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A RESEARCH UPDATE
FOR THE VETERINARIAN
FROM AFFINITY PETCARE

OBESITY AND OVERWEIGHT IN CATS

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Obesity is one of the most common nutritional diseases in the cat. In the most recent studies, the reported incidence rate of obesity and/or excess body weight (BW) in cats ranged from 17 to 52 % *(Lund et al., 1999 and 2005; Allan et al., 2000; Russel et al., 2000; Colliard et al, 2008)* (Figure 1).

1 INTRODUCTION

Obesity is defined as an excess of body weight of at least 20%. **A cat with an optimal body weight of 4kg that gains 400g can already be considered as overweight.** However, this definition means it is necessary to know the ideal body weight of the cat, but this is often not known.

Therefore, the easiest way to assess the degree of obesity/leanness of a cat in general practice is to assess its body condition score (BCS). A 5-point score may be the most practical to use in routine examinations (TABLE 1). Half points can be added to refine the scale if necessary.

In research trials, lean healthy cats are generally measured as having body fat levels between 13 and 20%, so that the ideal weight in cats is, still, to some extent, subjective.

Using a 5 point scale, each increase of one unit of body condition score corresponds approximately to a 10% increment in body fat and 20-30% body weight (Laflamme 1997).

A cat with an optimal body condition score (3 on a scale of 5) has around 22 ±2% of body fat.

2 RISK FACTORS FOR OBESITY

The principle risk factors for feline obesity or excess body weight are presented in Figure 2.

Increasing age is one of the most important risk factors (Figure 3). A cat starts to gain weight very early in his/her life (Lund et al, 2005; Scarlett et al, 1994). **By 1 year of age, obesity/ excess body weight is already a concern for more than 20% of cats.**

The peak for body weight attains a maximum at around 6-8 years old when more than 45% of cats are overweight or obese (Lund et al, 2005). By contrast, the risk of obesity seems to decrease after the age of 11, probably due to the increased incidence of pathologies negatively affecting body condition.

Male gender and being neutered are also important risk factors (Figure 4). The risk of obesity or overweight in neutered cats is approximately 3 times higher than for intact cats.

A cat being a male already represents a risk factor. Almost half (41%) of neutered male cats have excess bodyweight (Lund et al, 2005).

FIGURE 1. Prevalence of feline obesity in various countries *(adapted from Lund et al., 1999 & 2005; Allan et al., 2000; Russel et al., 2000; Colliard et al., 2008; Courcier et al., 2010).*

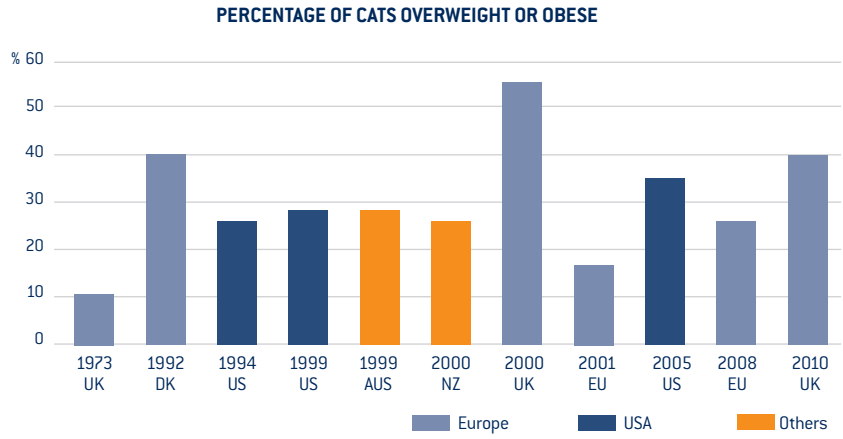


FIGURE 2. Risk factors for the development of obesity *(adapted from Lund et al., 2005; Colliard et al., 2008; Russel et al., 2002; Scarlett & Donoghue, 1996).*

OF THE CAT
- Male Cats
- Mixed Breed / European / Manx
- Median age
- Endocrine disorders

OF THE DIET
- Especially unbalanced diets (food scraps, human food etc.)
- Too many sweets, treats, or snacks
- Diets rich in fat and supplied ad libitum

FROM THE ENVIRONMENT
- Cats neutered / spayed
- Single family home cat or cats in a house without a dog
- Inactivity and confinement indoors
- Medication (progestogen)
- Human-animal bond

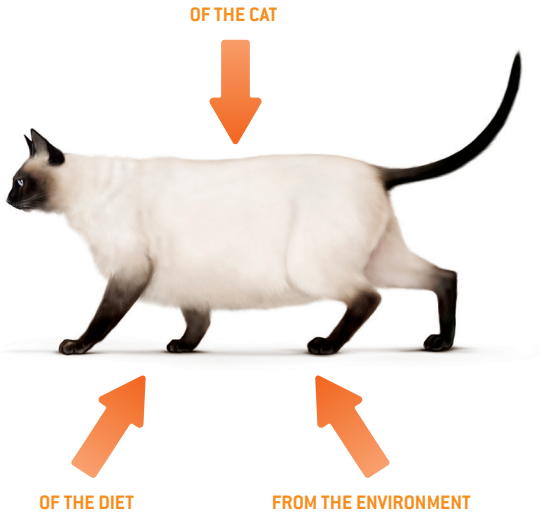
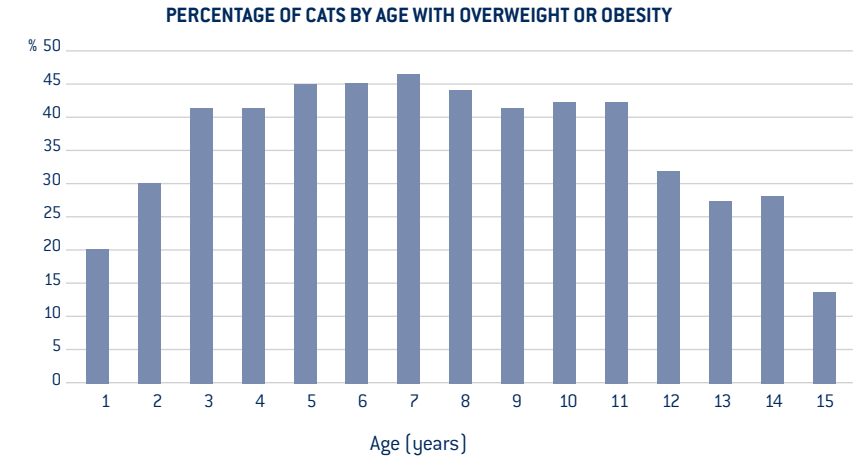


FIGURE 3. Prevalence of overweight and obesity according to age of cat *(adapted from Lund et al., 2005)*



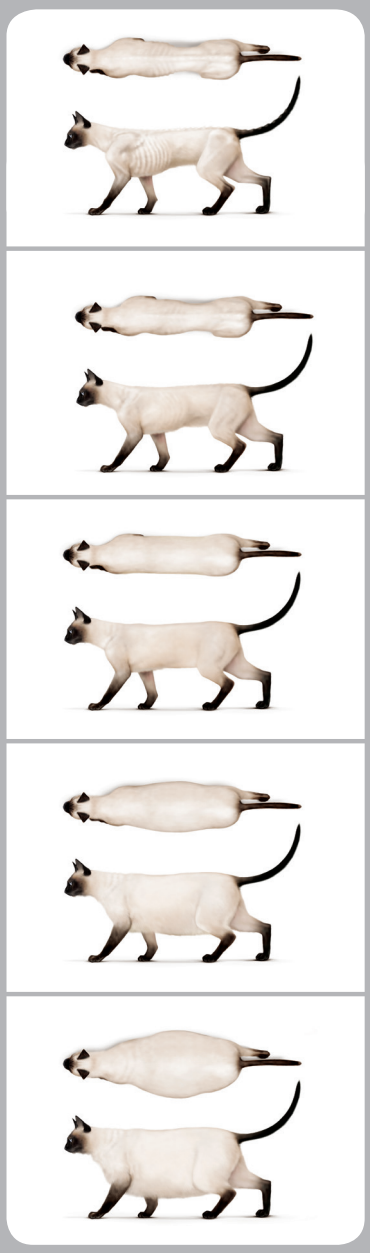
Prevention programs have to be set up early in a cat's life, while veterinary advice must be given immediately following neutering about preventing weight gain.

3 FELINE OBESITY AS A DISEASE

Feline excess body weight or obesity represents not only an increase of body weight: this really needs to be considered as a pathology with multiple consequences on the health and well-being of the cats.

The main pathologies of overweight and obese cats are presented in Table 2 and Figure 5. In addition, although not proven especially for cats, obesity is seen as a complicating factor in, or is associated with: heart conditions, heat and exercise intolerance, dyspnea, hypertension and increased risks of complications during anesthesia and parturition. Additionally, diagnostics and the treatment of obese animals is more of a challenge: organs are not readily palpable, x-rays are of lower quality due to additional absorption by the fat, and catheters are more difficult to place, and so on.

TABLE 1. Index of body condition in the cat *(adapted from Laflamme et al., 1997)*



1 VERY THIN
- **RIBS:** very evident in shorthairs; no palpable fat
- **VERTEBRAE:** easily palpable in lumbar area
- **ABDOMEN-PELVIS:** ileal wings easily palpated
- **ABDOMINAL TUCK:** very marked

2 LEAN
- **RIBS:** easily palpable with mínimum fat covering
- **VERTEBRAE:** lumbar vertebrae obvious
- **ABDOMEN-PELVIS:** marked waist; abdominal fat pad minimal
- **ABDOMINAL TUCK:** clearly visible

3 IDEAL
- **RIBS:** palpable with slight fat cover
- **VERTEBRAE:** inconspicuous
- **ABDOMEN-PELVIS:** waist evident; abdominal fat minimal
- **ABDOMINAL TUCK:** visible

4 OVERWEIGHT
- **RIBS:** palpable but with difficulty and covered with moderate fat
- **VERTEBRAE:** with fat cover and palpable with difficulty
- **ABDOMEN-PELVIS:** little perceptible waist; abdomen rounded; moderate abdominal fat
- **ABDOMINAL TUCK:** not visible

5 OBESE
- **RIBS:** not palpable under a thick layer of fat
- **VERTEBRAE:** not palpable and completely covered by fat
- **ABDOMEN-PELVIS:** the abdomen is distended and no waist; extensive deposits of abdominal fat
- **ABDOMINAL TUCK:** non-existent and a lax abdomen from fat deposits

» 3.1 METABOLIC SYNDROME

In human medicine, abdominal obesity associated with insulin resistance, glucose intolerance, dyslipidemia, pro-inflammatory state, elevated blood pressure and/or prothrombic state is referred to as **metabolic syndrome.**

Also in cats, scientific research has shown that obesity/weight gain are associated with increased expression of **inflammatory cytokines** (TNFα, IL-6) and reduced expression of anti-inflammatory adiponectin in adipose tissue (Hoenig et al, 2006; Belsito et al, 2009). Overweight cats also have a numerically higher plasma concentration of **acute phase protein** (α-glycoprotein and haptoglobin) than lean cats (Figure 6) (Jeusette et al, 2009). This inflammatory status could explain the decreased insulin sensitivity observed in obese neutered cats (Figure 7).

Indeed, for each kilo of weight gain, a 30% **decrease in insulin sensitivity** is observed in cats (Hoenig et al, 2006). This decrease is associated with **increased levels of blood cholesterol and triglycerides** (also called hyperlipidemia) (Figure 8). Obese cats also show changes in the levels of lipoproteins

Epidemiological studies have shown that obese cats are 2.7 more likely to die at middle-age (8-12years) than cats with an optimal body condition (Scarlett and Donoghue, 1996).

FIGURE 4. Percentage of obese cats by gender *(adapted from Scarlett et al., 1994).*

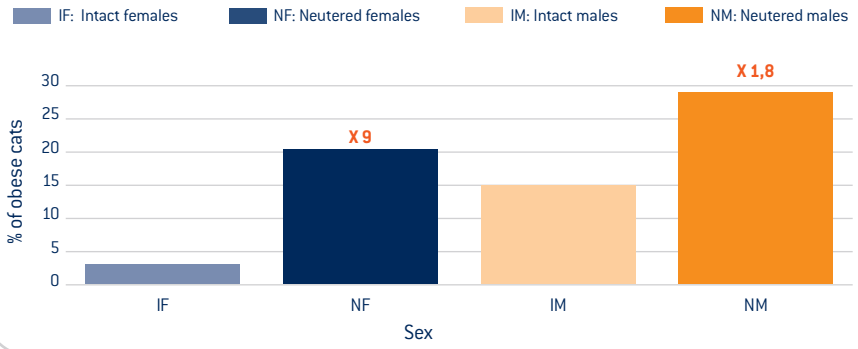


TABLA 2. Relative risk (odds ratio) of certain diseases in cats that are overweight or obese, compared to thin cats *(adapted from Donoghue., 1998; Lund et al, 2005).*

ILLNESS	OVERWEIGHT	OBESE	
Lameness	2.9	4.9	(Scarlett & Donoghue, 1998)
Diabetes mellitus		2.2-3.9	(Scarlett & Donoghue, 1998; Lund *et al*., 2005)
Skin problems		1.5-2.3	(Scarlett & Donoghue, 1998; Lund *et al*., 2005)
Oral diseases	1.8	1.4	Lund *et al*., 2005
Urinary diseases	1.6	Increased	Lund *et al*., 2005
Neoplasia		2.0	Lund *et al*., 2005
Gastrointestinal diseases		Increased	Lund *et al*., 2005
Hepatic lipidosis		Increased	Lund *et al*., 2005

FIGURE 5. Relative risk for diabetes according to body condition *(adapted from Scarlett & Donoghue, 1998).*

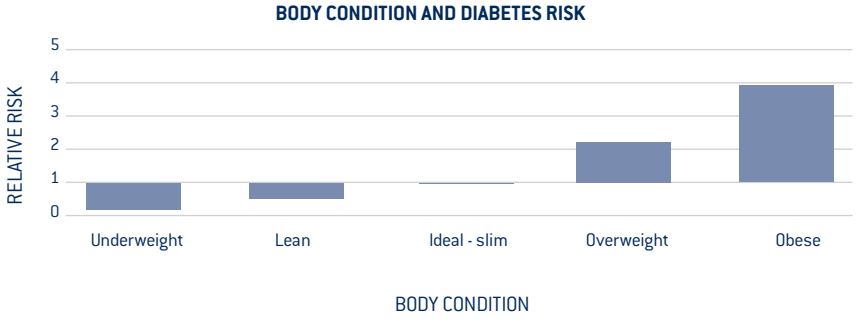
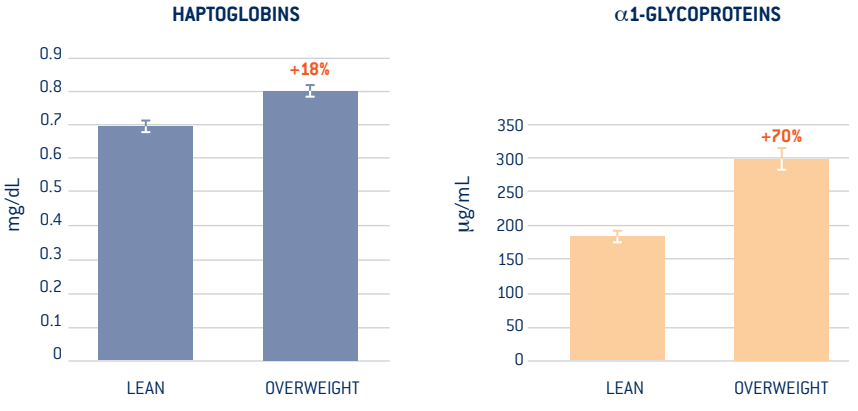


FIGURE 6. Plasma levels of acute phase proteins (haptoglobin, α1-glycoprotein) in lean and overweight cats *(adapted from Jeusette et al., 2009).*



(dyslipidemia) similar to those observed in humans: increased concentration of VLDL and LDL and decreased HDL concentrations (Hoenig et al, 2003; Jordan et al, 2008).

» 3.2 OXIDATIVE STRESS

In human studies, obesity is associated with oxidative stress which in turn is also associated with; hyperglycemia, hyperleptinemia, increased tissue lipid levels, inadequate antioxidant defences, increased free radicals and chronic inflammatory processes (Vincent and Taylor, 2006).

Affinity Petcare studies have shown that overweight cats also present an increase in oxidative stress, as indicated by urinary F2-isoprostane concentration, a marker of *in vivo* lipid peroxidation, suggesting that obesity in cats may be associated with an increased pro-oxidative burden or increased cellular susceptibility to oxidation (Figure 9) (Jeusette et al, 2009).

It remains to be determined whether an oxidative status change is a predisposing factor for diseases frequently observed in obese cats (e.g. hepatic lipidosis, hyperlipidemia, diabetes mellitus, lameness, renal or urinary tract diseases). It has been shown that cats with diabetes mellitus and renal failure suffer from oxidative stress (Falkowski, 2008; Yu and Pateau-Robinson, 2006).

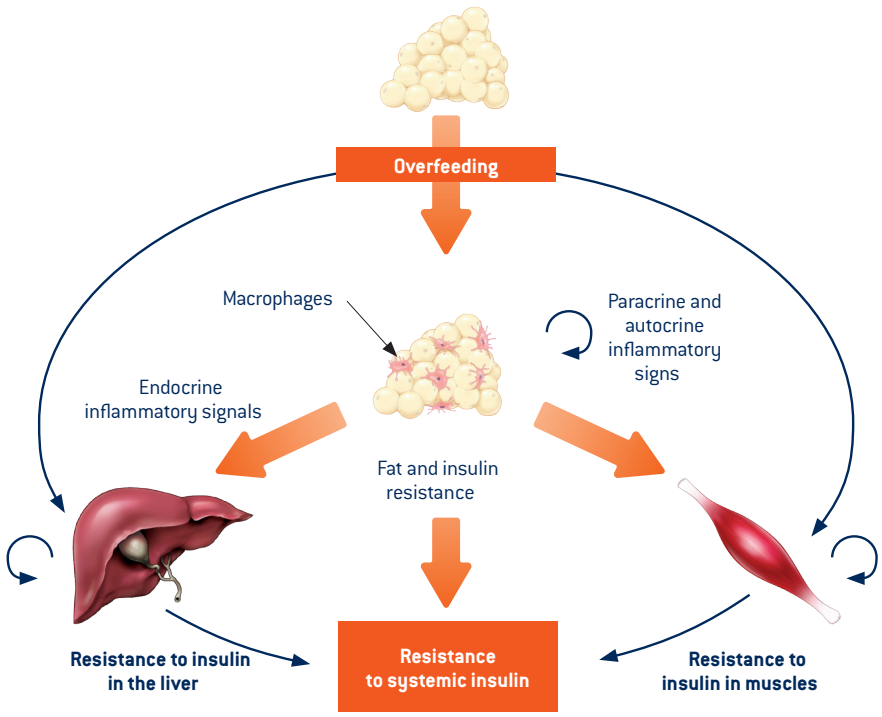
4 TREATMENT OF OBESITY IN CATS

» 4.1 OWNER EDUCATION AND LIFESTYLE MODIFICATIONS

It is important to spend time to explain to the owner of an obese cat about the following:

- How to recognize that the cat is overweight or obese.
- The consequences of obesity on health and well being of the pet.
- The energy intake of his or her cat versus the energy need.
- The importance of strictly following the dietary plan and of avoiding the provision of food supplements.

FIGURE 7. A low-grade inflammatory reaction in adipose tissue induces insulin resistance in adipose tissue, muscle, liver and eventually at a systemic level.



- To explain to the owner that the energy allowance will have to be changed over time to maintain the rate of weight loss.

- To explain to the owner about the possible behavioural changes the cat may show when energy intake is restricted (begging for food, stealing, ...) and how to combat it (food is not the solution to begging behaviour,...) in order to change the undesired behaviour.

It is recommended to make a dietary transition (by mixing increasing amount of the new food with the habitual food, from 10 up to 100%) before moving to exclusive feeding of the weight loss diet.

FIGURE 8. Plasma concentrations of cholesterol and triglycerides (TAG) in lean and obese insulin resistant cats *(adapted from Hoenig et al., 2003).*

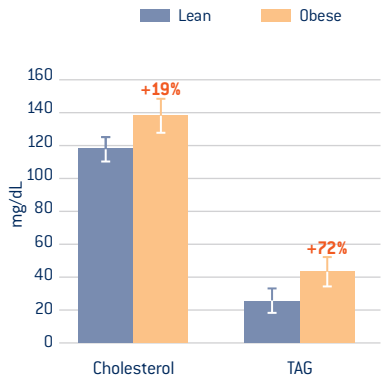
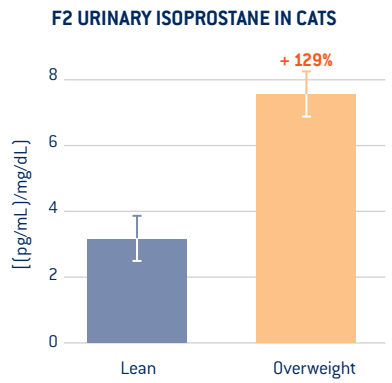


FIGURE 9. Oxidative stress (indicated by urinary F2-isoprostane concentration) in lean and overweight cats *(adapted from Jeusette et al. 2009).*



» 4.2 MEDICAL EVALUATION BEFORE WEIGHT LOSS

A complete physical exam should be performed before any weight loss program starts to exclude diseases that could complicate the treatment: renal failure, FLUTD, liver disease, diabetes mellitus, endocrinopathies...

A complete case history may help determine any predisposing factors for obesity and the precise energy intake.

» 4.3 INFLUENCE OF THE FOOD: KEY NUTRIENTS

The corner stone of all weight loss programs is to achieve a negative energy balance. That means that energy expenditure has to be increased (i.e. with exercise) and that energy intake has to be decreased. One way to achieve energy restriction is to decrease the quantity of food, but this will expose the cat to nutritional imbalances and hunger. For this reason it is evident that a change of diet composition is necessary. Diet composition can also modify the thermal effect of foods and therefore increase energy expenditure.

- The way to interact with the pet in other ways than with food (non food reward, play, ...)

- The importance of lifestyle modifications: play activity, encouraging activity to obtain the food, environmental enrichment to favour exploration activities, avoidance of stress-generating situations, ...

It is also important:

- To give objectives for the owner to achieve (ideal bodyweight, rate of weight loss, time to achieve ideal bodyweight): weight loss is a slow process (a 5kg cat is expected to lose 50g/ week) that will take a long time (if necessary 5 months to lose 1kg)

ENERGY RESTRICTION

A diet with reduced energy content is recommended. The goal is to induce a weight loss of **between 0.5-2% of the starting body weight per week**. Rapid weight loss (more than 2%/week) has to be avoided so as to minimize the risk of loss of muscular mass and the development of feline hepatic lipidosis.

Generally, weight loss is quicker over the first months, and then declines. This is why the starting energy allowance has to be reduced with time to maintain a reasonable rate of weight loss. The best approach is to start by offering 80% of the current energy intake. However, if the cat is being fed *ad libitum*, the intake is not known. Therefore, a starting point is to offer 100 kcal/kg $BW^{0.4}$ (about 75% of NRC requirement for overweight cats) and to adapt the energy intake with time to maintain optimal weight loss.

After 2 weeks, it is recommended to recheck the cats and their weight loss: if this level of feeding has failed (despite adequate compliance), energy intake has to be reduced further (70, 65 or 60% of requirement) and a further enquiry must be made to evaluate adequate compliance with feeding amount, verify the energy requirement of the cat and exclude endocrine pathologies. If weight loss is too quick, the food offered has to be increased in steps of 5 to 10%. During the weight loss program, a monthly check up is recommended to verify that the rate of weight loss is healthy.

In clinical studies, average weight loss rate of 0.5 or 0.8% per week are typically observed (German et al, 2008; Bissot et al, 2009).

LOW LEVEL OF FAT AND FUNCTIONAL FAT

The most efficient way to reduce the energy density of the diet is to decrease the fat content, and thus to allow a relatively higher food intake in weight terms, which in turn promotes satiety. High-carbohydrate diets have been implicated for some time as negatively affecting the glucose and insulin responses in cats. Recent research has shown that a high fat diet compared to a high carbohydrate diet, causes higher body weight and blood insulin levels (Backus et al, 2007), and reduces glucose tolerance in cats (Thiess et al, 2004).

However, a minimum of fat is required to cover the need for fat soluble vitamins and essential fatty acids. The type of fat is very important. A source of essential fatty acids (omega-6 and omega-3 fatty acids) is necessary including from vegetable, animal and fish oils.

Long chain Omega-3 fatty acids (LCPUFAs) also have anti-inflammatory properties and other associated health benefits (decreased blood lipids, cardio vascular effects, amelioration of lameness, improved insulin sensitivity, and may also help to prevent hepatic lipidosis (Szabo et al, 2003, Ibrahim et al, 2003).

Olive oil is the main source of MUFA (mono-unsaturated fatty acid) and a key component of the Mediterranean diet. In the human medical literature, the most documented effects of olive oil consumption concern improved insulin sensitivity and reduced risk of cardiovascular diseases. In men, substituting dietary saturated fat with MUFAs can induce a small but significant loss of body weight and fat mass without a significant change in total energy or fat intake. Postprandial fat oxidation rate is higher after high-MUFA rather than high-saturated fat meals.

A recent research study by Affinity Petcare of overweight cats has shown that the substitution of a part of saturated fat by olive oil induces lower oxidative stress (urinary F2-isoprostane concentrations) (Figure 10) and decreased blood triglycerides.

FIBRE AND SATIETY

Another way to achieve energy dilution is to increase dietary fibre. In addition, fibre can increase satiety. Some types of fibres, due to their particular physical properties, are particularly potent regarding satiety (Figure11), (Affinity, data on file).

HIGH-PROTEIN AND LOW-STARCH DIET

Once fat and fibre contents have been fixed, increasing the dietary protein in place of starch has numerous advantages for an obese cat:

- Improves body composition: increases fat loss and maintains more effectively the muscular mass of obese cats when following a weight loss protocol (Laflamme and Hannah 2005, Hoenig et al, 2007, Vasconcellos et al, 2009). Maintaining muscle mass is very important for long term weight management because much energy expenditure depends on the muscle mass. A substantial loss of muscle mass causes a lower energy requirement and thus favours metabolic resistance to weight loss and a potential for weight rebound.
- Allows higher energy intake (+10%) for the same weight loss (Vasconcellos et al, 2009).
- Improves insulin sensitivity in obese cats (Hoenig et al, 2007).

ANTIOXIDANTS AND ANTI-INFLAMMATORY COMPOUNDS: CITRUS FLAVANONES

As discussed earlier, the pathophysiology of feline obesity includes inflammatory and oxidative mechanisms. The citrus flavanones hesperidin and naringin (subclasses of flavanoids) are reported to have antioxidant, lipid-lowering, hypoglycemic and anti-inflammatory properties, underlining the interest in using them for obese cats (see below).

FIGURE 10. Oxidative stress (indicated by F2-isoprostane in urine) after 5 months feeding a diet with saturated fat or olive oil *(adapted from Jeusette et al., 2010).*

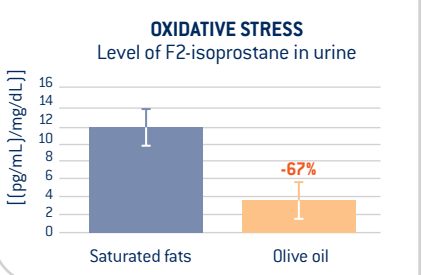


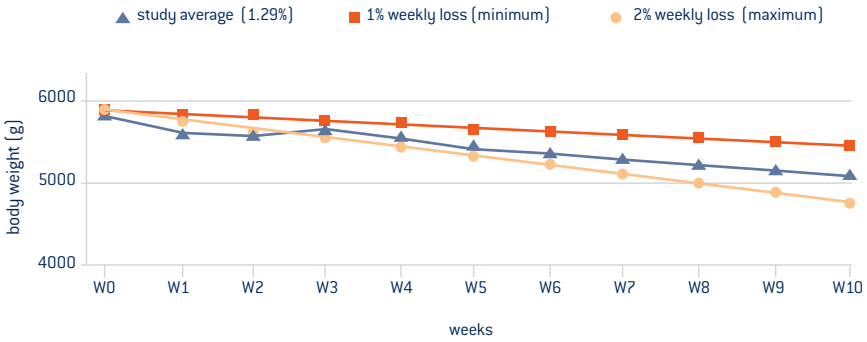
FIGURE 11. Consumption of high palatability food 3 hours following consumption of a regular obesity diet or ADVANCE OBESITY diet (mean of 3 tests)

» 4.4 INFLUENCE OF FOOD: SPECIFIC DIETS

DIET FOR WEIGHT LOSS

An appropriate modified diet (with energy restriction, high in protein, low in fat, with fibres and with balanced nutrients) helps to lose fat, while maintaining muscular mass and avoiding vitamin or mineral deficits and excessive hunger sensations. Tests with the **Advance Veterinary Diets Obesity Diet** in obese cats, applying a 29% restriction of energy needs, resulted in a mean weight loss of 1.25% per week, as targeted. (Figure 12).

FIGURE 12. Average weight loss of 6 cats with the slimming diet Advance Obesity. A restriction of 29%



METABOLIC SUPPORT

Jeusette et al (2010) and Leray et al (in press) have shown that the addition of citrus flavanones in the diet of cats that are overweight or obese (Figure 13):

- significantly reduces a marker of oxidative stress (urinary F2-isoprostane)
- significantly reduces some blood markers of inflammation (haptoglobin, α1-glycoprotein)
- significantly reduces blood lipids [cholesterol and triglycerides (TAG)].

DIABETES SUPPORT

As has been shown by Hoenig et al (2006), weight loss normalizes insulin sensitivity in obese cats. **AFFINITY Petcare** has demonstrated that after only 3 weeks of treatment with **Advance Veterinary Diets Obesity diet**, markers of glucose metabolism are significantly improved (18% reduction in fructosamine, 40% reduction of basal insulin and 21% reduction of amylase).

LIVER SUPPORT

Cats have a high tendency to accumulate triglycerides in their hepatocytes for reasons that remain unclear. Accumulation is likely to occur if TAG synthesis is increased, if fatty acids cannot be oxidised in the mitochondria or if TAG cannot be exported from the liver within very-low-density lipoproteins (VLDLs) Obesity probably predisposes cats to hepatic lipidosis during periods of reduced food intake because of:

- The quantity of free fatty acids that can be rapidly released from peripheral fat stores.
- Some pre-existing insulin resistance related to obesity.
- Baseline hepatic lipid content that is higher in obese cats.

L-carnitine can help to improve fatty acid oxidation in the mitochondria and glucose utilization during weight loss (Ibrahim et al, 2003). When carnitine availability is compromised, TAG accumulates in tissues.

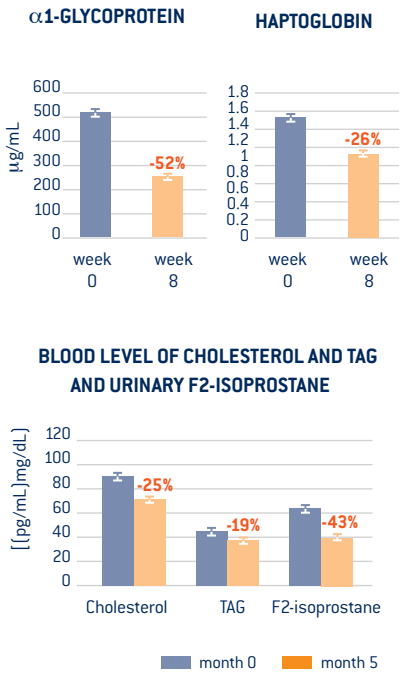
Citrus flavanones may also help to limit liver lipid accumulation (Chiba et al, 2003).

LCPUFAs are significantly reduced in cats with hepatic lipidosis. Some studies provide evidence that diets low in omega-3 LCPUFA increase the susceptibility of cats to hepatic lipidosis (Ibrahim et al, 2000, Szabo et al, 2003). Affinity Petcare has demonstrated that a 3 month weight loss program using Advance Veterinary Obesity Diet resulted in a weight reduction of 15%, and significantly improved hepatic markers (-26% of alkaline phosphatase, -28% of haptoglobin, along with lower levels of transaminases and bile acids.)

SKIN SUPPORT

As discussed above, feline obesity is generally associated with poor coat and skin condition. Therefore, increased dietary concentration of essential nutrients for hair and skin quality is fundamental even though the cat is restricted for its energy and fat intake. Essential amino-acids, essential fatty acids, zinc and biotin are particularly important.

FIGURE 13. Effects of supplementation with citrus flavonones in obese cats on the plasma concentrations of α1-glycoprotein, haptoglobin, urinary isoprostane and blood lipids *(adapted from Leray et al., in press; Jeusette et al., 2010).*



ARTICULAR AND BONE SUPPORT

Decreased mechanical stress on joints by reducing body weight, omega-3 and antioxidants are some of the factors that can regulate pathophysiological changes that occur with articular disease.

URINARY TRACT SUPPORT

Overweight cats are at higher risk for FLUTD. Optimal urinary pH helps to minimize the risk. Water intake has to be sufficient.

INTESTINAL SUPPORT

Obese cats have more gastrointestinal disorders, supplementation with prebiotics helps to restore gut flora and intestinal health.

» 4.5. EXERCISE

It is difficult *per se* to directly increase exercise in cats. However, the natural behaviour of a cat can be enhanced in order to promote physical activity:

- curiosity: enrich the environment to motivate the cat to explore it (garden, window, boxes, possibility to climb, channels, ...)
- hunt: simulate hunting activity with play (mouse, balls, feather on the end of a stick, ...)
- feeding: persuade the cat to follow the owner in order to obtain the food, and use a food dispensing ball such as for Advance Veterinary diets ball.

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