An International Genetic Survey of Working Canines from the United States, Israel and Poland

Lisa G Shaffer, PhD, FACMG¹,², Christina Ramirez, DVM, PhD, DACVP¹, Patricia Phelps, PhD³*, Maya Aviram⁴, Marta Walczak, PhD⁵, Gila Kahila Bar-Gal, PhD⁴, Blake C Ballif, PhD¹

¹Paw Print Genetics, Genetic Veterinary Sciences, Inc., Spokane, WA, USA
²School of Molecular Biosciences, College of Veterinary Medicine, Washington State University, Pullman, WA, USA
³Smithsonian Museum of Natural History, Washington DC, USA
⁴Koret School of Veterinary Medicine, The Robert H Smith Faculty of Agriculture, Food and Environment, Hebrew University of Jerusalem, Israel
⁵Department of Animal Behavior, Institute of Genetics and Animal Breeding, Polish Academy of Sciences, Magdalenka, Poland
Introduction

Genetic diseases are found in dog breeds commonly used as working dogs.

As important members of their teams, dogs are expected to operate at peak performance for several years.
Introduction

Working dogs are a significant investment for both cost of purchase and training.

Previous studies examining reasons for discharge or euthanasia failed to include genetic risks.
To identify breed-specific genetic risks for inherited diseases in working dogs

With the goal of providing a justification for screening dogs prior to breeding, buying or training
304 dogs were ascertained
  - 267 law enforcement dogs
    - 122 US, 87 Israel, 58 Poland
  - 37 search & rescue (SAR) dogs (US)

Study participants included dogs in training, active duty or retired

Handlers collected 3 cheek swabs (US) or veterinarians collected blood in EDTA (Israel, Poland)

Dogs were screened with routine molecular genetic methods for 1-15 disease mutations based on breed
Results – Carrier Dogs

29% (n=89) heterozygous carrier dogs identified

- Degenerative myelopathy
  - 46 German shepherd dogs (30 US, 4 Israel, 12 Poland)
  - 9 Belgian malinois (5 Israel, 4 Poland)
  - 2 Bloodhounds (US)
  - 5 mixed breed dogs (US)
Results – Carrier Dogs

- 29% (n=89) heterozygous carrier dogs identified
  - Leukocyte adhesion deficiency, type III
    - 7 German shepherd dogs (5 US, 1 Israel, 1 Poland)
  - Exercise-induced collapse
    - 12 Labrador retrievers (3 US, 9 Israel)
  - Progressive retinal atrophy (PRCD)
    - 6 Labrador retrievers (2 US, 4 Israel)
  - Hereditary nasal parakeratosis
    - 1 Labrador retriever (Israel)
6% (n=19) homozygous at-risk dogs identified

- Degenerative myelopathy
  - 12 German shepherd dogs (9 US, 1 Israel, 2 Poland)
  - 2 Bloodhounds (US)
- Leukocyte adhesion deficiency, type III
  - 1 German shepherd dogs (US)
- Exercise-induced collapse
  - 4 Labrador retrievers (1 US, 3 Israel)
Degenerative Myelopathy

- DM occurs in more than 150 breeds of dog
- All 304 dogs were tested and 25% were carriers or at-risk for DM
- DM affects white matter of spinal cord
- Average age of onset for symptoms is 9 years
- Mutation in SOD1
  - Also found in humans, Lou Gehrig’s Disease (amyotrophic lateral sclerosis, ALS)
- Gradual muscle atrophy, begins in hind limbs
- Progressive disease
Degenerative Myelopathy - GSD

- No dogs showed symptoms at the time of study
- 150 GSD studied: 46 carriers, 12 at-risk
  - 67% US, 9% Israel, 24% Poland
- Significant number of GSD with DM mutations
  - 38% from US, 20% from Israel, 25% from Poland
Analysis of molecular variance and pairwise relatedness analysis was calculated on a subset of GSD to understand any bias of ascertainment.

Analyses indicated:

- Closer relationship between dogs from US and Poland, than Israel.
- Overall, 92.2% of dogs were unrelated.
- 7.8% showed some degree of relatedness
  - Only 1 pair from the US indicated full siblings.
Degenerative Myelopathy - GSD

Previous studies cite degenerative diseases, spinal cord disease, or musculoskeletal disease, as reasons for early discharge or euthanasia of working dogs, leading to the speculation of possible DM.

Our study showed DM in a substantial number of German shepherd dogs and other working breeds tested.

Thus, DM is likely a significant challenge among law enforcement and other working dogs.
Exercise-induced Collapse - Labrador

- 16 dogs identified - 12 carriers, 4 at-risk
- Neuromuscular disorder presents with exercise intolerance
- Many dogs diagnosed after 2 years of age
- 5-20 min. of strenuous exercise results in collapse with recovery
  5-30 min.
- Episodes would be stressful to the handler and could jeopardize both handler and dog in certain situations
Leukocyte Adhesion Deficiency III

- 7 dogs identified – 6 carriers, 1 affected
- Blood disorder characterized with abnormal platelets, abnormal clotting and immune system dysfunction
- Dogs may present with lameness, prolonged bleeding, recurrent infections
- One pup, identified as affected, was in training when entered into the study
  - Pup presented with severe joint swelling and persistent high neutrophil count
Search and Rescue Dogs

- 37 dogs studied from a variety of breeds
  - Australian shepherd, Belgian sheepdog, Belgian tervuren, bloodhound, border collie, catahoula leopard dog, Czechoslovakian vicak, Dutch shepherd, German shepherd dog, golden retriever, Labrador retriever, standard poodle, mixed breeds

- Tested for breed-specific mutations

- Australian shepherd
  - 1 dog at-risk for multi-drug resistance (MDR1)
Summary

35.5% of all dogs studied were either carriers or at risk for known genetic diseases

Based on this study, before breeding, buying or training, working dogs should be screened for common, breed-specific genetic conditions

Identifying carriers allows informed breeding decisions and avoidance of breeding carrier x carrier

Conditions identified in this study are likely to put the dog, handler or the mission in jeopardy (EIC) or shorten a K9’s career (DM)
The loss of dogs due to early retirement or euthanasia as a result of preventable genetic conditions has emotional costs to handlers and financial costs to service organizations.

Known genetic conditions are easily avoided through relatively low cost genetic testing.

These findings and conclusions are applicable to any working or assistance dogs.
Paw Print Genetics is a fee for service lab that provides genetic testing to breeders, owners and trainers

Funding was provided by Paw Print Genetics and NCN grant 2012/07/D/NZ9/03370 to GKB-G

This study was part of a high school summer internship for A Giri, at the Smithsonian Museum of Natural History, Washington DC

We thank all of the handlers, officers and K9s that participated in this study