INTRODUCTION

The well-being of dogs used in research is contingent upon the development and implementation of appropriate programs that promote: disease prevention, adequate veterinary care, proper nutrition, sound husbandry, socialization and appropriate facilities (92). There are two factors affecting well-being: physiological and psychological. Physiological well-being may be defined as a state of clinical health or absence of disease or injury. Psychological well-being, however, is problematic in definition because of the complexity of assessing the "mental state" of an animal. One working definition refers to psychological well-being as a state in which an animal is free of distress for the most part, is in good health, exhibits a substantial range of behaviors typical of the species and can deal effectively with its environment (64).

Psychological well-being of dogs has been of recent concern to biological scientists, animal protection groups, the general public and regulatory agencies. The 1985 amendments to the Animal Welfare Act (Public Law 99-189) directed the Animal and Plant Health Inspection Service (APHIS) to promulgate regulations that would require registered dealers, exhibitors and research institutions to provide dogs with the opportunity to exercise. All registrants must develop an institutional plan that would satisfy regulatory requirements (1). APHIS has suggested that opportunities for exercise may be provided in a number of different ways. For example:

- Dogs may be group housed in cages, pens or runs that provide at least 100 per cent of the regulated space requirement for each dog.
- Individually housed dogs can be housed in cages, pens or runs that provide at least double the minimum regulated space required.
- Dogs can be given access to a run or open space.
Dogs can be given positive physical contact with a human which encourages exercise (e.g. play).

Treadmills, carousels, swimming or other forms of forced exercise cannot be utilized to meet regulatory criteria since the intent of Congress was to provide the dog with the "opportunity" for exercise (1).

Controversy has surrounded the development of standards to satisfy Congressional intent (2,5). Although research has been conducted using dogs as a model for exercise physiology, little scientific work has been conducted to determine a dog's exercise "needs" in a physiologic and psychological sense (63,64,66,92). However, comparative studies may be beneficial in establishing physiological reference values of physical fitness that can be used to further investigate physiological "need".

Many factors are thought to influence the physiological and psychological well-being of the confined dog. Genotype, housing, behavior, sex, breed, age and socialization have been cited as variables (69,87,90). Of these factors housing and socialization (animal or human) have been studied to a limited degree. To date, studies have not been able to significantly demonstrate that cage size affects exercise and/or physical fitness when submaximal heart rate, muscle enzymes (O2 utilization) and plasma cortisol (stress) are measured (63,66,70,71).

There is, however, evidence that well-socialized dogs are more likely to be active than those that are socially deprived (67,69,76). Socialization can be provided through conspecifics, human contact or both. Ethological studies of wild animals have revealed that when all physiological criteria are met through food abundance, shelter and there is absence of predation animals will not "exercise". The conservation of energy is of utmost importance in wild animals and unnecessary expenditure is not a viable strategy. Therefore exercise happens as a result of animals satisfying other behavioral and physiological activities (e.g. foraging for food, socializing or seeking shelter (69). Socialization in packs for the purpose of maintaining heirarchy, resource access and breeding priviledge may be considered one of the activities. How this extrapolates to the confined domestic dog has not been determined.

More research into physiological and psychological factors is needed to fully determine their importance in maintaining a dog's psychological well-being in a variety of environments and how to measure those factors to determine whether needs are met (63,64,66,67).

This Special Reference Brief (SRB) is designed to provide bibliographic information on exercise for dogs. The SRB has been divided into categories that are related to the subject area: Regulatory Issues, Exercise Physiology, Environmental Physiology and Behavior, Husbandry and Management and, Biological Reference Values. The information in this document was derived from a variety of information resources. All citations available from the collection of the National Agricultural Library (NAL) will provide the NAL call number.

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REGULATORY ISSUES

001
NAL call number: JK6.F4
Descriptors: regulations, housing, handling, transport, treatment, care.

002
"Doghouse or dogtrot -- How much exercise does a dog need?" Upfront 9(1) Winter 1991, The Veterinary Medical Experiment Station, College of Veterinary Medicine, The University of Georgia, Athens, GA 30602 (Newsletter).
Descriptors: caging, indoor and outdoor housing, exercise, physical fitness.

003
"Caging systems for dogs under the new standards of the Animal
NAL call number: QL737.C22C36
Descriptors: pens, runs, kennels, facility design, floor space.

004
NAL call number: QL737.C22C36
Descriptors: legislation, housing, Canadian Council on Animal Care, recommendations.

005
NAL call number: QL737.C22C36
Descriptors: Animal Welfare Act, proposed regulations, housing, exercise requirements.

006
NAL call number: 470 Sci2
Descriptors: dogs, nonhuman primates, facilities, costs, regulations, Animal Welfare Act, exercise, cages, biomedical research.

EXERCISE PHYSIOLOGY

Cardiovascular

007
Descriptors: dogs, coronary blood flow (CBF), ventricular pressure, atrial pressure, prazosin, adenosine, submaximal exercise.

008
Descriptors: arterial pressure, baroreceptor pressure, electrocardiogram, heart rate, R-R interval, nitroprusside, carotid occlusion.
Descriptors: dogs, myocardial degeneration-regeneration.

NAL call number: 447.8 J825
Descriptors: dogs, intracoronary infusion, alpha-adrenergic agonists, beta 2-adrenergic agonists, vasodilator, nonspecific potentiation, stellate ganglionectomy.

NAL call number: 447.8 J825
Descriptors: baroreflex modulation, heart rate, vascular resistance, phenylephrine, treadmill, ganglionic blockade.

NAL call number: 447.8 J825
Descriptors: propranolol, treadmill, heart rate, blood volume, arterial lactates.

Descriptors: left ventricular function, cardiomegaly, systemic vascular resistance, cardiac index, stroke volume.

NAL call number: 447.8 J825
Descriptors: maximal exercise, submaximal exercise, treadmill, cardiac output, lactate, VO2max.

NAL call number: QP121.A1R4
Descriptors: average blood flow, treadmill, oxygen uptake, cardiac output, muscle blood flow.
Descriptors: treadmill, submaximal exercise, endurance, alpha-adrenergic stimulation, serotonin.

NAL call number: 447.8 J825
Descriptors: dogs, sedentary, exercise-trained, coronary blood flow, permeability surface area, labelling, muscles, vasodilation.

NAL call number: 447.8 J825
Descriptors: microspheres, adenosine, myocardial flow.

NAL call number: 447.8 J825
Descriptors: treadmill, resting, submaximal exercise, alpha-receptor stimulation, neural control, potentiation.

NAL call number: 41.8 AM3A
Descriptors: radionuclide angiography, interrelationships, cardiovascular system.

NAL call number: 41.8 R3224
Descriptors: tracing analysis, diagnostics, interpretation, clinical studies.

NAL call number: 447.8 J825
Descriptors: treadmill, diastolic coronary resistance, aortic pressure, left coronary circumflex flow, adrenergic blockade.
NAL call number: 447.8 J825
Descriptors: intrapericardial denervation, chronoic exercise, bradycardia, treadmill.

NAL call number: 447.8 J825
Descriptors: treadmill, gastrocnemius malate dehydrogenase, cardiac output, stroke volume, tension-time index, pressure time-index.

NAL call number: 447.8 J825
Descriptors: left circumflex coronary flow, aortic pressure, heart rate, adrenergic blockade, myocardial oxygen consumption.

NAL call number: 447.8 J825
Descriptors: coronary blood flow, atrial pacing, occlusion, reactive hyperemia.

NAL call number: 447.8 AM3
Descriptors: chemoreceptors, hypercapnia, acidosis, pressure reflex, tachycardia reflex.

NAL call number: 447.8 J825
Descriptors: hypertrophy, hemodynamics, bloodflow, treadmill.

NAL call number: 447.8 J825
Descriptors: coronary occlusion, blood flow, vascular resistance,
weight ratios, hypertrophy.

NAL call number: DISS 72-7, 724
Descriptors: vascular reactivity, physiology.

NAL call number: 447.8 J825
Descriptors: coronary blood flow, blood pressure, atropine.

Musculoskeletal

Descriptors: articular blood flow, microsphere technique, treadmill, justa-articular bone.

Descriptors: histology, microspectrophotometry, stifle joint, GAGs, chondroitin sulfates, calcification.

NAL call number: 447.8 J825
Descriptors: treadmill, blood flow, muscles, dynamic exercise training.

NAL call number: 447.8 J825
Descriptors: gastrocnemius, triceps, semitendinosus, treadmill, biochemical analysis, histochemical analysis.

037
NAL call number: 447.8 J825
Descriptors: endurance, body temperature, hyperthermia, heart rate, respiratory rate, blood lactic acid, plasma osmolality.

038
NAL call number: 447.8 AM32
Descriptors: endurance, treadmill, muscle biopsy, stereology, heterochromatin, euchromatin.

039
NAL call number: 41.8 Am3A
Descriptors: enzymes, humeral head, lactic acid dehydrogenase, succinic acid, nicotinamide dinucleotide dehydrogenase, glucose-6-phosphatases, lipid synthesis.

040
Descriptors: articulation, joint.

041
NAL call number: 41.8 Am3A
Descriptors: laboratory, treadmill, blood lactate, pulse rate, alkaline reserve, hemoglobin, muscle fibers.

Biochemical/Metabolic

042
NAL call number: QL737.C22C36
Descriptors: cage housing, serum chemistry, cortisol, lymphocyte transformation.
Descriptors: hematology, treadmill, endurance training, blood cell index.

NAL call number: 41.8S08
Descriptors: indices of fitness, heart rate, rectal temperature, plasma creatine kinase, plasma lactate, hemoglobin.

NAL call number: 41.8 Am3A
Descriptors: heart rate, respiratory rate, rectal temperature, blood cell counts, sodium, chloride, aspartate transaminase, creatine kinase, urea.

NAL call number: 41.8 V641
Descriptors: red blood cell counts, hemoglobin, hematocrit, plasma protein, creatinine, blood lactate, plasma glucose, ammonia, glycerol, uric acid.

NAL call number: 41.8 Am3A
Descriptors: coagulation Factor VIII, von Willebrand factor, coagglutinin cofactor activity, plasma concentrations.

NAL call number: 442.9 F31P
Descriptors: succinate dehydrogenase, gastrocnemius, triceps brachii, gluteral, gracilis, flexor digitorum superficialis.

Descriptors: hematology, confinement.

050
"Important role of glucagon during exercise in diabetic dogs."
NAL call number: 447.8 J825
Descriptors: glucose kinetics, insulin, counter-regulatory hormones, epinephrine, norepinephrine, cortisol, lactate, immunoreactive glucagon (IRG).

051
NAL call number: 41.8 M69
Descriptors: temperature, ear canal, rectal, blood samples, morphology, lactic acid, blood cell count, hemoglobin, packed cell volume, biochemical changes.

052
NAL call number: 447.8 J825
Descriptors: fatty acids, working muscle, triglyceride uptake.

053
NAL call number: QP1.I522 1980
Descriptors: treadmill, creatine phosphokinase, 1,6 diphosphate-aldolase, glutamic pyruvic transaminase, glutamic oxaloacetic transaminase.

054
NAL call number: 41.8 R3224
Descriptors: hematology, hemoglobin, hematocrit, blood cell counts, lactate, creatine, phosphokinase, glutamic pyruvic transaminase, heart rate.

055
Descriptors: exertion, fatty acids, norepinephrine, thyroid hormones.

056
NAL call number: 444.8 AC8
Descriptors: temperature, rectal, blood samples, glucose, lactate, free fatty acid, adrenaline, noradrenaline, muscle glycogen, muscle biopsy.

057
NAL call number: 444.8 AC8
Descriptors: temperature, blood enzymes, muscle biology.

058
NAL call number: 447.8 J825
Descriptors: turnover, oxidation, gluconeogenesis, utilization.

Respiration

059
"Ventilatory responses during electrically induced muscular work in anesthetized dogs after both deafferentation and cross circulation of hindlimbs." A.C. Da Silva, et.al. Brazilian Journal of Medical and Biological Research 15(2-3):153-159 (July 1982).
Descriptors: neural afferent component, hyperpnea, humoral effects, respiratory minute volume, frequency, tidal volume, oxygen consumption, tachypneic response.

060
NAL call number: QP121.A1R4
Descriptors: VE response, treadmill, VT response, frequency.

061
NAL call number: QP1.1522 1980
Descriptors: lingual blood flow, respiratory rate, thermoregulation, treadmill, blood pressure, interplueral
pressure, electromagnetic flowmetry.

062
NAL call number: 447.8 J825
Descriptors: energy metabolism, ventilation, respiratory parameters.

ENVIRONMENTAL PHYSIOLOGY AND BEHAVIOR

063
NAL call number: 41.3 AmA3
Descriptors: environment, treadmill, heart rate, enzyme activities.

064

065
NAL call number: Q17337.C22C36
Descriptors: temperature, humidity, ventilation, contaminants.

066
NAL call number: QL737.C22C36
Descriptors: confinement systems, housing, experimental design, EKG, muscle enzyme, behavior.

067
NAL call number: QL737.C22C36
Descriptors: housing, movement, distance, time, handling.
NAL call number: QL737.C22C36
Descriptors: whelping, neonatal care, social behavior program.

NAL call number: QL737.C22C36
Descriptors: ethology, socialization, exercise, housing, environment, psychological well-being.

NAL call number: 410.9 P94
Descriptors: distance, activity patterns, movement, socialization.

NAL call number 41.8 Am3A.
Descriptors: dogs, exercise, stress, lymphocyte transformation, cortisol, animal welfare.

NAL call number: SF402 S3
Descriptors: circadian activity, behavioral patterns, rhythms, eating, elimination, aggression, environmental conditions.

NAL call number: 410 Z36
Descriptors: breeds, cage size, cage rearing, growth rate, food intake, fur quality, animal behavior.

NAL call number: 410 Z36
Descriptors: environment, red blood cell counts, packed cell
volume, hemoglobin, plasma enzymes, substrates, minerals.

075
NAL call number: 41.8 AM3
Descriptors: stress, eustress, feeding behavior, reproduction, ACTH, glucocorticoids, sympathetic nervous system, responses.

076
NAL call number: SF406 F69
Descriptors: confinement effects, physical activity, stereotypies, cage size.

077
NAL call number: 410 Z36
Descriptors: dogs, animal housing, movements, dark, light, kinetic energy.

078
NAL call number: QL55.A1L33
Descriptors: behavior, temperament testing, selection and breeding.

079
NAL call number: QL750.A6
Descriptors: hand-rearing, litter-rearing, stimulus, exploratory behavior, locomotor activity, novel objects, reactivity.

080
NAL call number: QL750.A6
Descriptors: activity patterns, range, social interaction, roaming.

081
Descriptors: aggression, crowding, dominance, eating, spatial behavior.
082
NAL call number: 447.8 J825
Descriptors: treadmill development, banked track, construction, design, speed, maintenance, diagram.

083
NAL call number: 410.9 P94
Descriptors: weight gain, activity patterns, standing, lying, sitting, sleeping, electrocardiograph, examinations, ophthalmic, hematologic, biochemical measurements.

084
NAL call number: 410.9 P94
Descriptors: physical activity, specific activity measurements, body weight, blood chemical and urine values.

085
NAL call number: 410.9 P94
Descriptors: calcium-47 kinetic analysis, myofibrillar enzymes.

086
Descriptors: petting, human presence, bradycardia, genetics.

087
NAL call number: SF406 I52
Descriptors: selective breeding, genotype, handling, socialization, temperament, isolation, exercise.

088
NAL call number: 410 B393
Descriptors: intra-species socialization, intra-species identification, avoidance, recognition, bonding.
NAL call number: 442.8 262
Descriptors: social interaction, environment, electrophysiology, electroencephalography, chemical analysis.

090
NAL call number: 410.9 P94
Descriptors: review, normal behavior, abnormal behavior, social stimulation, crowding.

091
NAL call number: 41.8 AM3
Descriptors: housing, economics, design, welfare.

HUSBANDRY AND MANAGEMENT

092
NAL call number: QL737.C22C36
Descriptors: psychological well-being, exercise, socialization, management, performance vs. engineering standards.

093
NAL call number: SF406 F69
Descriptors: behavior, care, management, wellbeing.

094
NAL call number: SF406 N32 1985
Descriptors: guidelines, policy, husbandry, facilities, laboratory management.

095
Comfortable Quarters for Laboratory Animals Animal Welfare Institute: Washington, DC; 1979, pp. 52-57.
NAL call number: SF91.A5
Descriptors: housing, facilities, site visits, requirements, indoor, outdoor.
Dogs: Standards and Guidelines for the Breeding Care and Management of Laboratory Animals ILAR (Institute of Laboratory Animal Resources) Subcommittee on Dog and Cat Standards, Committee on Standards, National Academy of Sciences, Washington, DC; 1973, 48 pp. NAL call number: SF407 D6N38 Descriptors: selection, conditioning, procurement, facilities, husbandry, restraint, euthanasia, disposal.


BIological REFERENCE VALUES


NAL call number: 447.8 AM3
Descriptors: hemodynamic variables, vagal afferents, hypertension, regional blood flow.

NAL call number: 396.8 C61
Descriptors: pretreatment values, reference intervals, experimental design, analytical methods, variance.

NAL call number: SF601 V523
Descriptors: thrombokinetics, screening techniques, plasma, clotting factors.

NAL call number: 41.8 Am3A
Descriptors: measurements, correlations, body weight.

NAL call number: 41.9 AM37
Descriptors: m-mode echocardiography, amplitude, dimensions, aortic and atrial measurements.

Descriptors: conscious and unconscious dogs, catecholamine, hemodynamic variables.

NAL call number: 41.8 Am3A
Descriptors: mean conduction velocities, sensory action potentials, average evoked response technique.

110 "Normal biochemical values of canine blood." P. Schoning and A.C.
111 "Hematology reference values for dogs of Beagle stock." J.
NAL call number: 410 Z36
Descriptors: hematology, red blood cell counts, leukocyte counts,
leukocyte profiles.

112 "Hematology of the normal dog and cat." H.W. Tvedten. Veterinary
NAL call number: SF601.V523
Descriptors: hematology, blood profiles, review.

113 "The normal electrocardiogram of the conscious Beagle dog." A.
Eckenfels and G. Trieb. Toxicology and Applied Pharmacology
NAL call number: RA1190.S627
Descriptors: methods, aging, sex, heart rate, body weight.

114 "Canine hematology and biochemistry reference values." J.H.
Lumsden, K. Mullen, et.al. Canadian Journal of Comparative
Descriptors: hemodynamics, calcium, magnesium, standards.

115 "Normal laboratory values in Beagle dogs of twelve to eighteen
months of age." J.E. Jordan. American Journal of Veterinary
NAL call number: 41.8 Am3A
Descriptors: spinal fluid variables, urinalysis, creatine
phosphokinase, urine 5-hydroxyindoleacetic acid, urine
vanillylmandelic.

116 "Serum chemistry values of normal dogs (Beagles): Association
with age, sex and family line." L.V. Kaspar and W.P. Norris.
NAL call number: 410.9 P94
Descriptors: serum component analysis, age, sex and familial
effects.

117 The Beagle as an Experimental Dog A.C. Anderson and L.S. Good
NAL call number: QL737 C22A5
Descriptors: husbandry, management, experimental variables,
reference values.

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