

Mitigating Feline Obesity - Where Are We?

Dr. Adronie Verbrugghe

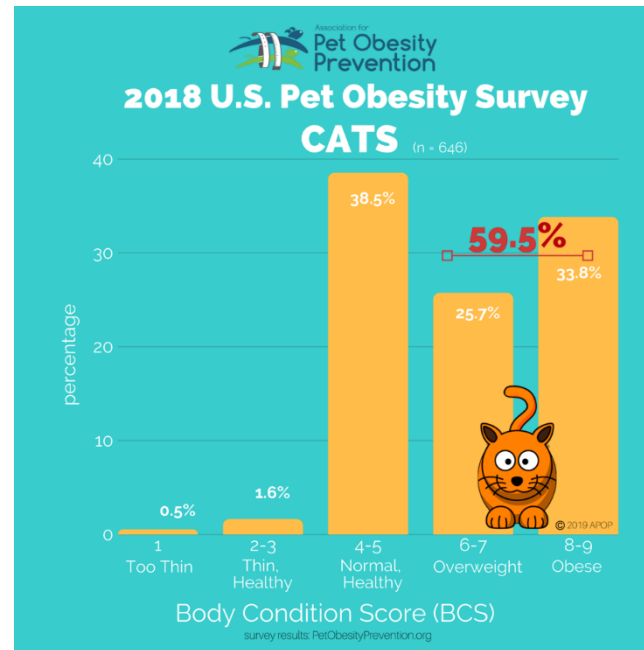
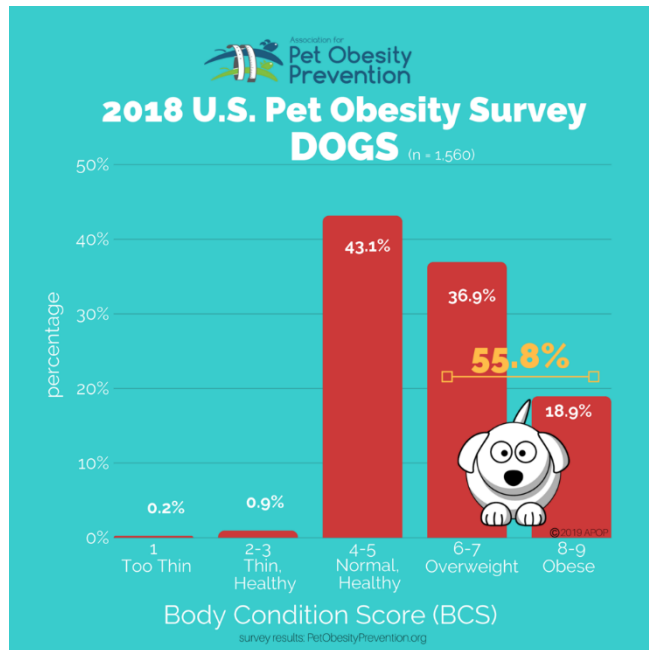
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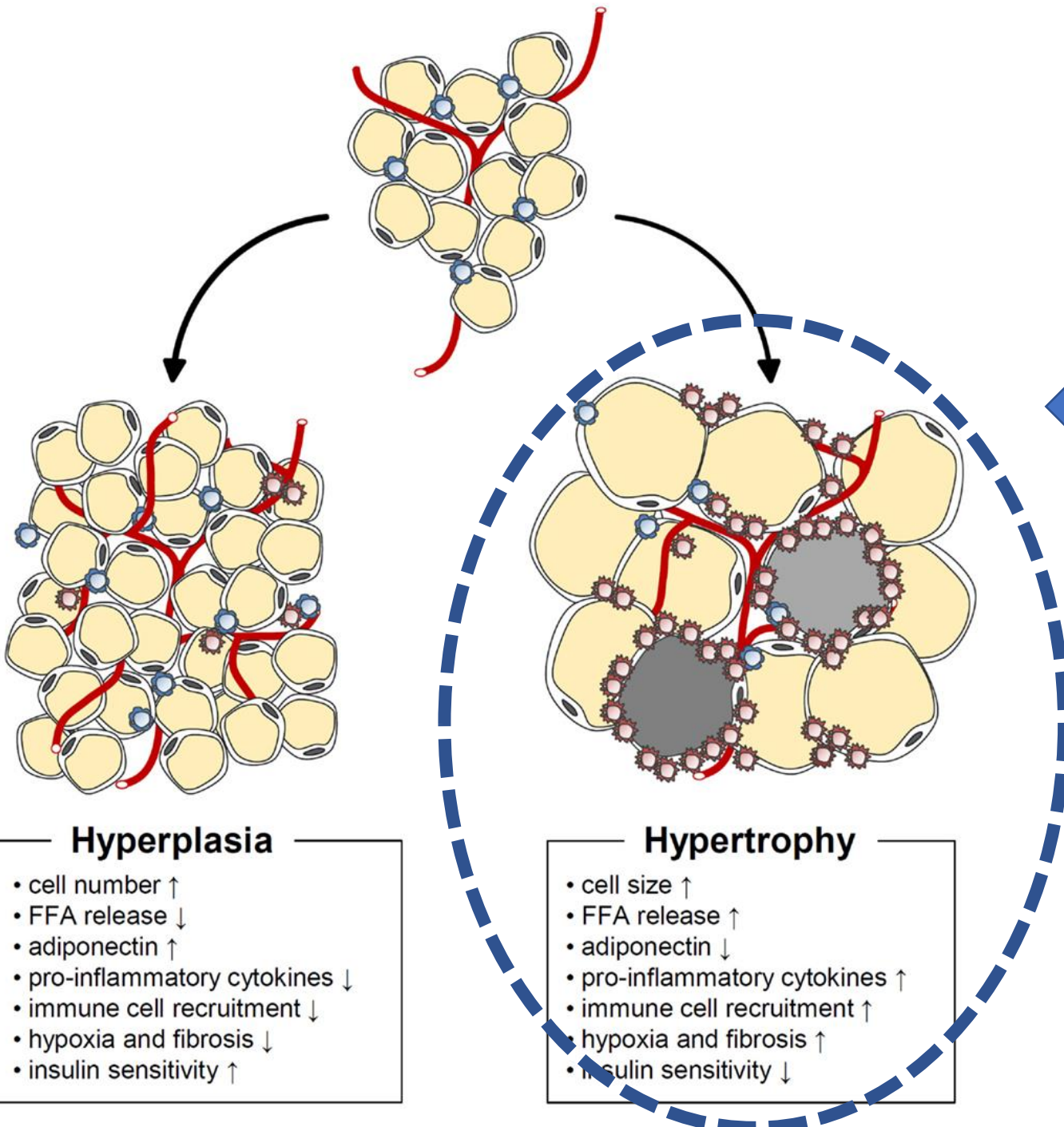
Pet Obesity



- Global problem, most common nutritional disorder
- What? Accumulation of excessive amounts of adipose tissue that is causing disease

energy intake >> energy needs

Obesity-related Health Consequences

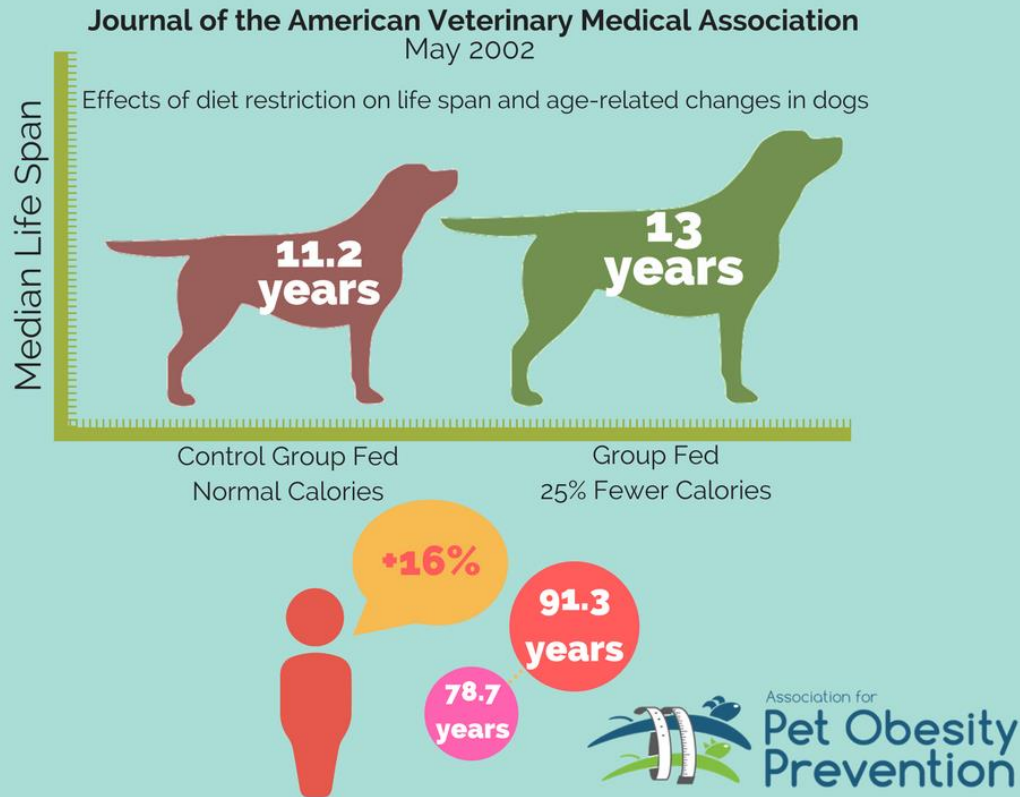


OBESITY

CHRONIC LOW-GRADE INFLAMMATION

- Joint problems, osteoarthritis
- Skin & coat disorders
- Difficulty breathing
- Heat intolerance
- Reduced activity
- Diabetes mellitus
- Heart disease
- Urinary tract disease
- Gastrointestinal problems

Shortened Lifespan



Effects of diet restriction on life span and age-related changes in dogs

Richard D. Kealy, PhD; Dennis F. Lawler, DVM; Joan M. Ballam, MS; Sandra L. Mantz; Darryl N. Biery, DVM, DACVR; Elizabeth H. Greeley, PhD; George Lust, PhD; Mariangela Segre, DSc; Gail K. Smith, DVM, PhD, DACVS; Howard D. Stowe, DVM, PhD



Not Easy To Treat

- **45% completed weight loss program**
- Reason for stopping prematurely
 - Inability to contact owner
 - Owner request before target
 - Another illness
 - Owner illness/personal issues
 - Refusal to comply
- Main factors for success
 - Rate of weight loss
 - Weight loss required to meet target weight
 - Not diet factors

O'Connell et al. *BMC Veterinary Research* (2018) 14:397
<https://doi.org/10.1186/s12917-018-1740-5>

BMC Veterinary Research

RESEARCH ARTICLE

Open Access



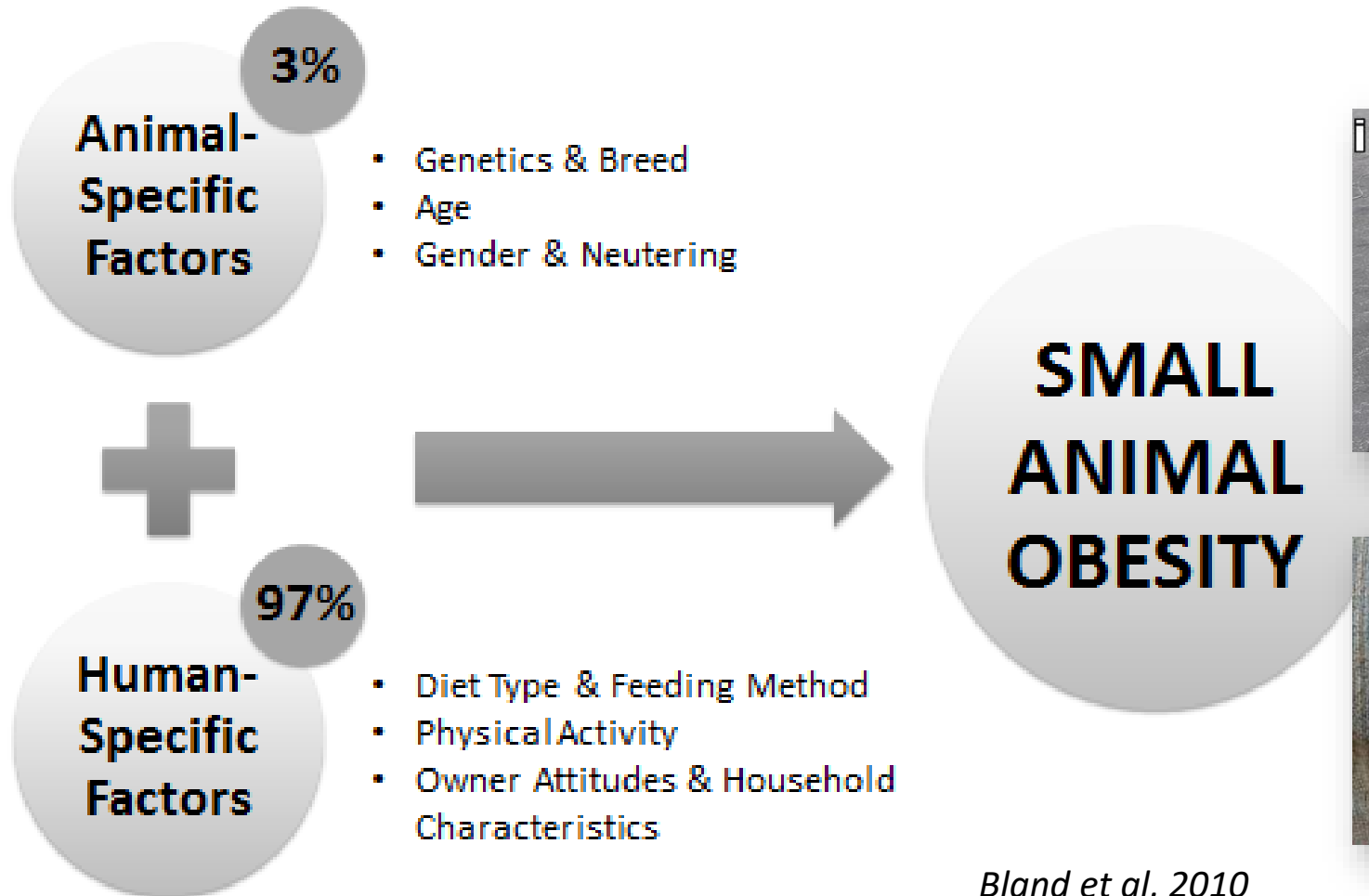
Factors associated with overweight cats successfully completing a diet-based weight loss programme: an observational study

Erin M. O'Connell¹, Maria Williams¹, Shelley L. Holden^{2,4}, Vincent Biourge³ and Alexander J. German^{1,2*}



Focus On Obesity Prevention

Recognize predisposing factors



Bland et al, 2010



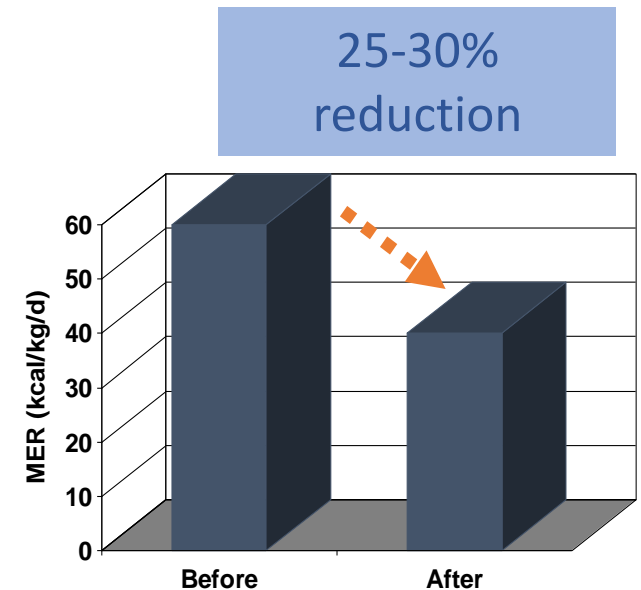
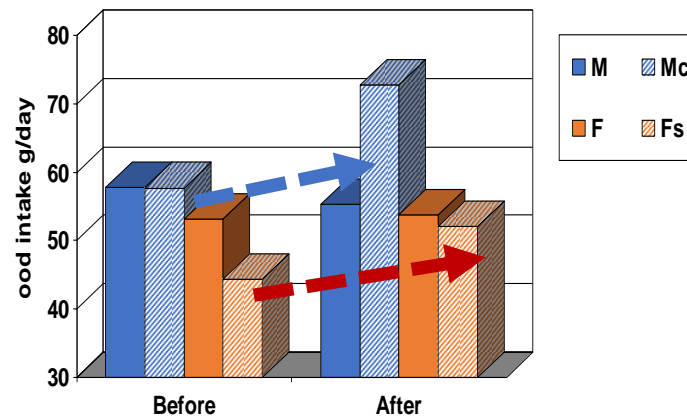
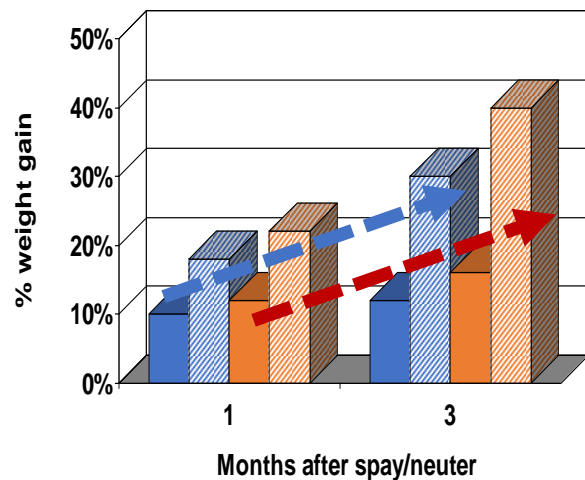
Obesity Management Starts Early In Life!

- Spay/neuter practices common and certainly have benefits
- Many studies have found a **key link between neutering & obesity**
- Neutered dogs 3.8 times, cats 2.6 times more likely to be obese

Robertson, 2003; Courcier et al., 2012

Gonadectomy

- Removal of sex hormones → ex. estrogen known to cause appetite suppression
- Leads to:
 - Increased food intake and body weight post-gonadectomy
 - Substantial food restriction is needed to maintain ideal body weight
 - Resting energy requirement lower
 - Reduction of spontaneous activity



Battling Obesity In Cats Is A Challenge

1. Assessment & identification
2. Feeding management strategies
3. Diet selection & energy restriction for weight loss

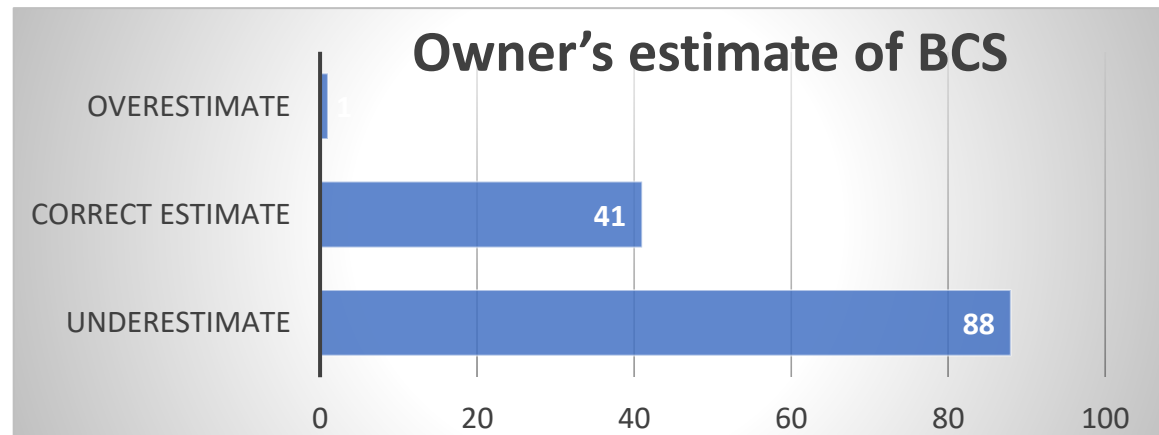


ASSESSMENT & IDENTIFICATION

Build Pet Owner Awareness

- Veterinary teams have trouble communicating the issue with pet owners
- Client communication is utmost important
- Pet owners underestimate their pet's BCS (Cave et al, 2012)

63% Cats BCS >6/9 (n=200)

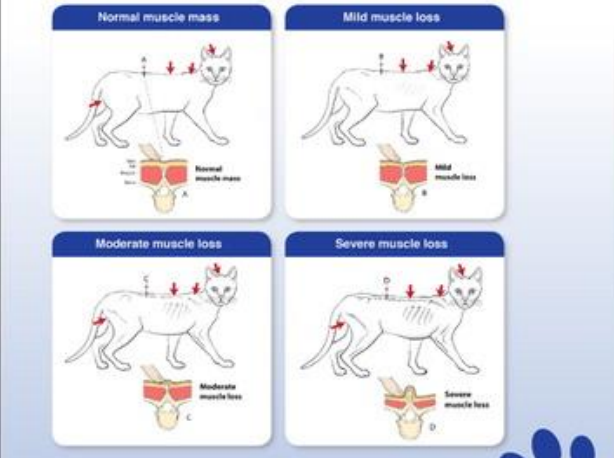
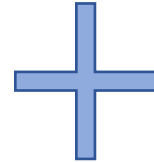


Body Composition Assessment




The chart displays a scale from 1 to 9. Scores 1-4 are categorized as 'UNDER IDEAL', score 5 as 'IDEAL', and scores 6-9 as 'OVER IDEAL'. Each score is accompanied by a silhouette of a cat and a corresponding photograph of a cat's back. The 'IDEAL' section (score 5) shows a cat with a visible waist and a layer of fat that is not excessive. The 'UNDER IDEAL' section shows cats that are too thin, with prominent ribs and a lack of fat. The 'OVER IDEAL' section shows cats that are too fat, with a rounded body and no visible waist.

Body Condition Scoring



The diagrams show four levels of muscle mass: 'Normal muscle mass' (A), 'Mild muscle loss' (B), 'Moderate muscle loss' (C), and 'Severe muscle loss' (D). Each diagram includes a silhouette of a cat with red arrows pointing to the ribs and a corresponding photograph of a cat's back. 'Normal muscle mass' shows a cat with a well-defined waist and a layer of fat. 'Mild muscle loss' shows a cat with a slightly less defined waist. 'Moderate muscle loss' shows a cat with a very thin waist and prominent ribs. 'Severe muscle loss' shows a cat with a very thin waist and very prominent ribs.

Muscle Condition Scoring



A photograph of a tortoiseshell cat sitting on a black digital scale. The scale's display shows the number '13.10'. The scale has buttons for 'ON/OFF', 'UNIT', 'HOLD', and 'ZERO'.

Body Weight

Every Pet → Every Visit

Article

Can Vet J 2018;59:1280–1286

Assessment of canine and feline body composition by veterinary health care teams in Ontario, Canada

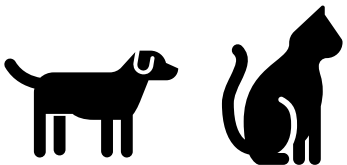
Amanda Santarossa, Jacqueline M. Parr, Adronie Verbrugghe



177 responses: 91 veterinarians, 87 veterinary technicians/assistants

81% heard of AAHA and WSAVA nutritional assessment guidelines

- Of these, 25% (36/143) implemented the guidelines in their practice
- Only 44% of the respondents who implemented the guidelines (16/36) use BCS, MCS and BW together to assess body condition



Article

Can Vet J 2018;59:1280–1286

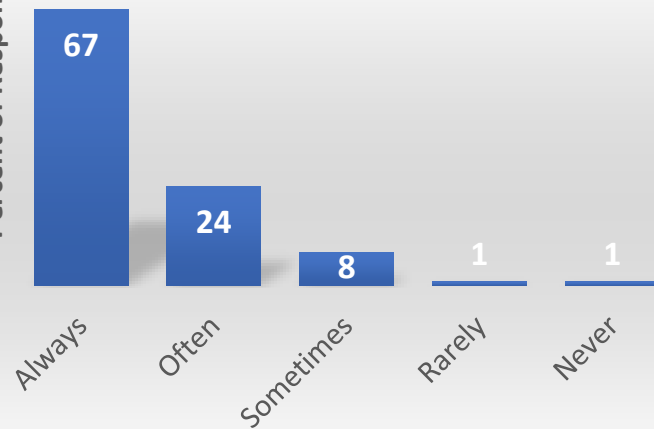
Assessment of canine and feline body composition by veterinary health care teams in Ontario, Canada

Amanda Santarossa, Jacqueline M. Parr, Adronie Verbrugghe



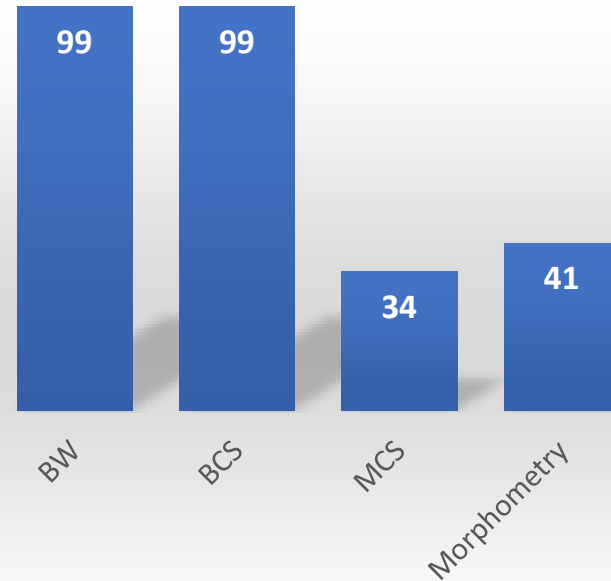
67% reported always assessing body composition

Percent of Respondents

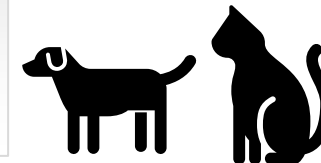


How often assess body composition in patients?

Percent of Respondents



Use of body composition assessment methods



Body Condition Score



UNDER IDEAL

- 1 Ribs visible on short-haired cats. No palpable fat. Severe abdominal tuck. Lumbar vertebrae and wings of ilia easily palpated.
- 2 Ribs easily visible on short-haired cats. Lumbar vertebrae obvious. Pronounced abdominal tuck. No palpable fat.
- 3 Ribs easily palpable with minimal fat covering. Lumbar vertebrae obvious. Obvious waist behind ribs. Minimal abdominal fat.
- 4 Ribs palpable with minimal fat covering. Noticeable waist behind ribs. Slight abdominal tuck. Abdominal fat pad absent.

IDEAL

- 5 Well-proportioned. Observe waist behind ribs. Ribs palpable with slight fat covering. Abdominal fat pad minimal.

OVER IDEAL

- 6 Ribs palpable with slight excess fat covering. Waist and abdominal fat pad distinguishable but not obvious. Abdominal tuck absent.
- 7 Ribs not easily palpated with moderate fat covering. Waist poorly discernible. Obvious rounding of abdomen. Moderate abdominal fat pad.
- 8 Ribs not palpable with excess fat covering. Waist absent. Obvious rounding of abdomen with prominent abdominal fat pad. Fat deposits present over lumbar area.
- 9 Ribs not palpable under heavy fat cover. Heavy fat deposits over lumbar area, face and limbs. Distention of abdomen with no waist. Extensive abdominal fat deposits.

Spurred CR, et al. Evaluation of a nine-point body condition scoring system in physically inactive pet cats. *JAVMA* 2011;172:435-437.
Lafamme DR. Development and validation of a body condition score system for cats: A clinical look. *Feline Pract* 1997;25:13-18.

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wsava.org

20%
BODY
FAT

> 40%
BODY
FAT

The Hill's Healthy Weight Protocol Morphometric Measurement Instructions – FELINE

Patient: _____
 Date: _____
 Age: _____ Current weight: _____

Record results from HWP:HillsVet.com
 BFI: _____
 Ideal weight: _____

Accurate measurements are important to ensure an accurate result. Every effort should be made to be as close as possible to the skin surface. The measuring tape should be snug around the body part, but not so snug that it causes an indentation. Record the numbers in centimeters to one decimal point. Double check your measurements.

Record final measurements on this worksheet. Enter the data into the Hill's Healthy Weight Protocol e-tool at HWP:HillsVet.com. Record results above and file with patient data.

There are SIX FELINE MEASUREMENTS



1. Head circumference

Measure circumference by placing the tape equidistant between the eyes and ears at the widest part of the head.

_____cm
Enter measurements in centimeters



2. Thoracic circumference

Measure the girth at the level of the heart (~ 6th – 7th rib, just behind elbow).

_____cm
Enter measurements in centimeters



3. Front leg circumference

Measure circumference at the midpoint between the carpus and the elbow.

_____cm
Enter measurements in centimeters



4. Front leg length

Measure from the proximal edge of the central foot pad to the point of the elbow (olecranon process). Carpus must be straight.

_____cm
Enter measurements in centimeters



5. Hind leg length

Measure from the proximal edge of the central foot pad to the tip of the hock (dorsal tip of the calcaneal process). Tarsus must be straight.

_____cm
Enter measurements in centimeters



6. Body length

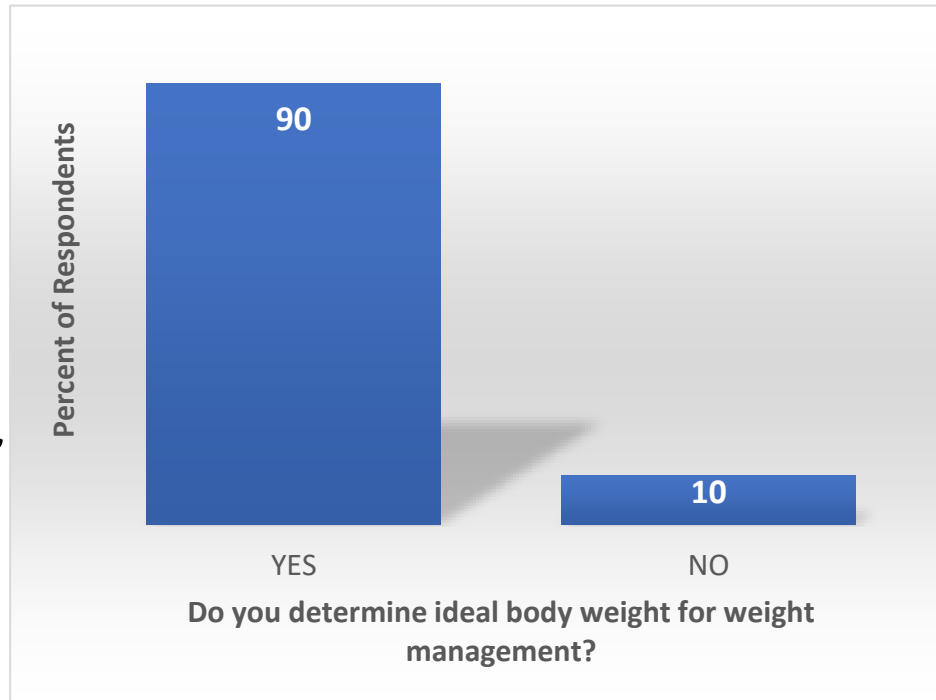
Starting from the base of the tail measure along the dorsal midline following the contours of the back, neck and head to the proximal edge of the nose pad.

_____cm
Enter measurements in centimeters

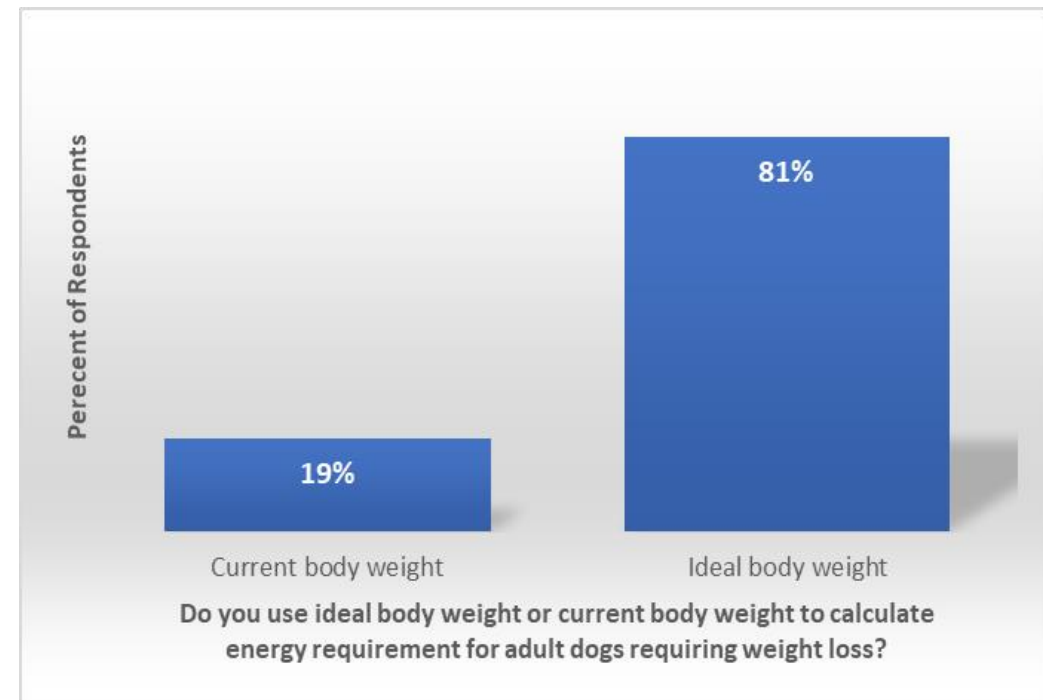


<https://www.hwp.hillsvet.com/>

Ideal Body Weight



Santarossa et al, 2018



Wellard et al, 2020, Unpublished

Body composition Survey

Ontario, Canada, 2014-2015

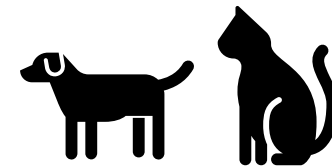
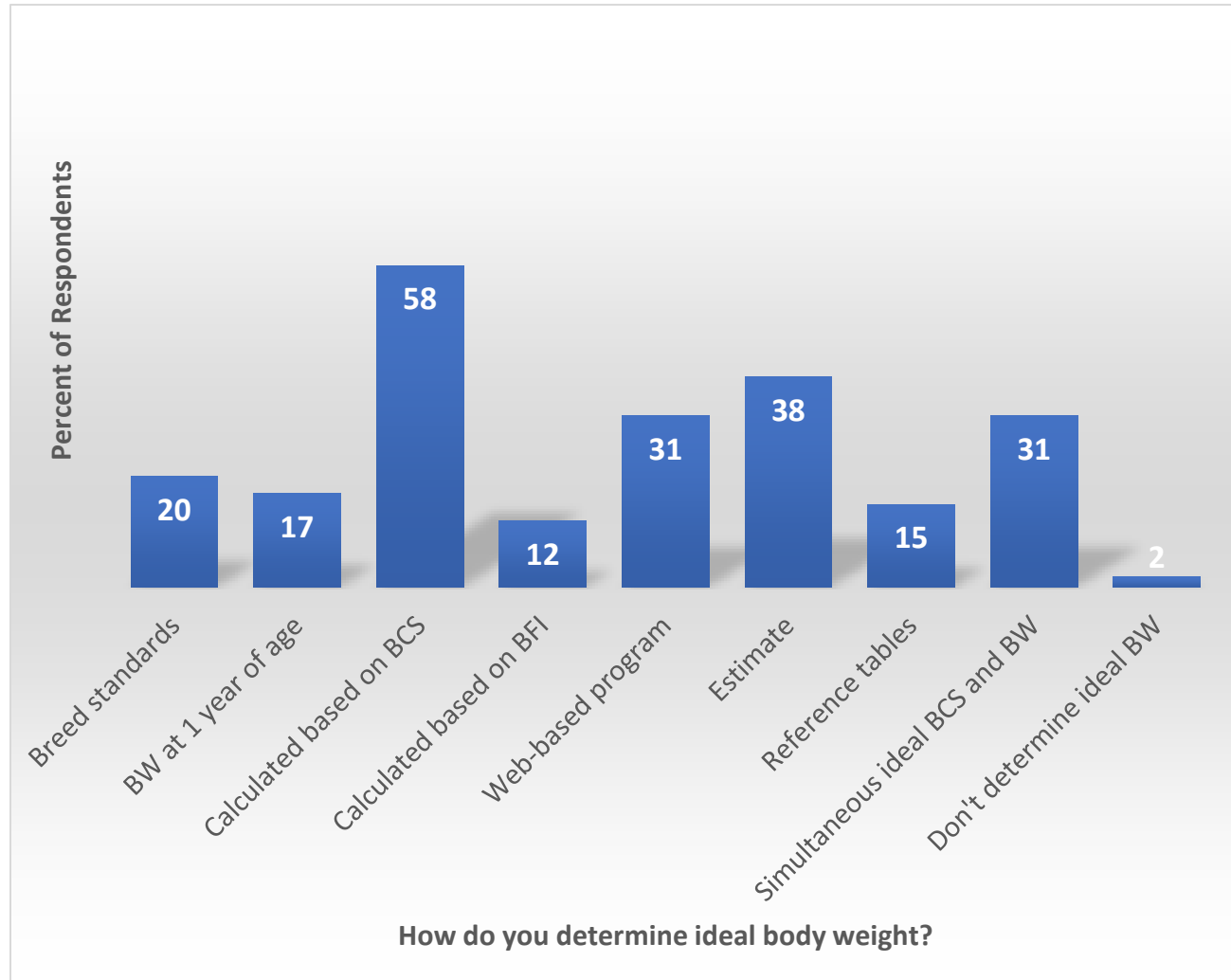
177 respondents: 91 veterinarians, 87 veterinary technicians/assistants

Energy Requirement Survey

Ontario, Canada 2018

343 respondents: 205 veterinarians, 138 veterinary technicians/assistants

Ideal Body Weight



Santarossa et al, 2018


Prevention Early In Live

- Body weight – not a good predictor of age > 10 weeks
- Body condition scoring – not validated
- Growth charts – not published

Original Article



Assessment of body weight for age determination in kittens

Brian A DiGangi¹ , Jessica Graves¹, Christine M Budke², Julie K Levy³, Sylvia Tucker³ and Natalie Isaza¹

Journal of Feline Medicine and Surgery
2020, Vol. 22(4) 322–328
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by the American Editorial Office (AAFP)
for publication in *JFMS*



A tabby cat with a white chest patch is sitting behind a white bowl filled with dry, brown, kibble-shaped cat food. Some kibble is scattered on the surface around the bowl. The cat is looking directly at the camera with its mouth slightly open, showing its pink tongue. The background is a plain, light gray.

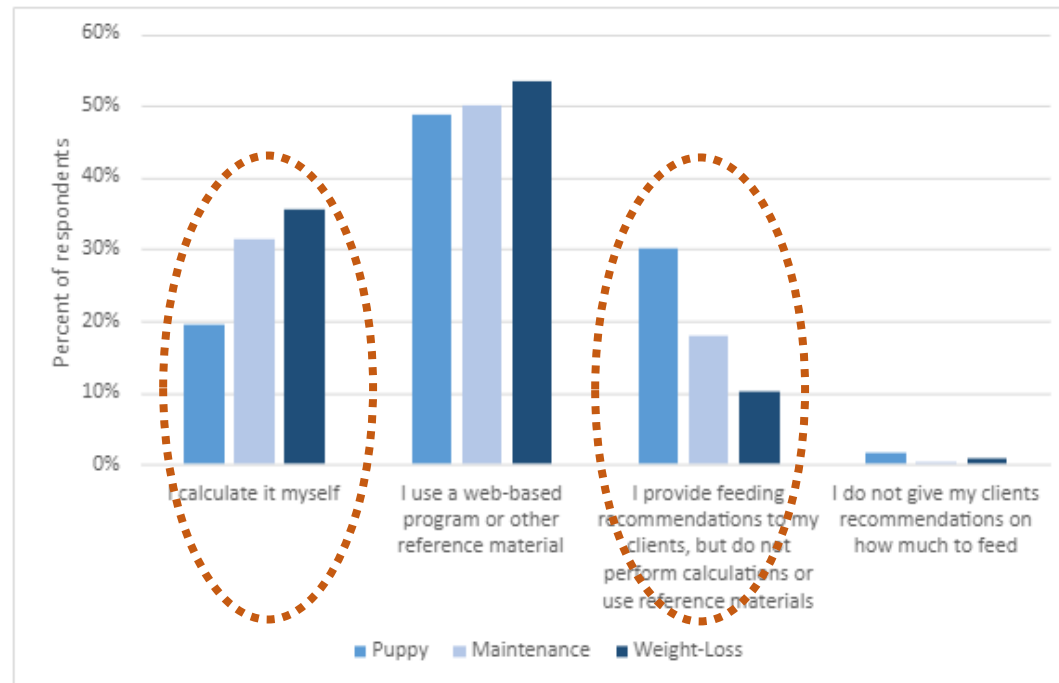
FEEDING MANAGEMENT

Determination Energy Requirement

Veterinary professionals in Ontario, 2018 Survey

Wellard et al, 2020, Unpublished

- Reference materials are most frequently used
- Nonspecific recommendation more often for puppies than for maintenance and for weight loss
- Calculations performed more for adult maintenance and weight loss than for puppies



98% provide feeding recommendation
80% performed energy requirement assessment



Maintenance Energy Requirements (MER)

British Journal of Nutrition (2010), **103**, 1083–1093
© The Authors 2009

doi:10.1017/S000711450999290X

Meta-analysis

Energy requirements of adult cats

Emma N. Bermingham^{1*}, David G. Thomas², Penelope J. Morris³ and Amanda J. Hawthorne³

¹*Food, Metabolism and Microbiology Section, AgResearch Limited, Grasslands Research Centre, Tennent Drive, Palmerston North 4442, New Zealand*

²*Centre for Feline Nutrition, Massey University, Palmerston North 4442, New Zealand*

³*Waltham Centre for Pet Nutrition, Waltham on the Wolds LE14 4RT, UK*

- Predictive MER lower than reported in NRC
- Large variation among cats
- MER based on BW alone not accurate prediction
→ age, gender, neuter status, body composition
- Little information: young, senior, intact, outdoor cats

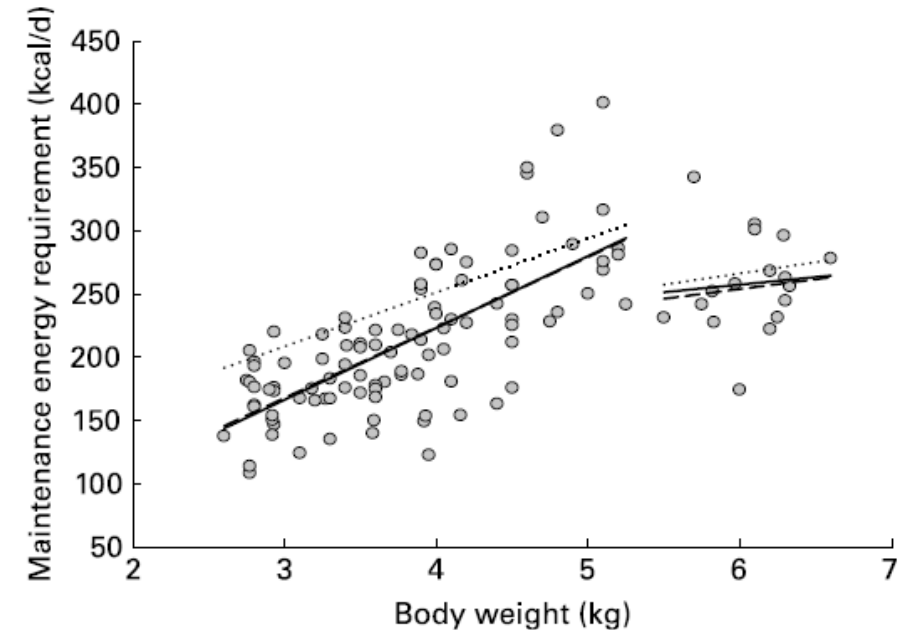


Fig. 1. Effect of body weight (BW) on the maintenance energy requirements in domestic cats (○; —), compared with the predicted requirements from the present study (---) and those predicted by the National Research Council⁽⁵⁾ (.....). Allometric equations predicted from the present study were $56.2 \text{ kcal/kg BW}^{-0.966}$ and $131.8 \text{ kcal/kg BW}^{-0.366}$ for light and normal cats and heavy cats, respectively, in the present study. The corresponding predictive equations from the National Research Council⁽⁵⁾ were $100 \text{ kcal/kg BW}^{-0.667}$ and $130 \text{ kcal/kg BW}^{-0.40}$ for light and normal cats and heavy cats, respectively.

Metabolisable Energy (ME)

Table 5. Comparison of measured ME with ME calculated using Atwater and modified Atwater equations, and resulting caloric surplus per day for 3 experimental diets differing in perceived glycemic response (PGR) fed to cats.

Name	HighPGR	MediumPGR	LowPGR
Measured ME, kcal/kg as fed	4259 ^a	4574 ^b	4787 ^c
Calculated ME, kcal/kg as fed			
Modified Atwater ¹	3752	4081	4137
Traditional Atwater ²	4176	4505	4565
NRC ³	3778	4301	4413
Calorie surplus per day (kcal/day)			
Modified Atwater	21.7	22.2	29.3
Traditional Atwater	3.6	3.1	10
NRC	21.1	12.1	16.4
Calorie surplus per day, %			
Modified Atwater	11.9	10.8	13.6
Traditional Atwater	2.0	1.5	4.6
NRC	11.3	6.0	7.8

^{a-c} Within a row, means without a common superscript differ ($p < 0.05$). ¹ Calculated with modified Atwater equation (AAFCO, 1997): ME (kcal/kg) = $10 \times (3.5 \times \text{Crude Protein \%} + 8.5 \times \text{Crude Fat \%} + 3.5 \times \text{Nitrogen-Free Extract \%})$. ² Calculated with traditional Atwater equation (Atwater, 1902): ME (kcal/kg) = $10 \times (4 \times \text{Crude Protein \%} + 9 \times \text{Crude Fat \%} + 4 \times \text{Nitrogen-Free Extract \%})$. ³ Calculated using the NRC predictive equations (NRC, 2006): Step 1: GE (kcal) = $(5.7 \times \text{g protein}) + (9.4 \times \text{g fat}) + 4.1 \times (\text{g NFE} + \text{g fiber})$; Step 2: Percentage energy digestibility = $87.9 - (0.88 \times \text{percentage crude fiber in dry matter})$; Step 3: DE (kcal/g) = $(\text{GE} \times \text{percentage energy digestibility}/100)$; Step 4: ME (kcal/g) = $\text{DE} - (0.77 \times \text{g protein})$.

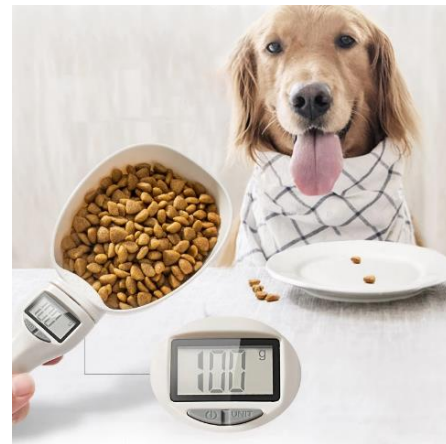
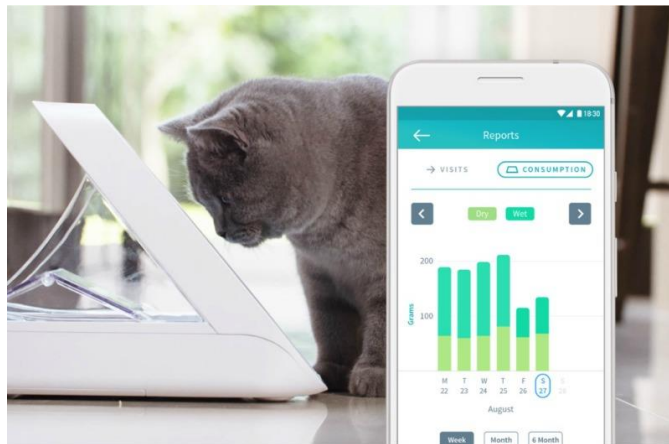
$$\text{Traditional ME (kcal/kg)} \\ = [4 \times \text{CP (\%)} + 4 \times \text{NFE (\%)} + 9 \times \text{crude fat (\%)}] \times 10$$

$$\text{Modified ME (kcal/kg)} \\ = [3.5 \times \text{CP (\%)} + 3.5 \times \text{NFE (\%)} + 8.5 \times \text{crude fat (\%)}] \times 10$$

NRC
4 step calculation, that includes Crude Fibre

- Traditional Atwater
Closest to measured ME
- Modified Atwater
Underestimation ~12 %
- NRC
Underestimation 8%

Measuring Food



ORIGINAL ARTICLE

Imprecision when using measuring cups to weigh out extruded dry kibbled food

A. J. German¹, S. L. Holden¹, S. L. Mason¹, C. Bryner², C. Boulidoires², P. J. Morris³, M. Deboise⁴ and V. Biourge⁴

1 School of Veterinary Science, University of Liverpool, Neston, Wirral, UK,

2 Royal Canin (Schweiz) AG, Regensdorf, Switzerland,

3 The WALTHAM Centre for Pet Nutrition, Waltham-on-the-Wolds, Melton Mowbray, LE, UK, and

4 Royal Canin Research Center, Aimargues, France



OPEN ACCESS

PAPER

Dog owner's accuracy measuring different volumes of dry dog food using three different measuring devices

Jason B Coe,¹ Alexandra Rankovic,² Tara R Edwards,³ Jacqueline M Parfitt^{2,4}

Veterinary Record (2019) doi:10.1136/vetrec-2018-105319



Feeding Method

- Multiple small meals
- Automated feeders
- Food toys and puzzles
- Put play & activity into feeding

→ Enhance activity & mental stimulation

Feeding Method

Physiological & metabolic effects?

Tested 1 versus 4 meals in cats

Physical activity greater in cats fed 4 times, though energy expenditure not different

Cats fed once daily compared to eating four times daily had:

- Higher plasma satiety hormones (GIP, GLP-1 and trend for PYY)
- Greater postprandial plasma amino acid and insulin response concentrations.
- Lower fasting respiratory quotient



PLOS ONE

RESEARCH ARTICLE

The daytime feeding frequency affects appetite-regulating hormones, amino acids, physical activity, and respiratory quotient, but not energy expenditure, in adult cats fed regimens for 21 days

Alexandra Camara¹, Adronie Verbrugghe¹, Cara Cargo-Froom², Kylie Hogan², Trevor J. DeVries², Andrea Sanchez¹, Lindsay E. Robinson³, Anna K. Shoveller^{2*}

¹ Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada, ² Centre for Nutrition Modelling, Department of Animal Biosciences, Ontario Agricultural College, University of Guelph, Guelph, Ontario, Canada, ³ Department of Human Health and Nutritional Sciences, College of Biological Sciences, University of Guelph, Guelph, Ontario, Canada

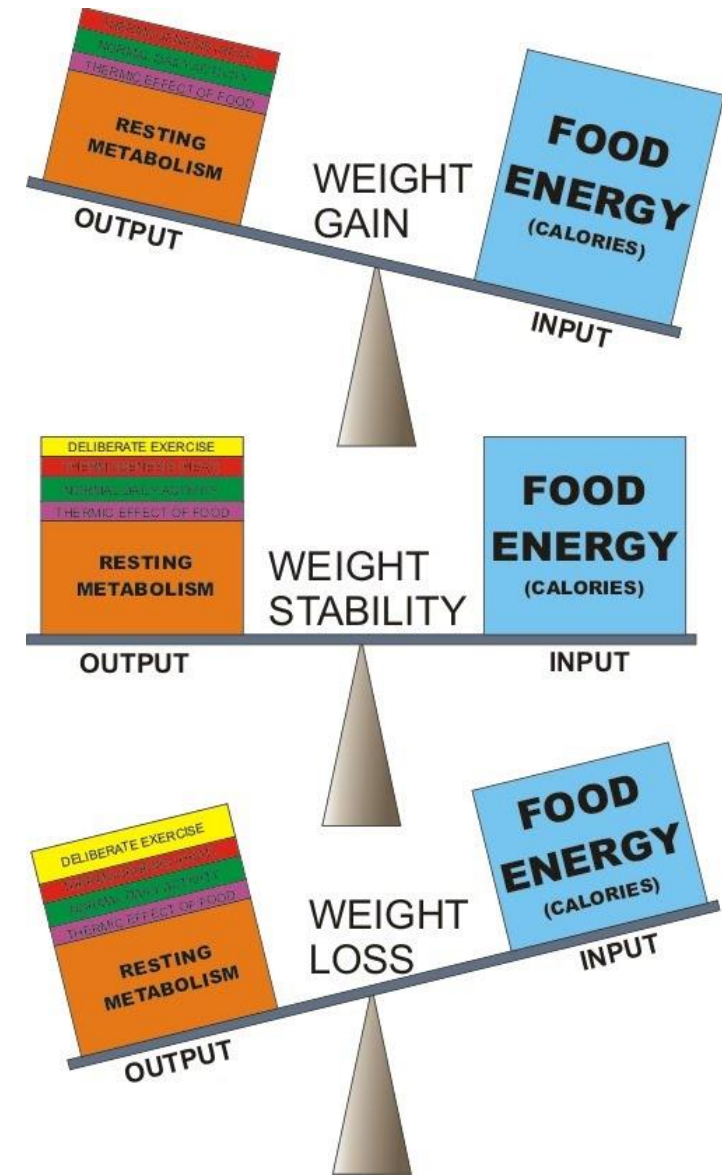
A close-up photograph of two cats eating from a white bowl. The cat on the left is a ginger and white tabby, and the cat on the right is a grey tabby. The grey tabby is in the foreground, with its pink tongue extended and touching the food. The ginger and white cat is behind it, also eating. The background is dark and out of focus. The text "DIET SELECTION & ENERGY RESTRICTION" is overlaid in white, sans-serif font across the middle of the image.

DIET SELECTION & ENERGY RESTRICTION

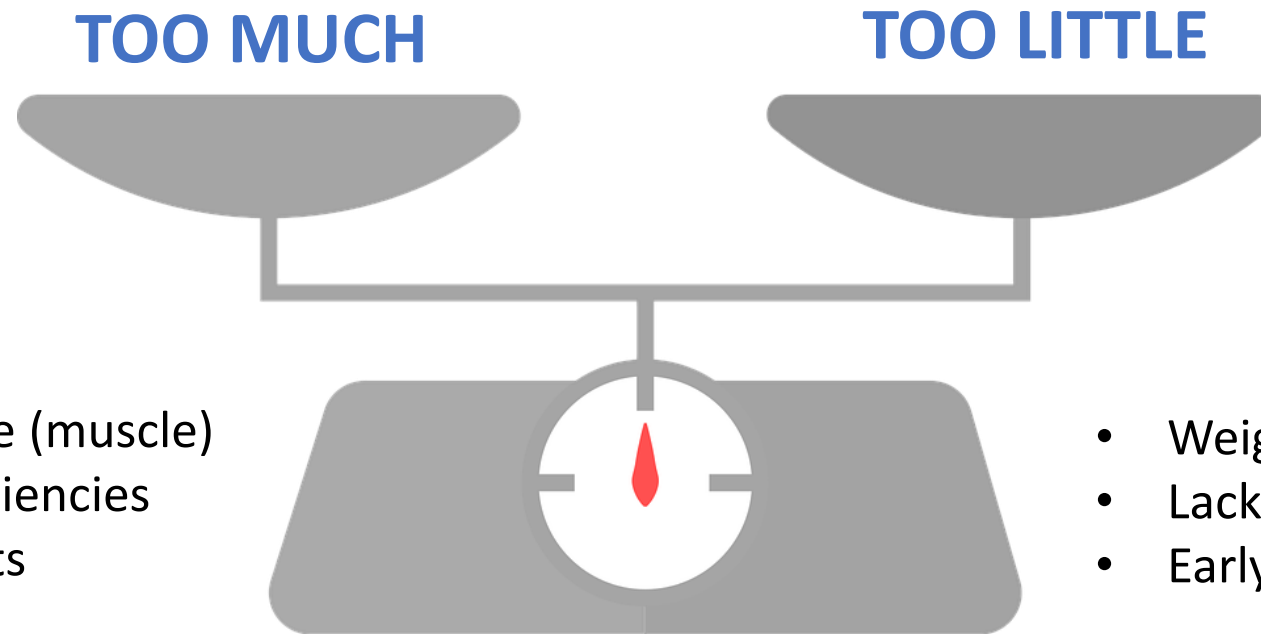
Caloric Restriction

Negative energy balance = key to weight loss

- Equations to estimate energy for weight loss:
 - Resting energy requirement (RER; $70 \text{ kcal/kg}^{0.75}$)
Thatcher et al., 2010
 - 80% of RER
Brooks et al., 2014; German et al., 2011; Wakshlag et al., 2012
 - 60% of percentage MER ($130 \text{ kcal/kg}^{0.4}$)
NRC, 2006
- Current or ideal body weight



Caloric Restriction



- Loss of lean body tissue (muscle)
- Essential nutrient deficiencies
- Hepatic lipidosis → Cats

- Weight loss plan not successful
- Lack of owner compliance
- Early drop out

AIM: Slow & steady
0.5-2% of start BW per week

Diet Choices

Over the counter diets

- Feed less current diet
- Light, low calorie, low fat
- Formulated for maintenance not for calorie restriction

Add low calorie human food

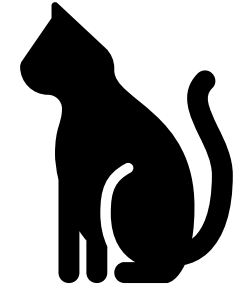
- Pumpkin, green beans
- Dilute energy but also nutrients

Veterinary weight loss food

- Formulated accounting for calorie restriction



Food Selection For Weight Loss



Grant et al. BMC Veterinary Research (2020) 16:426
<https://doi.org/10.1186/s12917-020-02649-0>

BMC Veterinary Research

RESEARCH ARTICLE

Open Access

Dietary intake of amino acids and vitamins compared to NRC requirements in obese cats undergoing energy restriction for weight loss



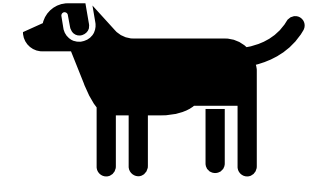
Caitlin E. Grant¹, Anna K. Shoveller², Shauna Blois¹, Marica Bakovic³, Gabrielle Monteith¹ and Adronie Verbrugghe^{1*}

- **Weight loss trial** with VTD
 - Intake of majority of indispensable amino acids and vitamins greater than NRC recommended allowance
 - Except **arginine, choline, crude protein, phenylalanine plus tyrosine and threonine**

Grant et al, 2020 DVSc thesis

- **Theoretical estimation** of amino acid and vitamin intake during energy restriction
 - Fewer nutrient intakes below NRC recommended allowance with VTD compared to OTC maintenance and low-calorie diets
 - Higher number of nutrients below NRC recommended allowance with increasing level of restriction
 - Nutrients of concern: **crude protein, phenylalanine plus tyrosine, choline**

Food Selection For Weight Loss




German et al. *BMC Veterinary Research* (2015) 11:253
DOI 10.1186/s12917-015-0570-y



RESEARCH ARTICLE

Open Access

Assessing the adequacy of essential nutrient intake in obese dogs undergoing energy restriction for weight loss: a cohort study 

Alexander J. German^{1,2*}, Shelley L. Holden^{1,2}, Samuel Serisier^{1,2}, Yann Queau^{1,2} and Vincent Biourge^{1,2}

- **Weight loss trial** with VTD
 - Intake of majority of nutrients greater than NRC recommended allowance
 - Some nutrients lower than NRC recommended allowance
 - **Total fat, tryptophan, methionine and cysteine, magnesium, potassium, selenium, choline**

Veterinary Quarterly
Vol. 32, Nos. 3–4, September–December 2012, 123–129

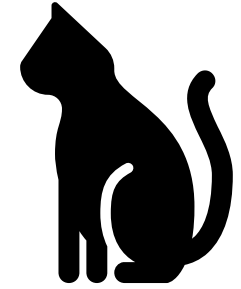


RESEARCH ARTICLE

Theoretical evaluation of risk for nutritional deficiency with caloric restriction in dogs
Deborah E. Linder^a, Lisa M. Freeman^{a*}, Penelope Morris^b, Alexander J. German^c, Vincent Biourge^d,
Cailin Heinze^a and Lucille Alexander^b

- **Theoretical** estimation of nutrient intake during energy restriction → VTD and OTC diets
 - All diets → at least one nutrient below NRC recommended allowance when restricted minimally
 - Number of nutrients deficient increased with increased degree of restriction
 - Most common were **selenium and choline**

Food Selection For Weight Loss



Grant et al. BMC Veterinary Research (2020) 16:426
<https://doi.org/10.1186/s12917-020-02649-0>

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Dietary intake of amino acids and vitamins compared to NRC requirements in obese cats undergoing energy restriction for weight loss



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- **Weight loss trial** with VTD
 - Intake of majority of indispensable amino acids and vitamins greater than NRC recommended allowance
 - Except **arginine, choline, crude protein, phenylalanine plus tyrosine and threonine**

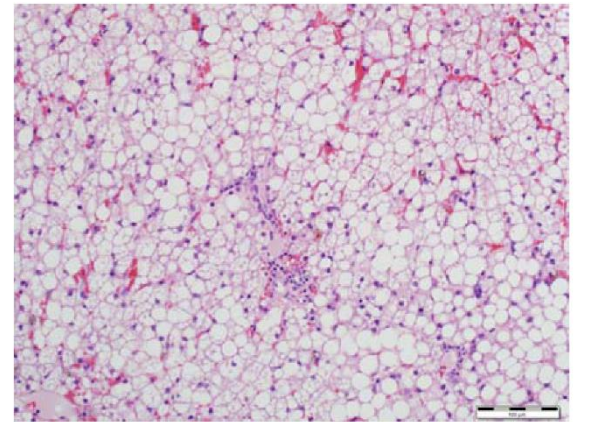
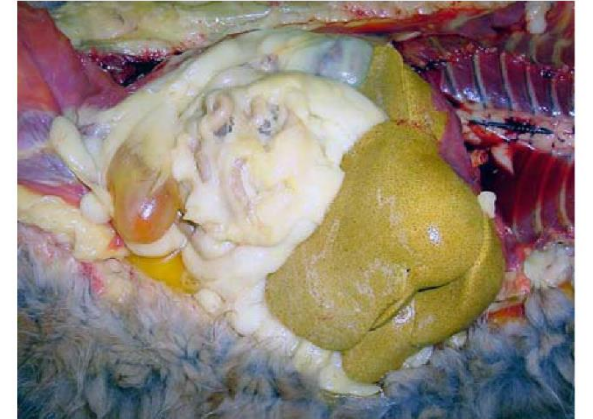
Grant et al, 2020 DVSc thesis

- **Theoretical estimation** of amino acid and vitamin intake during energy restriction
 - Fewer nutrient intakes below NRC recommended allowance with VTD compared to OTC maintenance and low-calorie diets
 - Higher number of nutrients below NRC recommended allowance with increasing level of restriction
 - Nutrients of concern: **crude protein, phenylalanine plus tyrosine, choline**

Fatty Liver In Cats

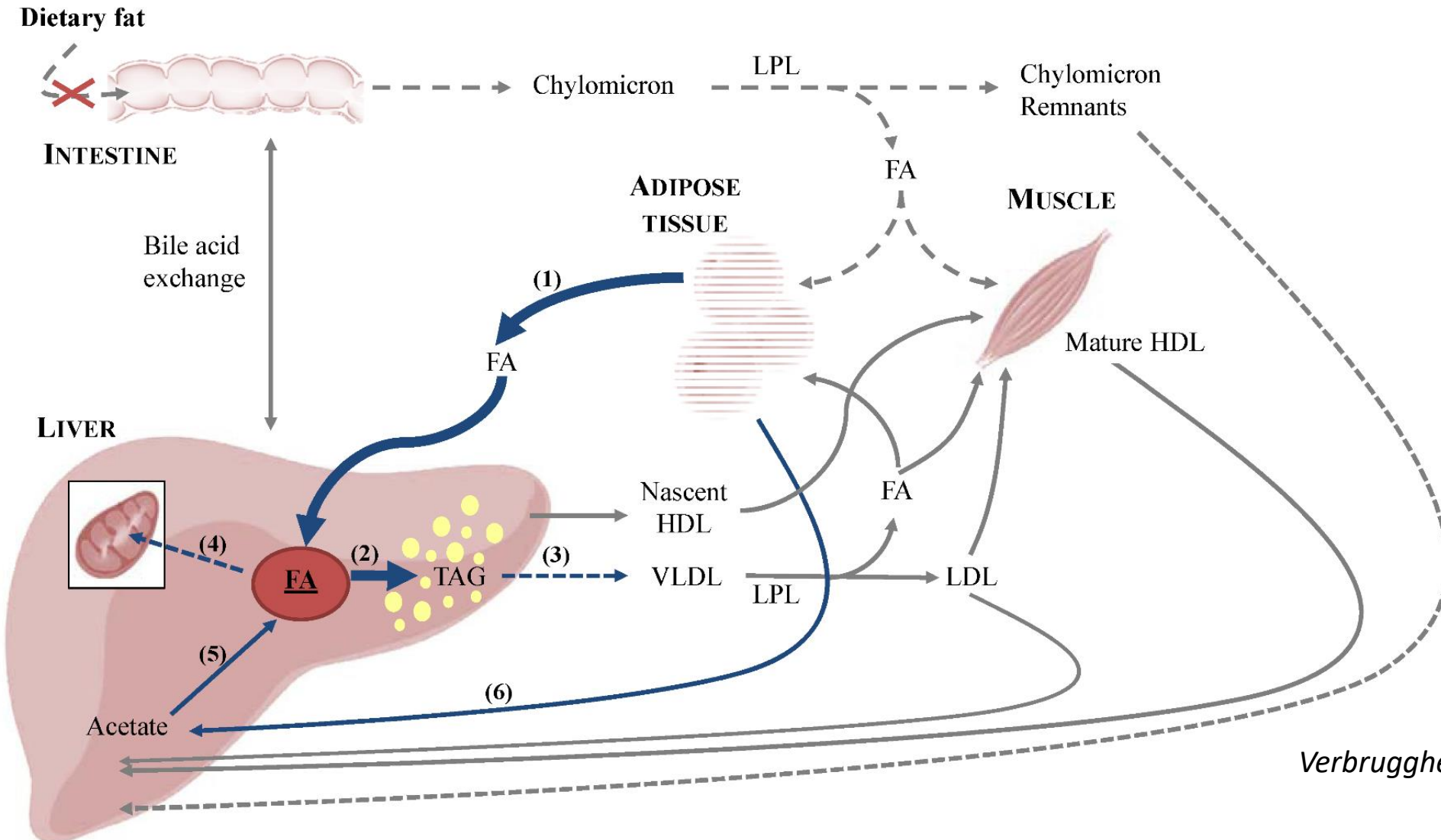
Feline Hepatic Lipidosis

- Most common liver disease affecting cats in North America
 - Estimated prevalence 0.16%
 - > 50% liver biopsies performed
- Most commonly affects overweight & obese cats
- Most common cause = complete or partial anorexia



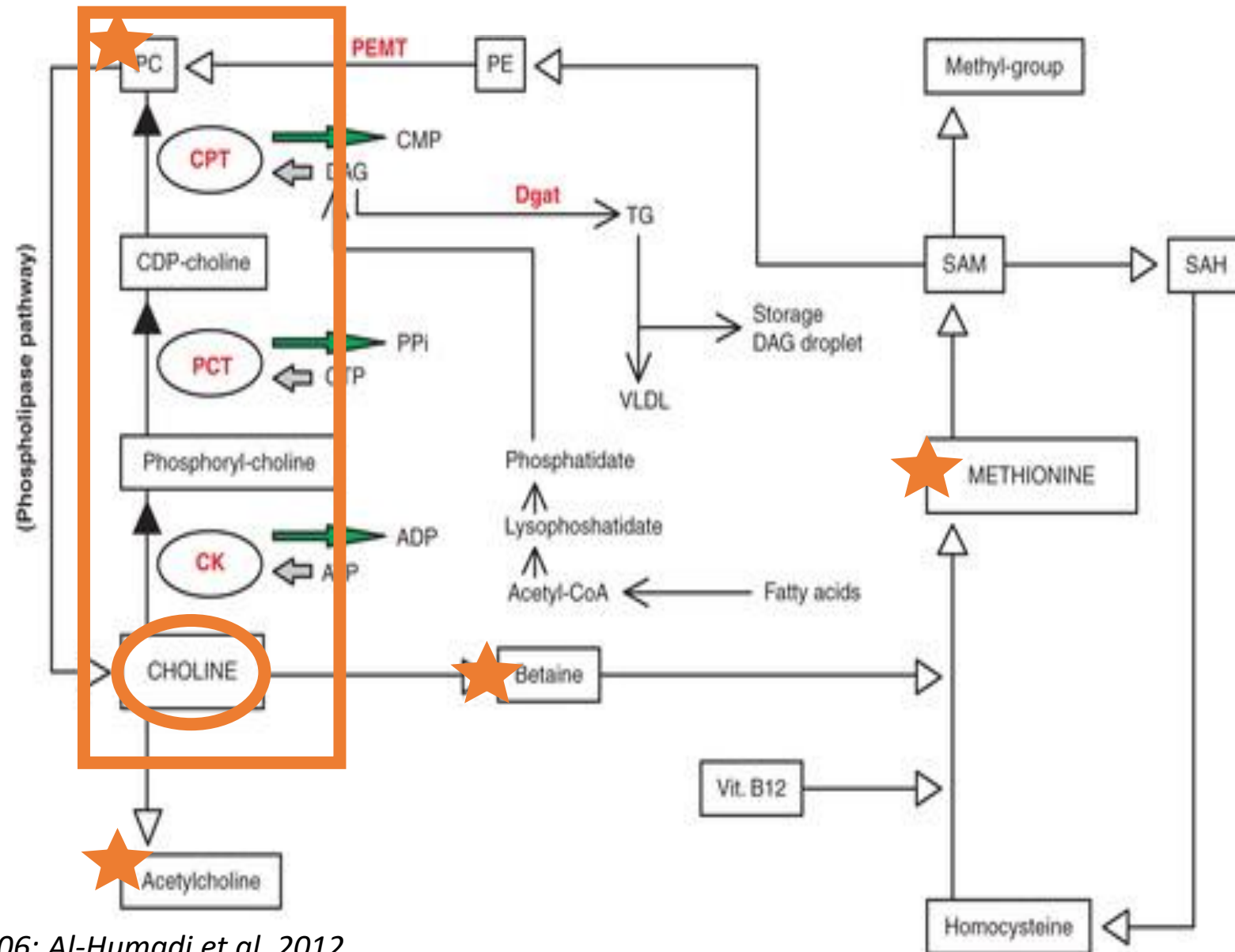
Armstrong et al. 2009; Gagne et al. 1996; Crawford et al. 2010; Valtolina et al. 2005

Fatty Liver In Cats



Verbrugghe & Bakovic, 2013

Choline Functions



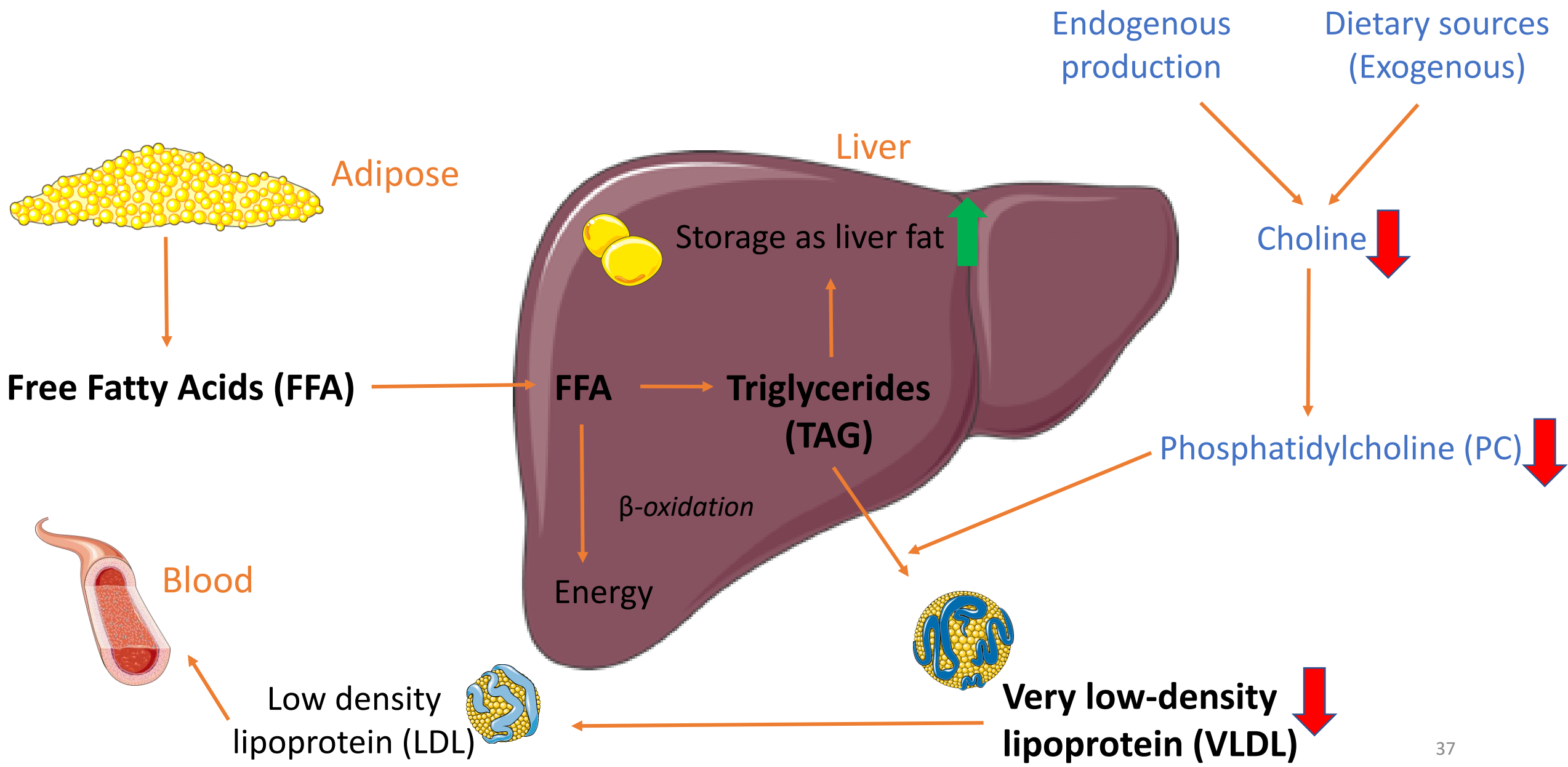
Lipotropic Effects Of Choline

Roles in fat metabolism

- Stimulating lipid transport

Liver – synthesis of phosphatidylcholine (PC)

→ structural component very low-density lipoproteins (VLDL)



Lipotropic Effects Of Choline

Roles in fat metabolism

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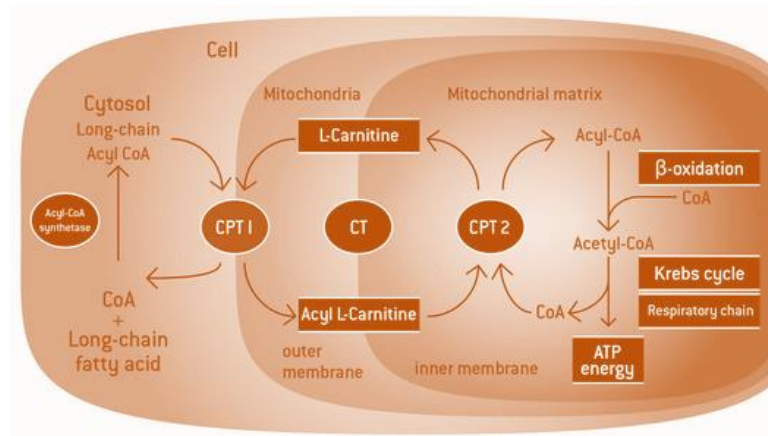
Liver – synthesis of phosphatidylcholine (PC)

→ structural component very low-density lipoproteins (VLDL)

- Increasing oxidation of fatty acids

- Stimulates re-methylation of methionine → SAM produced → ↑ PC and carnitine

- Carnitine essential for mobilization of long-chain fatty acids for oxidation



Duric et al. 2012; Rebouche & Seim 2002



CHOLINE SUPPLEMENTATION

Obese Adult Cats

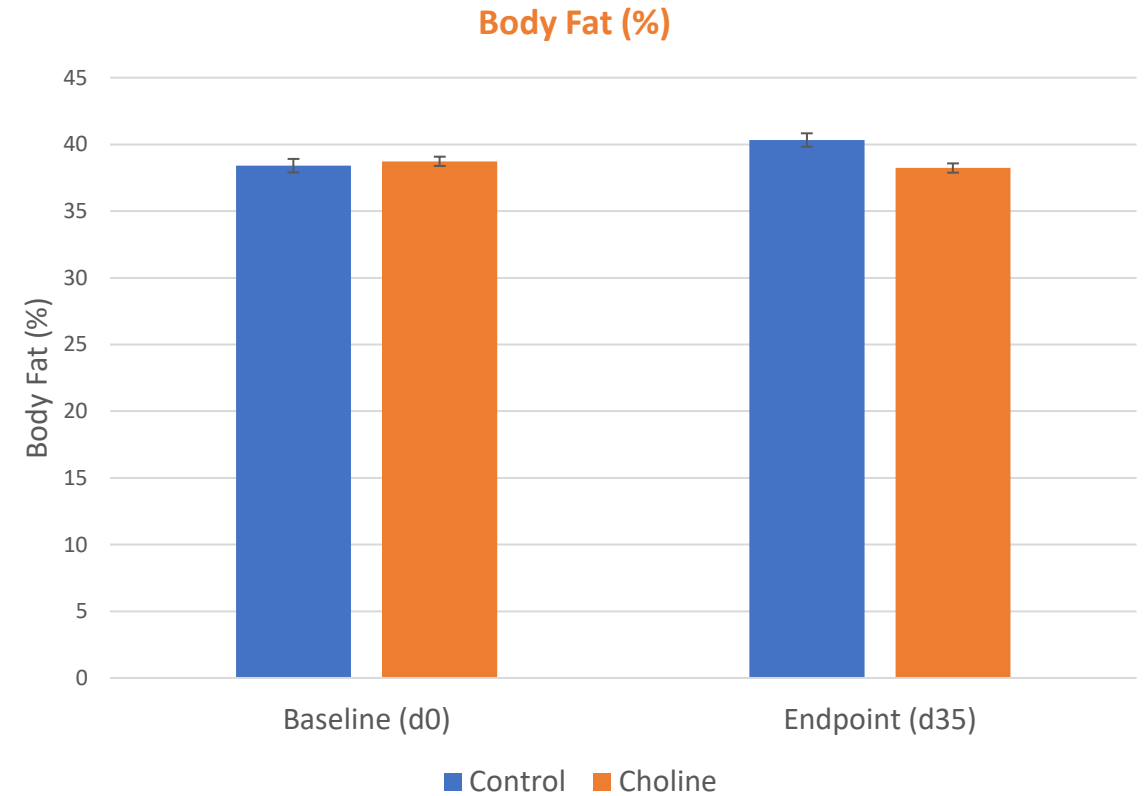
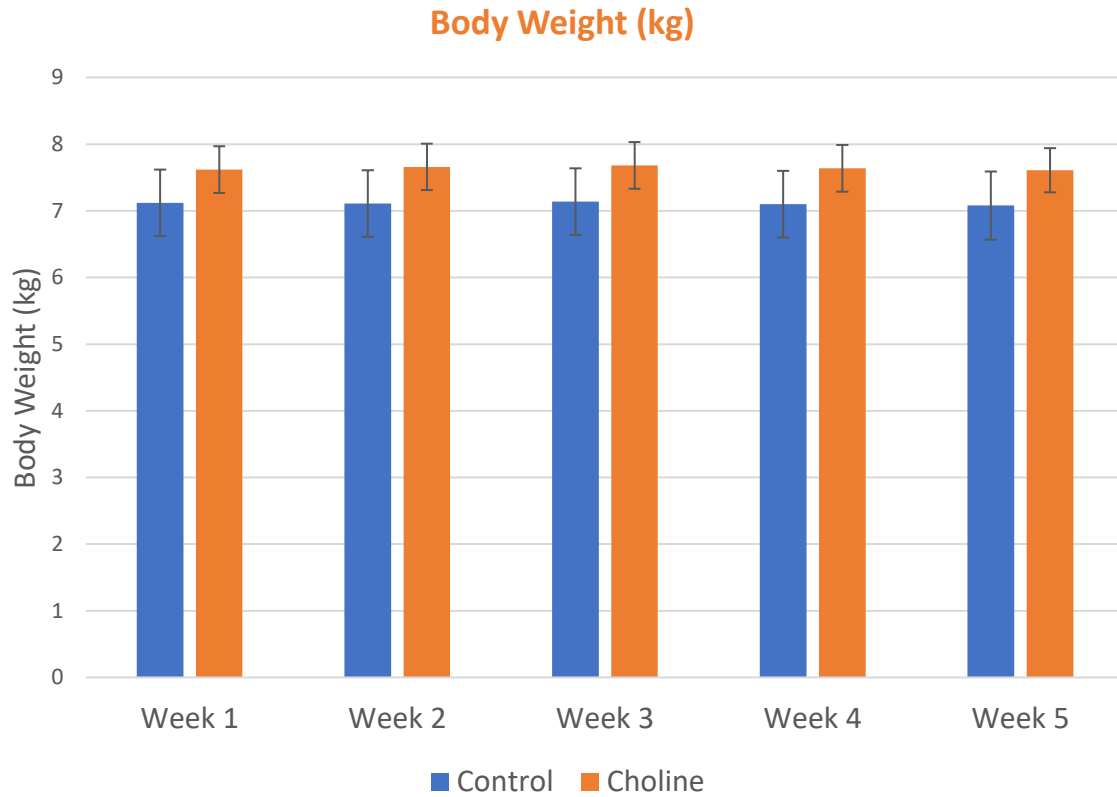
- N = 12
- 5 weeks
- Weight maintenance
- 2 extruded diets
 - Control
 - AAFCO adult maintenance
 - 458.7 mg choline/kg DM
 - Control + Choline chloride
 - VitaCholine (Balchem)
 - 1895.7 mg choline/kg DM



Verbrugghe et al. (Unpublished)

Obese Adult Cats

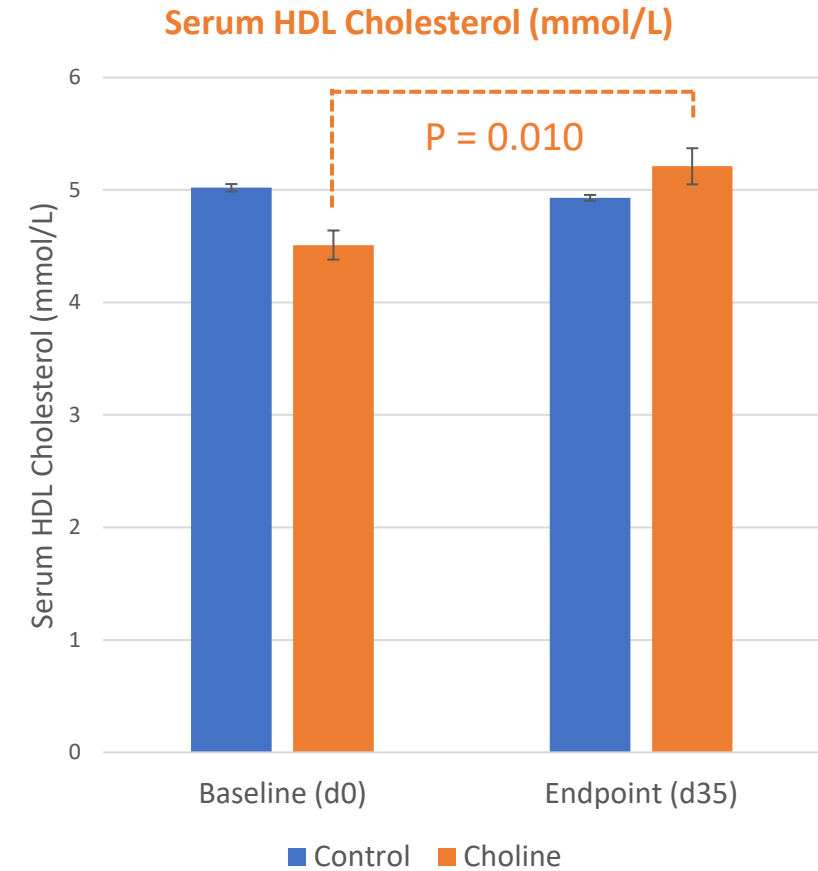
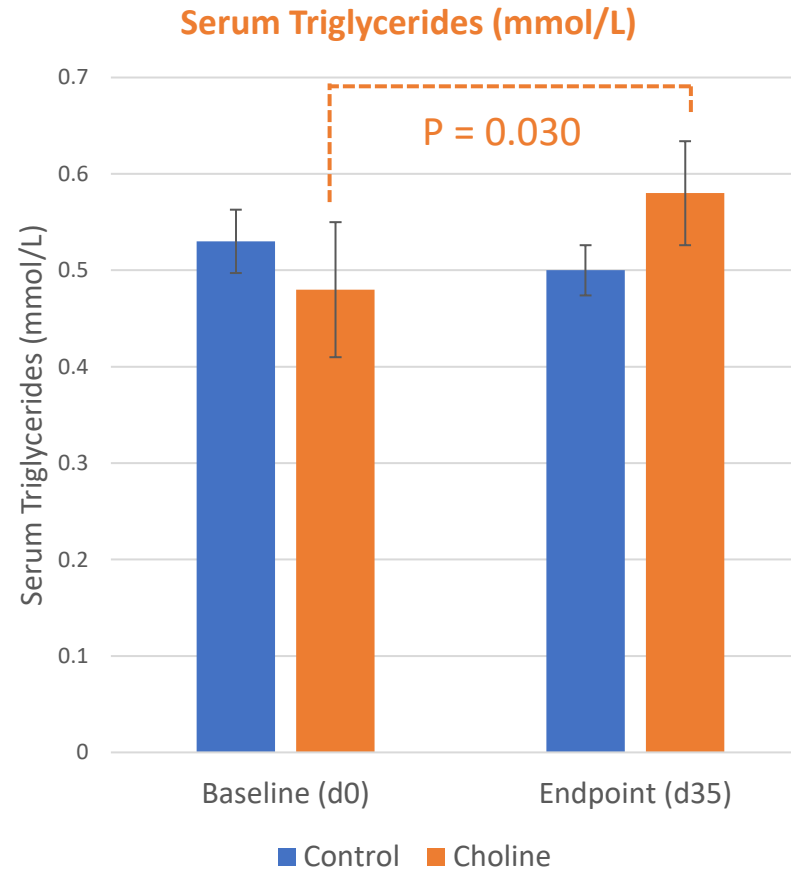
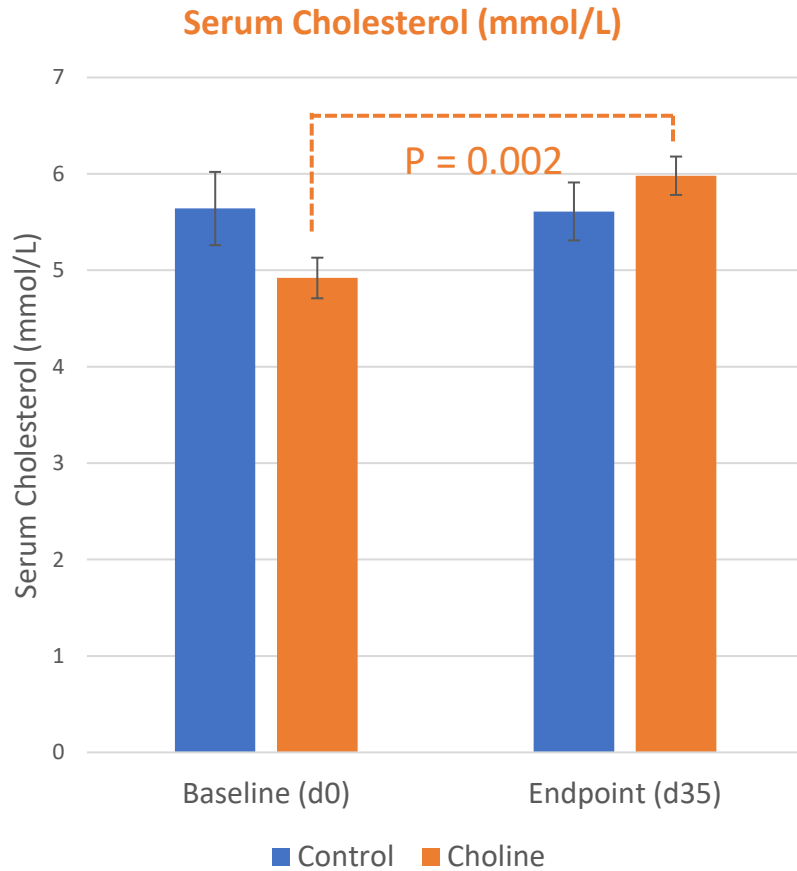
P-value	BW	Fat
time	0.138	0.394
diet	0.401	0.827
diet x time	0.921	0.161



Verbrugghe et al. (Unpublished)

Obese Adult Cats

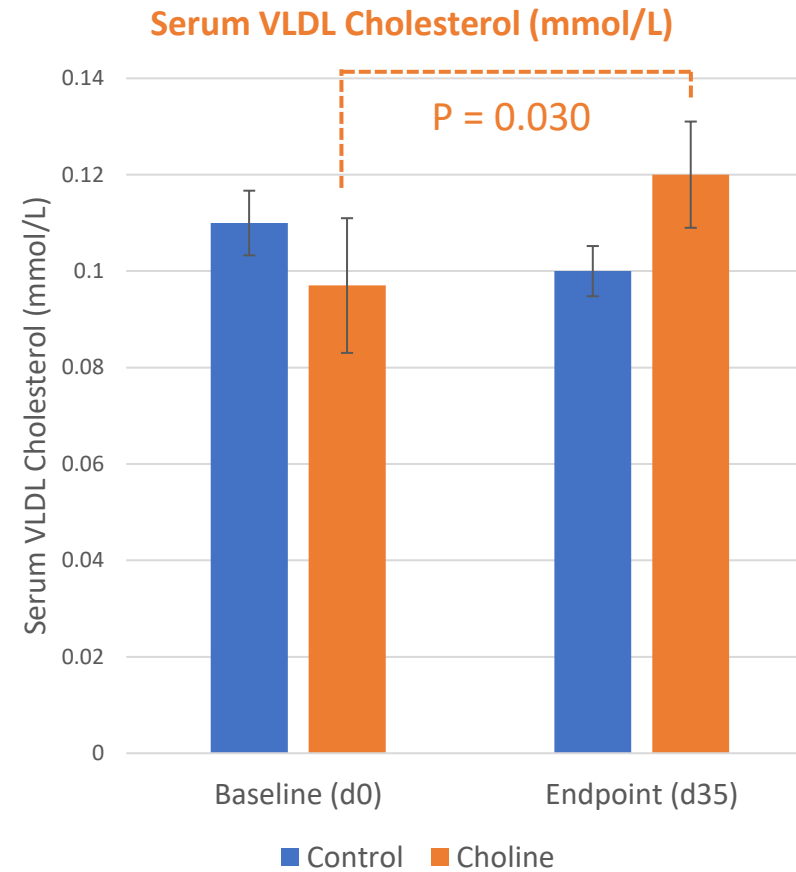
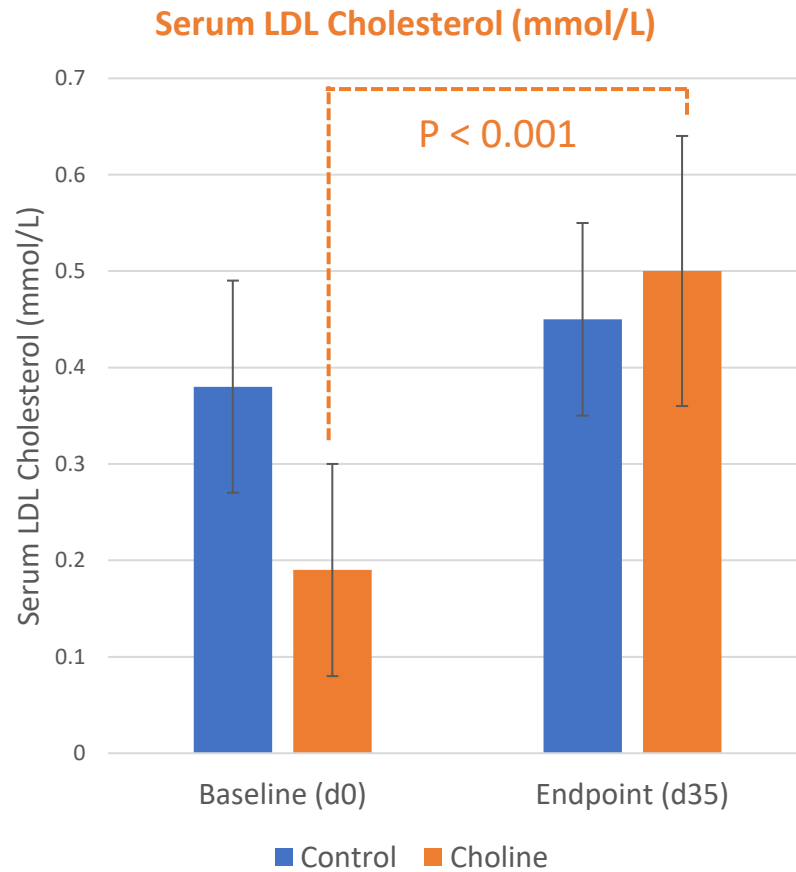
P-value	CHOL	TRIG	HDL
time	0.017*	0.260	0.077
diet	0.634	0.799	0.679
diet x time	0.013*	0.038*	0.029*



Verbrugghe et al. (Unpublished)

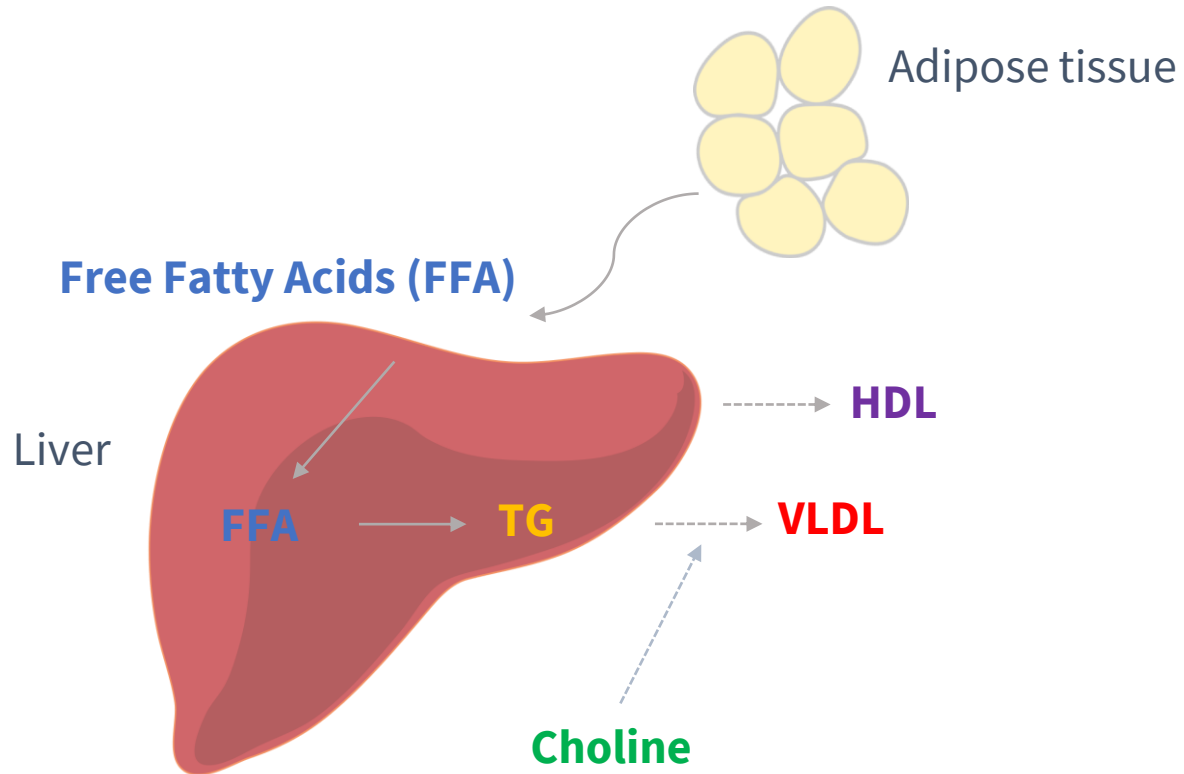
Obese Adult Cats

P-value	LDL	VLDL
time	0.001*	0.260
diet	0.683	0.799
diet x time	0.014*	0.038*



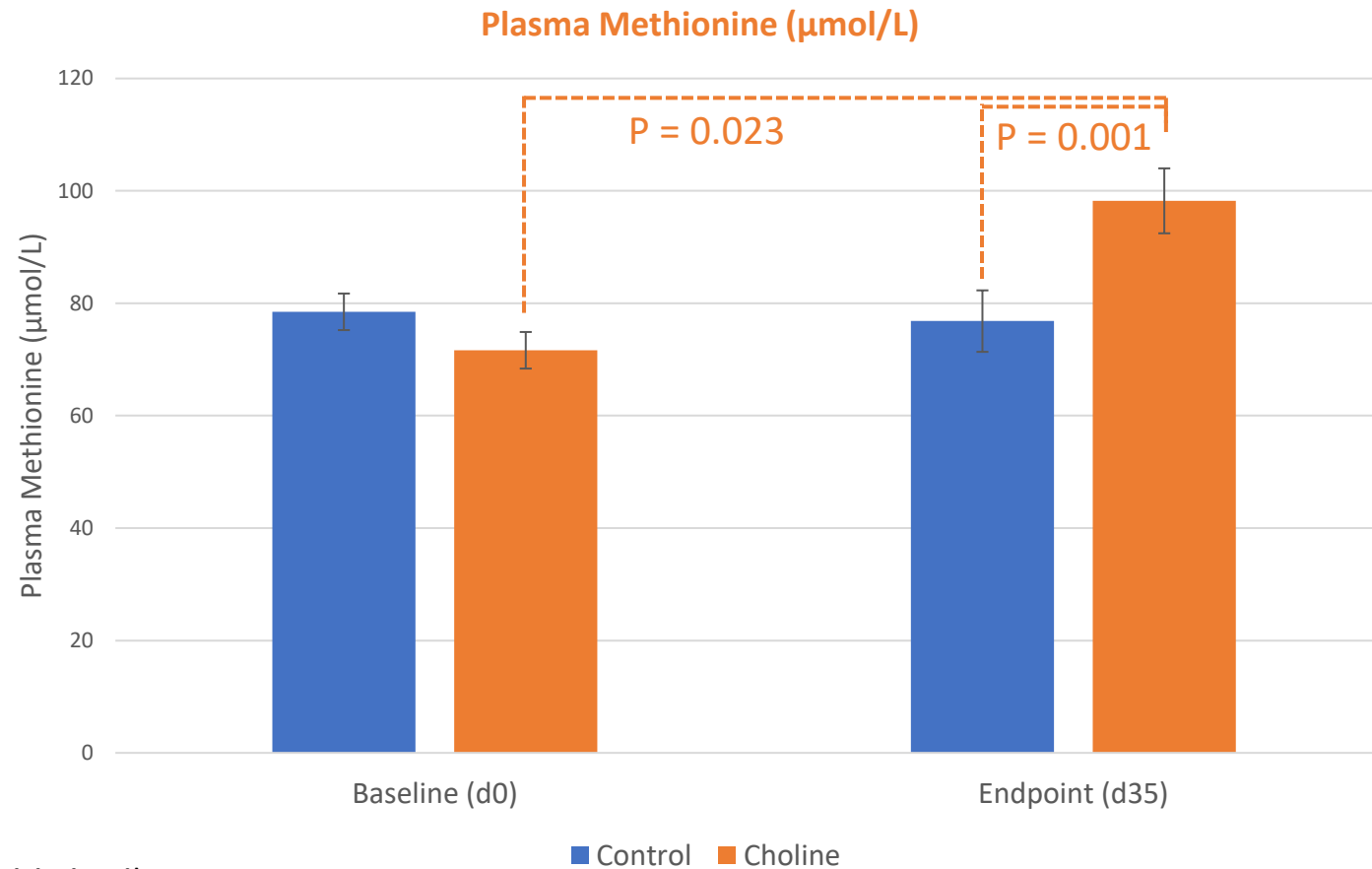
Verbrugghe et al. (Unpublished)

Obese Adult Cats



- Supplementation of choline in obese cats:
Assists in eliminating hepatic fat
→ ↑ lipolysis & mobilization

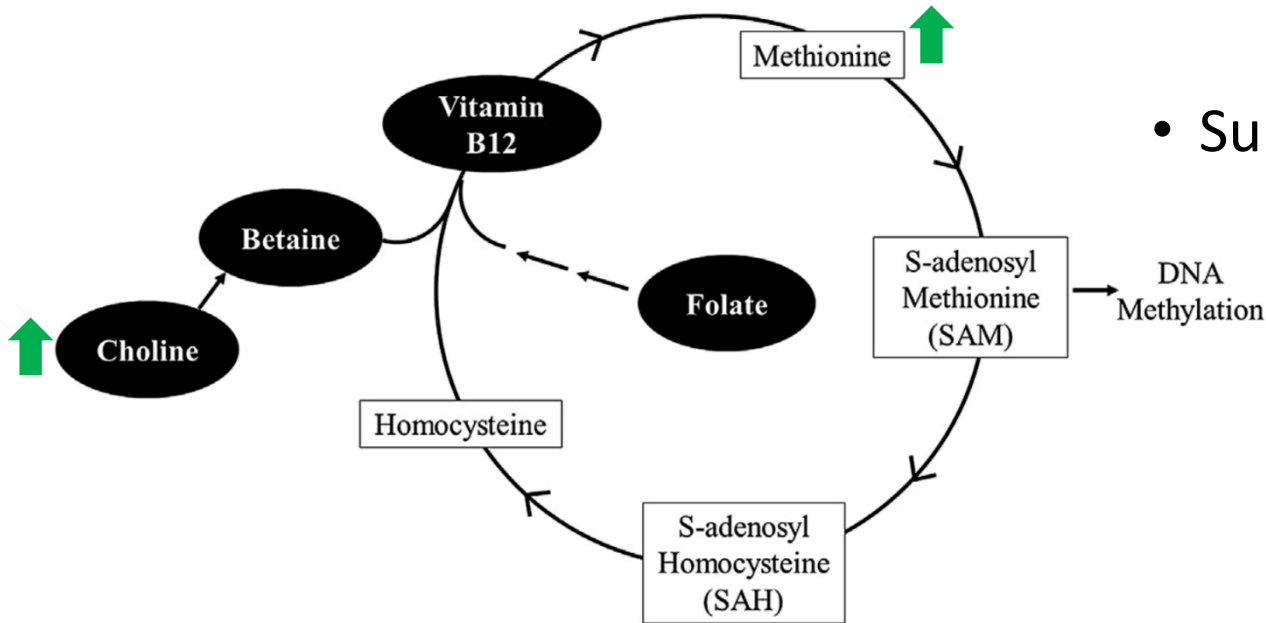
Obese Adult Cats



P-value	Methionine
time	0.010*
diet	0.190
diet x time	0.005*

Verbrugghe et al. (Unpublished)

Obese Adult Cats



- Supplementation of choline in obese cats:
May ↑ methionine recycling

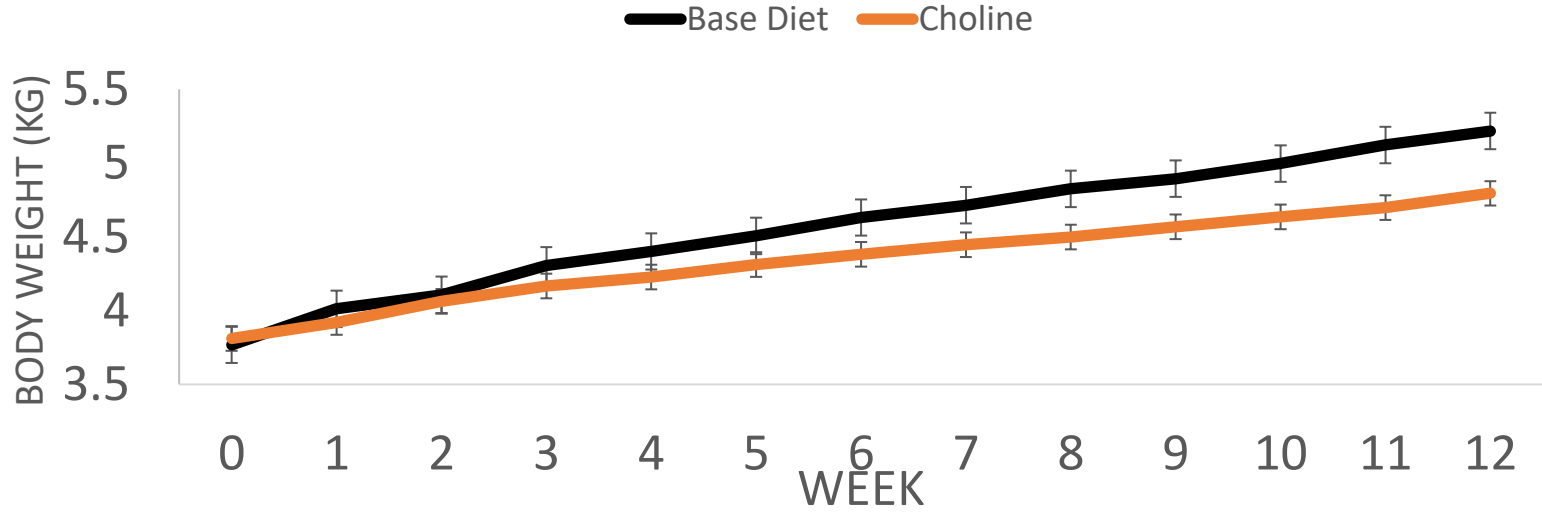
Kittens Post-Neutering

- N = 16
- 12 weeks post-gonadectomy
- DER for growth
- Extruded diet AAFCO growth
330 mg choline/kg DM
- Supplement
 - Control
 - Choline chloride
PetShure (Balchem)
300 mg choline/kgBW^{0.75}



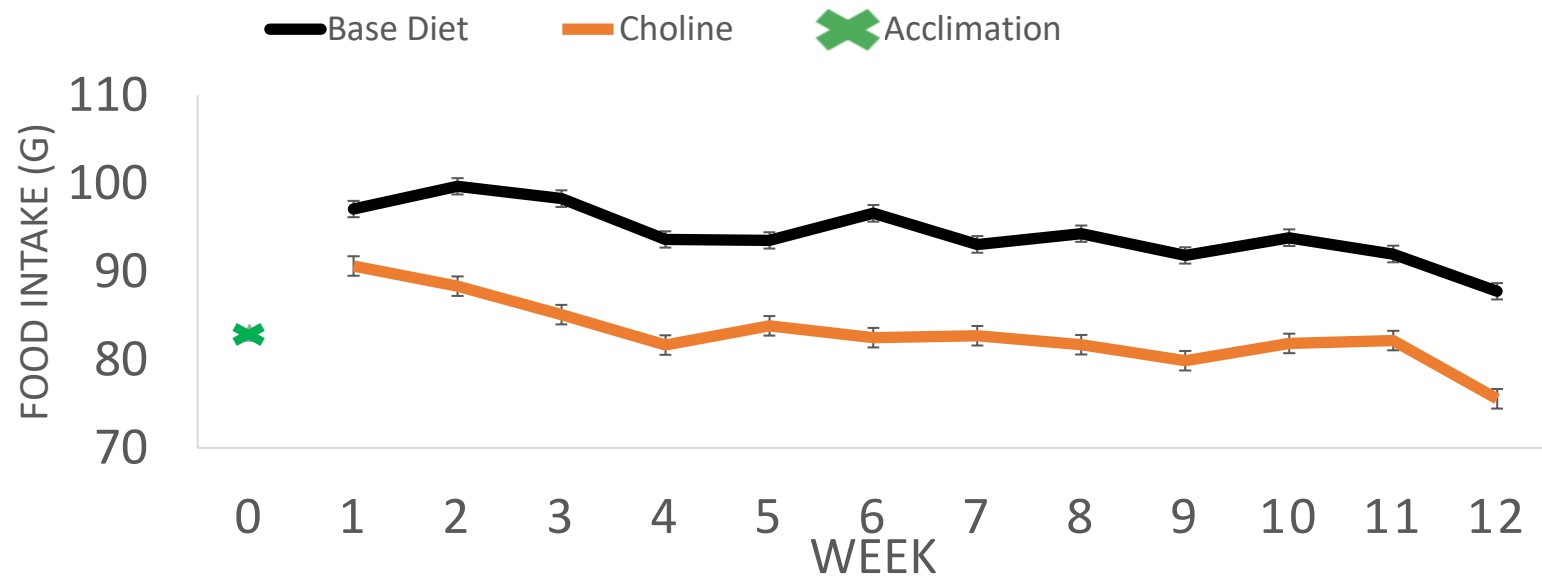
Godfrey et al. 2021, MSc thesis

Kittens Post-Neutering



Body Weight

Treatment: P=0.0209
 Time: P<0.0001
 Treatment*Time: P<0.0001



Food Intake

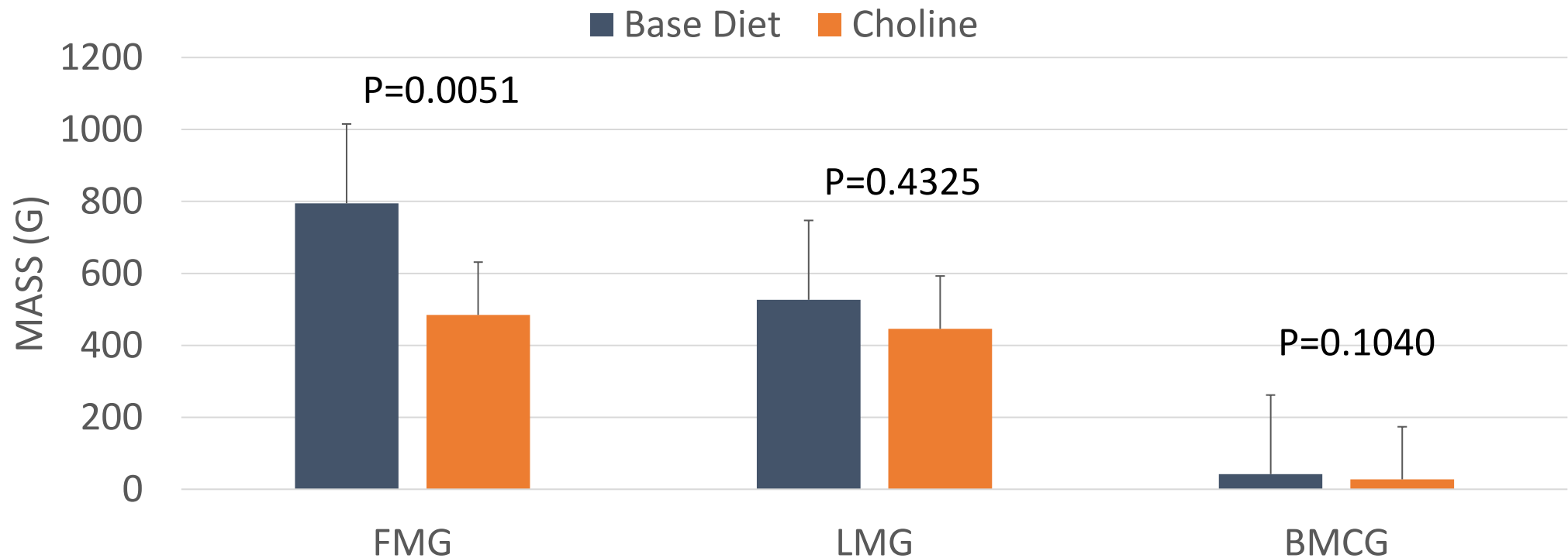
Treatment: P<0.0001
 Time: P<0.0001
 Treatment*Time: P<0.0001

Godfrey et al. 2021, MSc thesis

Kittens Post-Neutering

Body Composition

FMG = Fat Mass Gain
LMG = Lean Mass Gain
BMCG = Bone Mineral Content Gain



Kittens Post-Neutering

Satiety Hormones

	CHOLINE (n=8)			CONTROL (n=7)					
	Week -1 LSM	Week 12 LSM	SEM	Week -1 LSM	Week 12 LSM	SEM	P _{Choline}	P _{Time}	P _{Choline*Time}
Leptin (ng/mL)	4.04	3.28	0.32	3.77	3.50	0.34	0.946	0.141	0.467
Ghrelin (ng/mL)	15.13	16.67	2.58	14.19	16.24	2.76	0.804	0.512	0.924
GLP-1 (ng/mL)	1.03	0.90	0.42	1.08	1.21	0.50	0.703	0.981	0.765
PYY (ng/mL)	2.48	1.56	0.51	1.71	2.36	0.61	0.983	0.810	0.179
GIP (ng/mL)	286.34	271.43	16.67	277.05	328.26	17.84	0.220	0.318	0.082

Kittens Post-Neutering

Indirect Calorimetry

	CHOLINE (n=8)			CONTROL (n=7)					
	Week -1 LSM	Week 12 LSM	SEM	Week -1 LSM	Week 12 LSM	SEM	P _{Choline}	P _{Time}	P _{Choline*Time}
EE Fasted (kcal/kg BW)	25.50	21.19	2.47	25.45	18.18	2.65	0.114	0.123	0.681
EE Fed (kcal/kg BW)	28.75	20.33	2.32	31.15	17.84	2.48	0.976	0.004	0.453
RQ Fasted	0.75	0.78	0.01	0.75	0.78	0.01	0.664	0.014	0.856
RQ Fed	0.82	0.82	0.01	0.82	0.83	0.01	0.425	0.564	0.516

Kittens Post-Neutering

Serum Lipids & Lipoproteins

	CHOLINE (n=8)			CONTROL (n=7)					
	Week -1 LSM	Week 12 LSM	SEM	Week -1 LSM	Week 12 LSM	SEM	P _{Choline}	P _{Time}	P _{Choline*Time}
Chol (mmol/L)	4.36	4.45	0.18	4.42	4.20	0.19	0.607	0.716	0.395
Gluc (mmol/L)	15.68	14.22	0.69	15.85	15.08	0.73	0.491	0.140	0.639
NEFA (mmol/L)	0.31	0.26	0.03	0.29	0.37	0.03	0.174	0.715	0.091
TAG (mmol/L)	0.39	0.43	0.04	0.40	0.50	0.04	0.156	0.134	0.480
LDL (mmol/L)	1.03	0.60	0.08	1.10	0.37	0.08	0.181	<0.0001	0.151
VLDL (mmol/L)	0.18	0.19	0.02	0.18	0.23	0.02	0.153	0.133	0.476
HDL-C (mmol/L)	3.13	4.06	0.17	3.13	3.59	0.18	0.209	0.002	0.212

Godfrey et al. 2021, MSc thesis

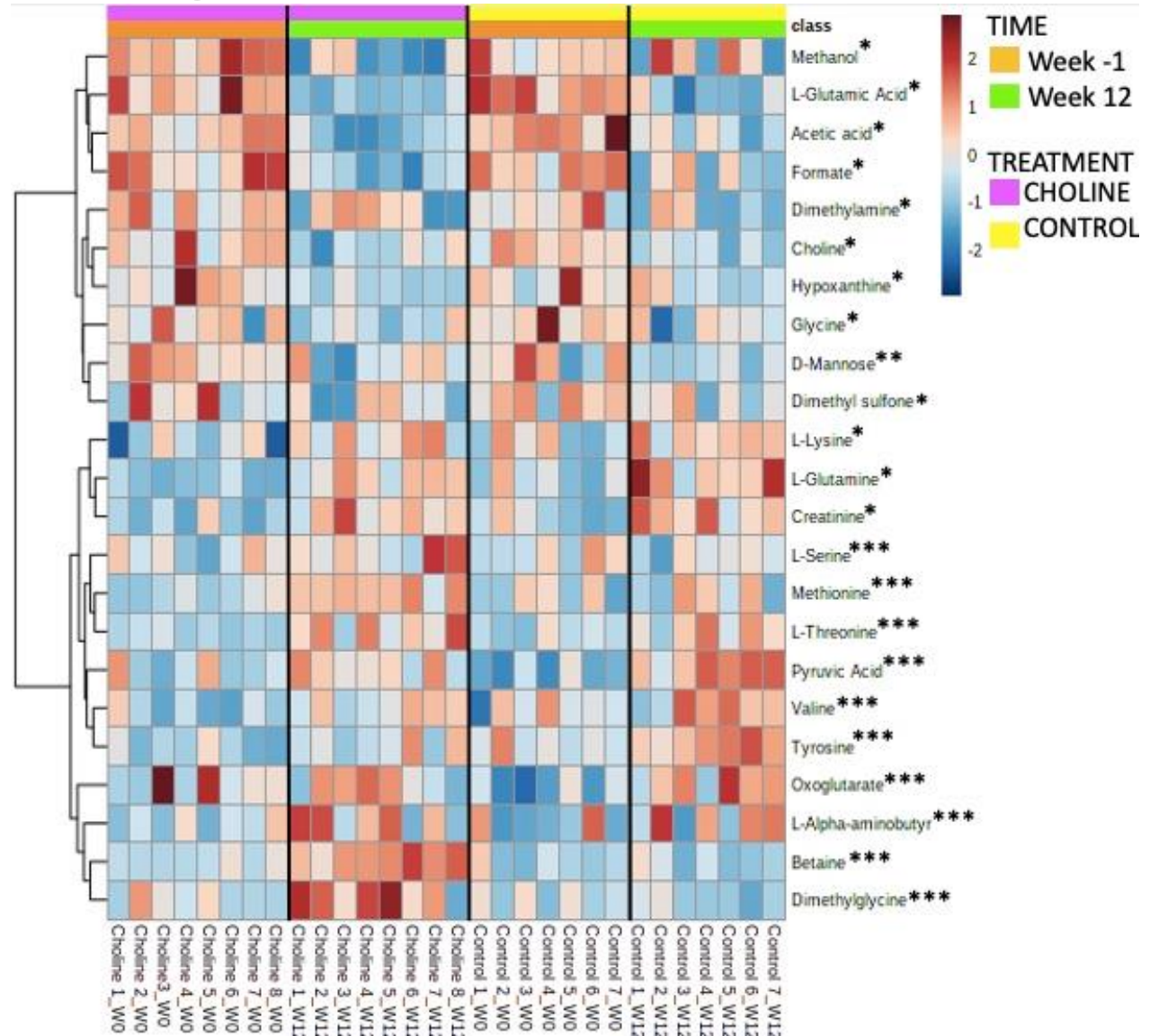
Kittens Post-Neutering

Serum Metabolomics NMR

* = $P_{\text{time}} < 0.05$

** = $P_{\text{treatment}} < 0.05$

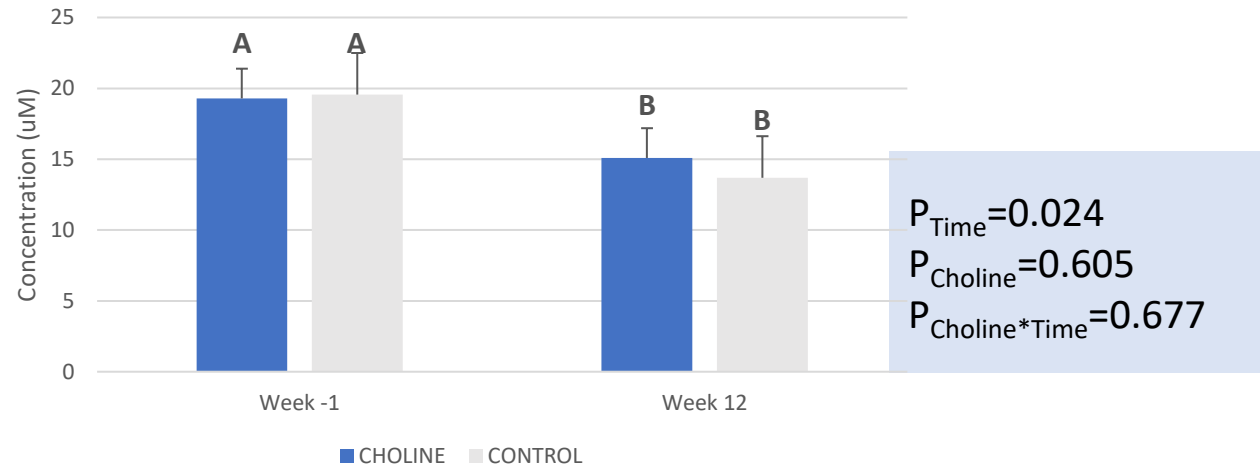
*** = $P_{\text{treatment} \times \text{time}} < 0.05$



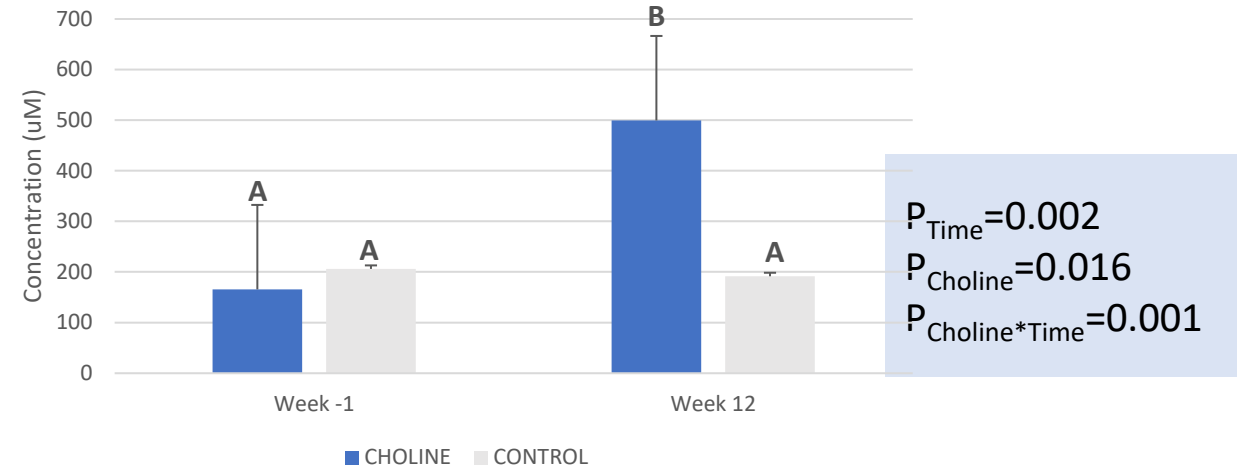
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Kittens Post-Neutering

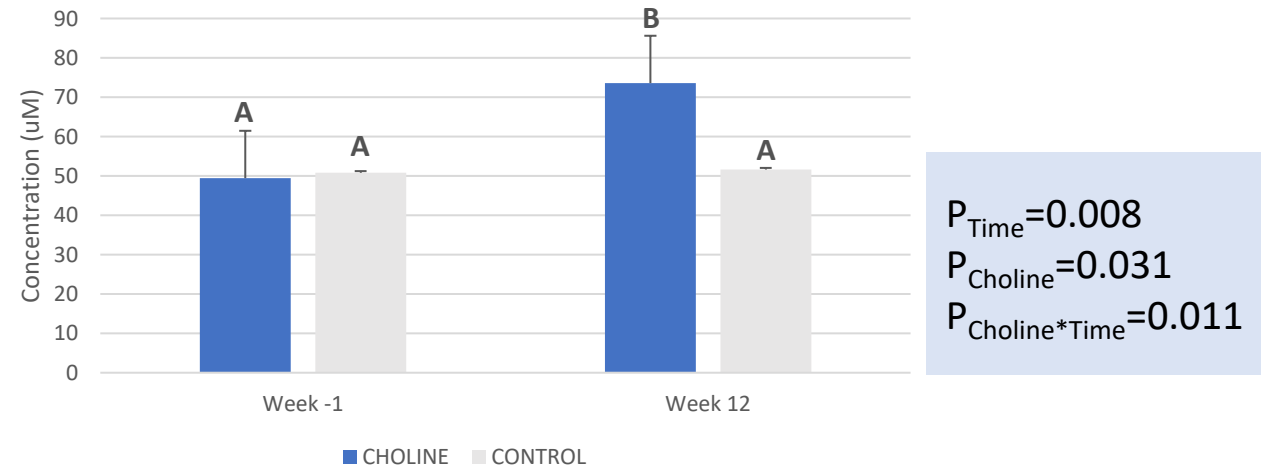
Choline



Betaine



Methionine



A large, fluffy orange tabby cat is lying on a white sofa. The cat is positioned on the left side of the frame, resting its head on a black and white striped cushion. The background is a blurred indoor setting, likely a living room, with a white wall and some furniture visible. The overall lighting is soft and natural.

Conclusion

- Feline obesity is a continuous **BATTLE**
 - Affects feline welfare, quality of life and life span
- Pet food industry and veterinary community **JOIN FORCES** to win this battle
- Focus on **ALL ASPECTS!**
 - Beyond perfectly designed veterinary weight loss foods
 - Product development aim at prevention
 - Feeding management strategies are very important
 - Pet food marketing & veterinary communication

Acknowledgements

- OVC Pet Nutrition Team
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- Dr. Marica Bakovic & Dr. Gordon Kirby

Questions?

Dr. Adronie Verbrugghe

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