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Quality of life is reduced in obese dogs but improves after successful weight loss

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ABSTRACT

Obesity is thought to affect quality of life, but limited objective data exist to support this supposition. The current study aim was to use a questionnaire to determine health-related quality of life (HRQOL) both before and after weight loss, in obese client-owned dogs. Fifty obese dogs were included, and represented a variety of breeds and genders. Prior to weight loss, owners were asked to complete a validated standardised questionnaire to determine HRQOL. Thirty of the dogs successfully completed their weight loss programme and reached target, and owners then completed a follow-up questionnaire. The completed questionnaire responses were transformed to scores corresponding to each of four factors (vitality, emotional disturbance, anxiety and pain), and scored on a scale of 0–6. Changes in the scores were used to explore the sensitivity of the questionnaire, and scores were correlated with responses to direct questions about quality of life and pain, as well as weight loss.

Dogs that failed to complete their weight loss programme had lower vitality and higher emotional disturbance scores than those successfully losing weight ($P = 0.03$ for both). In the 30 dogs that completed, weight loss led to an increased vitality score ($P < 0.001$), and decreased scores for both emotional disturbance ($P < 0.001$) and pain ($P < 0.001$). However, there was no change in anxiety ($P = 0.09$). The change in vitality score was positively associated with percentage weight loss ($r_P = 0.43$, $P = 0.02$) and percentage body fat loss ($r_P = 0.39$, $P = 0.03$). These results indicate demonstrable improvement in HRQOL for obese dogs that successfully lose weight.

Introduction

Excessive bodyweight (overweight and obesity) is common in dogs, and linked to both decreased longevity and various associated conditions (German, 2006). Even modest weight loss (e.g. 5–10%) can lessen the severity of associated diseases such as osteoarthritis (Mlacnik et al., 2006; Marshall et al., 2010) and improve insulin sensitivity (German et al., 2009). Such data indirectly suggest that weight loss improves quality of life, although no direct evidence currently exists.

Measurement of health-related quality of life (HRQOL), is now a key tool in outcome assessment for human medicine (Skevington, 1998), and is being increasingly adopted in veterinary medicine. Recently, a tool for measuring canine HRQOL has been developed for use by owners (Wiseman-Orr et al., 2004, 2006), since they are best placed to identify the subtle behavioural changes of early chronic illness. This tool has previously been validated and has good discriminatory properties for dogs with chronic pain from degenerative joint disease (Wiseman-Orr et al., 2006). However, it has not yet been used to determine quality of life in other conditions including obesity. The aim of the current study was to use this questionnaire to determine changes in HRQOL in obese client-owned dogs undergoing weight management. The null hypothesis was that successful weight loss would not affect HRQOL.

Materials and methods

Study design

This was a non-randomised observational study assessing HRQOL in a cohort of dogs with naturally-occurring obesity, and has been reported according to the Strengthening and Reporting of Observational Studies in Epidemiology (STROBE) statement guidelines (von Elm et al., 2007).

Animals

Participating dogs were referred to the Royal Canin Weight Management Clinic, University of Liverpool, for management of obesity. Fifty dogs were recruited between July 2005 and June 2008, and those successfully losing weight had completed by August 2009. Eligibility criteria included confirmation of obesity (based upon

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body fat measurement by dual-energy X-ray absorptiometry (DEXA), owner willingness to complete a pre-weight loss questionnaire, and (in cases reaching target weight) completion of a post-weight loss questionnaire.

The study protocol adhered to the University of Liverpool Animal Ethics Guidelines, and was approved by both the University of Liverpool Research Ethics Committee and the WALTHAM ethical review committee. Owners of all participating animals gave informed written consent.

Weight loss regimen

Full details of the weight loss regimen have been previously described (German et al., 2007, 2010). Briefly, dogs were determined to be systemically well, and without significant abnormalities on complete blood count, serum biochemical analysis and urinalysis. Throughout weight loss, patients were weighed on electronic weigh scales (Soehnle Professional), which were regularly calibrated using test weights (Blake and Boughton Ltd.). Body composition was analysed by fan-beam DEXA (Lunar Prodigy Advance; GE Lunar), and results used to estimate target weight (Raffan et al., 2006; German et al., 2010).

A weight management protocol was then instigated (German et al., 2007, 2010), using either a high protein high fibre (Satiety Support, Royal Canin) or high protein moderate fibre (Obesity Management, Royal Canin) weight loss diet (Table 1). The initial food allocation for weight loss was determined by first estimating maintenance energy requirement (MER = 440 kJ [105 kcal] × bodyweight [kg]$^{0.75}$/day; National Research Council, 2006) using the estimated target weight. The exact level of restriction for each dog was then individualised based upon gender and other factors (i.e. presence of associated diseases), and was typically between 50% and 60% of MER at target weight (German et al., 2010). Owners also implemented lifestyle and activity alterations to assist in weight loss. Dogs were reweighed every 7–21 days and changes made to the dietary plan if necessary (German et al., 2007, 2010).

In dogs that successfully reached target weight, detailed evaluation was conducted after the weight loss. At this stage, bodyweight was recorded, and body composition assessed by DEXA. The detailed re-evaluation assessment was not conducted in dogs failing to complete, either because they were euthanased before reaching target weight or were lost to follow-up.

Assessment of quality of life

At initial enrolment, owners completed a validated standardised questionnaire to determine HRQOL (Wiseman-Orr et al., 2004). This questionnaire included 109 simple descriptor items (scored on a 7-point Likert-type rating scale); transition questions about global changes in behavioural and HRQOL domains (e.g. activity, pain, sociability, aggression, anxiety, enthusiasm, happiness, and mobility); and demographic questions about the dog, the respondent and their environment (Wiseman-Orr et al., 2004, 2006). Owners of dogs successfully reaching target, but not those whose dogs stopped prematurely, also completed a follow-up questionnaire at final visit. In addition, the examining clinician (AJG) completed a separate questionnaire, providing a quality of life rating (0–10 scale), and a rating of clinical change (0–7 Likert-type scale, at follow-up only).

All questionnaire responses were transformed to scores corresponding to four HRQOL factors namely vitality, emotional disturbance, anxiety and pain as previously described (Wiseman-Orr et al., 2004). Briefly, factor analysis (Minitab 15) was used to identify common factors from all descriptor terms. Factor models were then developed, each interpretable as an HRQOL domain, and a score for each domain was subsequently obtained by calculating the mean rating for all items loading onto that factor. At each time-point, the scores for all domains were collated to provide a profile for each dog.

The original HRQOL questionnaire was validated by comparing dogs with and without chronic pain, since this was expected to affect quality of life adversely (Wiseman-Orr et al., 2006). However, through further validation and testing, 60 items were identified which could be used for generic measurement of HRQOL, since they could all discriminate well dogs from dogs with both painful and non-painful chronic diseases. These items contributed to four HRQOL domains named 'vitality', 'emotional disturbance', 'anxiety', and 'pain'. For vitality, high scores represent high levels of vitality; for emotional disturbance, lower scores are better; for anxiety, a high score means more anxious, and for pain lower scores are better i.e. correlate with lower perceived levels of pain. Therefore, quality of life improvements would manifest by increasing vitality score, and decreasing emotional disturbance, anxiety, and pain scores. These four HRQOL domains were used in the current study to assess the impact of obesity on quality of life.

The HRQOL data from the 48 control dogs originally used to validate the questionnaire were also used for comparative purposes in the current study; 17 were recruited from patients attending the Glasgow University Small Animal Hospital (April 2002), and 31 recruited from a first-opinion veterinary practice in the Glasgow area (June 2005–May 2006). The breeds represented were Bearded collie ($n = 1$), Border collie ($n = 5$), Border terrier ($n = 2$), Boxer ($n = 1$), Cavalier King Charles spaniel ($n = 5$), Crossbreed ($n = 13$), German shepherd dog ($n = 1$), Golden retriever ($n = 2$), Gordon setter ($n = 1$), Great Dane ($n = 1$), Jack Russell terrier ($n = 1$), Labrador retriever ($n = 8$), Lurcher ($n = 2$), Miniature poodle ($n = 1$), Siberian husky ($n = 2$), Standard poodle ($n = 1$), and West Highland white terrier ($n = 1$).

There were 28 males (15 neutered), 20 females (11 speyed), and mean age was 49 months (range 6–139 months). Attending clinicians confirmed that all dogs were in good health and pain free. Forty-three dogs were classified as being in ideal weight and five dogs were classified as mildly overweight (but not obese), respectively.

Data handling and statistical analysis

Data capture from all questionnaires was performed by author coding of responses, followed by manual data capture by a skilled operator (EMS), and responses were transformed to scores for the four HRQOL domains (using the original 0–6 response scale). Changes could then be assessed for all domains and for correlation with other responses (e.g. direct questions about quality of life and pain), with weight loss parameters and with the transition questions.

Baseline data are expressed as median (range), except where indicated. No follow-up visit data were available from those not completing the weight programme, but all remaining data were complete for every variable. Given that there were no known previous studies on HRQOL in obese dogs, a meaningful power calculation could not be performed. Instead, the number of dogs enrolled (50) was based upon the prior experience with HRQOL for chronic pain in dogs (Wiseman-Orr et al., 2004, 2006). In dogs successfully completing weight loss, energy intake data are expressed as proportions of the estimated requirement at target weight. Change in body fat mass was calculated as follows:

$$\frac{\text{body fat pre-weight loss (g)} - \text{body fat post-weight loss (g)}}{\text{body fat pre-weight loss (g)}} \times 100.$$

Computer software was used for statistical analysis. Baseline comparisons between dogs completing and not completing the weight loss programme were performed with Stats Direct version 2.6.2 (Stats Direct Ltd.), and Minitab 15 (Minitab Inc.) was used for HRQOL analyses. The Shapiro–Wilk test was first used to assess data distribution, and either parametric or non-parametric tests were used as appropriate. Comparisons between dogs completing and not completing were made with Fisher's exact test (for population proportions), unpaired Student's t tests (for continuous variables with a normal distribution), or Mann–Whitney U tests (for continuous variables where normality could not be assumed). For comparisons of before and after weight loss data, either paired Student's t tests (assuming normal data distribution) or Wilcoxon signed-rank tests (where normality could be assumed) were used. Pearsons' correlation coefficient (r_P) was calculated to explore the associations between variables (e.g. weight loss and changes in HRQOL). Statistical significance was assumed at $P < 0.05$ (2-sided analyses).

Table 1
Composition of the two diets used for weight loss in the study dogs.

Criterion	High protein high fibre		High protein medium fibre	
ME content	12,142 kJ/kg (2900 kcal/kg)		13,712 kJ/kg (3275 kcal/kg)	
	Per 100 g DM	g/1000 kcal (ME)	Per 100 g DM	g/1000 kcal (ME)
Moisture	8	28	9	27
Crude protein	30	103	34	104
Crude fat	10	34	10	31
Crude fibre	17.5	60	11.5	35
Total dietary fibre	28	97	18.5	56
Ash	5.3	18	7.9	24
Fibre sources	Cellulose, beet pulp, FOS, psyllium husk, diet cereals		Cellulose, beet pulp, diet cereals	

High protein high fibre diet (Satiety Support, Royal Canin). High protein medium fibre diet (Obesity Management, Royal Canin). Fifteen dogs were fed the high protein high fibre diet for maintenance, and 18 were fed the high protein medium fibre diet. DM, dry matter; ME, metabolisable energy content, as measured by animal trials according to the 2010 American Association of Feed Control Officials (AAFCO) protocol; FOS, fructo-oligo-saccharides.

Results

Dogs and weight loss outcome

Sixty-six new cases were seen during the enrolment period, 50 of these dogs were actually enrolled, and 30/50 successfully reached target weight. The proportion of cases completing did not differ between those enrolled and those not participating ($P = 0.4$). A variety of breeds, ages and genders were represented, and no significant baseline differences, were evident between successful and unsuccessful dogs ($P > 0.1$ for all; Table 2).

Of the 20 dogs not reaching target weight, six were euthanased for unrelated reasons including chronic kidney disease, metastatic mast cell tumour, cranial thoracic tumour, ketoacidotic diabetes mellitus, and unknown ($n = 2$). The weight programme was discontinued in four dogs for owner-related reasons (illness, $n = 2$; bereavement, $n = 1$; change in personal circumstances, $n = 1$). The remaining 10 dogs were lost to follow up, whereby owners stopped attending weight checks, answering or returning telephone calls, and responding to written correspondence. However, even these unsuccessful dogs lost some weight before their programme was stopped (median loss 12.1% [−2.3% to 30.2%] at the last recorded check).

In successful dogs, percentage weight loss was 24.4% (10.0–43.5%) of starting bodyweight (SBW), at a rate of 0.8% (0.3–1.4%) SBW/week (Table 2). Given that the diet used for weight loss had no impact on any HRQOL domain (data not shown), results are expressed for all dogs as a whole.

Domain scores for HRQOL in successful and unsuccessful dogs

For vitality and emotional disturbance, there were differences at baseline between dogs that completed and those that did not ($P < 0.03$ for both), with dogs that did not complete having lesser vitality and greater emotional disturbance (Table 3). However, there was no difference between successful and unsuccessful dogs for both anxiety ($P = 0.8$) and pain ($P = 0.3$).

Pre- and post-weight loss HRQOL

Initial median vitality score was 4.00 (0.76–5.47), and this increased after weight loss (mean change 1.13, 95% confidence interval [CI] 0.71–1.55, $P < 0.001$; Fig. 1a). Initial median emotional disturbance score was 1.28 (0.17–4.73), which had also declined after weight loss (mean change −0.72, 95% CI −0.29 to −1.15, $P < 0.001$; Fig. 1b). In contrast, anxiety score was unchanged (pre-weight loss: 1.00, 0.14–5.57; mean change 0.37, 95% CI −0.80–0.06, $P = 0.09$; Fig. 1c). Finally, pain score (pre-weight loss: 1.31, 0.00–4.88) decreased significantly after weight loss (mean change −0.86, 95% CI −0.44 to −1.27, $P < 0.001$; Fig. 1d).

Associations between HRQOL domains and weight loss parameters

Change in vitality score was positively associated with percentage weight loss ($r_P = 0.43$, $P = 0.02$) and percentage body fat loss ($r_P = 0.39$, $P = 0.03$), but not rate of weight loss ($r_P = -0.12$, $P = 0.5$). In contrast, weight loss parameters were not associated with emotional disturbance (percentage weight loss: $r_P = -0.18$, $P = 0.3$; percentage body fat loss: $r_P = -0.04$, $P = 0.8$; rate of weight loss: $r_P = 0.34$, $P = 0.07$), anxiety (percentage weight loss: $r_P = 0.10$, $P = 0.6$; percentage body fat loss: $r_P = 0.06$, $P = 0.3$; rate of weight loss: $r_P = -0.02$, $P = 0.9$) or pain (percentage weight loss: $r_P = -0.23$, $P = 0.2$; percentage body fat loss: $r_P = 0.28$, $P = 0.1$; rate of weight loss: $r_P = -0.08$, $P = 0.7$).

Transition questions

Transition questions (whether quality of life had improved, was unchanged or was worse) were also studied. After weight loss, most ($n = 21$) owners thought that the quality of life of their dog had improved, whilst the remainder ($n = 9$) did not answer this question. Percentage weight loss (improved 31% [12–44%]; no reply 15% [10–35%] $P = 0.008$) and percentage body fat loss (improved 38% [13–74%]; no reply 26% [15–44%], $P = 0.04$) were greater in dogs whose owners thought they had improved (Fig. 2), but rate of weight loss did not differ (improved 0.8% SBW/week [0.3–1.4]; no reply 1.0% SBW/week [0.6–1.3], $P = 0.2$).

Discussion

In the current study, we have assessed HRQOL in obese dogs using a previously validated questionnaire. Comparisons were first made between dogs that successfully completed a weight loss programme reaching target weight and those that failed to complete. Subsequently, the effects of successful weight loss on HRQOL were assessed. The main conclusion is that pre-weight loss HRQOL is low

Table 2
Starting characteristics and outcome of weight loss in the 30 study dogs.

Criterion	Dogs completing weight loss (*n*/range)	Dogs failing to complete weight loss (*n*/range)	*P* value
Breed	Border collie, CKCS (4), Cairn terrier, Corgi, Crossbred (4), English bull terrier, German shepherd dog, Golden retriever, Irish setter, Jack Russell terrier, Labrador retriever (8), Lhasa apso, Yorkshire terrier (4)	Border collie, Bichon Frise CKCS, Crossbred (4), Dachshund (2), Dalmatian (2), English bull dog, German shepherd dog, Jack Russell terrier, Labrador retriever (5), Lancashire heeler, Weimaraner, Shih tzu, Yorkshire terrier	–
Gender	Male (3), neutered male (16), neutered female (10)	Male (2), neutered male (7), neutered female (11)	0.400
Age (months)[a]	84 (19–163)	96 (25–156)	0.134
Starting bodyweight (kg)	24.0 (5.2–65.3)	22.7 (4.4–60.8)	0.691
Final bodyweight (kg)	20.6 (4.2–41.9)	–	–
Duration of weight loss (days)	182 (105–391)	–	–
Weight loss (%)	24.4 (10.0–43.5)	–	–
MEI during weight loss[b]	60 (42–82)	–	–
Mean rate of weight loss (%)[c]	0.8 (0.3–1.4)	–	–
Starting body fat (%)	43 (27–53)	46 (32–58)	0.224
Final body fat (%)	28 (10–39)	–	–
Change in body fat mass (%)[d]	33 (17–74)	–	–

All data are expressed as median (range).
[a] Age at the start of the weight loss programme.
[b] Mean energy intake (MEI) expressed as a proportion of maintenance energy requirement at per kg of metabolic body weight (using target weight).
[c] Mean rate of weight loss expressed as percentage of starting bodyweight per week.
[d] Change in body fat mass calculated as described in text.

Table 3
Comparison of health-related quality of life in dogs completing weight loss and those failing to complete.

Quality of life factor	Reference interval[a]	Dogs completing[b]	Dogs failing to complete[b]	*P* value
Vitality	2.28–6.00	4.00 (0.76–5.47)	2.76 (1.35–5.35)	0.03
Emotional disturbance	0.17–2.17	1.28 (0.17–4.73)	2.17 (0.22–4.50)	0.03
Anxiety	0.43–2.64	1.00 (0.14–5.57)	1.00 (0.36–4.14)	0.8
Pain	0.00–1.43	1.62 (0.00–4.87)	1.39 (0.37–4.38)	0.3

[a] Quoted reference intervals represent the 2.5th and 97.5th percentiles of factor scores from a control group of 48 healthy pain-free dogs in optimal body condition.
[b] Data are expressed as median (range).

in obese dogs, especially in those that ultimately fail, but improves with successful weight loss.

When results were modelled using four HRQOL domains, pre-weight loss vitality was greater and emotional disturbance less in dogs that were successful with weight loss compared with those that ultimately failed. These findings should be interpreted cautiously given that there were various reasons for discontinuing, and the reason was unclear for dogs lost to follow-up. However, such HRQOL differences might either directly or indirectly affect the outcome of subsequent weight loss. For instance, dogs whose vitality score is low could have most trouble with exercising, leading to slower rates of weight loss. Alternatively, an owner might discontinue prematurely if they perceive their dog to have a poor quality of life. Further, when the programme stopped for an unrelated problem (e.g. owner issue or another illness), this might independently have contributed to poor HRQOL. Further studies are recommended both to help explain why weight loss programmes fail.

In dogs that successfully completed weight loss, improved vitality and emotional wellbeing, and decreased pain scores were seen. These results complement those of other studies that suggest improved quality of life through reductions in disease severity (Mlacnik et al., 2006; Marshall et al., 2010) or improved metabolic status (German et al., 2009) as a result of weight loss in obese dogs. Further, similar HRQOL improvements are seen in obese humans with bariatric surgery (Kral et al., 1992; Isacsson et al., 1997; Rippe et al., 1998) and other strategies. For instance, improved physical function, vitality and mental health is seen when moderately obese women losing approximately 6 kg (Rippe et al., 1998).

As discussed above, vitality scores were greater in dogs that successfully lost weight than in those that failed, perhaps suggesting that better inherent vitality can promote initial weight loss and help maintain progress. However, a related finding was that weight loss improved vitality score, and the magnitude of change correlated with both the percentage weight loss and change in fat mass. Thus, improved vitality might be important in driving both the rate and magnitude of weight loss. However, it should be noted that the percentage weight loss was actually determined by initial degree of overweight, since each dog's programme continued until the dog was confirmed to have reached its target. Therefore, it is more likely that pre-weight-loss HRQOL (especially vitality) is worst in the most severely overweight dogs, and consequently can improve most in this cohort. Similarly, previous work suggests that decreased pain is associated with increased physical activity, mental alertness, and extroversion (Wiseman-Orr et al., 2004) all of which contribute to vitality. While this change may reflect an increased physical ability to exercise, other beneficial effects on health may have contributed including improved insulin sensitivity and reductions in the magnitude of circulating adipokines (German et al., 2009).

Emotional disturbance score also decreased upon weight loss, although the magnitude of improvement did not correlate with either weight loss or fat loss. The reason for this is not clear but, in human studies, physical aspects of HRQOL change more after moderate weight loss than do psychological aspects (Fine et al., 1999; Fontaine et al., 1999). Decreases in pain score were also noted upon weight loss, which concurs with other studies demonstrating improved mobility when overweight dogs with orthopaedic disease lose weight (Marshall et al., 2010). In contrast to vitality score, however, these changes did not correlate with the degree of weight loss or magnitude of fat loss. This may relate to the fact that only a minority (9/30) of dogs were reported to have orthopaedic problems, thereby limiting the influence of this effect in the overall population.

Rate of weight loss was not associated with changes any in any HRQOL score. This is interesting because a slow rate of weight loss, which would increase programme duration, might feasibly have negatively impacted owners' impressions of their pets quality of life; similarly, rapid weight loss might provoke unwanted behaviours i.e. increased hunger and food-seeking behaviour, which an owner might also associate with poor quality of life. Respondent bias is a widely recognised risk to valid measurement using questionnaire instruments. The HRQOL instrument was designed to minimise such risk by including a large number of items, each designed to be answered easily and quickly using a ubiquitous rating scale with inference reversed according to whether the item is positive or negative. The finding that anticipated bias was not reflected in instrument scores suggests that the instrument as intended is not vulnerable to respondent bias.

When transition questions were examined, the outcomes of dogs of owners who chose not to answer whether HRQOL had improved were inferior to those of owners who believed their dogs had improved, in terms of percentage weight loss and body fat loss. These results might suggest that failing to answer this question is a proxy for owners who did not believe that their dogs' HRQOL had improved noticeably. Although the numbers are small, agreement of global rating of HRQOL with domain scores provides additional evidence for the validity of the instrument as a measure of HRQOL.

The HRQOL instrument is designed to facilitate access to the subjective experience of the dog. This is the current focus in human HRQOL measurement where an individual's subjective evaluation and their reaction to health or illness are most important (Fontaine and Bartlett, 1998). Indeed, HRQOL is now a required outcome measure for clinical studies (Fayers et al., 1999) and one sought even for paediatric populations who cannot self-report (Matza et al., 2004). Similarly, HRQOL should be an important outcome measure for assessing the impact of companion animal therapies. Continuing development of the HRQL instrument used in this study has now resulted in a short-form instrument delivered on a web platform, and pilot testing is underway. It is hoped that this will improve the instrument's utility in the future.

The study has a number of limitations. First, it was observational, open-label and uncontrolled, meaning that the possibility of bias cannot be eliminated, not least given that employees of the sponsoring company were co-authors. Therefore, it is possible that at least some of the improvement noted was attributable to a placebo effect, rather than being the result of the weight loss and a positive diet effect. However, arguably each dog acted as its own control and the change to baseline captures any HRQOL effect. Further, not all HRQOL factors changed upon weight loss (i.e. anxiety),

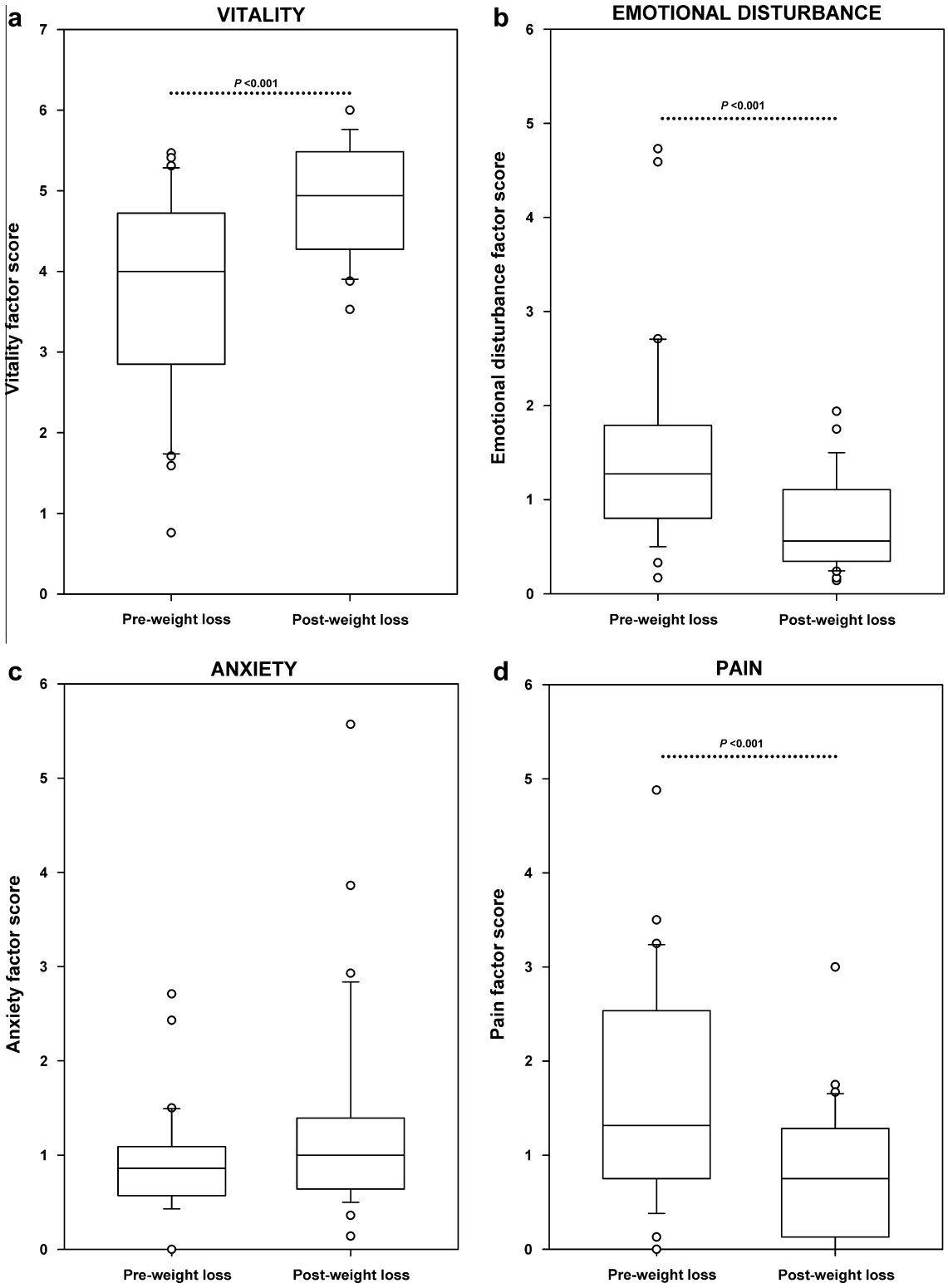

Fig. 1. Health-related quality of life before and after weight loss in 30 obese client-owned dogs. Domains assessed were vitality (a), emotional disturbance (b), anxiety (c), and pain (d), whereby improved quality of life manifests as increased vitality score, and decreased emotional disturbance, anxiety, and pain scores. The boxes depict median (horizontal line) and inter-quartile range (top and bottom of box), the vertical lines show the 10th and 90th percentiles, and outliers are shown as separate points. Weight loss was associated with improved vitality, decreased emotional disturbance, and decreased pain score ($P < 0.001$ for all).

and the effects were different for different HRQOL domains (i.e. only vitality scores were associated with percentage weight loss) whereas a placebo effect might be expected to have a similar impact on scores in all domains. As detailed in the conflict of interest statement below, there were limits to the involvement of the co-authors who were company employees in data handling and analysis. Nonetheless, the findings should still be cautiously interpreted and prospective, blinded, randomised controlled trials are

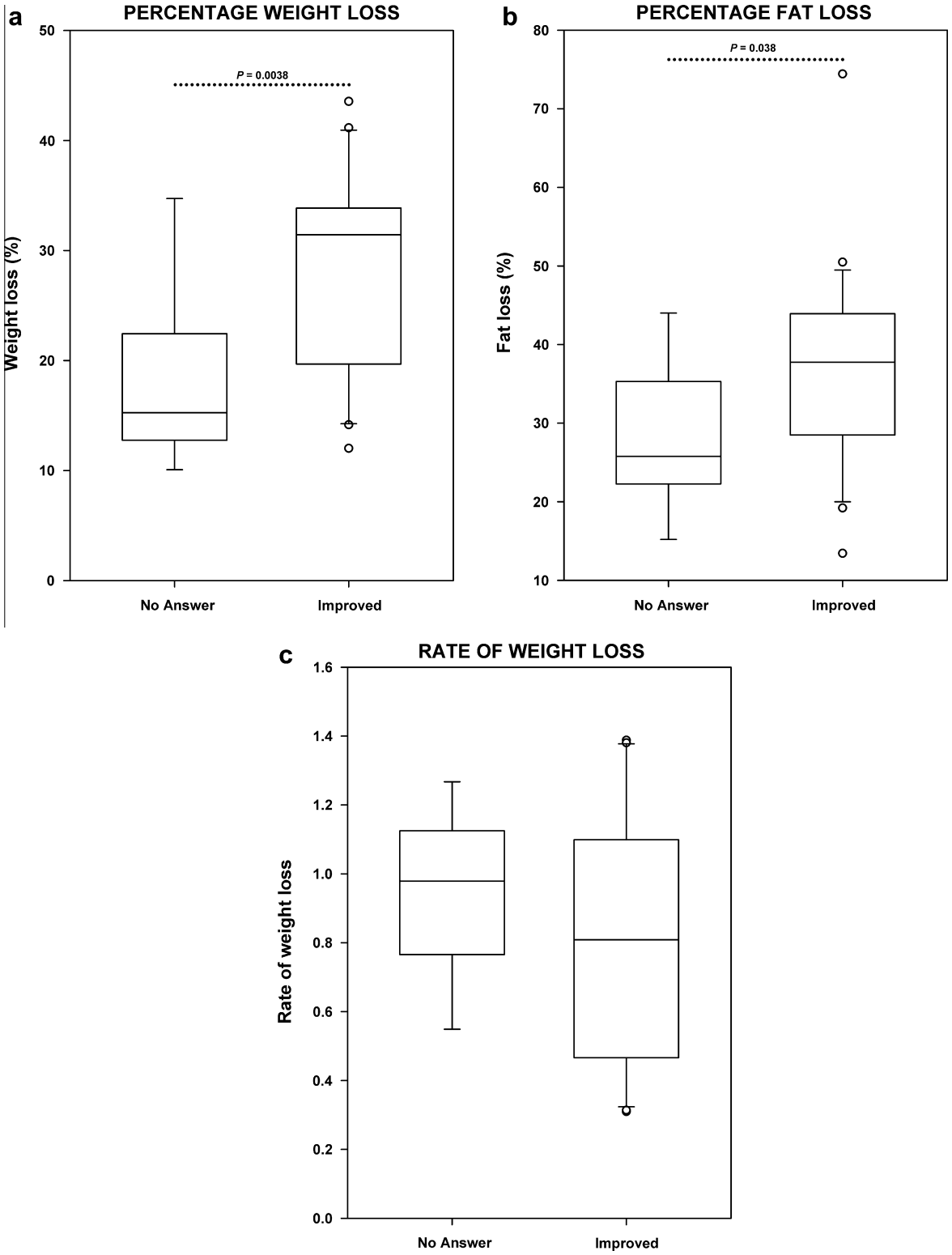

Fig. 2. Weight loss outcomes in the dogs of owners responding differently to transition questions. Group comparisons were made between the dogs whose quality of life was thought to have improved ('improved'), and those whose owners did not answer the question ('no answer'). Outcome measures assessed included percentage weight loss (a), percentage fat loss (b), and rate of weight loss (c). The boxes depict median (horizontal line) and inter-quartile range (top and bottom of box), the vertical lines show the 10th and 90th percentiles, and outliers are shown as separate points. Percentage weight loss ($P = 0.008$) and percentage body fat loss ($P = 0.04$) were greater in those dogs whose owners had said their dog had improved, compared with the owners who did not answer the question.

recommended to compare different weight loss strategies (i.e. diet only vs. diet and exercise or vs. drug therapy) and determine which approach is optimal.

A second limitation was that follow-up HRQOL data were only available in dogs successfully completing the programme. This was because the study was designed so that follow-up body com-

position data could be matched to HRQOL data collected at the same time. However, given the requirement for sedation, ethical limitations meant that follow-up DEXA could only be performed once, and the optimal time for this was deemed to be at the end of weight loss. Since the target was never reached in dogs failing to complete, neither the follow-up DEXA nor post-weight loss HRQOL questionnaire were completed. In theory, these tests could have been performed when unsuccessful dogs were withdrawn. However, unfortunately this was not feasible either because it was inappropriate (e.g. when dogs were euthanased), could have spuriously affected body composition and HRQOL results (e.g. when another illness had developed ultimately leading to euthanasia), or was simply not possible (e.g. when contact was lost with owners).

A third limitation was that changes in physical activity were not objectively quantified, which would have confirmed validity of the vitality scores. Physical activity through dog walking can improve the quality of life of both dogs and their owners (Bauman et al., 2001; Thorpe et al., 2006); however, further work would be required to examine the exact role of physical activity on canine weight loss protocols. Further, the degree of obesity and activity of owners may have influenced both vitality scores in dogs and the success of weight loss. Owner factors were not examined in the current study, and these require further research.

Other limitations included the fact that the study was small and was conducted on pet dogs with variable signalment. Age can affect domain scores in healthy pain-free dogs (E.M. Scott; unpublished observations) and, intuitively, breed differences may also introduce some variability. The cases studied had all been seen at a referral clinic for weight management, and are typically moderately-to-markedly overweight. Further, a full-time staff member (SH) was employed specifically to oversee weight loss programmes, enabling close case supervision. Therefore, the HRQOL improvements might not reflect what would be expected general practice. Against this, the advantage of studying a referral population meant that cases were better characterised clinically and body fat was quantified by DEXA.

Conclusions

The current study provides evidence that HRQOL may improve in obese dogs that successfully lose weight. The data also provide evidence for the validity of a novel instrument for the measurement of canine HRQOL. Future studies should determine the significance of these findings in relation to weight loss, and determine whether certain strategies may maximise the beneficial effects seen.

Conflict of interest statement

Royal Canin manufactured both study diets. V.B. is a Royal Canin employee, and P.J.M. an employee of Mars Petcare. Royal Canin also financially supports the posts of A.J.G. and S.L.H. Although all were involved, the extent varied. For instance, A.J.G. and S.L.H. collected clinical data, which other authors could then review. However, authors who were direct employees of the commercial sponsor were not involved in case recruitment, data handing and data storage. Data analysis was performed by A.J.G. and E.M.S., and authors with a commercial interest were not directly involved; however, all authors subsequently discussed and interpreted the results. A.J.G. produced the initial manuscript draft, which was circulated to other authors for review. All authors commented at various stages during manuscript writing, approved the final manuscript and agreed with its submission for publication. The commercial sponsor could not prevent the manuscript from being submitted for publication.

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