Original Article

Effects of swimming frequency on body weight and serum lipid profile in small-breed dogs during a four-month period

Korakot Nganvongpanit[1*] Napat Ruamrungsri[1] Boonyapawn Tepsoontorn[1]

Terdsak Yano[2] Puntita Siengdee[1] Siriphun Kongsawasdi[3]

Abstract

Lack of activities for dogs, that is, decreased body motion and lack of opportunities to exercise, can cause dogs to become overweight. Swimming is one of the best physical exercises for a dog that has been approved by a veterinary doctor, and it provides a form of supported exercise. Almost all the muscles are required for the movement that involves improving strength, working the cardiovascular and respiratory system, and increasing the metabolic rate withoutimpact on joints. One interesting aspect of swimming is its ability for weight and serum lipid control. The effect of frequency-controlled swimming activity on a dog's weight and its effect on the serum lipid profile level have been well examined and recorded in this study. The dogs were randomly categorized into four groups that swam every day, four times a week, two times a week, and once a week, respectively. The dogs exercised twice a day for 20 minutes each time. The swimming program was continued for a period of four months. Swimming every day significantly reduced the dogs' weight and cholesterol level after one month, while swimming four days per week significantly reduced weight and cholesterol level after four months. After just one month of swimming four days per week, serum triglyceride level was found to be significantly reduced compared with the other groups. HDL level decreased steadily until the third month in the group that swam every day. However, in all the groups, no significant changes were found in the levels of LDL and VLDL in dog serum after 4 months of swimming. In conclusion, higher frequency of swimming per week yields better results than lower frequency for weight and serum lipid control.

Keywords: dog, swimming, serum lipid, weight

[1]*Animal Bone and Joint Research Laboratory, Department of Veterinary Biosciences and Public Health, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand*
[2]*Department of Food Animal Clinic, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand*
[3]*Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai 50200, Thailand*
***Correspondence**: korakot.n@cmu.ac.th*

Introduction

Swimming is one of the most beneficial physical exercises. It is widely used in many health conditions: for example, to control or reduce body weight (Higa et al., 2012; Jeong and Yoon, 2012), to improve muscle mass (Matsakas et al., 2012), to improve joint motion (Batterham et al., 2011; Nganvongpanit et al., 2014), to improve neurological function (Oblby et al., 2005), or to improve the cardiovascular system (Thompson et al., 2003).

Many research studies have been carried out around the world to study the effects of swimming in various categories, but almost all the research used rats, mice, or humans as the subjects of the study, while studies on dogs are limited. A previous study from our group (Nganvongpanit et al., 2014) demonstrated that swimming can improve the function of osteoarthritic joints in dogs with osteoarthritis (OA) by swimming over a period of 2 days per week for 8 weeks, continuously. To design swimming programs for each condition of dogs, a lot of basic and applied research data is still needed. Whether the intensity and frequency of swimming would make an effective impact on the condition of the dog remains questionable. We do believe that swimming protocols for humans cannot be used for dogs due to their physical differences, particularly given the wide variety of breeds and types of dogs. For example, we found that leg movement in small-breed dogs is around 99.7 times/min, which is significantly higher (p<0.05) than the leg movement in large-breed dogs (71.72 times/min) (Nganvongpanit et al., 2015). Additionally, this study determined that the highest level of serum lactate was found in small-breed dogs after 15 min of swimming, while swimming for 30 min was found to be unsuitable for reaching the highest level of serum lactate (Nganvongpanit et al., 2015).

It is known that exercise increases the utilization of lipids in the body as a source of energy (Jordy and Kiens, 2014). Numerous studies have reported that aerobic exercise combined with weight loss significantly reduces blood cholesterol, low density lipoprotein (LDL), very low density lipoprotein (VLDL), and triglycerides, while improving high density lipoprotein (HDL) (Gordon et al., 2014; Ravi Kiran et al., 2006; Taralov et al., 2000). Research has demonstrated that the regulation of fat metabolism is complex and involves many sites of control, including the transport of fat into the myofibril cells and mitochondria, the binding and transport of fat from the cell membrane in the cytoplasm, and the regulation of intramuscular triacylglycerol synthesis and breakdown (Spriet, 2014). One interesting aspect of swimming is its capability to change weight and control serum lipid level. Many lipids are insoluble in serum, although they are made soluble by attachment to circulating lipoproteins. Five lipoprotein types are predominant; these include cholesterol, triglycerides, HDL, LDL, and VLDL. The effects of a swimming program on serum lipid profile level have been reported in rats (Ravi Kiran et al., 2006) and humans (Taralov et al., 2000). So far, no study has reported the effects of swimming frequency on weight change and serum lipid profile in dogs. This study aims to observe the effects of the frequency of swimming on canine body weight and serum lipid profile (triglycerides, cholesterol, LDL, and HDL) during a four-month period of exercise. The results of this study will be beneficial for developing an exercise protocol for dogs using a swimming program.

Materials and Methods

Animals: Twenty-four small-breed dogs (Shi-Tzu, Pug, Pomeranian, Poodle, and French Bulldog) of good health and body condition score (BCS) 4–6 from a score system of 9 (Dorsten and Cooper, 2004) were the subjects of this study. All the animals were physically examined by veterinarians (3 persons), and they agreed that the dogs were in good health. Three mL of blood samples were used to evaluate the dogs' health. The blood samples were analyzed for complete blood count, including hematocrit, hemoglobin level, red blood cell count, white blood cell count, and platelet count. Serum was analyzed for aspartate aminotransferase (AST), alanine aminotransferase (ALT), blood urea nitrogen (BUN), and creatinine. If, in any of these animals, these values were found to be abnormal, those animals were excluded from the study.

Compared to the pre-study period, during the study all the animals received the same food (all commercial food), the same amount, and at the same frequency. The animals were prohibited from taking medicines, food supplements, and snacks during the study. All ill dogs were immediately excluded from the study. The trial protocol was approved by the Faculty of Veterinary Medicine, Chiang Mai University's Ethics Committee, Chiang Mai, Thailand, in the year 2012.

Experimental design: The dogs were randomly categorized into four groups of six dogs per group (Table 1): the dogs in group 1 (G1) swam every day; those in group 2 (G2) swam four times a week; the dogs in group 3 (G3) swam two times a week; and those in group 4 (G4) swam once a week. After the randomized categorization, the BCS, body weight, and age were subjected to statistical analysis using t-tests to prove that no significant differences were observed between the groups.

Table 1 Experimental groups of dogs.

Group	Number of dogs			Swimming frequency (days/week)	Weight (kg)	Age (months)	BCS
	Total	M	F				
G1	6	2	4	7	6.28 ± 3.47	31.33 ± 16.48	4.3 ± 1.0
G2	6	3	3	4	7.74 ± 4.07	35.50 ± 26.49	4.0 ± 1.1
G3	6	3	3	2	8.91 ± 4.29	33.50 ± 19.02	4.5 ± 0.8
G4	6	3	3	1	7.34 ± 4.04	38.50 ± 17.40	4.5 ± 1.0

Note: BSC = body condition score; M = male; F = female.

The swimming program was continued for a period of 4 months. The swimming protocol consisted of starting each session with a warm-up exercise of walking for 5 min, followed by swimming for 20 min and resting for 5 min, which was then followed by swimming for 20 min (Nganvongpanit et al., 2011).

The swimming pool (2.5 × 6.0 × 1.5 m, W × L × H) in this study was a chlorine-system pool using calcium hypochlorite, a long-lasting chlorine compound (J.D. Pools, Thailand). During the day, the water temperature ranged between 25°C and 30°C, with the pH between 7.2 and 8.4, and the chlorine level in the range of 0.5–2.0 ppm.

To prevent the dogs from swimming by themselves during the study, the dogs were not made to wear swimming suits while swimming; however, trainers were stationed close to the dogs in the pool to prevent any accidents, and all the dogs were controlled by the trainers as regards the speed of swimming.

Data and blood collection: To evaluate the effects of the difference in the frequency of swimming, data collection was carried out, including body weight and serum lipid profile. Lipid profiles, including cholesterol, triglycerides, HDL, LDL, and VLDL, were collected using an Automated Hitachi 917 analyzer (USA) at the Central Laboratory, Maharaj Nakorn Chiang Mai Hospital, Faculty of Medicine, Chiang Mai University.

Three μL of fasting blood was collected from the cephalic vein. Blood was collected two times before the start of the experiment and 1 time per month until the end of study, for a total of 6 times of collection. The data regarding weight were recorded at the same time period as that of the blood collection. In order to control the intensity of swimming, the front leg (both right and left) movement of all the dogs during swimming was counted by two veterinarians.

Statistical analysis: The relative change in the weight and serum lipid value was calculated using the level of those values prior to the start of the experiment. Differences in the relative changes in body weight and serum lipid value in the same period between groups were tested by one-way analysis of variance (ANOVA). The non-parametric two-sample Mann–Whitney procedure was used to test for differences before and after treatment in each group. The data were analyzed using the Statistical Analysis System version 8.0 (SAS Institute, USA) software package, and presented as mean ± SD; $p \leq 0.05$ was considered to be significant.

Results

Animal data and normal value of serum lipid profile: The average weight, age and BCS were not significantly different between the four groups (p>0.05), as shown in Table 1, and the blood results were in the normal range (data not shown). The front leg movement during swimming was in the range of 90–120 times/min. The average serum lipid profile level of the 24 dogs, including cholesterol (251.50 ± 58.43 mg/dl), triglycerides (46.25 ± 16.29 mg/dl), HDL (165.17 ± 32.89 mg/dl), LDL (51.38 ± 50.19 mg/dl), and VLDL (12.71 ± 9.26 mg/dl), was estimated.

Swimming frequency and weight: In the first month, dogs in G1 had significantly lower (p<0.05) body weight compared with G2 and G4. During the 2nd–4th month, G1 had significantly lower (p<0.05) body weight as well, compared with the other three groups (Table 2). Dogs in G1 were observed to undergo a significant decrease (p<0.05) in body weight every month from the 2nd month through the 4th month; G2 had significantly decreased (p<0.05) body weight in the 4th month; while in the other two groups (G3 and G4), the weight did not significantly change throughout the 4 months of the swimming period (Table 2).

Swimming frequency and serum lipid profile: Upon doing a comparison of the same periods, it can be observed that in the 1st month, the dogs in G4 had a significantly higher level of serum cholesterol compared with those in G1 (p<0.05). During the 2nd month, the G4 group had a significantly higher level of serum cholesterol compared with G1, G2, and G3 (p<0.05). In the 3rd month, the G3 and the G4 groups were found to have significantly higher levels of serum cholesterol compared with G1 (p<0.05). And, in the 4th month, the G3 and the G4 groups were observed to have significantly higher levels of serum cholesterol compared with G1 and G2 (p<0.05) (Table 3). Upon performing a comparison within the same group, it can be seen that the relative level of serum cholesterol of the G1 and the G2 groups had significantly decreased after swimming for 2 months (p<0.05). The relative level of serum cholesterol in the G3 group was significantly decreased (p<0.05) after swimming for 4 months (Table 3).

Table 2 Relative change in body weight during 4 months of swimming.

Group	Relative change in body weight compared with pre-swimming			
	1st month	**2nd month**	**3rd month**	**4th month**
G1	0.94 ± 0.04^{a1}	0.91 ± 0.06^{a2}	0.88 ± 0.06^{a3}	0.87 ± 0.06^{a4}
G2	0.99 ± 0.01^{b1}	0.98 ± 0.02^{b1}	0.97 ± 0.03^{b1}	0.94 ± 0.01^{b2}
G3	0.98 ± 0.05^{ab}	0.98±0.05^{b}	0.98 ± 0.05^{b}	0.98 ± 0.04^{bc}
G4	1.01 ± 0.01^{b}	1.00 ± 0.01^{b}	1.00 ± 0.03^{b}	1.00 ± 0.04^{b}

Note: Different superscript letters (^{a,b,c}) indicate the difference in the means between the four groups in the same time, and different superscript numbers (^{1,2,3,4}) indicate the difference in the means between the four time periods in the group.

Table 3 Relative change in serum cholesterol during 4 months of swimming.

	Relative change in serum cholesterol compared with pre-swimming			
Group	**1st month**	**2nd month**	**3rd month**	**4th month**
G1	0.88 ± 0.28^{a1}	0.78 ± 0.18^{a2}	0.69 ± 0.17^{a2}	0.66 ± 0.16^{a2}
G2	0.94 ± 0.12^{ab1}	$0.90 \pm 0.21^{a1,2}$	0.81 ± 0.10^{ab2}	0.68 ± 0.10^{a3}
G3	$0.97 \pm 0.24^{ab1,2}$	0.88 ± 0.18^{a1}	0.97 ± 0.17^{b1}	1.07 ± 0.21^{b2}
G4	1.08 ± 0.09^{b}	1.14 ± 0.12^{b}	1.06 ± 0.13^{b}	1.08 ± 0.20^{b}

Note: Different superscript letters (^{a,b}) indicate the difference in the means between the four groups in the same time, and different superscript numbers (^{1,2,3}) indicate the difference in the means between the four time periods in the group.

In the 1st month, the serum triglyceride level of the G2 group was significantly lower (p<0.05) than that of the G4 group; whereas in the 3rd month, the serum triglyceride level of the G2 group was significantly lower (p<0.05) than that of the G3 group (Table 4). The serum triglyceride level of the G1 group in the 4th month was significantly lower (p<0.05) compared with that in the 2nd month. But the serum triglyceride level of the G2 group in the 4th month was found to be significantly lower (p<0.05) compared with that in the 3rd month (Table 4).

During the 1st–3rd month, the G3 group had a significantly higher (p<0.05) level of serum HDL compared with G1 (Table 5). In the G1 group, a significant difference (p<0.05) was found in serum HDL between the 2nd, 3rd, and 4th months. The G1 and the G2 groups showed significantly lower levels (p<0.05) of serum HDL in the 2nd month compared with the 1st month (Table 5).

Table 4 Relative change in serum triglyceride during 4 months of swimming.

	Relative change in serum triglyceride compared with pre-swimming			
Group	**1st month**	**2nd month**	**3rd month**	**4th month**
G1	$1.20 \pm 0.55^{ab1,2}$	1.18 ± 0.39^{1}	$1.01 \pm 0.27^{ab1,2}$	0.83 ± 0.15^{2}
G2	$0.92 \pm 0.35^{a1,2}$	$1.04 \pm 0.32^{1,2}$	1.09 ± 0.37^{a1}	0.84 ± 0.20^{2}
G3	1.38 ± 0.58^{ab}	1.53 ± 0.59	1.57 ± 0.65^{b}	1.38 ± 0.45
G4	1.54 ± 0.66^{b}	1.41 ± 0.42	1.43 ± 0.45^{ab}	1.35 ± 0.39

Note: Different superscript letters (^{a,b}) indicate the difference in the means between the four groups in the same time, and different superscript numbers (^{1,2}) indicate the difference in the means between the four time periods in the group.

Table 5 Relative change in serum high density lipoprotein (HDL) during 4 months of swimming.

	Relative change in serum HDL compared with pre-swimming			
Group	**1st month**	**2nd month**	**3rd month**	**4th month**
G1	$0.99 \pm 0.15^{a1,2}$	0.92 ± 0.12^{a3}	0.94 ± 0.09^{a1}	1.04 ± 0.08^{2}
G2	1.07 ± 0.24^{ab1}	0.98 ± 0.20^{a2}	$1.02 \pm 0.14^{ab1,2}$	$1.03 \pm 0.16^{1,2}$
G3	1.16 ± 0.11^{b}	1.19 ± 0.15^{b}	1.12 ± 0.13^{b}	1.17 ± 0.16
G4	1.09 ± 0.10^{ab}	1.06 ± 0.11^{ab}	1.06 ± 0.09^{ab}	1.07 ± 0.03

Note: Different superscript letters (^{a,b}) indicate the difference in the means between the four groups in the same time, and different superscript numbers (^{1,2,3}) indicate the difference in the means between the four time periods in the group.

Accordingly, the serum LDL (Table 6) and VLDL (Table 7) of all four groups did not show any significant differences during the 4-month period, and did not show any significant differences when comparing among the four groups within the same month (p>0.05).

Table 6 Relative change in serum low density lipoprotein (LDL) during 4 months of swimming.

	Relative change in serum LDL compared with pre-swimming			
Group	**1st month**	**2nd month**	**3rd month**	**4th month**
G1	0.78 ± 0.56	0.6 5± 0.46	0.60 ± 0.36	0.52 ± 0.24
G2	1.58 ± 1.47	1.24 ± 1.12	1.34 ± 1.32	1.02 ± 1.02
G3	1.65 ± 0.69	1.81 ± 1.27	1.82 ± 0.94	1.52 ± 0.60
G4	1.16 ± 0.71	1.35 ± 0.78	1.18 ± 0.33	1.20 ± 0.58

Table 7 Relative change in serum very low density lipoprotein (VLDL) during 4 months of swimming.

Group	Relative change in serum VLDL compared with pre-swimming			
	1st month	2nd month	3rd month	4th month
G1	1.25 ± 0.36	1.21 ± 0.30	1.17 ± 0.17	1.14 ± 0.28
G2	1.04 ± 0.43	1.20 ± 0.53	1.36 ± 0.77	1.40 ± 0.67
G3	1.36 ± 0.79	1.33 ± 0.49	1.23 ± 0.23	1.34 ± 0.46
G4	1.65 ± 0.66	1.48 ± 0.49	1.58 ± 0.59	1.44 ± 0.38

Discussion

Our study is the first to demonstrate the effect of swimming frequency on body weight and serum lipid level in dogs. Swimming every day had greater effect as regards decreased body weight after 1 month. Swimming 4 days per week also decreased the body weight after 2 months; swimming 2 days per week could the decrease body weight after 4 months; while swimming once a week could not decrease the body weight. Swimming every day or 4 days per week could decrease serum cholesterol after a period of 2 months. On the other hand, swimming 1 or 2 days per week could not alter the body weight and the serum cholesterol level. Dogs swimming at different frequencies of days per week for 4 months, two times (continuous) per day for 20 min each time, did not demonstrate any alteration in the levels of serum LDL and VLDL.

This study found that higher intensity of swimming (every day and 4 days per week) had a significant effect ($p<0.05$) on decreasing body weight and cholesterol. Similar results were reported in a rat study, which found that swimming can prevent body weight gain, but that it did not modify adipose tissue gene expression (Higa et al., 2012). However, some research studies have reported different results; for example, Jeong and Yoon (Jeong and Yoon, 2012) suggested that swimming can effectively prevent weight gain, adiposity, adipocyte hypertrophy, and lipid disorders caused by ovariectomy in rats.

Swimming for 20 min, twice a day, every day for 4 months did not alter the level of serum LDL and VLDL, possibly because the intensity/frequency was not high enough or because our studies were conducted in normal dogs. However, it is believed that the major reason is that the intensity and duration of exercise are not long enough to increase the metabolism of the muscles by using fatty acids as a source of energy. In agreement with a previous work (Nganvongpanit et al., 2015) in small-breed dogs, it was found that the highest level of serum lactate was after 15 min of swimming; while in large-breed dogs, swimming for 30 min was not observed to increase the maximum serum lactate. A study in rats reported a reduction in serum cholesterol, triglycerides, and LDL, and elevated levels of HDL in the case of swimming for 20 min/day and 40 min/day, 6 days/week and for 4 weeks continuously (Ravi Kiran et al., 2006).

In humans, it has also been reported that the serum levels of triglycerides in trained pubescent boy and girl athletes are lower than in untrained youths (Taralov et al., 2000). However, in some studies, total plasma cholesterol and LDL were not significantly different among competitive swimmers, synchronized swimmers, and sedentary controls (Smith et al., 1999). Another study was carried out in obese human beings, who swam at 60% of the maximal heart rate reserve for 45 min per day, 3 days per week, for 10 weeks (Tanaka et al., 1997). The results from this study did not demonstrate any significant difference in HDL and LDL between exercised and non-exercised groups. Ghaemmaghami et al. (1986) investigated the effect of swimming on plasma LDL, HDL, and VLDL in Lyon genetically hypertensive rats. They demonstrated that swimming can alter the serum lipid in hypertensive rats, with a decrease in LDL and VLDL as well as an increase in the HDL:VLDL ratio. As far as humans are concerned, it is well documented that exercise can be categorized into three groups – slight exercise, moderate exercise, and heavy exercise – using heart rate and oxygen uptake (Casaburi et al., 1987; Rakobowchuk et al., 2012; Wolfe et al., 1978). In the case of animal models, rats or mice can be categorized in a manner similar to humans. A study conducted on diabetic rats by Belotto and colleagues reported that moderate exercise (60% of VO_2 (max), 30 min/day, 6 days a week) can decrease levels of FFA and other cytokines in serum by 40%; the study also reported a reduction in tumor necrosis factor (TNF)-α (6%), cytokine-induced neutrophil chemotactic factor 2 alpha/beta (CINC-2α/β) (9%), interleukin (IL)-1β (34%), IL-6 (86%), and C-reactive protein (CRP) (41%).

In dogs, however, there are limitations as far as studies are concerned, due to variations in the genetics and the morphology of dogs, which makes it extremely difficult for scientists to evaluate the heart rate maximum (HRmax), which is important for the calculation of the intensity of exercise. Moreover, the possibility of measurement of oxygen consumption during swimming in dogs is also limited. It is possible that the style of exercise adopted in this study is a light exercise that does not change the metabolism of lipids in the body. To confirm the exercise type, heart rate measurements need to be done; a limitation of this study was that instruments for measuring real-time heart rate of dogs during swimming were not available. Another limitation of this study is that the swimming time might have been too short; if dogs had exercised for longer than 20 min/time, the results might have been different.

Conclusion

Our study is the first to demonstrate the effect of swimming frequency on body weight and serum lipid level in dogs. From this study, it can be concluded that dogs swimming for 20 min each time, two times (continuous) per day, at different frequencies of days per week for 4 months, induced a reduction in body weight and in cholesterol, triglyceride, and HDL levels, but was not found to alter the levels of serum, LDL, and VLDL. At the same time, swimming for 1 or 2 days per week did not alter body weight and serum lipid level.

Acknowledgements

The authors gratefully acknowledge financial support via research grants from the Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai, Thailand. Sincere thanks are also extended to the Metta Pet Hospital, Chiang Mai, Thailand, for kindly providing the use of their swimming pool and all equipment.

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บทคัดย่อ

ผลของความสม่ำเสมอของการว่ายน้ำในช่วงระยะเวลาสี่เดือนที่มีต่อน้ำหนักตัว และระดับไขมันในเลือดในสุนัขพันธุ์เล็ก

กรกฎ งานวงศ์พาณิชย์[1] ณภัทร ร่วมรังษี[1] บุญญาพร เทพสุนทร[1]*
เทิดศักดิ์ ญาโน[2] ปัณฑิตา เสียงดี[1] ศิริพันธุ์ คงสวัสดิ์[3]

ในปัจจุบันสุนัขมีกิจกรรมประจำวันที่ลดลง ซึ่งการเคลื่อนไหวของร่างกายที่ลดลงและการขาดโอกาสในการออกกำลังกายส่งผลให้เกิดภาวะน้ำหนักเกินในสุนัข การออกกำลังกายด้วยการว่ายน้ำเป็นหนึ่งของการออกกำลังกายทางกายภาพที่ดีที่สุดสำหรับสุนัขที่ได้รับการอนุมัติโดยแพทย์สัตวแพทย์ คุณสมบัติของน้ำสามารถช่วยพยุงรองรับทุกส่วนของร่างกายให้สามารถเคลื่อนไหวได้อิสระ และเนื่องจากต้องอาศัยกล้ามเนื้อใช้เกือบทั้งหมดในร่างกายในการเคลื่อนไหว การว่ายน้ำจึงสามารถช่วยฟื้นฟูความแข็งแรงของร่างกาย ฟื้นฟูการทำงานของระบบหัวใจและหลอดเลือดและระบบทางเดินหายใจรวมไปถึงการเพิ่มอัตราการเผาผลาญโดยไม่ไม่ทำให้เกิดแรงกระแทกขึ้น อีกสิ่งหนึ่งที่น่าสนใจเกี่ยวกับการว่ายน้ำก็คือ การว่ายน้ำสามารถช่วยในการควบคุมน้ำหนักและระดับของไขมันในเลือดได้ ในการศึกษาครั้งนี้ ผลของการควบคุมความถี่ในกิจกรรมว่ายน้ำต่อน้ำหนักตัวและระดับของไขมันในเลือดของสุนัขได้รับการตรวจสอบและจดบันทึก สุนัขได้รับการออกกำลังกายทั้งหมดเป็นระยะเวลาสี่เดือน โดยแบ่งเป็นกลุ่มที่ว่ายน้ำทุกวัน ว่ายน้ำสี่วันต่อสัปดาห์ ว่ายน้ำสองวันต่อสัปดาห์ และว่ายน้ำหนึ่งวันต่อสัปดาห์ โดยกำหนดให้มีการว่ายน้ำสองครั้งต่อวันและในแต่ละครั้งของการออกกำลังกายกำหนดระยะเวลาอยู่ที่ 20 นาที ผลการทดลองพบว่าการว่ายน้ำทุกวันสามารถลดน้ำหนักและลดระดับคอเลสเตอรอลในเลือดได้ภายในหนึ่งเดือนของการว่ายน้ำอย่างมีนัยสำคัญ ในขณะที่การว่ายน้ำสี่วันต่อสัปดาห์สามารถลดน้ำหนักและลดระดับคอเลสเตอรอลในเลือดได้ภายในสี่เดือน ภายในระยะเวลาเพียงหนึ่งเดือน การว่ายน้ำสี่ครั้งต่อสัปดาห์สามารถลดระดับไตรกลีเซอไรด์ในเลือดได้อย่างมีนัยสำคัญเมื่อเทียบกับกลุ่มอื่น ระดับไขมันที่มีความหนาแน่นสูงหรือ HDL ลดลองอย่างต่อเนื่องจนถึงเดือนที่สามของการว่ายน้ำในกลุ่มที่ว่ายน้ำทุกวัน แต่อย่างไรก็ตามไม่มีการเปลี่ยนแปลงอย่างมีนัยสำคัญของระดับของไขมันที่ความหนาแน่นต่ำ LDL และ ไลโปโปรตีน VLDL ในซีรัมสุนัขภายหลังจาก 4 เดือนของการว่ายน้ำในทุกกลุ่มการทดลอง โดยสรุปความสม่ำเสมอที่สูงขึ้นของการว่ายน้ำในสัปดาห์ให้ผลลัพธ์ที่ดีกว่าในการควบคุมน้ำหนักและระดับไขมันในเลือด

คำสำคัญ: สุนัข ว่ายน้ำ ไขมันในเลือด น้ำหนักตัว

[1]*ห้องปฏิบัติการวิจัยโรคกระดูกและข้อในสัตว์ ภาควิชาชีวศาสตร์ทางสัตวแพทย์และสัตวแพทย์สาธารณสุข คณะสัตวแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ อ. เมือง จ. เชียงใหม่ 50100 ประเทศไทย*

[2]*ภาควิชาคลินิกสัตว์บริโภค คณะสัตวแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ อ. เมือง จ. เชียงใหม่ 50100 ประเทศไทย*

[3]*ภาควิชากายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยเชียงใหม่ อ. เมือง จ. เชียงใหม่ 50200 ประเทศไทย*

***ผู้รับผิดชอบบทความ** korakot.n@cmu.ac.th*