	A few times a week	22	8.7 (5.2 - 12.2)
	A few times a month	21	8.3 (4.9 - 11.7)
	A few times a year	46	18.3 (13.5 – 23.0)
	Never	153	60.7 (54.7 - 66.7)

Pruritic behaviour	Frequency	Number of dogs (n = 252)	95% CI
Head shaking	> 3 times/day	16	6.3 (3.3 – 9.4)
	1-2 times/day	24	9.5 (5.9 - 13.1)
	A few times a week	50	19.8 (14.9 - 24.8)
	A few times a month	41	16.3 (11.7 - 20.8)
	A few times a year	51	20.2 (15.3 - 25.2)
	Never	70	27.8 (22.2 - 33.3)
Scooting	> 3 times/day	1	0.4 (0 - 1.2)
	1-2 times/day	0	0
	A few times a week	2	0.8 (0 - 1.9)
	A few times a month	6	2.4 (0.5 - 4.3)
	A few times a year	24	9.5 (5.9 - 13.1)
	Never	219	86.9 (82.7 - 91.1)

Table 2.13 The number and percentage (with 95% CI) of working dogs stratified by the frequency of tail biting and pruritus of the lower portion of the back. Data was collected from 250 working dogs.

Pruritic behaviour	Frequency	Number of dogs (n = 250)	% (95% CI)
Tail biting/chewing	> 3 times/day	0	0
	1-2 times/day	15	6.0 (3.1 - 8.9)
	A few times a week	28	11.2 (7.3 - 15.1)
	A few times a month	29	11.6 (7.6 - 15.6)
	A few times a year	57	22.8 (17.6 - 28.0)
	Never	121	48.4 (42.2 - 54.6)
Back rubbing	> 3 times/day	0	0
	1-2 times/day	8	3.2 (1.0 - 5.4)
	A few times a week	12	4.8 (2.2 - 7.4)
	A few times a month	27	10.8 (7.0 - 14.6)
	A few times a year	45	18.0 (13.2 - 22.8)
	Never	158	63.2 (57.2 - 69.2)

2.4.4.6 Clinical signs associated with allergic problems

The frequency of clinical signs of allergic reactions, including sneezing and conjunctivitis, were available for 252 dogs. Two hundred and eight dogs (82.5%, 95% CI = 77.9 – 87.2) exhibited at least one allergic sign at least a few times a year. The frequency of each sign is shown in Table 2.14

Table 2.14 The number and percentage (with 95% CI) of working dogs stratified by frequency of sneezing and the frequency of conjunctivitis/ocular discharge. Data was collected from 252 working dogs.

Clinical sign	Frequency	Number of dogs (n = 252)	% (95% CI)
Sneezing	1 – 2 times/day	11	25.0 (19.7 – 30.3)
	A few times a week	33	13.1 (8.9 - 17.3)
	A few times a month	46	18.3 (13.5 – 23.0)
	A few times a year	99	39.3 (33.3 - 45.3)
	Never	63	25.0 (19.7 - 30.3)
Conjunctivitis/ocular discharge	Every day	10	4.0 (1.6 - 6.4)
	A few times a week	19	7.5 (4.3 - 10.8)
	A few times a month	27	10.7 (6.9 - 14.5)
	A few times a year	58	23.0 (17.8 - 28.2)
	Never	138	54.8 (48.6 - 60.9)

2.5 Discussion

This is the first study to describe the population features and health management practices of New Zealand working dogs. This chapter describes the feeding practice, health management, pruritic behaviour, and clinical signs of allergic disease in 252 enrolled dogs. In this study, we found that 90% of working dogs exhibited at least one pruritic behaviour at least a few times a year. The most common pruritic behaviour was head shaking, with 72% of working dogs exhibited this behaviour a few times a year or less (Table 2.11). Moreover, more than 80% of enrolled dogs exhibited at least one allergic sign at least a few times a year.

When evaluating the number of dogs exhibited pruritic signs, previous studies focused on dogs with specific skin diseases such as atopic dermatitis (Favrot et al., 2010; Picco et al., 2008a; Shaw et al., 2004; Tarpataki et al., 2006), otitis externa (Terziev & Urumova, 2018), flea bite hypersensitivity (Bruet et al., 2012; Shimakura & Kawano, 2021), and food hypersensitivity (Picco et al., 2008a; White, 1986). These previous studies primarily focused on a group of dogs with skin diseases without comparison to a group of healthy dogs. In addition, they have described pruritus in general terms (e.g., chewing, licking, rubbing, rolling,

or scratching in various parts of the body) without reporting the specific behaviours on the affected body regions. In contrast, our study reported the specific pruritic behaviours (e.g., leg chewing, eye rubbing, facial/muzzle rubbing, paws licking) in the entire group of working dogs regardless of health problems. This makes it difficult to directly compare our study's results to those studies in dogs with dermatological problems. However, it remains important to consider the skin problems as possible underlying causes of pruritic behaviour in our working dogs. While previous studies used hospital-based data and focused on behaviours observed during clinical visits, this study used a questionnaire to capture both frequent and infrequent behaviours throughout a year. Therefore, we can capture pruritic behaviours even if working dogs did not show the behaviour at the time of survey.

Head shaking was reported in 72% of working dogs in this study, with approximately 15% of working dogs exhibited this behaviour at least once daily. This sign has been reported to be associated with otitis externa and injury of the ears (Terziev & Urumova, 2018). Therefore, frequent head shaking in working dogs may be due to ear problems such as debris accumulation or ear infections, which were reported in 18% of working dogs. Moreover, 5.6% of working dogs showed ear pruritus (Table 2.10), which can induce head-shaking behaviour. However, the ear problems reported in this study were based on handler observations. Some dogs may have an ear problem that was unnoticed by the handlers. These findings suggest the need for routine ear examinations in working dogs to accurately diagnose potential ear conditions and further investigate the underlying causes of head-shaking behaviour.

Our study revealed that 66% of working dogs exhibited facial rubbing behaviour at least a few times a year. Five percent of working dogs in our study showed this clinical sign daily or more. In comparison, Stetina et al. (2015) reported that 10% (34 from 340) of healthy companion dogs without skin or ear abnormalities exhibited this behaviour daily or more frequently. As Stetina et al. (2015) point out, treats can induce facial pruritus, as dogs may be allergic to the ingredients. Therefore, the lower percentage of working dogs showed facial rubbing daily compared to healthy companion dogs may be explained by the fact that a smaller percentage of working dogs received treats. However, some working dogs in this study did not receive treats but exhibited this behaviour. This suggests that some working dogs might have mild atopic dermatitis, which can cause facial pruritus without the ingestion of food allergens (Favrot et al., 2010; Shaw et al., 2004). However, the difference in the percentage of dogs with facial pruritus might be due to the source of the sample. Stetina focused on healthy dogs with a wide variety of breeds, while we focused on a general group of working dogs, most of them

were German Shepherds. Therefore, we speculated that breed may be a preventive factor of facial rubbing behaviour. Future research should focus on how breed influences the pruritic behaviour and determine if genetics plays an important role in developing facial pruritus.

Conjunctivitis and sneezing concurrent with pruritus have been reported in dogs with atopic dermatitis. One study investigated the clinical sign in dogs with atopic dermatitis and found that 21% of dogs with atopic dermatitis exhibited conjunctivitis, and seven percent showed sneezing during spring and summer (Favrot et al., 2010). In our study, 47.2% of working dogs showed conjunctivitis or ocular discharge at least a few times a year. We cannot compare our finding with the previous studies because we did not evaluate the season which dogs exhibited clinical signs. Moreover, we evaluated the general population of working dogs regardless of underlying skin diseases. Four percent of dogs in our study exhibited conjunctivitis/eye discharge every day. This suggests that further investigation is needed to determine whether these signs occur concurrently with pruritus and investigate canine atopic dermatitis as an underlying disease in working dogs. In this study, we found that 25% of working dogs sneeze daily. This finding contrasts with a previous study that reported only 6.7% healthy dogs (21 from 314) without skin or systemic disease exhibited sneezing daily or more (Stetina et al., 2015). The higher proportion in our study suggests that the working dogs might have an underlying disease that can cause sneezing behaviour. Moreover, it is possible that there are environmental factors that induce sneezing behaviour in New Zealand working dogs. In working dogs, sneezing and nasal problems can affect the work performance, especially altering their search behaviour or missing an explosive odour (Farr et al., 2021b). It is worth to investigate the underlying cause of sneezing and conjunctivitis, as well as the risk factors of these clinical signs.

Thirteen percent of working dogs exhibited scooting behaviour (Table 2.12), and 53% of dogs chewed the area under their tail at least a few times a year (Table 2.13). These two behaviours were associated with anal sac disease (Salichs et al., 2025) and allergic disease (Maina et al., 2014). In this study, three dogs had a history of anal gland treatment in the past. It is possible that the anal gland problem may be recurrent in these dogs. Moreover, some working dogs in this study may currently have an undiagnosed problem of canine atopic dermatitis, which can cause scooting behaviour. Investigating the underlying cause of scooting behaviour would be helpful for veterinarians and handlers to understand and prevent anal problems in working dogs. Further research should make a diagnosis of anal gland problems and investigate the cause of anal pruritus in working dogs.

This study included 210 working dogs that worked with the New Zealand Police and 42 dogs from other organisation. Although we did not investigate the types of work performed by these police dogs, it can be assumed that we included both patrol police dogs and detector police dogs. The overrepresentation of police dogs likely reflects the questionnaire distribution method, as the survey was sent to police dogs' breeder and police dogs section supervisor. Dogs from other organisations may have been included if they worked with police dogs at the time of the survey. Moreover, it is possible that police dogs are the major group of working dog population in New Zealand. Because this study is the first to investigate the population of New Zealand working dogs, it cannot directly compared with the previous research that focused on the New Zealand police (Baltzer et al., 2019; Worth et al., 2013). Moreover, this study included working dogs from various organisations. It is possible that the differences observed in health management practices among handlers in this study may be attributed to the organisation which they work. However, we believe that our study provides the baseline information on the population and health management of a broader working dog population.

The age of enrolled dogs in our study was two months to 12 years, which was wider than the previous report by Baltzer et al. (2019). The age difference is due to the sample selection. Baltzer et al. (2019) conducted on police dogs in active duty, while our study includes working dogs from other organisations, regardless of work status. A study by Worth et al. (2013) reported that the average retirement age of New Zealand police dogs was 6.6 years, while the highest rate of enrolled dogs in our study was 12 years old. However, Worth's study included only retired German Shepherd police dogs. In contrast, our study included the various breeds from the New Zealand Police and other organisations. Therefore, we cannot directly compare the age distribution of our study with the previous studies. Further research on the demographics of working dogs should evaluate both age and work status and investigate if the age of active working dogs and the age of retirement differ across the organisation.

The sex distribution of the New Zealand working dogs in this study was consistent with previous research in New Zealand and other countries, which reported that male dogs were commonly used for law enforcement (Baltzer et al., 2019; Park et al., 2023; Tamimi & Wali, 2019). The preference for male dogs may be due to handlers' perception that male dogs are more aggressive than females. Interestingly, 43.3% of dogs in this study were female, a higher proportion than the 36% of Iraq police dogs (Tamimi & Wali, 2019). As Tamimi and Wali (2019) proposed, Iraqi police do not prefer female dogs because they distracted male dogs when in heat and were considered less aggressive. However, Tamimi's study collected

data from veterinary hospitals where male dogs may be more frequently assigned to dangerous tasks, increasing the risk of work-related injury. In contrast, our study surveyed handlers directly and represents the general population. In addition, the higher proportion of females in this study may be because our sample included dogs from other organisations, where females may be preferred. Future studies should investigate the differences in sex distribution between different organisations and explore the association between sex and the performance of working dogs.

One aim of this study is to describe the management practices of New Zealand working dogs. Over 60% of working dogs spent most of their time outdoors, which is higher than the 9% of companion dogs reported by Stetina et al. (2015). One possible reason is the demands of training and operational activities of working dogs, which require them to spend most of their time outdoors. However, since our study did not define an "indoor" area, the response may be influenced by the handler's perception. For example, for detector dogs, "indoor" might include workplaces such as airport terminals, cargo areas, and ships, which differ from the "indoor" environments of companion dogs, typically referred to as the owner's house. Similarly, the outdoor kennel at the training centre or the handler's house may be defined as an outdoor area by the handler. Consequently, dogs that spent time in an outdoor kennel may be reported to have more outdoor periods. This study did not investigate the characteristics of the outdoor areas, which are an important factor on the type of health management required. For example, dogs that work in natural environments may need parasitic prevention before each work session. In contrast, dogs that work on hot or sharp surfaces that have a high risk of footpad injuries may benefit from protective footwear during operations. To gain a comprehensive understanding of the environment of working dogs, future studies should include information on specific characteristics of their working environment as well as their living spaces.

Over 70% of working dogs received flea and worm prevention, but only 10.4% had been vaccinated in the past six months. This low percentage of vaccinated dogs is likely because the questionnaire focused on the previous six-month period, while core vaccinations were required every three years (Squires et al., 2024). It is possible that most working dogs received their last vaccination more than six months ago. The question about the most recent vaccination would help determine vaccination status. Moreover, this study found that 12 dogs younger than six months had no vaccination history. This finding contrasts with a guideline of the World Small Animal Veterinary Association (WSAVA), which recommends starting

vaccinations at 6–8 weeks of age, with a final booster at six months before transitioning to annual revaccination (Squires et al., 2024). Following up on vaccination records or inquiring about the reasons for not providing the vaccines would be helpful to ensure that working dogs have up-to-date vaccination status.

This study also investigated the feeding practice of New Zealand working dogs, and 40% of dogs in this study were fed once daily. Currently, there is no consensus on how many meals working dogs should be provided. Previous studies focused on the effect of meals on gastrointestinal health and the performance of dogs. A previous study in large-breed dogs reported that a large amount of food per meal may increase the risk of gastric dilation and volvulus. (Raghavan et al., 2004), a cause of death or euthanasia in 3% - 10% of working dogs (Moore et al., 2001; Worth et al., 2013). Moreover, Salichs et al. (2022) reported that large-breed dogs fed a large volume of food once daily have the highest risk of gastric dilation and volvulus. Therefore, providing one meal daily can increase the risk of gastric dilation and volvulus in working dogs. In addition, working dogs should not be fed within eight hours before intense exercise, as this may impair performance (Wakshlag & Shmalberg, 2014). Conversely, providing food within two hours immediately after exercise can help replenish muscle protein (Cave, 2013). Future studies should aim to investigate the feeding frequency, meal size, time between meals and work sessions, and investigate the association between these factors and work performance.

Eighty-four percent of working dogs were fed dry food only. This finding is consistent with practice in pet dogs, which 70% were fed with dry food only (Stetina et al., 2015). Moreover, most of the working dogs in our study were fed with commercial food brands that have completed and balanced nutrition. The consistency of diet type in working dogs is due to the standardised feeding practices of their organisation. For example, the New Zealand Police provided dry food for police dogs. However, when evaluating the feeding practice in working dogs, most studies focused on nutrient composition rather than the form of the food. Hill et al. (2009) used a canine model of working farm dogs exercised for 30 minutes daily and found that low-carbohydrate, high-protein diets were more beneficial than high-carbohydrate, low-protein biscuits. In contrast, endurance dogs that exercise more than two hours daily required high-fat diets to support mitochondrial biogenesis and to enhance oxidative phosphorylation capacity (Wakshlag & Shmalberg, 2014). Research in detector dogs trained for one hour per day suggested that a low-protein, high-fat diet offers better thermoregulation and weight maintenance compared to high-protein diets.(Ober et al., 2016). Given the variation in activity

across patrol and detector dogs in this study, data on daily activity are needed to inform dietary recommendations. Moreover, the feeding information (nutrient composition, portion size) and level of activity should be investigated in future studies.

Twenty-four percent of working dogs received treats at least once daily, while 45% of companion dogs received treats at least once daily (Stetina et al., 2015). One explanation is that handlers may provide treats exclusively for training purposes, while pet owners tend to give treats more freely or based on their personal preferences. Thirty-three dogs were given extra food in addition to their regular diet or had access to food from other people. This additional food may increase total caloric intake and the risk of overweight or obesity (Lund et al., 2006). However, since Lund's study focused on companion dogs, it is unclear whether this risk factor can apply to working dogs, which require high energy consumption. In our study, 52 dogs experienced weight changes, and 23 showed weight loss despite no change in appetite. This suggests that some dogs might have received an imbalanced diet or inappropriate energy intake for their activity level. It should be noted that weight change was reported by handlers and may not be accurate. Moreover, giving treats to dogs before their working period also increases faecal output, leading to the need for elimination during work (Wakshlag & Shmalberg, 2014). Investigating the nutritional content, volume, and time of treats may help determine their effects on the health of working dogs.

In this study, the frequency of bathing varied among the handlers from once a year to multiple times a week. Twelve handlers reported they bathe their dogs at least once weekly as part of a grooming routine. This practice raises concerns about the risk of skin problems in these working dogs. As Meury et al. (2011) noted, bathing more frequently than once a week may remove skin sebum and increase the risk of allergic skin disease. However, it is also possible that dogs with allergic skin conditions in Meury's study were bathed more frequently as part of their treatment. Additionally, when asked about the advice on bathing, more than half of the handlers in our study did not receive advice on bathing. This highlights the need for the instruction for handlers to include a section on skin health management to ensure consistent and proper management across all handlers.

Approximately 70% of working dogs received ear cleaning at least once a year, which is higher than 46.5% reported in companion dogs (Stetina et al., 2015). This could be because of the difference in sample selection. Stetina et al. (2013) focused on healthy dogs without skin problems, while 23 dogs in our study had ear problems that required regular cleaning. Moreover, 17 handlers cleaned their dogs' ears after swimming, a detail not mentioned in

Stetina's study. This finding suggests that working dogs' handlers might pay more attention to ear care compared to pet owners. Although no literature directly compared the effect of ear cleaning frequency and ears' health, Nuttall and Cole (2004) suggested that the ear should not be cleaned more frequently than every 48 hours, as it can increase the risk of otitis externa. Moreover, the ear cleaning methods performed by handlers varied, with some handlers used dry wipes while some applied ear cleaner into the ear canal. This variation may reflect differences in the knowledge, training, or advice they received. There is a need for further research to assess the impact of the ear cleaning method and the frequency of ear cleaning on the ear health of working dogs. This could help handlers and veterinarians determine the most appropriate ear management practices for their dogs.

Although we try to investigate the health management of working dogs, the questionnaire was adapted from companion dogs (Stetina et al., 2015), especially the feeding and grooming routine. As previously discussed, our questionnaire cannot investigate the characteristics of the work environment. This study cannot evaluate the nutrition, diet composition, body condition score, body muscle score, and the level of activity. Therefore, we cannot determine the appropriate of current diet and current feeding practices of working dogs. Further research should focus on the feeding practices, environmental and living space management to gain a broad view of health management and welfare of working dogs.

This study used a questionnaire to capture pruritic behaviours and found that 16 dogs exhibited all pruritic behaviours with various frequencies, but the handlers did not report any dermatological problems in the previous six months. This suggests that the pruritic behaviour was sometimes perceived by the handler as normal behaviour that not need to report to veterinarians (Stetina et al., 2015). This underreported problem may progress to a severe problem that affects their work performance. It would be helpful to follow up on dogs that exhibited pruritic behaviour and determine whether it develops into chronic pruritus and whether it can induce skin lesions.

Using a handler-reported questionnaire, the answers can be influenced by how the handlers understand pruritic behaviours and the handler's memory. For example, the handlers may not differentiate similar behaviours, such as eye rubbing and face rubbing or sneezing and coughing. Moreover, when asked about rubbing behaviour, some handlers may interpret it as the dogs rub their face on the ground, while others may understand it as the dogs using their paws to rub their face. Future research should provide description of each behaviour along with a questionnaire to ensure the accuracy of handler-reported data. In addition, handlers may

not remember signs shown by their dogs in the previous six months and may report “never” instead of “a few times a year”. Furthermore, this questionnaire did not evaluate the pruritic behaviour across the entire body, such as the abdominal, flank, and inguinal area. As a result, dogs with possible skin disease affecting the abdomen or inguinal region have been missed. Future research should assess pruritus in these and other body areas to provide a more comprehensive understanding of pruritic behaviours in working dogs.

There were several issues with inconsistent responses from handlers, which may affect the reliability of the study’s results. Twelve handlers reported that they never bathe their dogs, but they also selected a bathing product when asked (Table 2.7). This inconsistency may be due to the design of the questionnaire, as the option “no product used because never bathed” is unavailable. As a result, handlers had to select a product even if they did not bathe the dogs. Moreover, when asked about ear cleaning frequency, cleaning method, and reasons for ear cleaning, the number of dogs that received ear cleaning is inconsistent (Table 2.8). This reflects that the handler may have different interpretations of the questions. Some handlers may consider ear cleaning to be the use of ear drops, not wiping. Others may have indicated “do not clean ears” if the ear cleaning was performed by someone else. The handler may report that they do not clean the ear when asked about the ear cleaning method section if they felt it was too infrequent. In addition, 66 handlers reported they never gave a dog treats but 76 handlers said they did not give any treats when asked about the type of treats (Table 2.5). Overall, these inconsistencies may indicate poor questionnaire design, and the handler may misunderstand the questions. With the inconsistent response, it is difficult to determine what they actually did in practice, and the percentage reported here is unreliable. Moreover, the inconsistent answers may be due to errors in data entry. Therefore, double-checking is recommended to ensure the accuracy of data. Future research should develop a questionnaire with clearly defined questions to improve the understanding of the handlers.

This study aims to investigate the pruritic behaviour in the general population of working dogs. However, some dogs in this study were being treated with anti-pruritic or anti-inflammatory treatments at the time of survey. This treatment can reduce the severity and the frequency of pruritus, leading to an underestimation of the frequency reported in this study. Therefore, the result of this study may differ from those observed in other populations of working dogs.

In this study, we did not ask about the time period that dogs exhibited the pruritic behaviour. This makes it hard to determine the number of dogs that currently exhibit pruritic

behaviour at the time of the survey. For example, dogs that were reported to show pruritic behaviour a few times per month may have recovered and did not show pruritus during the survey period. Therefore, the prevalence reported here may differ from previous studies that assess pruritus at the time of veterinary visits. Moreover, a previous study reported that healthy dogs without skin or systemic disease exhibited pruritic behaviour at least a few times a year (Stetina et al., 2015). Therefore, we cannot conclude that dogs that exhibited pruritic behaviour in this study truly had underlying skin problems. Future studies should collect data on the intensity and severity of pruritic behaviours. The information on the severity of pruritus would help veterinarians and handlers identify dogs that exhibit severe pruritus that may need further investigation.

2.6 Conclusion

This study provides basic information on population features and the health management practices of New Zealand working dogs. This study also reports the pruritic behaviours and clinical signs of allergic disease in working dogs. Pruritus is a common behaviour seen in working dogs, with head shaking was the most common pruritic sign. Future studies should investigate the severity of pruritus in working dogs and determine whether data on the frequency of pruritic behaviour can be used to identify dogs with abnormal pruritus. This can help handlers and veterinarians identify dogs with early signs of skin abnormalities before they progress to more severe conditions.

Chapter 3 The association between the pruritic behaviours, the level of pruritus, and the presence of skin lesions in New Zealand police dogs

3.1 Abstract

Background: Pruritus is a common behaviour in New Zealand working dogs. This behaviour can lead to alopecia, erythema, and excoriation of the skin. However, no studies have investigated the level of pruritus and skin lesions in these working dogs.

Objectives: To evaluate the level of pruritus in New Zealand police dogs and whether they presented skin lesions. Moreover, this study explored the association between pruritic behaviours, the level of pruritus, and the presence of skin lesions.

Methods: The level of pruritus was assessed using the PVAS, which was measured by the handlers. The presence of skin lesions was evaluated by veterinarians using the CADESI-04 score. The handlers completed the questionnaire about the frequency of pruritic behaviours and the frequency of allergic signs after completed physical examination. Fisher's exact test was used to determine the relationship between pruritic level and the presence of skin lesions. The association between each pruritic behaviour, the level of pruritus, and the presence of skin lesions was assessed using univariable logistic regression.

Results: Twenty-seven police dogs whose handlers completed the questionnaire on the same day as physical examination were included in this study. Seven dogs (25.9%, 95% CI = 9.4 – 42.5) exhibited an abnormal level of pruritus and six dogs (22.7%, 95% CI = 6.5 – 37.9) presented with skin lesions. Dogs older than four years were 7.9 times more likely to exhibit an abnormal level of pruritus compared to younger dogs ($p = 0.0297$). The level of pruritus was not associated with the presence of skin lesions. Moreover, there was no significant association between pruritic behaviour, level of pruritus, and the presence of skin lesions.

Conclusions: This study provided information on the level of pruritus and the presence of skin lesion in New Zealand police dogs. The presence of pruritic behaviours was not associated with the level of pruritus or the presence of skin lesions. Future studies should increase sample size,

examine wider range of behaviours and skin lesions, and explore the combination of pruritic behaviour to predict the level of pruritus.

3.2 Background

Pruritus, an unpleasant sensation that triggers a desire to rub or scratch (Metz et al., 2011), is the most common clinical sign in dogs with skin disease (Akter et al., 2018; Hill et al., 2006; Khoshnegah et al., 2013). Pruritic dogs show clinical signs of pruritus, including scooting, head shaking, scratching, licking, chewing, biting and rubbing in various parts of the body (Banovic et al., 2019; Griffies et al., 2018). In chapter two of this thesis, we reported that 90% of New Zealand working dogs exhibited at least one pruritic behaviour at least a few times a year. However, the previous study found that healthy dogs without skin or systemic disease can exhibit signs of pruritus such as head shaking, facial/muzzle rubbing, scooting, and paw licking at least a few times a year (Stetina et al., 2015). This makes it hard to conclude that New Zealand working dogs that exhibited pruritic behaviours truly have skin problems. Collecting the data on the severity of pruritus using the validated scale can help determine if these working dogs have an abnormal level of pruritus and need further investigation.

The severity of pruritus can be assessed using the validated Pruritus Visual Analog Scale (PVAS) (Hill et al., 2007; Rybníček et al., 2009). This scale allows owners to select a point that best reflects their dog's pruritus, from zero (“I don’t think itch a problem”) to ten (“extremely severe itching”) (Rybníček et al., 2009). Dogs with the $PVAS \leq 1.9$ are considered to have “normal level of pruritus”, a level that most owners would not seek veterinary attention. A previous study in a group of healthy dogs without skin diseases reported that some owners thought their dogs had mild pruritus, even though they reported a high PVAS score (Stetina et al., 2015). This suggests that the PVAS can be influenced by the owner’s perception of what they consider normal or abnormal behaviour. Owners who are more concerned about their dogs may assign a high score even if the pruritus is infrequent. Moreover, Stetina et al. (2015) reported that the PVAS was positively associated with the frequency of paw licking/chewing, facial/muzzle rubbing, and head shaking (Stetina et al., 2015). Since Stetina et al. (2015) focused in a group of healthy dogs without skin or systemic disease, it remains unclear whether this association can be applied to a group of working dogs, regardless of health problems. Moreover, no studies have investigated the relationship between the level of pruritus and the frequency of pruritic behaviours. Understanding this association could help veterinarians identify dogs with abnormal levels of pruritus, which may indicate undiagnosed skin problems.

Pruritic behaviours can lead to alopecia, excoriation, and inflammation of skin in frequently groomed areas and lead to hyperpigmentation and lichenification in areas of chronic pruritus (Coatesworth., 2019; Rooney et al., 2009). In dogs with atopic dermatitis, the severity of skin lesions can be measured using the Canine Atopic Dermatitis Extent and Severity Index-04 (CADESI-04) (Olivry et al., 2014). The CADESI-04 is used to assess the severity of erythema, lichenification/ hyperpigmentation and excoriation lesions on 20 body areas. The previous research found that there was no significant relationship between the intensity of pruritus and erythematous skin lesion (Hill et al., 2010). However, the association of the pruritic behaviour and other skin lesions such as alopecia, hyperpigmentation, and lichenification are underinvestigated. Understanding this relationship can help veterinarians early identify pruritic dogs before they develop skin lesions and progress to severe skin problems.

This study aims to evaluate the level of pruritus in police dogs using the PVAS and evaluate the presence of skin lesions using the CADESI-04. The second objective is to investigate the association of the pruritic behaviour with the level of pruritus and the presence of skin lesions. This could help veterinarians understand the pruritic problems and skin disease in police dogs as well as help veterinarians identify pruritic dogs early.

3.3 Materials and methods

3.3.1 Data collection

3.3.1.1 The survey

Data used in this study was collected from the handlers of New Zealand working dogs between October 2018 and July 2021. The description of the study design and questionnaire has been reported in Chapter 2. Briefly, the data collection was divided into two rounds, the first and second survey. In the first survey, the questionnaire was published online via SurveyMonkey and the link was distributed to the police dogs section supervisor (District Officer in Charge of Dog Section) via e-mail. Then, the police dogs section supervisor distributed the questionnaire to police dogs' handlers across New Zealand. This first survey questionnaire consists of eight sections with 71 questions (see Appendix 1) regarding general health management, health problems, gastrointestinal signs, and pruritic behaviour. At the first survey, handlers have options to complete the survey independently or bring their dogs to veterinary clinics for a physical examination at their convenience.

The second survey consists of the physical examination by veterinarians, and the questionnaire was completed by the handlers. Handlers of police dogs who had completed the

first survey were recruited for the second survey. The questionnaire used in the second survey was the short version of the first survey that focused on pruritic behaviour and gastrointestinal signs (see Appendix 2). The handlers were required to bring their dog to a veterinary clinic for examination and have the PVAS and CADESI-04 scores recorded. The handlers were required to complete the short questionnaires as soon as possible after their dogs finished the physical examination.

3.3.1.2 Physical examination

At the second survey, the recruited police dog handlers were required to bring their dog for physical examination. Physical examination was done by two veterinary dermatologists in Auckland and Wellington on the 5th, 6th, 10th of June 2019 and 18th, 19th, 22nd November 2019. During the physical examination, two veterinary dermatologists collected the PVAS and CADESI-04 score of each dog. The veterinarian showed the PVAS to the handler (see Appendix 3). The handler was then asked to select the point on scale that best describes the level of pruritus of their dogs. The PVAS score of 0 means “normal dog – I don’t think pruritus is a problem”, and the PVAS score of 10 was “Extremely severe itching/almost continuous”. The severity of skin lesions were assessed using the validated CADESI-04 scoring system. The veterinarian evaluated three skin lesions, including erythema, lichenification, and alopecia/excoriation on 20 body sites and then recorded a score range from 0 (none) to 3 (severe) for each lesion at each body site. The possible highest score of CADESI-04 was 3 lesions x 20 body sites x the highest score of 3 = 180 (see Appendix 4). The scores from the veterinarians and hard copies of the questionnaire were manually entered to Microsoft Excel [version 2502] for further analysis.

3.3.2 Data management

The original data from the questionnaire was exported from SurveyMonkey and Qualtrics to Excel® spreadsheet (Microsoft Corporation). The hard copy questionnaires were manually entered into the Excel® spreadsheet. The PVAS and CADESI-04 scores of each dog were manually transferred from the scoring sheet to an Excel® spreadsheet. The data from first and second survey were combined to one data sheet, which consists of 340 responses. Data categorised and data cleaning process were previously described in chapter 2.

3.3.3 Selection of data

This study used the same original dataset as described in Chapter 2, which contains 340 responses from 252 working dogs. To reduce handler’s bias and ensure that the pruritic

behaviour reported by handlers accurately reflected the dogs' condition at the time of examination, dogs were selected in this second study if they attended the physical examination, had a questionnaire completed on the same day, and had both PVAS and CADESI-04 scores recorded. In total, 47 dogs were brought to the veterinarian for a physical examination. Of 47 dogs, 15 were excluded because the handler completed the questionnaire three to ten months after physical examination. Five dogs were excluded due to missing data for PVAS, CADESI-04, and both. Therefore, only 27 dogs were included in this study. The number of dogs and the reasons why dogs were excluded from this study are shown in Figure 3.1.

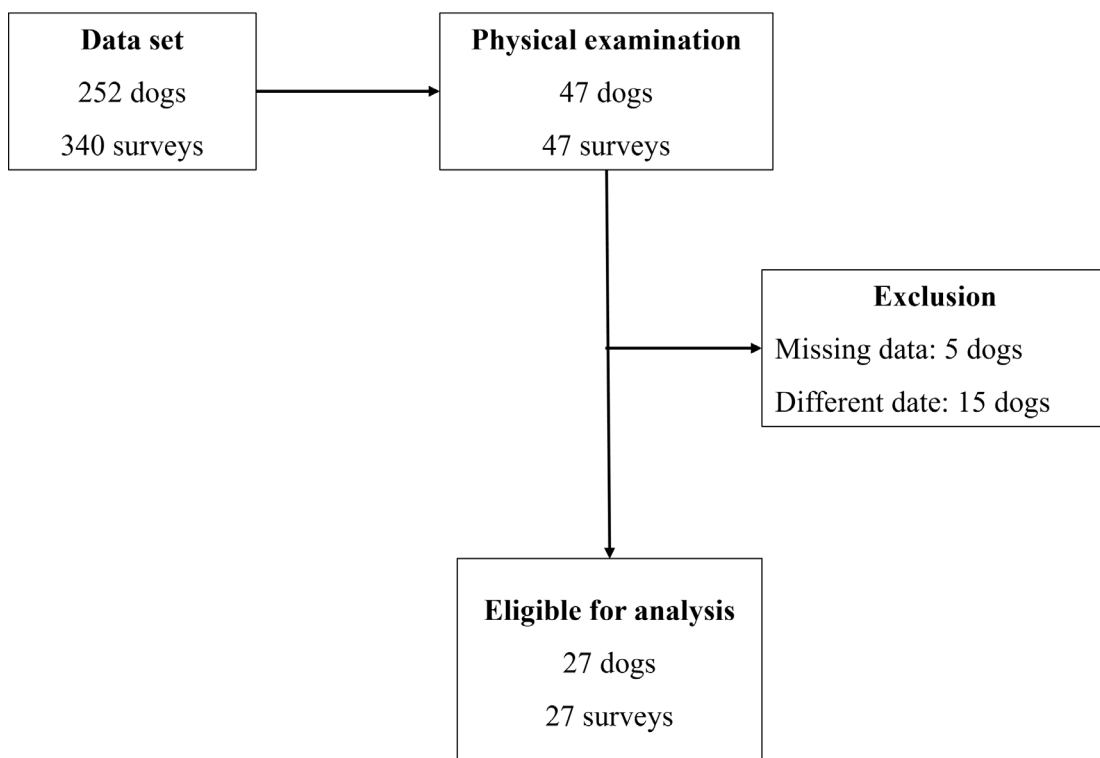


Figure 3.1 Data selection process. Forty-seven dogs attended a physical examination. Of 47 dogs that attended a physical examination, 20 were excluded due to missing data. A total of 27 dogs met the inclusion criteria and were included in this study.

3.3.4 Outcome of interest

3.3.4.1 Level of pruritus

The level of pruritus was assessed using the PVAS score that was collected from handlers at the time of physical examination. The $PVAS \leq 1.9$ were classified as “normal level of pruritus” and the $PVAS > 1.9$ were classified as “abnormal level of pruritus”.

3.3.4.2 The presence of skin lesions

The skin lesions were assessed using CADESI-04 score that evaluated by veterinarians at the time of physical examination. The CADESI-04 was validated to assess the severity of skin lesions in atopic dogs with proposed benchmarks for mild, moderate, and severe atopic dermatitis skin lesions were 10, 35, and 60, respectively (Olivry et al., 2014). However, due to the small sample size, we simply classified dogs with CADESI-04 < 10 as “dogs without skin lesions” and dogs with score of CADESI-04 \geq 10 as “dogs with skin lesions”.

3.3.5 Explanatory variables

The signalment of dogs (age, sex, and breed) were collected from a questionnaire. The age of dogs was categorised into “less than or equal to 4 years” and “more than 4 years old”. Sex was categorised into “male” or “female”.

The pruritic behaviours evaluated in this study were eye rubbing, face/muzzle rubbing, paw licking/chewing, legs licking/chewing, head shaking, and scooting. Conjunctivitis and sneezing were evaluated because it is associated with canine allergic dermatitis. The possible answers for the frequency of pruritus and the clinical signs of allergy were “never”, “multiple times a day”, “daily”, “once a week”, “once a month”, and “once a year”.

Due to the small sample size, the frequency of each pruritic behaviour was categorised into two groups for statistical analysis. Dogs that reported to never exhibit each individual pruritic behaviour were classified as “No” while those that displayed pruritic behaviour a few times per year, a few times per month, a few times per week, daily, or multiple times per day were classified as “Yes”.

3.3.6 Data analysis

The population features (sex, age, breed, department) were described using the percentages and relative 95% confidence intervals (95% CI). The PVAS and CADESI-04 were summarised using histograms, medians, and interquartile ranges (IQR).

The association between the level of pruritus and the presence of skin lesions was investigated using Fisher’s exact test. $P < 0.05$ was accepted as a significant association.

The relationship between each pruritic behaviour and the outcome of interest was assessed using logistic regression. The univariable logistic regression was performed to investigate the relationship between each pruritic behaviour and the outcome. The analysed factors for the univariable model included age, breed, sex, and the presence of pruritic

behaviours (eye rubbing, face/muzzle rubbing, paw licking/chewing, legs licking/chewing, head shaking, scooting, conjunctivitis, and sneezing). The odds ratio (OR) and 95% CI were calculated by taking the exponent of the coefficients. The significance of each predictor was checked using a likelihood ratio test (LRT). Due to the small sample size, multivariable analysis cannot be performed in this chapter.

The data management and data selection were performed using Microsoft Excel [version 2502]. Statistical analysis was carried out using RStudio [version 4.1.1] (R Core Team, 2024). The figures in this chapter were created using ggplot2 (Wickham, 2016) except Figure 3.1 was created using Microsoft PowerPoint [version 2504].

3.4 Result

3.4.1 Descriptive statistics

In total, 47 of 252 working dogs were brought for physical examination. Five dogs were removed due to missing data on the PVAS or CADESI-04 or both. Fifteen dogs were excluded because the handler did not complete the survey on the same date as the examination (Figure 3.1). Therefore, 27 working dogs are eligible for data analysis. All enrolled dogs were police dogs. The population features (sex, age, and breed) of police dogs are described in Table 3.1.

Of 27 police dogs, 19 dogs (70.4%, 95% CI = 53.1 – 87.6) exhibited at least one pruritic behaviour at least a few times a year. The number and percentage of dogs exhibited each behaviour are shown in Table 3.2. Sneezing and conjunctivitis were investigated because they are associated with canine atopic dermatitis. The number of dogs exhibited clinical signs of sneezing and conjunctivitis are shown in Table 3.3.

Table 3.1 The number and percentage (with 95% CI) of police dogs stratified by sex, age, and breed. Data was collected from 27 police dogs.

Category		Number of dogs	% (95% CI)
		(N = 27)	
Sex	Female	9	33.3 (27.5 – 39.2)
	Male	18	66.7 (60.8 – 72.5)
Age	4 years or less	17	63.0 (57.0 – 68.9)
	More than 4 years	10	37.0 (31.1 – 43.0)
Breed	German Shepherd	24	88.9 (85.0 – 92.8)
	Labrador retriever	3	11.1 (7.2 – 15.0)

Table 3.2 The number and percentage (with 95% CI) of police dogs stratified by whether the dogs exhibited pruritic behaviour or not. Data was collected from 27 police dogs.

Pruritic behaviour	Number of dogs (N=27)	% (95% CI)
Facial/muzzle rubbing		
No	14	51.9 (45.7 – 58.0)
Yes	13	48.1 (42.0 – 54.3)
Eye rubbing		
No	16	59.3 (53.2 – 65.3)
Yes	11	40.7 (34.7 – 46.8)
Paws licking/chewing		
No	16	59.3 (53.2 – 65.3)
Yes	11	40.7 (34.7 – 46.8)
Legs licking/chewing		
No	18	66.7 (60.8 – 72.5)
Yes	9	33.3 (27.5 – 39.2)
Head shaking		
No	11	40.7 (34.7 – 46.8)
Yes	16	59.3 (53.2 – 65.3)
Scoting		
No	24	89.9 (85.0 – 92.8)
Yes	3	11.1 (7.2 – 15.0)

Table 3.3 The number and percentage (with 95% CI) of police dogs stratified by whether they presented clinical signs associated with canine allergic dermatitis or not. Data was collected from 27 police dogs.

Clinical signs	Number of dogs (N=27)	% (95% CI)
Conjunctivitis/ocular discharge		
No	17	63.0 (57.0 – 68.9)
Yes	10	37.0 (31.1 – 43.0)
Sneezing		
No	9	33.3 (27.5 – 39.2)
Yes	18	66.7 (60.8 – 72.5)

3.4.2 The PVAS and CADESI-04

Figure 3.2 shows the distribution of the PVAS scores of 27 enrolled dogs. The PVAS score ranged from 0 to 5.5, with a median of 0.3 (IQR = 0 – 1.9). Twenty dogs (74.1%, 95% CI = 57.5 – 90.6) exhibited a normal level of pruritus (PVAS score \leq 1.9), and seven dogs (25.9%, 95% CI = 9.4 – 42.5) exhibited an abnormal level of pruritus (PVAS score $>$ 1.9).

Figure 3.3 shows the distribution of the CADESI-04 score of 27 enrolled dogs. The CADESI-04 score ranged from 0 to 63, with a median of 4 (IQR = 1.5 – 9.0). Six dogs (22.7%, 95% CI = 6.5 – 37.9) presented with skin lesions, and 21 dogs (77.2%, 95% CI = 62.1 – 93.5) did not present with skin lesions.

3.4.3 The association between the level of pruritus and the presence of skin lesions

Figure 3.4 shows the difference in the prevalence of skin lesions between dogs with normal pruritus and abnormal pruritus. The prevalence of skin lesions in abnormal pruritus dogs was 42.9% (95% CI = 6.2 - 79.5), while the prevalence of skin lesions in normal dogs was 15% (95% CI = 0 – 30.6).

The prevalence ratio of skin lesions among dogs with abnormal pruritus compared with normal dogs was 2.86. However, there was no significant association between the level of pruritus and the presence of skin lesions ($p = 0.2896$).

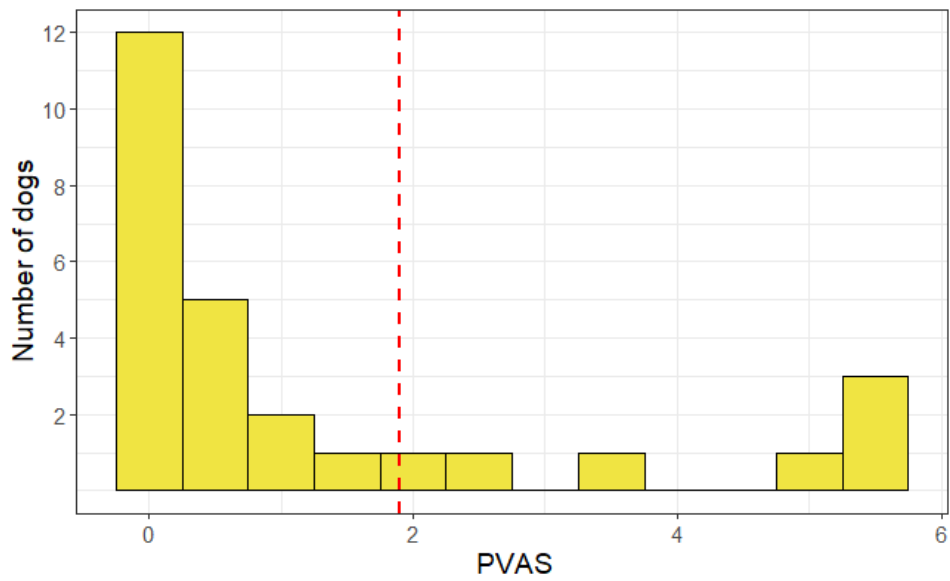


Figure 3.2 The distribution of the PVAS of 27 police dogs. The red dot line represents the cut-off value at 1.9. Dogs with the PVAS more than 1.9 were classified as “dogs with abnormal level of pruritus”.

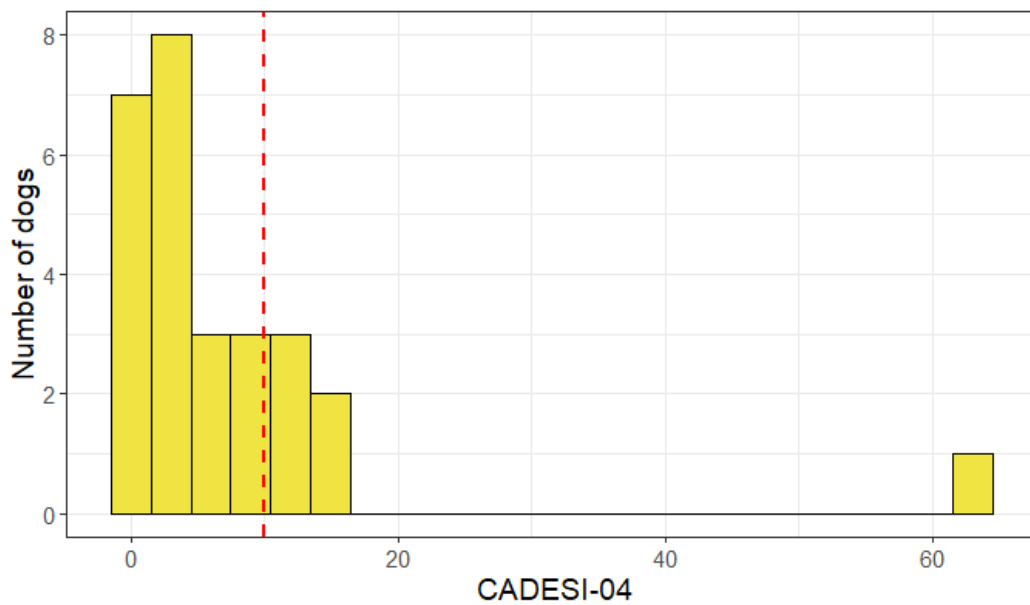


Figure 3.3 The distribution of the CADESI-04 of 27 police dogs. The red dot line represents the cut-off value at 10. Dogs with CADESI-04 score equal to or more than 10 were classified as “dogs with skin lesions”.

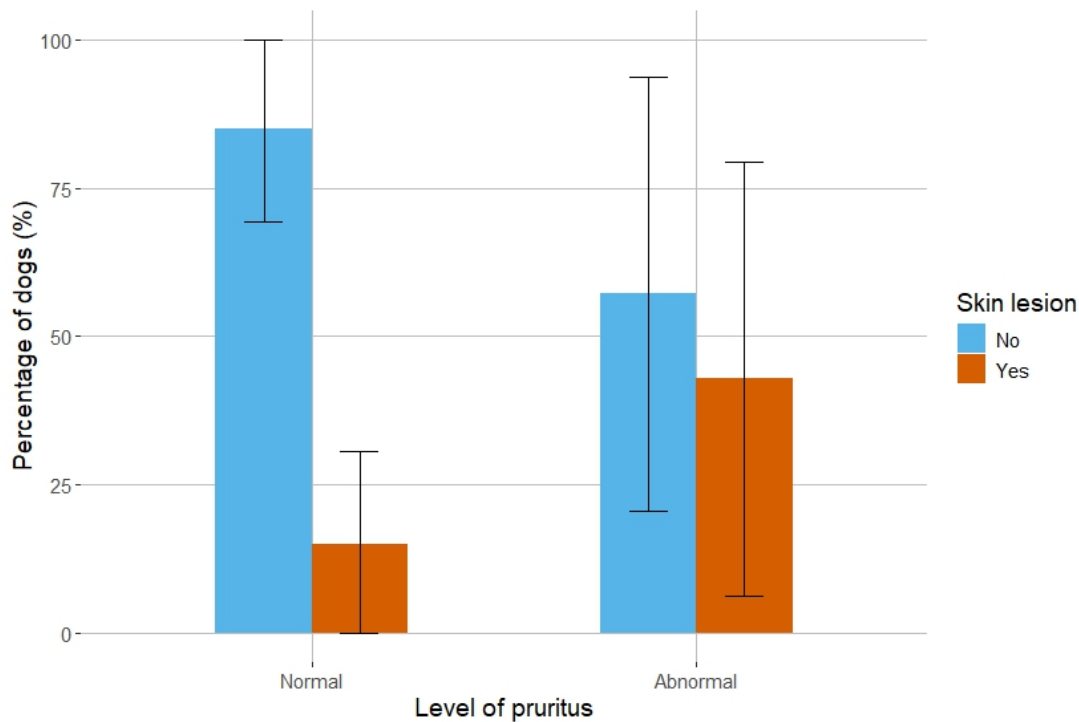


Figure 3.4 The percentage of dogs with and without skin lesions in dogs with normal pruritus and dogs with abnormal levels of pruritus. The vertical lines indicate the 95% CI of each group. Data was collected from 27 police dogs.

3.4.4 Univariable logistic regression

3.4.4.1 Pruritic behaviour and the level of pruritus

Table 3.4 shows the result from univariable logistic regression between each explanatory variable and the level of pruritus. There is a significant association between age and the level of pruritus ($p = 0.0297$). The OR and 95% CI of the breed variable cannot be calculated due to the presence of zero values in the descriptive table.

3.4.4.2 Pruritic behaviour and skin lesions

Table 3.5 shows the result from univariable logistic regression between each explanatory variable and the presence of skin lesions. There is no significant relationship between each variable and the presence of skin lesions. The OR and 95% CI of breed and scooting behaviour variables cannot be calculated due to the presence of zero values in the descriptive table.

Table 3.4 The results of univariable logistic regression models examine the association of the level of pruritus and explanatory variables. Beta-coefficients (with SE) and odds ratio (with 95% CI) derived from the logistic regression models. P-values derived from log-likelihood ratio tests (LRT). Data collected from 27 police dogs. The 100% percentage was calculated based on whether dogs presented the pruritic behaviour or not.

Explanatory variable	Levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Normal level of pruritus (n = 20)	Abnormal level of pruritus (n = 7)				
Age	≤ 4 years	15 (88.2)	2 (11.8)	Reference			0.0297
	> 4 years	5 (50.0)	5 (50.0)	2.01	0.983	7.50 (1.21 – 65.7)	
Sex	Female	6 (66.7)	3 (33.3)	Reference			0.5395
	Male	14 (77.8)	4 (22.2)	- 0.560	0.906	0.57 (0.09 – 3.64)	
Breed	German Shepherds	11 (70.8)	7 (29.2)	Reference			
	Labrador retrievers	3 (100.0)	0 (0)	-	-	-	
Facial/muzzle rubbing	No	12 (85.7)	2 (14.3)	Reference			0.1476
	Yes	8 (61.5)	5 (38.5)	1.32	0.953	3.75 (0.64 -31.02)	

Explanatory variable	Levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Normal level of pruritus	Abnormal level of pruritus				
		(n = 20)	(n = 7)				
Eye rubbing	No	14 (85.7)	2 (12.5)	Reference			0.0548
	Yes	6 (54.5)	5 (45.5)	1.76	0.969	5.83 (0.97 – 49.7)	
Conjunctivitis/ocular discharge	No	12 (70.6)	5 (29.4)	Reference			0.5851
	Yes	8 (80.0)	2 (20.0)	-0.511	0.953	0.60 (0.07 – 3.59)	
Paws licking/chewing	No	13 (81.2)	3 (18.8)	Reference			0.3078
	Yes	7 (63.6)	4 (36.4)	0.907	0.896	2.48 (0.42 – 15.90)	
Legs licking/chewing	No	15 (83.3)	3 (16.7)	Reference			0.1279
	Yes	5 (55.6)	4 (44.4)	1.39	0.922	4.00 (0.66 – 27.20)	
Head shaking	No	10 (90.9)	1 (9.1)	Reference			0.0816
	Yes	10 (62.5)	6 (37.5)	1.79	1.17	6.00 (0.81 – 124.00)	

Explanatory variable	Levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Normal level of pruritus (n = 20)	Abnormal level of pruritus (n = 7)				
Sneezing	No	7 (77.8)	2 (22.2)	Reference			0.7541
	Yes	13 (72.2)	5 (27.8)	0.297	0.959	1.35 (0.22 – 11.10)	
Scooting	No	19 (79.2)	5 (20.8)	Reference			0.1124
	Yes	1 (33.3)	2 (66.7)	2.03	1.32	7.60 (0.61 – 185.0)	

Table 3.5 The results of univariable logistic regression models examine the association of skin lesions and explanatory variables. Beta-coefficients (with SE) and odds ratio (with 95% CI) derived from the logistic regression models. P-values derived from log-likelihood ratio tests (LRT). Data was collected from 27 police dogs. The 100% percentage was calculated based on whether dogs presented the pruritic behaviour or not.

Explanatory variable	levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Without skin lesions (n = 21)	With skin lesion (n = 6)				
Age	Less than 4	14 (82.4)	3 (17.6)	Reference			0.4612
	More than 4 years	7 (70.0)	3 (30.0)	0.693	0.939	2.00 (0.30 – 13.50)	
Sex	Female	7 (77.8)	2 (22.2)	Reference			1.00
	Male	14 (77.8)	4 (22.2)	0.00	0.982	1.00 (0.15 – 8.50)	
Breed	German Shepherds	18 (75.0)	6 (25.0)	Reference			-
	Labrador retrievers	3 (100.0)	0 (0)	-	-	-	
Facial/muzzle rubbing	No	12 (85.7)	2 (14.3)	Reference			0.1476
	Yes	9 (69.2)	4 (30.8)	0.981	0.972	2.67 (0.42 – 22.50)	

Explanatory variable	levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Without skin lesions	With skin lesion				
		(n = 21)	(n = 6)				
Eye rubbing	No	14 (85.7)	2 (12.5)	Reference			0.1447
	Yes	7 (63.6)	4 (36.4)	1.39	0.982	4.00 (0.62 – 34.40)	
Conjunctivitis/ocular discharge	No	13 (76.5)	4 (23.5)	Reference			0.8304
	Yes	8 (80.0)	2 (20.0)	-0.208	0.976	0.812 (0.09 – 5.24)	
Paws licking/chewing	No	14 (87.5)	2 (12.5)	Reference			0.1447
	Yes	7 (63.6)	4 (36.4)	1.39	0.982	4.00 (0.62 – 34.40)	
Legs licking/chewing	No	16 (88.9)	2 (11.1)	Reference			0.0550
	Yes	5 (55.6)	4 (44.4)	1.86	1.01	6.40 (0.96 – 57.70)	
Head shaking	No	10 (90.9)	1 (9.1)	Reference			0.1545
	Yes	11 (68.8)	5 (31.2)	1.51	1.18	4.55 (0.59 – 95.20)	

Explanatory variable	levels	Number (%) of dogs		β - coefficient	SE	Odds ratio (95% CI)	p-value (LRT)
		Without skin lesions	With skin lesion				
		(n = 21)	(n = 6)				
Sneezing	No	7 (77.8)	2 (22.2)	Reference			1.00
	Yes	14 (77.8)	4 (22.2)	0.00	0.982	1.00 (0.15 – 8.50)	
Scooting	No	18 (75.0)	6 (25.0)	Reference			
	Yes	3 (100.0)	0 (0)	-	-	-	-

3.5 Discussion

This study is the first to evaluate the level of pruritus and the presence of skin lesions in New Zealand police dogs. This study reported that approximately one in four police dogs exhibited an abnormal level of pruritus, and 22% of dogs presented with skin lesions. This study found that the median of both PVAS and CADESI-04 of police dogs was within the normal limits (Olivry et al., 2014; Rybníček et al., 2009). There was a significant association between age and the level of pruritus. However, no significant association was found between the level of pruritus and the presence of skin lesions.

The median PVAS score in police dogs at the time of examination was 0.3. This score indicated that police dogs had slightly higher pruritus compared to dogs without skin disease (Rybníček et al., 2009), but the handlers did not consider it a problem to see veterinarians. Twenty-four percent of police dogs exhibited an abnormal level of pruritus (PVAS > 1.9). An abnormal level of pruritus has been reported in dogs with various skin problems, such as food hypersensitivity (Possebom et al., 2022), canine atopic dermatitis (Widorn et al., 2024), and infectious skin diseases (Rybníček et al., 2009). This suggests that our population may include dogs with dermatological problems. Clinically, this highlights the importance of diagnosing the underlying skin diseases in dogs reported to have an abnormal level of pruritus.

This study found that 22% of police dogs had skin lesions at the time of physical examination. This indicates that some police dogs may experience allergic skin disease, skin irritation, or unresolved skin problems. However, this study evaluated the presence of skin lesions using the CADESI-04 score, which was validated for assessing the severity of lesions in atopic dogs. The CADESI-04 focused on specific skin lesions such as excoriations/lichenification, erythema, and alopecia (Olivry et al., 2014). Other important skin lesions, such as papules, crusts, and nodules were not evaluated in this study. Consequently, the percentage reported here may underestimate the true prevalence of dogs with skin lesions. Future research should examine a broader range of cutaneous lesions, which would provide a better understanding of the common skin problems and enhance our understanding of the overall skin health of police dogs.

This study found that police dogs older than 4 years were more likely to exhibit an abnormal level of pruritus compared to younger dogs ($p = 0.0297$, OR = 7.50, 95% CI = 1.21 – 65.7). A similar association between age and pruritic behaviour has been reported in a study of 314 healthy companion dogs without skin or systemic disease, which found a positive

correlation between age and the frequency of facial pruritus (Stetina et al., 2015). Unlike Stetina's study, which included only healthy dogs, our study included police dogs regardless of current health problems. These findings indicate that age may play an important role in the development of pruritic behaviour across canine populations, both healthy and non-healthy dogs. Moreover, a previous study found that older dogs were more frequently reported to have a history of skin conditions, ranging from 7% in puppies to 37% in senior dogs (Nam et al., 2024). This may reflect age-related changes in skin structure, skin function, and the effects of long-term exposure to environmental factors. However, this relationship should be interpreted with caution, as our study did not control for potential confounders. Future studies should investigate the role of age in the development of skin disease in police dogs by controlling for possible confounders. Such information would help veterinarians and handlers develop preventive strategies for skin problems in police dogs.

The descriptive result found that the German Shepherd was the predominant breed that exhibited both abnormal pruritus and skin lesions (Table 3.4 and Table 3.5). This finding aligns with a previous study that German Shepherds had a higher risk for pruritic skin disease compared to other breeds (Vilson et al., 2013). Moreover, German Shepherds were found to have a genetic predisposition to atopic dermatitis, a condition that causes skin inflammation (Picco et al., 2008b). It is plausible that some of the German Shepherds in our study had skin problems, leading to skin lesions or pruritus at the time of survey. Therefore, it is recommended to diagnose the underlying dermatological disease in these dogs and investigate the genetic predisposition to this disease. However, it should be noted that the German Shepherd is overrepresented, approximately 90% of our study population. Moreover, handlers whose dogs had skin lesions or severe pruritus may be more likely to participate in this study. Therefore, this finding may not be generalised to other populations of police dogs with a wider range of breeds.

In this study, we found no significant association between the presence of individual pruritic behaviour and the level of pruritus measured by PVAS. This result was not unexpected. The PVAS was developed to assess the pruritic behaviour based on the severity of overall pruritic signs at the time of veterinary visit, ranging from occasional to continuous periods (Rybníček et al., 2009). In contrast, we asked about the frequency of individual pruritic behaviour during the previous period. Dogs were classified as present the specific pruritic behaviour if they exhibited the behaviour at least a few times a year. It is possible that dogs exhibited pruritic behaviour were no longer pruritic at the time of the survey and were reported

to have a normal level of pruritus. Dogs that reported as present pruritic behaviour and showed pruritus at the time of the survey may be reported to have an abnormal level of pruritus. Therefore, the question about the frequency of behaviour should focus on the time of the survey or specify the time frame to better align with the point-in-time nature of the PVAS scoring system.

In addition, the PVAS was determined based on the level of overall pruritic behaviours, including scratching, biting, chewing, rubbing, licking at the same time (Hill et al., 2007; Rybníček et al., 2009). In contrast, our study evaluated pruritic behaviours individually. As a result, police dogs may exhibit an abnormal level of pruritus even if they did not exhibit a specific behaviour. For example, a dog that did not show paw licking may still have an abnormal level of pruritus if it exhibited intense pruritus in other areas, such as the ears or eyes. This suggests that relying on the presence or absence of a single behaviour may not be sufficient to identify dogs with an abnormal level of pruritus. Future research should include multivariable analysis to explore the combination of multiple pruritic behaviours to predict the level of pruritus. This approach provides a more accurate assessment than evaluating individual pruritic behaviours alone.

Our study found no significant association between the level of pruritus and the presence of skin lesions. Individual dogs may exhibit pruritus without skin lesions or vice versa. This is not unexpected, as the skin inflammation can result from non-pruritic skin diseases (Hill et al., 2010). Similarly, hormonal disorders can cause alopecia or hyperpigmentation without pruritic behaviour (Bajwa, 2022). Moreover, the CADESI-04 used in this study was designed to evaluate lesions in specific body regions. If dogs exhibited a high level of pruritus in areas not included in the CADESI-04 assessment, such as the eyes and legs, the CADESI-04 score might be low despite high levels of pruritus. We therefore suggest that assessing both pruritic behaviours and skin lesions provides a more reliable approach for investigating skin problems in police dogs. Future studies should investigate the relationship between the severity of skin lesions and the level of pruritus within the same anatomical locations on individual dogs.

The multivariable logistic regression could not be performed in this study due to the small sample size. Bujang et al. (2018) recommended a minimum sample size for logistic regression in observational studies was $100 + 50(i)$ samples, where “i” refers to the number of independent variables in the final model. With only 27 samples in this study, we were unable to perform a multivariable analysis. Consequently, only univariable logistic regression results are presented here. The small sample size also led to zero values in the contingency table,

making it impossible to calculate OR and 95% CI for breed and scooting variables (Table 3.4 and Table 3.5). Furthermore, a limited sample size also reduces the power of this study and increases the risk of type II error (Dohoo et al., 2014). Since univariable analysis cannot account for confounders, the results should be interpreted with care. Future studies should increase sample size to allow multivariable analysis and confirm these preliminary findings.

In this study, we did not collect information on health status and current medication. The use of anti-pruritic or anti-inflammatory drugs can reduce the frequency of pruritic behaviours, lower pruritus scores, and suppress the appearance of skin lesions. As a result, our findings on pruritic behaviour and the prevalence of skin lesions may have been influenced by medication use. Future studies should consider the effect of current medication and control for its impact on pruritus and skin conditions.

In addition, the assessment of pruritic behaviours in this study was limited, as we did not investigate other possible signs of pruritus, such as abdominal scratching, back rubbing, and licking at an inguinal area. This makes it difficult to determine the true population of police dogs that exhibited pruritic behaviours. Future research should evaluate all pruritic signs, which would help veterinarians and handlers understand all aspects of pruritus in police dogs.

The major limitation of this study is the small sample size, which might be influenced by several factors. One possible reason is the limited timeframe and location of the physical examination. With only six days of examinations conducted in Wellington or Auckland, police dogs with operational duties or based in other regions may have been unable to participate. Therefore, future research should consider extending the examination period to ensure that most police dogs can participate in this study. Furthermore, it would be beneficial to the handlers if veterinarians could travel to each police dog's base to conduct physical examinations without the need to transport dogs to specific locations.

The physical examination in this study involved two veterinary dermatologists. These veterinarians were responsible for many tasks for each dog, including performing a physical examination, collecting the PVAS, evaluating the skin lesions, and asking the handler to complete a questionnaire. This process was time-consuming and could limit the number of examined dogs per day. Future studies should adjust the physical examination process. For example, the handler can complete the questionnaire while waiting for the physical examination. This adjustment could reduce the workload on veterinarians and decrease time of the overall process. Moreover, because the experience required for CADESI-04 evaluation,

training more veterinarians on how to evaluate this scoring system can increase the pool of trained veterinarians who can help in the physical examination. This would allow for more examination stations and more dogs were examined. Furthermore, allocating a separate veterinarian to collect the PVAS directly from the handler may decrease the time demand of veterinary dermatologists, allowing them to examine more dogs.

We aim to ensure that the PVAS accurately reflects the handlers' perception of pruritic behaviour at the time of the survey. Since the PVAS can change depending on the disease progression and the perception of handlers, we selected only dogs whose handlers completed the survey during the same period as the physical examination. Therefore, 20 from 47 dogs were excluded from this study because the handler completed the survey three to ten months after examination. Future studies should encourage the handler to complete the questionnaire after finishing the physical examination. Follow-up call should be made to ensure that all examined police dogs' handlers completed the survey within expected time.

3.6 Conclusion

This is the first study to provide evidence that some New Zealand police dogs exhibit an abnormal level of pruritus and present with skin lesions. This study's findings highlight the need for clinical investigation. Age was associated with the level of pruritus. However, individual pruritic behaviours were not associated with the level of pruritus or to the presence of skin lesions. We suggest that observing a single pruritic behaviour may not reliably identify pruritic dogs or dogs with skin lesions. Future studies should focus on the use of multiple pruritic behaviours to predict the level of pruritus and investigate whether these behaviours are related to the development of skin lesions. Moreover, larger sample sizes are needed in future studies to confirm these findings.

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Appendices

Appendix 1. First questionnaire used to collect data in the first survey.

* 1. What is your dog's name and ID number?

* 2. What is the age of your dog in months? For example: one and half years old would be 18 months. If known, please give date of birth.

* 3. What is the breed of your dog?

* 4. What is the sex of your dog?

Female, spayed

Female, intact (not spayed)

Male, neutered

Male, intact (not neutered)

* 5. How long have you had your dog? Please round to closest year.

Less than 3 months 1-3 years

Less than 6 months 4-6 years

6-12 months Greater than 6 years

* 6. What is the current weight of your dog in kg? (best estimate)

* 7. Where does your dog spend most of his/her time?

Mostly indoors Exclusively indoors

Mostly outdoors Exclusively outdoors

Equal time indoors and outdoors

* 8. How many hours a day on average is your dog directly observed (by yourself or family/household member/colleagues)?

- 4 hours or less a day Between 8 to 12 hours a day
- Between 4 to 6 hours a day More than 12 hours a day
- Between 6 to 8 hours a day

* 9. Please list all current or past medical problems your dog has had in the last 6 months. If none, please write "none." If there is a long list please just list main points and write "See vet records"

* 10. Please list any medications (including flea/other parasite medications) that your dog is getting or has received in the last 6 months. If none, please write "none."

* 11. Please list any current supplements or vitamins that your dog is getting. This includes fish oil, multivitamins, probiotics, etc. If none, please write "none."

* 12. How do you give medications or supplements to your dog?

- I don't give my dog any medications/supplements With dog treats (this includes pill pockets)
- With water only With human food
- With their own food or in their meal Not with food or water

* 13. Has your dog had a change in appetite over the last 3 months?

- No
- Yes, appetite has increased
- Yes, appetite has decreased

* 14. What type of dog food do you feed your dog? More than one answer is allowed.

- Canned/pouches/sachets
- Dry food/biscuits
- Dog roll
- Raw diet, dehydrated
- Raw diet, frozen
- Raw diet (dehydrated or frozen) and biscuits
- Home prepared diet
- Other

* 15. What is the name or names of the dog food brand/company/manufacturee that you currently feed your dog? For example Brand = Pedigree, Purina ONE, Butch, Tux, Ziwi peak, Hills Science diet, Royal Canin, K9 Natural, Orijen etc. If none please write "none"

* 16. What is the specific flavour or flavours or type(s) of dog food formula that you currently feed your pet? This is not the brand. For example Pedigree Vital, Purine ONE lamb and rice, Butch black label, Royal Canin medium adult, Ziwi peak lamb etc. If none please write "none"

* 17. How long have you been feeding your dog his/her current diet?

- Less than 1 month
- 1 to 3 months
- 3 - 12 months
- 12 months - 2 years
- Greater than 2 years

* 18. Please check all treats/human food that your dog receives (multiple answers allowed).

- Human food – meat
- Human food – dairy/egg
- Human food-fruits/vegetables
- Shop bought food treats
- Human food – carbohydrates
- None
- Other (please specify)

* 19. How often does your dog get treats/human food?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never I don't feed human food or other treats |

* 20. How often do you feed your dog per day?

- | | |
|-----------------------------------|--|
| <input type="radio"/> Once | <input type="radio"/> Four or greater |
| <input type="radio"/> Twice | <input type="radio"/> Free fed (there is always food down) |
| <input type="radio"/> Three times | |

* 21. Does your dog have access to other foods/treats besides their dog food (cat food, other dog food, food from neighbours or the postman, orchard etc)?

- Yes
 No

* 22. Has there been any change in your dogs weight in the last 3 months?

- | | |
|---|---|
| <input type="radio"/> No – no change in weight | <input type="radio"/> Yes – weight gain < 1.5 kg |
| <input type="radio"/> Yes – weight loss < 1.5 kg | <input type="radio"/> Yes – weight gain ≥ 1.5 kg |
| <input type="radio"/> Yes – weight loss ≥ 1.5 kg | <input type="radio"/> Yes – weight gain – unsure amount |
| <input type="radio"/> Yes – weight loss – unsure amount | <input type="radio"/> I don't know |

* 23. In the last 3 months where has your dog urinated? (multiple answers are allowed)

- | | |
|--|--|
| <input type="checkbox"/> Inside the house NOT including in the crate | <input type="checkbox"/> In the kennel |
| <input type="checkbox"/> Outside – on the property | <input type="checkbox"/> In the run |
| <input type="checkbox"/> Outside – when out on walks / off property | <input type="checkbox"/> In the crate |
| <input type="checkbox"/> Other (please specify) | |

24. How frequently does your dog have access to an area to toilet in?

25. In the last 3 months where has your dog defecated (passed a bowel motion)? (multiple answers are allowed)

- Inside the house but NOT including in the crate In the kennel
- On the ground outside – on the property In the run
- On the ground outside – when out on walks / off property In the crate
- Other (please specify)

* 26. If your dog eliminates (urinates or defaecates) in inappropriate areas or at inappropriate times - how frequently does this occur and where are the inappropriate areas and/or when is the inappropriate time?

- My dog does not inappropriately eliminate
- My dog does inappropriately eliminate - please comment below

Please specify how frequently inappropriate elimination occurs , when it occurs and/or where it occurs

Faecal scoring chart

* 27. Please enter your dogs average faecal score (see chart above) Only one number is allowed. Pick the single number that is most representative of your dog's stool.

- 1 3.5
- 1.5 4
- 2 4.5
- 2.5 5
- 3

* 28. Has there been a change in your dog's stool consistency over the past 3 months?

- Yes – softer stools recently
- Yes – harder stools recently
- No change

* 29. On average, how many times does your dog have fresh blood (red colour) in his/her stool?

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Never |
| <input type="radio"/> A few times a week | <input type="radio"/> Not sure |
| <input type="radio"/> A few times a month | |

* 30. If fresh blood is found in the stool, which one of the following best describes the appearance?

- My dog does not have fresh blood in his/her stool
- A thin streak of fresh blood on the outside of stool
- Fresh blood is mixed within the stool
- A few drops of fresh blood after the stool is released

* 31. On average, what is the NUMBER of times your dog passes a stool (bowel movements) per day?
This is the number of times per day not the amount or volume of faeces your dog has each time.

- | | |
|-------------------------|---------------------------------|
| <input type="radio"/> 1 | <input type="radio"/> 4 |
| <input type="radio"/> 2 | <input type="radio"/> 5 or more |
| <input type="radio"/> 3 | |

* 32. Has there been a change in your dog's number of bowel movements per day over the past 3 months?

- Yes – increase in bowel movements/day
- Yes – decrease in bowel movements/day
- No change

* 33. On average, how many times does your pet have a black or tarry colour appearance to his/her stool when just passed?

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Never |
| <input type="radio"/> A few times a week | <input type="radio"/> Not sure |
| <input type="radio"/> A few times a month | |

* 34. On average, how many times does your dog have mucous or a gelatinous appearance to his/her stool?

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Never |
| <input type="radio"/> A few times a week | <input type="radio"/> Not sure |
| <input type="radio"/> A few times a month | |

* 35. On average, how often do you notice your dog burp (belch)?

- | | |
|--|---|
| <input type="radio"/> Only after eating and/or drinking | <input type="radio"/> A few times a month |
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Never |
| <input type="radio"/> A few times a week | |

* 36. On average, how often does your dog have gas (flatulence, fart)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 37. On average, how often do you hear your dog's stomach growl or gurgle?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 38. On average, how often does your dog have belly pain or cramping? (Your dog has a tense belly or is hunched over).

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 39. On average, how often does your dog strain to defaecate or squat for long periods to defaecate?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 40. How often does your dog eat grass?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 41. How often is your dog's grass eating behaviour associated with vomiting?

- | | |
|--|---|
| <input type="radio"/> Not applicable because my dog does not eat grass | <input type="radio"/> 33-66% of the time that they eat grass they vomit |
| <input type="radio"/> Never (when my dog eats grass he/she does not vomit) | <input type="radio"/> 67-99% of the time that they eat grass they vomit |
| <input type="radio"/> Not sure if vomiting occurs after eating grass | <input type="radio"/> 100% of the time that they eat grass they vomit |
| <input type="radio"/> 1-32% of the time that they eat grass they vomit | |

* 42. How often does your dog vomit (usually associated with stomach contractions)?

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Rarely - not more than once a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |
| <input type="radio"/> A few times a month | |

* 43. How often does your dog regurgitate? This is when food (digested/non-digested) or water comes out with no stomach contractions. The food/water just comes out of the mouth passively without stomach contractions.

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> Rarely - not more than once a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |
| <input type="radio"/> A few times a month | |

* 44. On average, how often does your dog rub his/her eyes?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 45. On average, how often does your dog rub his/her face or muzzle (nose)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 46. On average, how often does your dog have red eyes and/or discharge from the eyes

- | | |
|---|--|
| <input type="radio"/> Every day all year | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |
| <input type="radio"/> A few times a month | |

* 47. On average, how often does your dog lick or chew his/her paws?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 48. On average, how often does your dog lick or chew his/her front legs?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 49. On average, how often does your dog shake his/her head?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 50. On average, how often does your dog sneeze?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 51. On average, how often does your dog lick or chew his/her skin under the tail (around the anus)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 52. On average, how often does your dog lick, chew, or rub his/her lower portion of the back above the tail?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 53. How often do you have your dog's anal glands expressed by yourself, a groomer, or a veterinarian?

- Never, because not needed
- Once every 2 weeks
- Once a month
- Once every 2 months
- Once every 3 months
- Twice a year
- Once a year

* 54. On average, how often does your dog scoot or rub his/her bottom on the ground?

- Multiple times a day (≥ 3 times/day)
- Daily (1-2 times/day)
- A few times a week
- A few times a month
- A few times a year
- Never

* 55. If your dog does scoot or has a history of scooting his/her bottom on the ground, how long does the problem resolve after anal gland expression?

- My dog does not get his/her anal glands expressed and/or does not scoot his/her bottom on the ground
- Scooting is not improved and/or anal gland expression does not help scooting
- Less than 3 days
- 4-7 days
- 1-2 weeks
- 2-4 weeks
- 1-2 months
- Greater than 2 months

* 56. Has your dog ever been treated by a veterinarian for an anal gland infection, rupture, or abscess?

- Yes
- No

* 57. What ear problems does your dog have?

- My dog does not have ear problems
- My dog's ear(s) develop an odour/smell
- The ear(s) get dirty
- Other - Please describe the ear problem
- The ear(s) become itchy and my dog head shakes or scratches or rubs the ear(s)
- The ear(s) get infected and need other medications which I administer at home
- The ear(s) get infected and we need to visit the vet

* 58. How often do you clean your dog's ears?

- | | |
|---|--|
| <input type="radio"/> Daily | <input type="radio"/> Once monthly |
| <input type="radio"/> A few times a week | <input type="radio"/> A few times a year |
| <input type="radio"/> Once weekly | <input type="radio"/> Rarely - not more than once a year |
| <input type="radio"/> A few times a month | <input type="radio"/> Never |

* 59. How do you clean your dog's ears?

- | | |
|---|---|
| <input type="radio"/> I do not clean my dog's ears | <input type="radio"/> Using an ear cleanser solution applied to a tissue/cotton ball/cloth/wipe to wipe out the ear opening |
| <input type="radio"/> Wipe out the ear opening with dry tissue/cotton ball/cloth/wipe | <input type="radio"/> Using an ear cleanser solution applied into the ear canal and allowing it to be shaken out and then wiped clean |
| <input type="radio"/> Using cotton buds or cotton tipped applicator | |

* 60. Why do you clean your dog's ear(s)? Check all answers that apply.

- I do not clean my dog's ears
- I clean the ears for routine maintenance and grooming purposes
- I clean the ears because my dog has ear problems and cleaning helps
- Because my vet recommended it as routine care
- Because my vet recommended it for ear problems
- I clean the ears when they look dirty and/or smell
- I clean the ears after the dog has been swimming

* 61. Have you been shown or trained how to clean a dog's ears?

- | | |
|--|--|
| <input type="radio"/> No | <input type="radio"/> Yes - I watched a video online on ear cleaning |
| <input type="radio"/> Yes - by a vet | <input type="radio"/> Yes - I read how to do it in a dog manual/book/magazine/online |
| <input type="radio"/> Yes - by a vet nurse | <input type="radio"/> Yes - by a pet shop staff member |
| <input type="radio"/> Yes - by a groomer | |
| <input type="radio"/> Yes - I was shown how to clean dog's ears by another source - (please specify) | |

* 62. If you apply an ear cleanser solution into the ear canal how much do you use?

- | | |
|--|---|
| <input type="radio"/> I do not apply an ear cleanser solution into the ear canal | <input type="radio"/> I apply enough to fill the ear canal so that I can see it |
| <input type="radio"/> A set number of drops are applied into the ear canal | <input type="radio"/> I apply ear cleanser solution into the ear canal but not to a specified level or volume |
| <input type="radio"/> A set volume is applied into the ear canal eg. 1/2ml, 1ml, 5ml | |

* 63. On average how often do you bath/wash your dog?

- | | |
|---|---|
| <input type="radio"/> Never, because not needed | <input type="radio"/> Once every 2 months |
| <input type="radio"/> Multiple times a week | <input type="radio"/> Once every 3 months |
| <input type="radio"/> Once weekly | <input type="radio"/> Twice a year |
| <input type="radio"/> Once a month | <input type="radio"/> Once a year |
| <input type="radio"/> Multiple times a month | |

* 64. What do you use to wash your dog? Multiple answers are allowed.

- Human shampoo or soap
- Medicated shampoo prescribed by veterinarian
- Non medicated shampoo from pet shop/supermarket/groomer
- Water only
- Dish-washing liquid
- Other (please specify)

* 65. Do you wash your dog's paws other than when he/she is bathed?

- Yes
- No
- If yes please indicate why you wash your dogs paws

* 66. If bathing was recommended who recommended it? (if multiple select the initial recommendation)

- | | |
|--|--|
| <input type="radio"/> It was not recommended | <input type="radio"/> By a pet shop/store employee |
| <input type="radio"/> By my veterinarian | <input type="radio"/> By a friend |
| <input type="radio"/> By my groomer | <input type="radio"/> By another source |
| <input type="radio"/> By the breeder | |

Please specify the other source

* 67. Why do you bath/wash your dog? (check all that apply and multiple answers are allowed)

- | | |
|---|---|
| <input type="checkbox"/> I do not bath my dog | <input type="checkbox"/> Because it was recommended as routine care |
| <input type="checkbox"/> I bath my dog for routine maintenance and grooming purposes | <input type="checkbox"/> Because it helps relieve itching |
| <input type="checkbox"/> I bath my dog because he/she develops an unacceptable body odour | <input type="checkbox"/> Because it helps resolve red skin, rashes, flaky skin and dandruff |

* 68. How would you rate your dog's body odour

- | | |
|--|----------------------------------|
| <input type="radio"/> Not detectable | <input type="radio"/> Strong |
| <input type="radio"/> Pleasant/inoffensive | <input type="radio"/> Unpleasant |
| <input type="radio"/> Mild | |

* 69. Describe your dogs dominant body odour.

- | | |
|--|---------------------------------------|
| <input type="radio"/> There is no odour | <input type="radio"/> Corn chips |
| <input type="radio"/> Yeasty | <input type="radio"/> Dusty old house |
| <input type="radio"/> Rancid | <input type="radio"/> Sour |
| <input type="radio"/> Musty | <input type="radio"/> Urine |
| <input type="radio"/> Other, please describe | |

* 70. Does your dog often engage in repetitive behaviours such as chronic licking, tail-chasing, spinning or light-chasing?

- | | |
|---|---|
| <input type="radio"/> No | <input type="radio"/> Yes - three to six times weekly |
| <input type="radio"/> Yes – more than twice daily | <input type="radio"/> Yes - Once to twice weekly |
| <input type="radio"/> Yes - Once to twice daily | |

Please specify the repetitive behaviours your dog does engage in if the answer is YES to any of the above options

* 71. When your dog is performing the repetitive behaviour how easy is it to distract them from that behaviour?

- | | |
|---|---|
| <input type="radio"/> Not applicable as my dog does not perform repetitive behaviours | <input type="radio"/> Difficult to distract them |
| <input type="radio"/> Very easy – immediately stops the behaviour when distracted | <input type="radio"/> Very Difficult – can be distracted from the activity with a lot of difficulty |
| <input type="radio"/> Easy – stops the behaviour fairly quickly with distraction | <input type="radio"/> Unable to distract them from the activity at all |

Appendix 2. Second questionnaire used to collect data in the first survey.

* 1. What is your dog's name and ID number?

* 2. On average, what is the NUMBER of times your dog passes a stool (bowel movements) per day?
This is the number of times per day not the amount or volume of faeces your dog has each time.

- 1 4
 2 5 or more
 3

* 3. Please enter your dogs average faecal score (see chart above) Only one number is allowed. Pick the single number that is most representative of your dog's stool.

- 1 3.5
 1.5 4
 2 4.5
 2.5 5
 3

Faecal scoring chart

* 4. On average, how many times does your dog have mucous or a gelatinous appearance to his/her stool?

- Multiple times a day (≥ 3 times/day) A few times a year
 Daily (1-2 times/day) Never
 A few times a week Not sure
 A few times a month

* 5. On average, how often do you notice your dog burp (belch)?

- Only after eating and/or drinking A few times a month
 Multiple times a day (≥ 3 times/day) A few times a year
 Daily (1-2 times/day) Never
 A few times a week

* 6. On average, how often does your dog have gas (flatulence, fart)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 7. On average, how often do you hear your dog's stomach growl or gurgle?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 8. On average, how often does your dog strain to defaecate or squat for long periods to defaecate?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 9. How often does your dog eat grass?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 10. How often is your dog's grass eating behaviour associated with vomiting?

- | | |
|--|---|
| <input type="radio"/> Not applicable because my dog does not eat grass | <input type="radio"/> 33-66% of the time that they eat grass they vomit |
| <input type="radio"/> Never (when my dog eats grass he/she does not vomit) | <input type="radio"/> 67-99% of the time that they eat grass they vomit |
| <input type="radio"/> Not sure if vomiting occurs after eating grass | <input type="radio"/> 100% of the time that they eat grass they vomit |
| <input type="radio"/> 1-32% of the time that they eat grass they vomit | |

* 11. On average, how often does your dog rub his/her eyes?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 12. On average, how often does your dog have red eyes and/or discharge from the eyes

- | | |
|---|--|
| <input type="radio"/> Every day all year | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |
| <input type="radio"/> A few times a month | |

* 13. On average, how often does your dog lick or chew his/her paws?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 14. On average, how often does your dog rub his/her face or muzzle (nose)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 15. On average, how often does your dog shake his/her head?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 16. On average, how often does your dog lick or chew his/her front legs?

- | | |
|--|--|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |
| <input type="radio"/> A few times a month | |

* 17. On average, how often does your dog sneeze?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 18. On average, how often does your dog lick or chew his/her skin under the tail (around the anus)?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 19. On average, how often does your dog lick, chew, or rub his/her lower portion of the back above the tail?

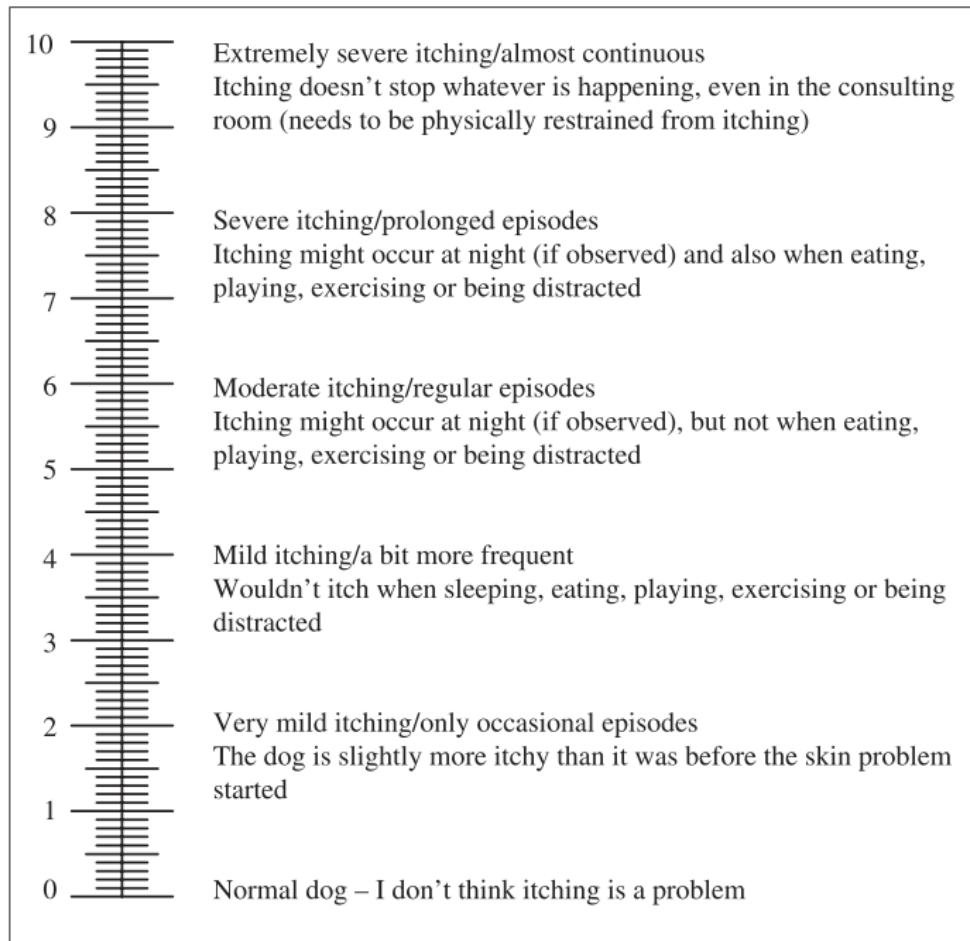
- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

* 20. On average, how often does your dog scoot or rub his/her bottom on the ground?

- | | |
|--|---|
| <input type="radio"/> Multiple times a day (≥ 3 times/day) | <input type="radio"/> A few times a month |
| <input type="radio"/> Daily (1-2 times/day) | <input type="radio"/> A few times a year |
| <input type="radio"/> A few times a week | <input type="radio"/> Never |

21. Please comment if there have been any changes in your dog's health since the first survey was completed eg. medical problems, medications, change in diet

Appendix 3. Pruritus Visual Analog Scale.







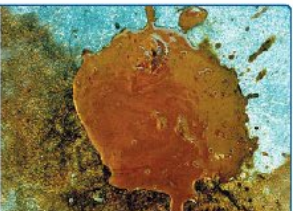


Appendix 4. The Canine Atopic Dermatitis Extent and Severity Index-04 (CADESI-04).

CADESI-04 (ICADA)		Erythema	Lichenification	Excoriations and/or Alopecia	TOTAL
Perilabial Area <i>(left and right combined)</i>	1				
Medial Pinnae <i>(concave pinnae)</i>	Left	2			
	Right	3			
Axillae	Left	4			
	Right	5			
Front Paws <i>(dorsal and palmar sides combined)</i>	Left	6			
	Right	7			
Hind Paws <i>(dorsal and plantar sides combined)</i>	Left	8			
	Right	9			
Cubital Flexor <i>(elbow folds)</i>	Left	10			
	Right	11			
Palmar Metacarpal <i>(from carpal to metacarpal pads)</i>	Left	12			
	Right	13			
Flanks	Left	14			
	Right	15			
Inguinal Areas <i>(groin)</i>	Left	16			
	Right	17			
Abdomen	18				
Perineum <i>(from vulva/scrotum to anus)</i>	19				
Ventral Tail <i>(proximal)</i>	20				
grade each site and each lesion type: <i>none: 0; mild: 1; moderate: 2; severe: 3</i>		TOTAL Score (20 x 3 x 3 = 180)			

Appendix 5. Faecal score used to evaluate faecal consistency.

The WALTHAM® Faeces Scoring System

<p>Grade 1 Hard dry and crumbly; 'Bullet-like'</p>		<p>Grade 1.5 Hard and dry</p>		<p>Grade 2 Well formed; does not leave a mark when picked up; 'kickable'</p>	
<p>Grade 2.5 Well formed, with a slightly moist surface, which leaves a mark when picked up; almost sticky to touch</p>		<p>Grade 3 Moist beginning to lose form, leaving a definite mark when picked up</p>		<p>Grade 3.5 Very moist, but still has some definite form</p>	
<p>Grade 4 The majority, if not all the form is lost; poor consistency; viscous</p>		<p>Grade 4.5 Diarrhoea, with some areas of consistency</p>		<p>Grade 5 Watery diarrhoea</p>	

Reference: Moxham, G. (2001) Waltham faeces scoring system – A tool for veterinarians and pet owners: how does your pet rate? WALTHAM® Focus, 11, 2, 24–25



