Energy intake and activity in a defined population of dogs

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Abstract

The main objective of this study was to obtain baseline data on levels of energy intake and physical activity in a defined population of privately owned dogs. For this purpose a previously validated mail and telephone questionnaire was used to collect data on nutrient intakes and activity in a randomly selected pure-bred dog population. The energy intakes were estimated using the modified Atwater factors for protein, fat and carbohydrates.

The total daily energy intakes of 461 dogs could be described by ME Intake = $554W^{0.66}$ (r^2 0.58, $P<0.0001$). The energy intakes showed large variation between size, breed and individual. On average, three quarters of the energy intakes originated from commercial feed sources. Small breeds consumed a significantly lower intake of energy, protein, fat and carbohydrates from commercial products than did larger dogs. The energy densities in the total diets most commonly reflected the concentrations of the commercial feeds given. The non-commercial parts of the diet consisted of more fat than the commercial part.

Most dogs in this study lived in the homes of their owners, and above half were mainly kept off the leash when outside. Three quarters of the dogs performed some type of activity one hour or more per day, mainly exercised by walks (83 min/d, SD 56) and obedience, tracking, searching and hunting activities (13 min/d, SD 24).

It is concluded that this validated questionnaire could be used to collect data on dietary intake and activity in order to quantify these factors in future epidemiological studies of the effects on health and disease in defined populations of dogs.

Introduction

Consuming a diet that contains all the required nutrients in the correct proportions in relation to needs, while at the same time maintaining energy balance, is one of the most important factors affecting health. In adult individuals, energy expenditure has to match energy intake in order to maintain stable body weight over time. Today, many dogs in the industrialised world suffer from obesity (Edney & Smith, 1986; Burkholder & Bauer, 1998), while the proportion of dogs that are malnourished is unknown. Due to a lack of suitable methodology, limited data are available on energy intake and activity of dogs living in private households. To be able to perform studies in these dogs, it is crucial to have a tool that allows identification and quantification of factors that are related to the energy balance, such as diet and physical activity. Recently, a validated mail and

telephone questionnaire has been presented (Sallander *et al*., 2001a), which allows this type of data to be collected and evaluated.

As has been shown previously (Sallander *et al*., 2001b), the diet of a typical Swedish dog diet is largely based on commercial dry feeds. In addition, a variable proportion of the diet of most dogs consists of table foods, which in general differs in nutrient composition from commercial feeds and may thus affect the daily energy intake.

The main objective of this study was to obtain baseline data on levels of energy intake and physical activity in a population of privately owned dogs.

Materials and methods

The study population was a simple random sample of 680 pure-bred dogs between 1 and 3 years of age registered in the largest animal insurance company of Sweden (Agria) during 1997, from which data were collected by using a previously validated combined mail and telephone questionnaire (Sallander *et al*., 2001a).

The dietary section included questions about feeding patterns, appetite, amount and frequency of commercial food, table foods and home-made diets. Owners were also asked questions about treats and vitamin- and mineral supplements. A list of table foods was given together with pictures for estimation of the quantity fed to the dog, a method earlier evaluated by Calmer *et al*. (1993).

One part of the questionnaire considered exercise and the way the dogs perform and lead their lives. Some questions addressed the general mentality of the dog, and how it was kept when inside and outside the house. The frequency, the time spent and weekly and/or seasonal variations in walks, cycle exercise and jogging were registered. The definition of a walk was that the dog was taken outside the confines of the grounds of the house or farm. Also, the activities performed by the dog on walks was noted. A few questions concerned play with a ball or stick, and play with another dog. The questionnaire also consisted of a part concerning exercise and training activities performed by the dogs, for example obedience, tracking and hunting. The dog owners had the possibility to grade the body condition of their dog on a 5-grade scale from very lean (0), lean (1), normal (2), slightly overweight (3), to overweight (4). For further details, see Sallander *et al*. (2001a, b, c).

The daily, nutrient intake of each dog was estimated from the commercial feeds or other ingredients reported to be given, using a commercial computer-based program (Animal Nutritionist, 1987). The database was updated and modified to suit Swedish conditions with data both on table foods (National Food Administration, 1996), as well as data on commercial products used. The

declared values of commercial products was used in calculations, and these values were validated by proximate and mineral analysis of 50 of the most commonly used feeds (Sallander *et al*., *unpublished data*).

The content of metabolisable energy (ME) in each diet ingredient and in commercial products was calculated by using the modified Atwater factors (14.6 kJ/g protein, 35.6 kJ/g fat, 14.6 kJ/g N-free extracts), as adapted in Sweden (Agricultural Board, 1993). The daily intake of ME for each individual dog was calculated using data on dietary intake and the ME content in the dietary components.

One outlier (a male German shepherd) was excluded from further calculations due to an incongruously high energy consumption. The data was analysed using Microsoft Excel (Microsoft Software, 1999) and the SAS statistical package (SAS Institute Inc., 1999). The relationship between metabolisable energy and BW was presented as log $ME_{(intake)}$ = log a + b log W with the GLM (General Linear Models) procedure. The $ME_{(intake)}$ is the metabolisable energy intake, W is the body weight, a is the mass coefficient, and b is the mass exponent. The data was analysed by SAS proc univariate normal plot, procedure GLM, one-way Anova, 2-sample t-test, 2-proportion t-test and chi-square test.

Results

In total, 461 owners completed the questionnaire that gave a response rate of 76% for persons possible to contact (461/608). The overall response rate was 68% (461/680).

As earlier reported (Sallander *et al*., 2000c), the dogs in this investigation were of 124 different breeds and were selected from those born in the years 1993-1995. Male dogs were slightly more numerous than the bitches (54 and 46%, respectively). The median weight for dogs was 21.0 kg (SD 13.5), ranging from 1.2 to 75 kg. The BW had a wide range within breeds; for example, the dachshunds had a range between 3-14 kg, the Golden retrievers 25-50 kg, and the German Shepherds 24-45 kg (Table 1). The majority (99%) of the dogs was not neutered.

The owners were asked to make a subjective judgement of the body condition of their dog. Approximately two thirds (64%) of the dogs were regarded as being of normal weight, while 19 and 17% of owners thought their dog to be under- and overweight, respectively. Among overweight dogs, bitches were over-represented ($P<0.01$) compared to males (61 versus 39%, respectively). When the number of feedings per day a dog received increased, the average body condition score of the dogs also increased ($P<0.001$). There was a significant difference ($P<0.001$) between the appetite of over-weight dogs compared to both the normal and

underweight dogs. Also, there was a significant ($P<0.001$) difference in appetite between normal and under-weight dogs (Table 2).

Energy Intake

The energy intakes ranged from 401 to 26,729 kJ/day (Fig. 1), and the median intake was 4,095 kJ/day. The energy intake of this population of dogs could be described with the equation $ME_{(intake)} = 554W^{0.66}$ (r^2 0.58, $P<0.0001$), where $ME_{(intake)}$ is the daily intake of metabolisable energy (kJ/day), and W is the body weight (kg). Relative to the size of the dogs, average energy intakes for all dogs ranged from 159 to 1,855 kJ/kg $BW^{0.66}$. The energy intakes (kJ/kg $BW^{0.66}$) showed large variations within the same size. For example, the coefficient of variation (CV) was 51% for dogs weighing 30 kg (mean 534, SD 271), and 35% (mean 609, SD 213) for dogs with a BW of 20 kg.

The average energy intakes per kg metabolic BW was 9% lower ($P<0.05$) for females than males (579 and 630 kJ/kg $BW^{0.66}$, respectively), corresponding to an average of 4,046 (range 401-13,523) and 4,886 (range 832-24,380) kJ per day for females and males, respectively (Table 1). Labrador and Golden retrievers had average energy intakes of 539 and 536 kJ/kg $BW^{0.66}$, respectively, and the to German shepherds of about the same size had an average intake of 612 kJ/kg $BW^{0.66}$ (Table 1). Although there was a large difference in the average energy intake between breeds, the individual variation was larger.

There were a significant difference ($P<0.001$) in energy intake between dogs regarded as being under- and of normal weight, respectively. Also, dogs considered to be overweight consumed significantly ($P<0.001$) lower levels of energy per kg BW than underweight dogs. Overweight dogs consumed on average 536 (SD 244) kJ/kg $BW^{0.66}$, dogs of normal weight 592 (SD 227), and underweight dogs 713 (SD 279) kJ/kg $BW^{0.66}$ (Table 2). Among dogs that were considered overweight, 12% consumed feeds labelled “light/low energy”. If the dogs consuming low energy products were excluded, the other overweight dogs consumed 561 kJ/kg $BW^{0.66}$. The dogs considered normal and subnormal BW both consumed light-products in 3% of the cases.

The dogs consuming light-products generally consumed significantly ($P<0.05$) less energy than other dogs (499, SD 186, versus 605, SD 246, kJ/kg $BW^{0.66}$, ^{respectively}). This especially applies to the individuals considered as overweight, where the energy intake was significantly ($P<0.05$) higher (564, SD 266 kJ/kg $BW^{0.66}$) for all overweight dogs versus overweight dogs consuming a low energy feed (403, SD 154, kJ/kg $BW^{0.66}$).

On average, 74% (SD 22) of the energy intake for the dogs in this study originated from commercial feeds, and there was no significant difference

between the sexes. Large dogs consumed a significantly higher proportion of energy from commercial feeds than smaller dogs (Table 1).

Among dogs that were given table foods (93%), an average individual consumed 185 g as fed (SD 214) table foods per day, which corresponded to 1190 kJ (SD 1233), and 26% (SD 22) of the total energy intake. Each single table food item contributed on average with totally 38 kJ per day. Vegetable oil, meat, sour milk, bread, potatoes, pasta, lard/tallow, sausage, cheese, fish and rice contributed mostly to the energy intake (Table 3).

Energy density of total diets

The average dog consumed a diet with 1,627 kJ/100 g DM (range 1,177-2,080). Most dogs were fed a total diet ranging from 1,400 to 1,800 kJ/100 g DM (Fig. 2), which corresponded to the energy densities in the most commonly used dry feeds. Six percent of the dogs consumed diets with less than 1,400 kJ/100 g DM, and out of these, 4 dogs were overweight, 20 of normal weight and 3 were underweight. Not one of the dogs consuming a total diet below 1,400 kJ/100 g DM was consuming a feed labelled "low energy" dry feed.

Dogs consuming the feeds labelled "low energy" commercial feeds had energy concentrations of the total diets between 1,206 and 1,859 kJ/100g DM. Another six percent were served diets with more than 1,800 kJ/100 g DM. Among these dogs, 4 were regarded as overweight (1,807-2105 kJ/100 g DM), 17 were of normal weight (1,813-2,080 kJ/100 g DM), and 9 were of subnormal weight (1,804-2,032 kJ/100 g DM). On average, dogs of a lower body score consumed a total diet with a similar energy density than dogs of a higher body score (Table 2).

On average, the energy density of the diets consumed by males and bitches were similar (1,627 and 1,592 kJ/100g DM, respectively). Dogs of different weights consumed on average diets with similar energy densities. For the four commonest breeds examined, the energy densities were in decreasing order 1,658 kJ/100 g (range 1,332-2,106) for the Golden retrievers, 1,644 kJ/100 g (range 1,319-2,003) for the German shepherds, 1,610 kJ/100 g (range 1,107-1,987) for the Dachshunds, and 1,605 kJ/100 g (range 1,175-1,826) for the Labradors.

Energy giving nutrients of the diets and energy percentage

On average, the total diets contained 15 g crude protein, 10 g crude fat and 30 g NFE (Nitrogen Free Extracts) per MJ. The nutrient content of the individual diets varied from 7 to 29 g/MJ for protein, 2-21 g/MJ for fat and 5-64 g/MJ for NFE (Table 4).

The dogs in this survey consumed diets where, on average, protein, fat and NFE contributed 23, 34 and 43% of the energy, respectively. The distribution of the energy percentage varied between the commercial and the non-commercial part of the diet (Table 4). The energy percentage from fat was higher ($P<0.05$) in the part of the diet originating from table foods and home-made diets than from commercial dog feeds.

Temperament and living conditions

Almost half (47 %) of the owners indicated that their dogs were very active individuals, one out of five indicated that the dog was calm, and a third reported that the dog was moderately active. Calm and moderately active dogs had average energy intakes very similar; 594 (SD 264) and 591 (SD 237) kJ/kg $BW^{0.66}$, respectively. The dogs considered moderately active in their general temperament had a tendency ($P=0.07$) to a lower energy intake than dogs considered as very active (634 kJ/kg $BW^{0.66}$, SD 247).

More than half (55%) of the dogs were mainly kept off the leash when they were outside, while a third were mainly kept on leash. Only a minor proportion of the dogs (3%) were kept on a chain outside some of the time. One third of the dogs spent some of their time outside in a garden or in a fenced yard.

The number of hours that dogs spent outdoors in activity (not sleeping) showed seasonal and weekly differences (Table 6). Most dogs spent more time outdoors in the summer than in the winter. Additionally, the dogs were outside more when their owners were free from work. In the summer, 64% of dogs were outside more than 2 hours per day when the owner worked, but this rose to 85% when owners were on leisure-time. In the winter, the corresponding figures were 44% and 69%, respectively.

Playing

Slightly under half (44%) of the respondents stated that their dog played with other dogs every day. On the other hand, almost one fifth (18%) never played with other dogs. The remaining group (38%) played with other dogs between 1 and 6 days per week.

Another common type of playing was when the owner threw a stick or ball repeatedly. Over half (53%) said that their dog performed this type of activity, and more than a quarter of the dogs were chasing sticks or balls every day, and another quarter between one and 6 times per week. This means that among those that did play with balls or sticks, almost half of them did this every day.

Exercise – walks and running

Almost all (97%) dogs were taken for walks, and the majority of the dogs were taken out for walks more than once daily; one third (33%) went for walks 1-2 times a day, half (49%) of the dogs were taken out for walks 3-5 times a day, and 2% were walked more than 5 times a day. The dogs that were exercised by walking did this on average 79 (range 1-300) minutes per day. Thirteen percent of the dogs were taken out for walks less than once daily, and 3% were never walked at all. However, the non-walked individuals were exercising in other ways in all cases except one. The time spent in activity for the non-walked dogs were on average 39 minutes per day (range 0-210).

The dogs were on average exercised to a lesser extent (29%) by running beside a bicycle (16 min/d, range 2-120) and jogging (16%) with the owner (24 min/d, range 1-347). There was a weekly variation in how much dog owners walk their dogs (Table 6). Between Monday and Friday, people tended to walk for shorter periods of time than on Saturdays and Sundays. On weekdays, 49% walked for less or equal to one hour, while the corresponding figure for the weekends was 39%.

When off the leash during walks, approximately a quarter (26%) of the dogs were said to be running at a longer distance than 20 meters from the owner, while the others kept a shorter distance. In the survey, 12% of the dogs were never allowed to run loose during walks. It is to be noted that some of these dogs do have the possibility to run free either in a fenced garden, yard or kennel.

The different activities that dogs performed during walks were most commonly play, either with the owners or with other dogs. Other popular activities were sniffing or tracking, carrying things, hunting wild game (although they shouldn't), searching for something eatable, running to/after human beings, training with their owners, swimming/bathing, running around, and chasing sticks/balls. Examples of some other activities that fewer dogs performed during walks were digging, herding, or barking (Table 7).

Hunting and training

Sixty percent of all dogs were trained in different activities, such as obedience, searching, tracking or hunting, on average 35 (SD 31, range 1-227) minutes per day for those that performed any of these activities. Approximately one fourth (27%) of the individual dogs were used for hunting on average 32 (SD 26, range 1-146) minutes per day, but this was strongly influenced by seasonal variations, the average time spent when hunting at most, was 158 minutes per week. Another popular activity performed by approximately a third (31%) of the dogs was obedience (21 minutes/week, SD 18, range 2-129). Also, a fifth (18%) of the dogs were tracking, either human or game tracks (13 minutes/week, SD 13, range 1-

69). Other activities performed more seldom and by fewer dogs were searching (human scent or game), sledge dog training, herding, military guarding, racing dog training and protective/IPO training.

Total activity level and energy intake

The dogs that were reported to be active for a short period every day (less than 1 hour), generally did not consume less energy per kg BW than dogs exercising up to 5 hours a day (Table 8). On average, dogs weighing between 30 and 50 kg had the highest total activity level. The range in activity level within each size group was large (Table 9).

Discussion

The present study has given estimates of energy intakes, living patterns and exercise in a defined population of dogs. The data showed that the average energy intakes in all dogs was 84-101 % of figures given by Sonnenschein (4195-5062 kJ/day; 1988) in a similar study with dogs of all sizes.

In our study, large variations were shown for energy intakes depending on weight, breed and individual. Moreover, dogs of approximately the same BW showed large variations in energy intake per kg BW. Factors associated with variations of energy intake between individuals might be weight, breed, sex, level of activity and body condition. Other factors influencing the variation in energy needs not examined in the present study are external temperature and fur, and whether the individual dog was increasing or decreasing in weight. The range in energy intake was wider than expected, due to some outliers in each weight interval. However, when examining dogs of the same BW (kg), the coefficients of variation was less than 50%. An explanation for the large variation may be that the energy intake of individuals could be misreported in the questionnaire.

The dogs in this survey consumed total diets with higher levels of carbohydrates than of fat and protein (23, 34 and 43% of the energy from protein, fat, and carbohydrates, respectively). For less active dogs, Case *et al*. (2000) suggested that a diet should contain 26, 38 and 36% of the energy originating from protein, fat and carbohydrates, respectively. However, given that the total amount of energy consumed remains constant and that the nutrient requirements are met, dogs have been shown to tolerate a wide range of these nutrients.

Rivers and Burger (1989) defined the maintenance energy requirements (MER) as the energy needed to maintain the body constant in the terms of body nitrogen, body energy and body weight. Wenk *et al*. (2001) stated that the MER corresponds to a situation where the energy intake equals the energy output and where no energy is retained (i.e. as growth or reproduction). MER is often defined to include “normal activity”, but the amount of activity that this refers to

is rarely given. The way the dog is housed, fed, the activity level and the external temperature are factors influencing the maintenance energy level. In this study, most dogs were exercised regularly, sometimes in conditions that were not thermoneutral. Therefore, the energy intakes registered in this study could be expected to be higher than figures given for MER.

Interestingly, the population of dogs in the present study showed energy intakes that were in the range of various suggested equations for ME. Many earlier studies have suggested MER to be much higher than the energy intakes registered for the dogs in this survey (Figure 3). An equation suggested for active dogs were almost identical to the one suggested in this paper ($ME=552W^{0.67}$; Case *et al*., 2000).

In 1945, Brody suggested that basal heat production could be determined by the equation $Y=295W^{0.73}$ (Y=kJ/d, W=BW in kg). Later, Kleiber (1961) argued that the equation could be simplified to $Y=293W^{3/4}$. Twenty years later, Heusner (1982) demonstrated that the exponent ¾ was an artefact, and that an exponent of 0.67 could be used for BMR (Basal Metabolic Rate) within species. The present study for example and Case *et al*. (2000) have arrived at equations with the same exponent as suggested by Heusner (1982).

The relationship between BMR and ME has been the subject of some debate. Studies have shown that the MER is often in the range 1.3-2.0 x BMR depending on species variation and experimental design (Rivers & Burger, 1989). When dogs are fed *ad libitum* this often yields a relation of MER=2.0 x BMR, while regressions based in changes in the energy balance in animals with a restricted feed intake often yield a relation of MER=1.5 x BMR. If using the BMR suggested by Heusner ($BMR=363W^{0.67}$; 1982), the energy intakes of the dogs in this study can be described by $ME_{(intake)}$=1.5 x BMR.

In most animal species the variation in adult body size is very limited. In dogs however, the range in BW is more than 100-fold. Therefore, careful consideration should be given to the equations used to predict the ME requirements in different dog populations. A number of equations to estimate MER have been suggested by different authors, and there are a wide range of estimates possibly due to differences in breeds, sex, age, number of individuals used and ranges in body weights. For example, the MER for a 50 kg dog are estimated to values between 7540 and 13624 kJ/day (German Society of Nutritional Physiology, 1989; NRC, 1985), the highest value being 1.8 times higher than the lowest estimation. AAFCO (2000) stipulate age and group size for feeding trials, but nothing is mentioned about breed or body weight. Using data from this study, it seems as if there is no reason not to include factors such as breed or body weight in future AAFCO regulations.

In the present study, the number of breeds and their range in body weights, body scores, living conditions and activity may have lowered the precision of the equation describing the relationship between ME intake and body weight. However, in the statistical analysis of the present work, the determination coefficient for energy intakes was not improved by the inclusion of sex, breed, body condition or any of the activity parameters measured. This study is based on dogs that were not castrated in 99% of the cases. Studies have shown that one of the effects of castration is that the MER decrease (Anderson, 1973; Edney & Smith, 1986). Therefore, it is possible that the average energy intakes would have been lower for the entire population if a larger fraction had been neutered. Our study indicates that the average figure of many published feeding trials are suited to estimate the energy needs for moderately active free-living dogs. This is also supported by Burger (1994).

The dogs in this study were exercised more often (85% were taken for walks at least once daily) than dogs in a study by Slater *et al*. (1995), where only 17% of the dogs were taken for walks on average at least once daily. On average, the dogs in this study were walked or trained in different activities for over 1.5 hours a day, probably quite a lot compared to dogs in some other countries. Slater *et al*. (1995) reported that 91% of the dogs were taking walks for more than 10 minutes a day, but did not report the average amount of time spent on walks. In the study by Slater *et al*. (1995) the proportion of dogs which played with other dogs was comparable to the proportion found in this study. However, Swedish dogs were playing with a ball or a stick to a lesser extent than did the American dogs (53 and 66%, respectively). A high proportion (27%) of the dogs in the present study were hunting, a circumstance which has not been reported by any other population of dogs. This high proportion of dogs hunting was confirmed in another study of all Swedish dogs (Egenvall *et al*. 1999).
The present study has given estimates of energy intakes, living patterns and exercise in a defined population of dogs. The energy intakes showed large variation between size, breed and individual. The energy intakes of this sample of dogs have been shown to be comparable with an average of many studies of the MER. Most dogs in this study lived in the homes of their owners, and performed comparatively high levels of activity, mainly exercise by walks and obedience, tracking and hunting. This validated questionnaire could be used to collect data on dietary intake and activity in order to quantify these factors in future epidemiological studies of the effects on health and disease in defined populations of dogs.

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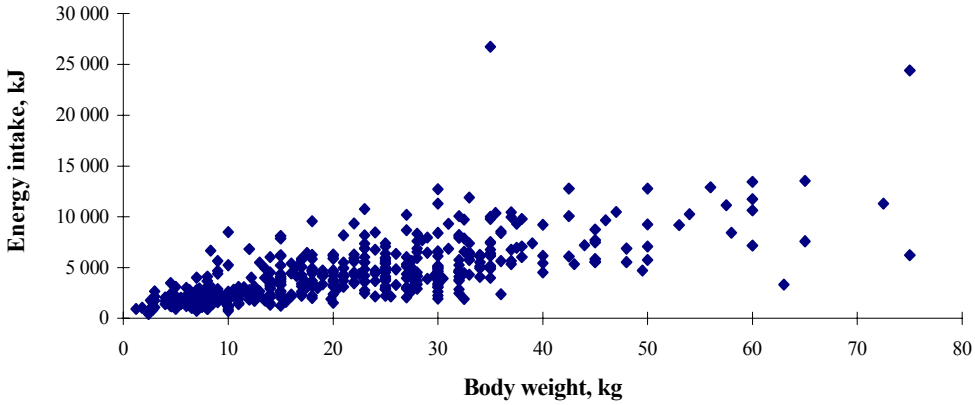

Figure 1. Energy intake in relation to body weight for all dogs in the survey, including a German shepherd outlier (n=461).

Table 1. *Daily ME intakes and average body weights for dogs in a population estimated in a validated questionnaire*

Category	n	Total energy intake (kJ per day)		Energy intake per kg metabolic BW (kJ/kg BW $^{0.66}$ and day)		Proportion of total energy intake from commercial feeds (%)		Weight of the dogs (kg)	
		Mean	SD	Mean	SD	Mean	SD	Mean	Range
All dogs	460	4,497	2,759	607	248	74	22	22	1-75
Male dogs	248	4,886	2,858	630	240	75[a]	23	24	3-75
Female dogs	212	4,046	2,573	579	255	73[a]	21	20	1-65
Dogs 1<x≤5 kg	27	1,635	712	700	272	64[b]	25	4	1-5
Dogs 5<x≤10 kg	85	2,248	1,265	578	296	65 [b]	24	8	6-10
Dogs 10<x≤20 kg	115	3,726	1,599	605	244	73[c]	19	16	11-20
Dogs 20<x≤30 kg	125	5,018	1,989	590	234	77[c]	23	26	21-30
Dogs 30<x≤40 kg	73	6,360	2,143	613	205	80[c]	20	35	31-40
Dogs 40<x≤50 kg	20	7,723	2,429	617	197	81[c]	11	46	43-50
Dogs >50 kg	15	10,743	4,732	702	279	83 [c]	12	63	53-75
Labrador retrievers	21	5098	2131	539	175	85[d]	16	30	21-43
Golden retrievers	32	5280	1988	536	187	76[d]	21	32	25-50
German shepherds	28	6307	2124	612	204	83[d]	21	34	24-45
Dachshunds	34	2285	1122	581	281	59[e]	27	8	3-14

[b, c] Means with different letters in the same column differ significantly ($p<0.001$)
[d, e] Means with different letters in the same column differ significantly ($p<0.001$)

Table 2. *Feeding patterns and energy intakes for dogs considered as underweight, normal, and over-weight in a validated questionnaire (n=460)*

		Underweight (n=88)		Normal weight (n=299)		Overweight (n=73)	
		Mean	Range	Mean	Range	Mean	Range
Sex	Males (%)	59	-	56	-	38 [a]	-
	Females (%)	41	-	44	-	62 [b]	-
Number of feedings per day		1.8[a]	1-3	1.9 [a]	1-4	2.0 [a]	1-3
Ad libitum feeding (%)		17	-	13	-	9	-
Appetite (1-2-3-4)		2.8 [a]	1-4	3.3 [b]	1-4	3.6 [c]	2-4
Dry feeds	Number of times/week	11.5 [a]	0-21	11.5 [a]	0-28	12.2 [a]	0-21
	Intake (g as fed/kg BW, day)	13.0 [a]	0-54.4	10.2 [a]	0-55.7	10.1 [a]	0-32.9
Table foods	Number of times/week	5.7 [a]	0-28	6.5 [a]	0-35	7.7 [a]	0-21
	Intake (g as fed/kg BW, day)	11.1 [a]	0-89.1	10.3 [a]	0-78.0	10.0 [a]	0-63.4
Treats	Yes	60	-	62	-	68	-
	Amount consumed (g as fed/kg BW, d)	0.5 [a]	0-4.1	0.5 [a]	0-8.3	0.5 [a]	0-3.6
Tidbits	Yes	47	-	38	-	52	-
Protein (% DM)		25.0[a]	14.4-52.7	25.1 [a]	11.2-47.8	24.3 [a]	14.9-41.1
Fat (% DM)		16.4 [a]	8.0-31.1	15.7 [a]	2.7-35.4	15.6 [a]	7.8-36.6
NFE (% DM)		46.5 [a]	15.5-64.7	46.9 [a]	9.4-74.7	47.5 [a]	30.5-62.4
Energy concentration (kJ/100 g DM)		1,624 [a]	1,206-2,032	1,609 [a]	1,107-2,080	1,606 [a]	1,209-2,106
Energy from protein (%)		23 [a]	12-42	23 [a]	12-47	22 [a]	11-35
Energy from fat (%)		35 [a]	21-58	34 [a]	7-61	34 [a]	19-62
Energy from NFE (%)		42 [a]	12-62	43 [a]	7-81	44 [a]	26-62
Exercise	Number of walks per day	4.3 [a]	1-6	4.3 [a]	1-6	4.2 [a]	1-5
	Walks and running (hours/day)	1.3 [a]	0-3.5	1.4 [a]	0-5	1.5 [a]	0-4
	Other training (hunting, obedience hours/day)	0.2 [a]	0-2.1	0.2 [a]	0-2.6	0.2 [a]	0-1.8
Weight (kg)		20	1-54	23	2-75	22	2-72
Body score (0-1-2-3-4)		1.28	-	1.99	-	2.63	-

[a, b, c] Means with different letters in the same row differ significantly ($p<0.001$)

Table 3. *Type and amount of table foods consumed by dogs in a validated questionnaire (n=460)*

Food item	Consume this food item at least once a week (%)	Number of servings per month [1]		Intake per day (g as fed) [1]		Energy contribution (kJ/day)[2]	
		Mean	SD	Mean	SD	Mean	SD
Vegetable oil	26	18	17	12	17	444	629
Meat	65	12	15	26	46	169	299
Sour milk	24	13	17	68	99	163	238
Bread	55	17	14	12	20	136	227
Potatoes	45	9	9	36	59	112	183
Pasta	41	6	7	21	39	111	206
Lard/tallow	11	5	6	4	7	110	192
Sausage	44	6	7	10	15	107	161
Cheese	47	13	13	6	12	92	185
Rice	32	7	12	16	47	85	249
Fish	6	6	6	10	13	54	70

[1]Means and standard deviations calculated on the individuals that did consume the table food in question.

[2]Energy values from protein, fat and NFE values of the Swedish Food Composition Table (National Food Administration, 1996). Protein and NFE multiplied with the 14.6 kJ/g and fat with 35.6 kJ/g (modified Atwater factors).

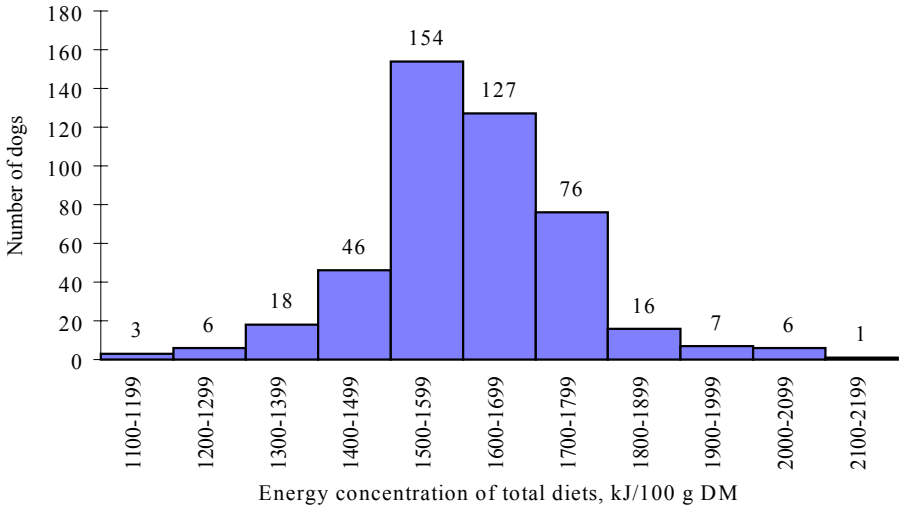

Figure 2. Distribution of the energy densities in the total dog diets (n=460).

Table 4. *Daily nutrient intakes from commercial and non-commercial feed sources and energy percentage in a dog population measured by a validated questionnaire (n=460)*

	Total diet		Commercial feed[a]		Non-commercial food[a]	
	Mean	Range	Mean	Range	Mean	Range
Protein (g/MJ)	15	7-29	16	9-30	13	6-79
Fat (g/MJ)	10	2-21	9	2-18	14	1-122
NFE (g/MJ)	30	5-64	31	1-57	27	0-271
Energy from protein (%)	23	11-47	24	13-49	18	0-64
Energy from fat (%)	34	7-62	31[b]	9-63	43[c]	3-100
Energy from NFE (%)	43	7-81	45	1-75	33	0-86

[a]Values calculated for the dogs that did consume commercial and non-commercial feeds, respectively.
[b,c] Means with different letters differ significantly ($p<0.001$).

Table 5. *Total number of hours alone (without human contact) per day for dogs in a population (n=460)*

Hours alone	Proportion	
	Mean (%)	95% CI
Alone Never	30.3	26.1-34.5
<3 h/day	28.4	24.3-32.5
3-6 h/day	28.6	24.5-32.7
6-9 h/day	8.2	5.7-10.7
>9 h/day	4.3	2.4-6.2

Table 6. *Seasonal and weekly differences in outdoor activities for dogs (n=460)*

		Proportion (%)				
		≤1 hour	1<x≤2 hours	2<x≤5 hours	5<x≤10 hours	>10 hours
General activity						
Summer	Owner at work	5	31	44	11	9
	Owner at home	1	14	44	22	19
Winter	Owner at work	11	45	34	6	4
	Owner at home	3	28	50	12	7

	≤1 hour	1<x≤2	>2 hours	Never
Walks				
Weekdays	49	33	13	5
Weekends	39	33	21	7
Running beside a bicycle				
Weekdays	27	1	0	72
Weekends	17	1	0	82
Jogging with the owner				
Weekdays	14	1	0	85
Weekends	10	1	1	88

Table 7. *Different activities that dogs perform during walks (n=447)*

Activity during walks	Proportion (%)	95% CI (%)
Play with owner	65.5	61.1-69.8
Play with other dogs	56.2	51.7-60.7
Walk forward by the side of the owner	48.6	44.0-53.2
Carry things	44.7	40.1-49.2
Sniffing/tracking	31.9	27.6-36.2
Hunt wild game	24.7	20.7-28.6
Search for something eatable	22.3	18.5-26.1
Run to/after human beings	12.1	9.1-15.1
Training	8.2	5.7-10.7
Swim/bath	4.8	2.8-6.8
Run around	3.5	1.8-5.2
Chase sticks/balls	1.7	0.5-2.9
Other activities	5.9	3.7-8.1

Table 8. *Energy Intake at different levels of activity in a dog population measured by a validated questionnaire (kJ/kg $BW^{0.66}$, n=460 dogs)*

Activity level (hours/d)	n	Energy Intake (kJ/kg $BW^{0.66}$)		BW (kg)	
		Mean	SD	Mean	Range
<1	118	618	237	21	2-65
1≤x<2	168	606	269	21	2-65
2≤x<3	108	594	250	22	2-72
3≤x<4	50	577	182	26	3-53
4≤x<5	12	623	211	32	15-47
5≤x<6	3	697	202	22	6-36
>6	1	921	-	15	-

Table 9. *Total daily activity for different weights in a dog population measured by a validated questionnaire (n=460 dogs)*

Weight (kg)	n	Total daily activity (minutes/day)		
		Mean	SD	Range
$1<x\leq5$	27	99	60	1-213
$5<x\leq10$	85	102	63	15-300
$10<x\leq20$	115	100	57	2-287
$20<x\leq30$	125	102	57	2-296
$30<x\leq40$	73	126	83	9-467
$40<x\leq50$	20	129	66	15-244
>50	15	102	73	0-243

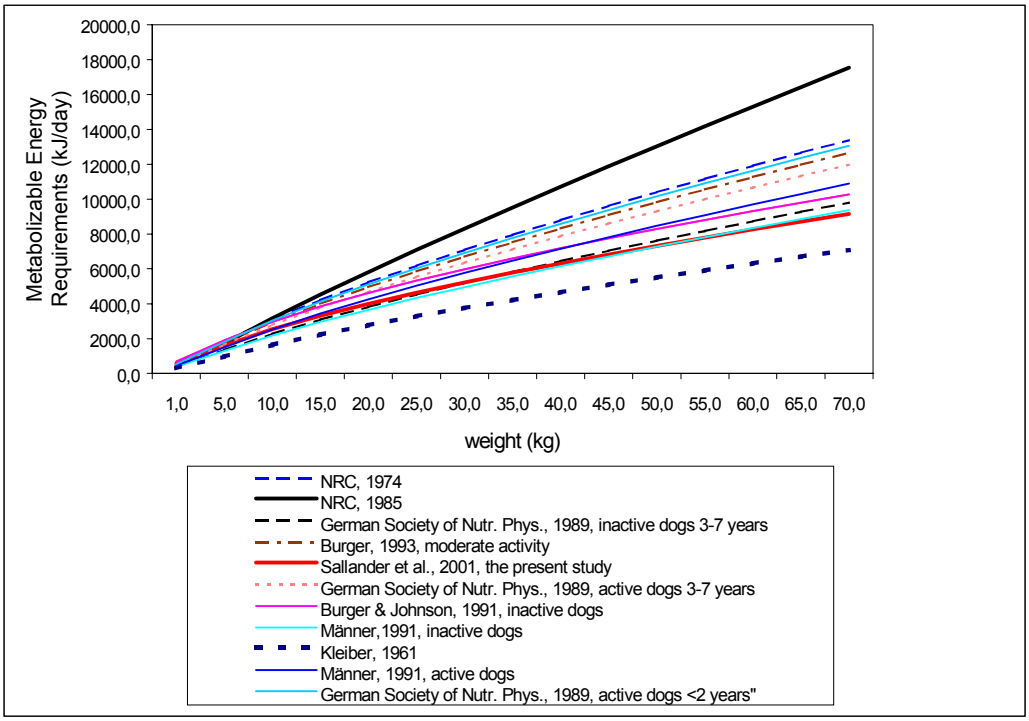

Figure 3. Comparison of studies of maintenance energy requirements of metabolisable energy (ME) in dogs compared to ME intakes in the Swedish survey study (n=460).

Kleiber, 1961:	$BMR=293W^{0,75}$
NRC, 1974:	$ME=552W^{0,75}$
NRC, 1985:	$ME=416W^{0,88}$
Germ. Soc. Nutr. Phys., 1989:	$ME=540W^{0,75}$ (Active dogs less than 2 years)
Germ. Soc. Nutr. Phys., 1989 :	$ME=405W^{0,75}$ (Inactive dogs 3-7 years)
Germ. Soc. Nutr. Phys., 1989:	$ME=495W^{0,75}$ (Active dogs 3-7 years)
Männer, 1991:	$ME=387W^{0,75}$ (Inactive dogs)
Männer, 1991:	$ME=450W^{0,75}$ (Active dogs)
Burger & Johnson, 1991:	$ME=554W^{0,66}$
Burger, 1993:	$ME=523W^{0,75}$
Sallander *et al*., the present study:	$ME_{Intake}=554W^{0,66}$

For those equations originally stated in DE, the ME values have been estimated by multiplying the DE with 0.90.