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Perspectives in Animal Health and Welfare provides an opportunity for the publication of articles by, and for, veterinary nurses, veterinary technicians and allied veterinary professionals. The scope of the journal is broad, with a multi-disciplinary approach – we are interested in publishing papers in the areas of animal disease, parasitology, nutrition, behaviour, anaesthesia and analgesia, breeding and reproduction, One Health, and social sciences related to the veterinary industry

Cover: Frank at the University of Waikato Animal Learning and Welfare Laboratory. Photo: Kristie Cameron

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EDITORIAL

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Welcome to the inaugural volume and first issue of *Perspectives in Animal Health and Welfare*. This journal was established to provide an opportunity for the publication of outputs by, and for, veterinary nurses, veterinary technicians and allied veterinary professionals. The scope of the journal is broad, with a multi-disciplinary approach – we are interested in publishing papers in the areas of animal disease, parasitology, nutrition, behaviour, anaesthesia and analgesia, breeding and reproduction, One Health, and social sciences related to the veterinary industry.

In this first issue, Hannah Sadler, Laura Harvey and Lauren Prior present their research into bullying in the veterinary industry, showing that bullying is a significant concern within the sector in Aotearoa. Meanwhile, Kristie Cameron, Lewis Bizo and Nicola Starkey investigate the impact of long-term free-feeding on the bodyweight of animals in use for operant experiments.

The two manuscripts included in this issue highlight the wide scope of outputs and we look forward to seeing more research for, and by, veterinary nurses, veterinary technicians and allied veterinary professionals. The online, open-source nature of *Perspectives in Animal Health and Welfare* means this research is available to all interested parties, and we look forward to seeing the impacts of this research in the veterinary industry.

If you are interested in submitting a manuscript, or would like to find out more about our editorial process, please email our publisher, epress@unitec.ac.nz

Laura Harvey and Kristina Naden
Editors

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Identifying the prevalence and implications of bullying in the Aotearoa New Zealand veterinary nursing industry

Hannah Sadler, Laura C. Harvey and Lauren Prior

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Identifying the prevalence and implications of bullying in the Aotearoa New Zealand veterinary nursing industry

Hannah Sadler, Laura C. Harvey and Lauren Prior

Abstract

Veterinary nursing, alongside other healthcare vocations, has been widely acknowledged as a high-stress occupation. Workplace stress, burnout and compassion fatigue have been described in veterinary nurses, but the prevalence of a bullying culture has not yet been formally identified in Aotearoa New Zealand. Research surrounding bullying in the human healthcare sector and amongst veterinarians exists, yet despite anecdotal evidence suggesting bullying is prevalent, Aotearoa New Zealand veterinary nurses are under-represented in the literature.

This study aimed to determine the prevalence and possible implications of bullying within the Aotearoa New Zealand veterinary nursing industry. An anonymous, self-selecting survey was adapted, with permission from the authors, from an existing questionnaire previously distributed in the United Kingdom. It was disseminated online through social media and to New Zealand Veterinary Nursing Association (NZVNA) members. A total of 396 respondents met the criteria for the survey: 70.2% (n = 278) of respondents identified that they had been bullied by at least one other staff member in their clinic; 29.86% (n = 83) of those reported being bullied by a veterinarian; and 80.92% (n = 320) of respondents reported they had observed a colleague subjected to bullying within their current clinic.

The high incidence of bullying identified in this study warrants further investigation, particularly as this survey was the first of its kind to be distributed in this country. Further research to understand the scope, nature and effect of bullying on Aotearoa New Zealand veterinary nurses is recommended.

Keywords

Veterinary nursing, workplace bullying, mental health, workplace wellbeing

Introduction

Workplace bullying is a globally recognised phenomenon with potentially severe physical and emotional consequences for those affected. Bullying is broadly defined as behaviour that intentionally causes physical and/or psychological harm to another individual (Fox & Cowan, 2015) and may be categorised in the workplace as horizontal (between employees of a similar level) or vertical (between those of a different level) (Huntington et al., 2011; Norton et al., 2017; Bedford and Anscombe-Skirrow, 2018).

Bullying is pervasive in demanding, high-stress working environments, such as human healthcare, and is widely agreed to be detrimental to mental and physical wellbeing, alongside promoting career disillusionment and poor employee retention (MacCurtain et al., 2018; Bedford & Anscombe-Skirrow, 2018; Lever et al., 2019). Disillusionment can be a result of bullying and is thought to be instrumental in instigating dissatisfaction, reduced motivation and poor performance at work, as well as insecurity at work translating into one's personal life (Einarsen et al., 2018; Glambek et al., 2018). Disillusionment has been cited as a prevalent cause of individuals leaving their place of work to seek employment elsewhere (Glambek et al., 2014; Laschinger & Fida, 2014). In addition to the concept of disillusionment, chronic stress, lack of sleep and engaging in destructive habits are also documented manifestations of compromised wellbeing (Gardner & Rasmussen, 2018), associated with persistent workplace bullying.

There has been a great deal of research undertaken in the human healthcare sector, where it is now widely recognised that the prevalence of bullying is consistently higher among nursing staff in comparison to other healthcare roles (Norton et al., 2017). Combined with the knowledge that bullying occurs most frequently in high-pressure/high-stress environments, it is plausible

to hypothesise that the Aotearoa New Zealand veterinary nursing industry could reflect a similar trend to its 'human' nursing counterpart (Bedford & Anscombe-Skirrow, 2018). Workplace stress, burnout and compassion fatigue have been described in veterinary nurses (Black et al., 2011; Lloyd & Campion, 2017; Harvey & Cameron, 2020), but the prevalence of bullying has not yet been formally recognised in Aotearoa New Zealand, although it is thought to be linked. Research surrounding bullying in the human healthcare sector and amongst veterinarians exists (Blackwood et al., 2017; Connolly et al., 2022), yet despite anecdotal evidence suggesting a bullying culture is prevalent, in Aotearoa New Zealand veterinary nurses are notably under-represented in the literature. The Aotearoa New Zealand veterinary sector is currently experiencing a shortage of veterinary professionals (Careers NZ, 2022) and it is important to monitor the cascading effect this may have on our veterinary nurses and their social interactions within the workplace. It is reasonable to assume that individual workloads within a clinic will increase, prompting a rise in stress and fatigue of veterinary nursing staff, and possibly leading to an increase in negative social interaction and bullying between staff. Bullying behaviours in the workplace may also be associated with a higher incidence of suicide (Lever et al., 2019), indicating a duty to consider the prevalence of bullying associated with the poor mental health of veterinary nurses.

A study designed to gain insight into the presence of bullying within the Aotearoa New Zealand veterinary nursing industry, to identify the most common negative behaviours exhibited between individuals within the profession, and possible implications of this behaviour, was undertaken. This research is understood to be the first of its kind in the Aotearoa New Zealand veterinary nursing profession and, as such, will hold value for allied veterinary professionals nationwide and prompt further research in the field.

Materials and methods

An online survey was adapted, with permission from the authors, from an existing questionnaire previously distributed in the United Kingdom (Bedford & Anscombe-Skirrow, 2018).

The survey, created using the online, cloud-based software SurveyMonkey, was open to veterinary nurses employed in Aotearoa New Zealand veterinary clinical practice within the previous six months. Respondents were self-selecting, remained anonymous, and a formal veterinary nursing qualification or professional registration was not required. The survey was disseminated online through social media (Facebook), via email directly to all veterinary clinics in Aotearoa New Zealand and to New Zealand Veterinary Nursing Association (NZVNA) members. The survey was open for 21 days. Ethics approval was obtained via the Unitec Human Research Ethics Committee (UREC #: 2019-1023).

Survey questions were multiple choice, multi-select or provided as a Likert scale. All questions were closed in nature, apart from the 'Other: please specify' options. Simple descriptive statistical analysis was performed. A notable feature of the survey adapted from Bedford and Anscombe-Skirrow (2018) was the inclusion of the 'Negative Acts Questionnaire – Revised' (NAQ-R), a high-validity framework attributed to Einarsen et al. (2009). The NAQ-R consists of 22 negative statements pertaining to negative social behaviours within the workplace, designed to identify the presence of bullying in an objective way. As recommended by Bedford and Anscombe-Skirrow (2018), 11 of 22 statements were reversed to assess positive behaviours in this study. This aimed to mediate response bias, enable reliable quantification of bullying behaviours and allow direct comparison with similar studies investigating bullying (Einarsen et al., 2009). Respondents could select 'Daily', 'Weekly', 'Monthly', 'Occasionally', 'Never' or 'Strongly agree', 'Agree', 'Neutral', 'Disagree', 'Strongly disagree' in response to the statements listed, depending on the question.

Results

Of a total of 517 respondents, 396 met inclusion criteria for the study (from a population of 2145 veterinary nurses [Stats NZ, 2018]). The age bracket 25–34 years had the highest representation (n = 164, 41.4%), followed by 35–44 years (n=107, 27%), then 18–24-years (n = 84, 21.2%). The remaining 10.4% of respondents were aged 45–65+. Female-identifying veterinary nurses made up 98.5% (n = 388) of survey respondents. Of all respondents, 97.5% held a relevant industry qualification, ranging from certificate to degree level. Respondents who had been working in the veterinary nursing industry for 2–5 years were most represented in the study (n = 112, 28.3%) (Table 1).

Table 1: Demographic data of the participants.

Gender		n (%)
Male		5 (1.25%)
Female		391 (98.5%)
Gender diverse		0
Prefer not to say		1 (0.25%)
Age		
18–24		84 (21.16%)
25–34		165 (41.56%)
35–44		107 (26.95%)
45–54		32 (8.06%)
55–64		8 (2%)
65+		1 (0.25%)
Tenure	In current role	In the profession
< 1 year	91 (22.92%)	31 (7.81%)
1–2 years	89 (22.42%)	53 (13.35%)
2–5 years	119 (29.97%)	113 (28.46%
5–10 years	54 (13.6%)	84 (21.16%)
10–20 years	38 (9.57%)	90 (22.67%)
20+ years	6 (1.51%)	26 (6.55%)
Highest qualification level		
Certificate		150 (37.39%)
Diploma		207 (52.14%)
Degree		22 (5.54%)
No qualification		10 (2.52%
Other		8 (2%)

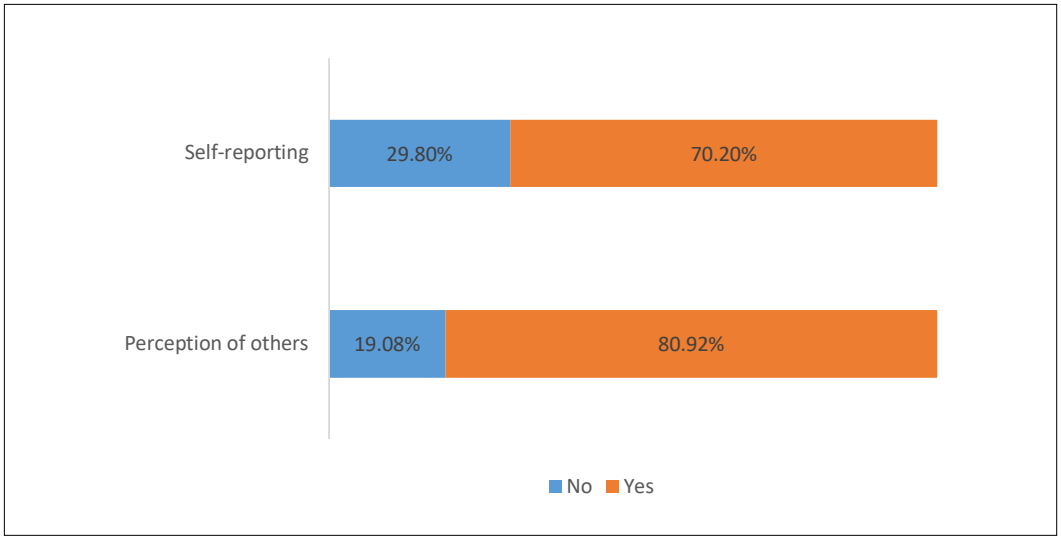

Figure 1. Percentage of respondents self-reporting bullying behaviours versus the perception of bullying reported to be occurring towards or amongst colleagues.

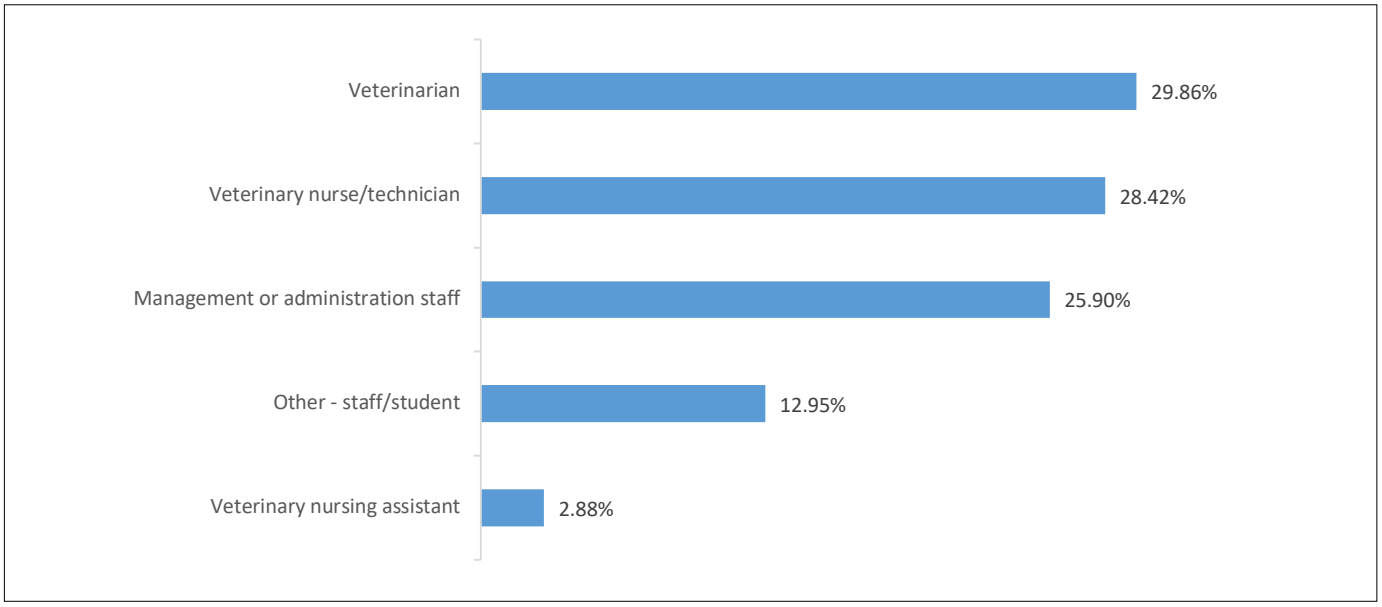

Figure 2. The source of bullying when self-reported by veterinary nursing respondents.

Incidence of bullying

Bullying by at least one other staff member in a veterinary clinic setting was self-reported by 70.2% (n = 278) of respondents, while 80.92% of respondents (n = 318) reported observing a colleague subjected to bullying, rather than themselves (Figure 1). Among those who self-reported bullying, the source varied, with 29.86% (n = 83) reporting being bullied by a veterinarian, 28.42% (n = 79) by another veterinary nurse or technician on the same level as them, and 25.9% (n = 72) by management (Figure 2). Among participants who reported a source when observing bullying of colleagues, 'Veterinarian' remained the most frequent response (Figure 3).

When asked to rate the occurrence of positive experiences in their workplace, 92.15% of respondents indicated that they felt trusted by their colleagues and 73.92% agreed that colleagues were able to effectively communicate on at least a 'Weekly' basis. In response to the positive statements 'You receive constructive feedback about your work as a veterinary nurse', 'You are praised for your work as a veterinary nurse', and to 'Your clinic management identifies the need for a healthy work–life balance', these were scored as being received at least weekly by 35.95%, 47.34% and 48.86% of respondents respectively. Notably, this last statement was the highest scoring 'Never' response (16.2%) of the positive statement matrix (Figure 4).

When asked to rate the occurrence of negative experiences in their workplace, 87.82% of respondents indicated that they had felt guilty for claiming their sick

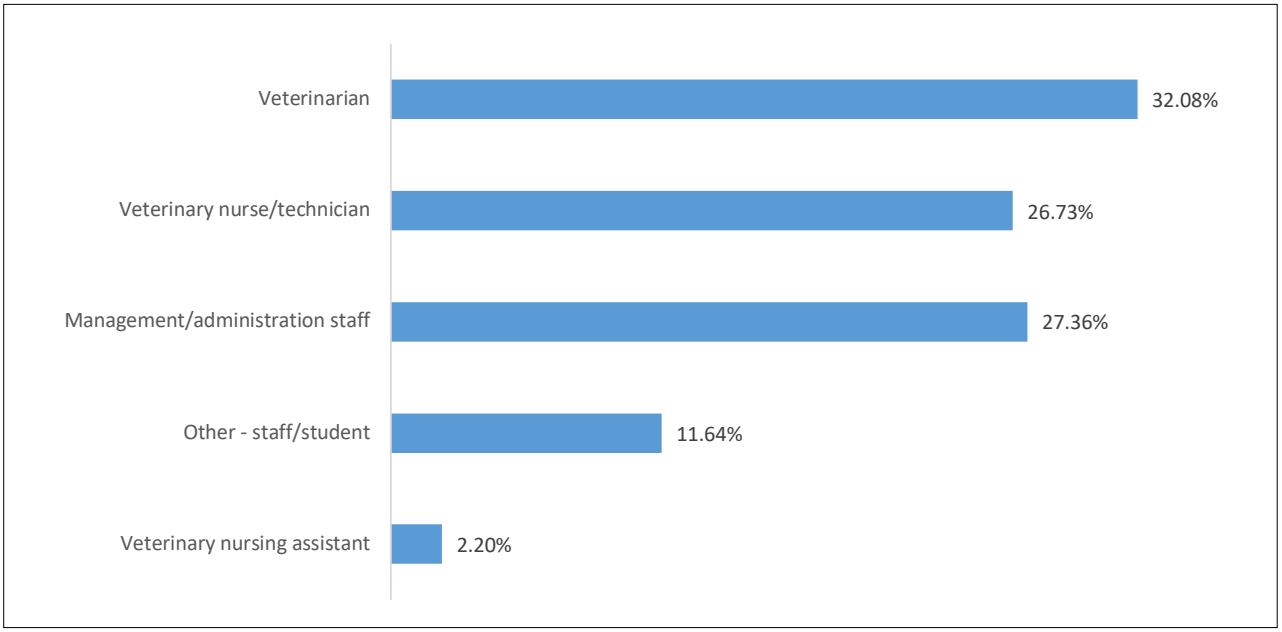

Figure 3. The source of bullying when reported towards or amongst colleagues.

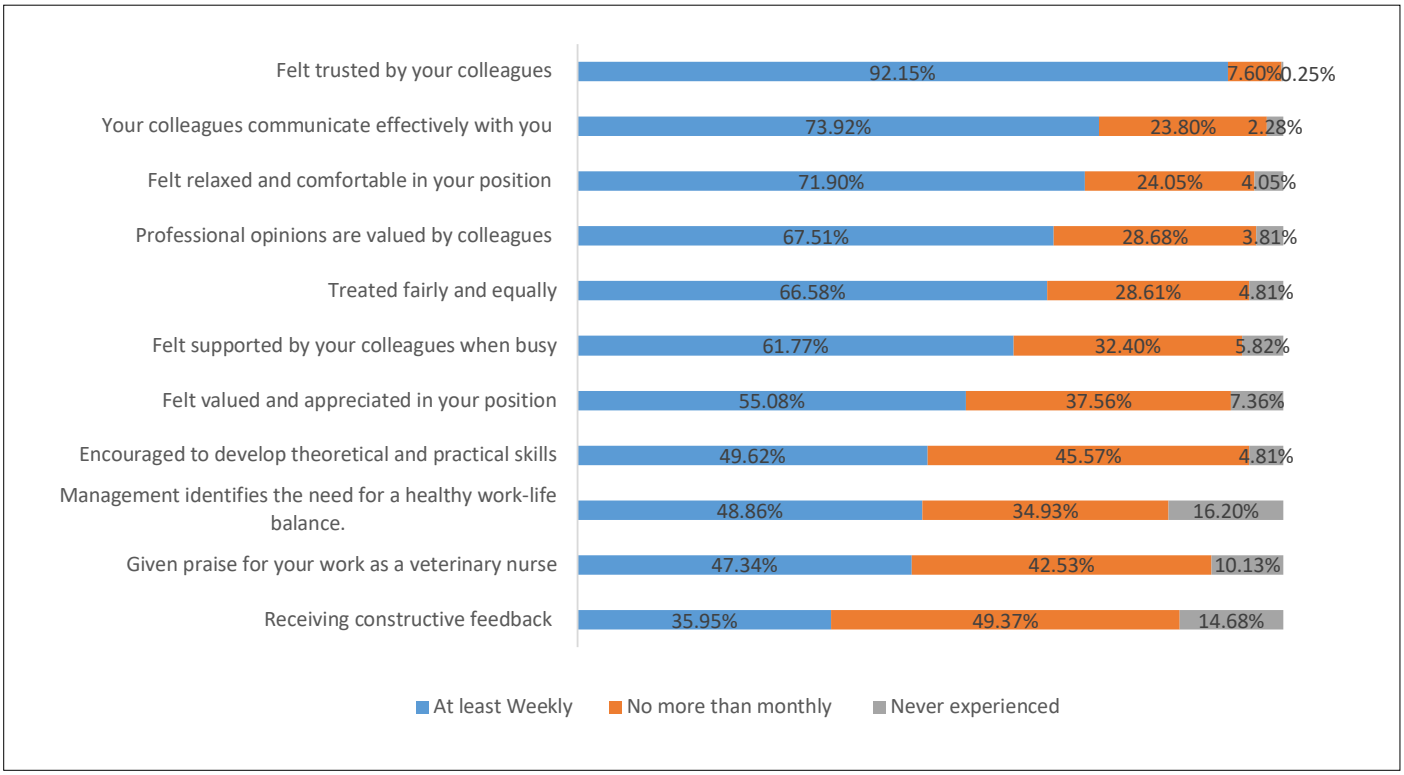

Figure 4. Respondents reporting their experience of positive statements occurring at least 'Weekly', no more than 'Monthly' or 'Never' in their current or most recent practice/clinic.

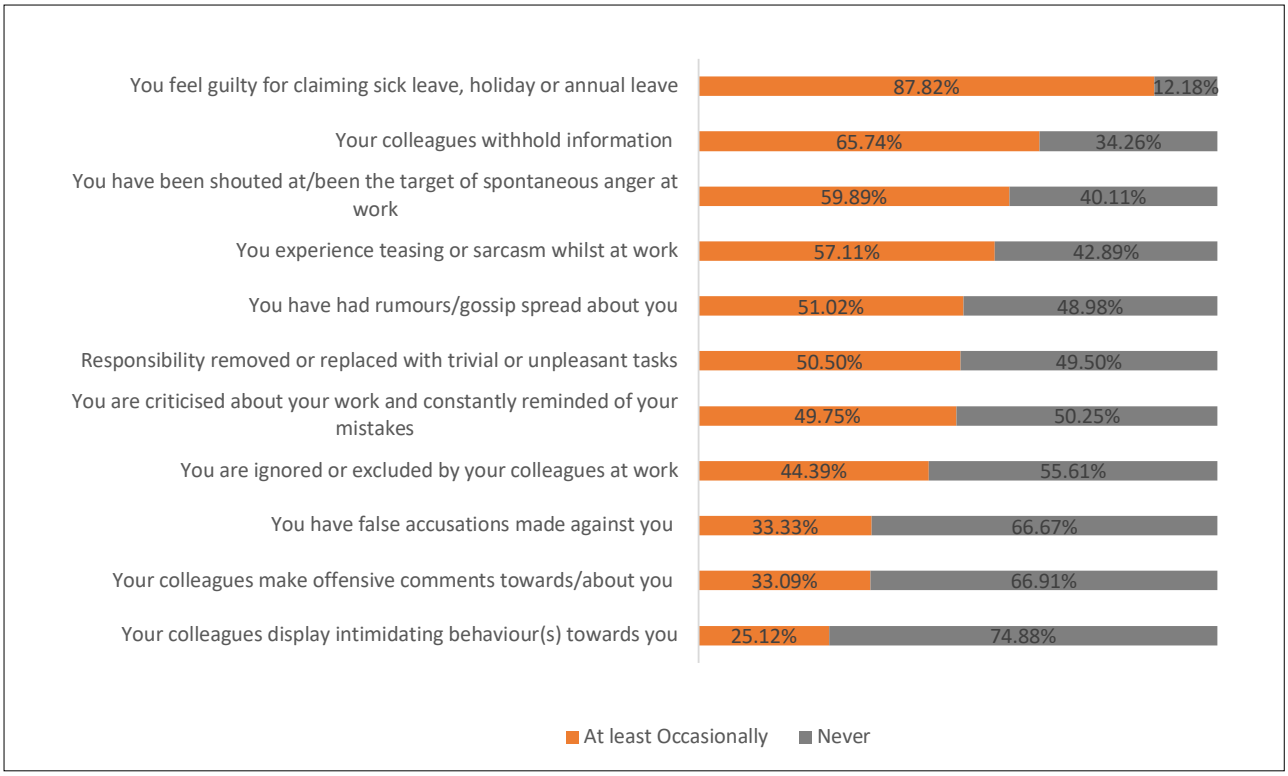

Figure 5. Respondents reporting their experience of the following negative statements occurring at least 'Occasionally' (daily, weekly, monthly and occasionally combined) or 'Never'.

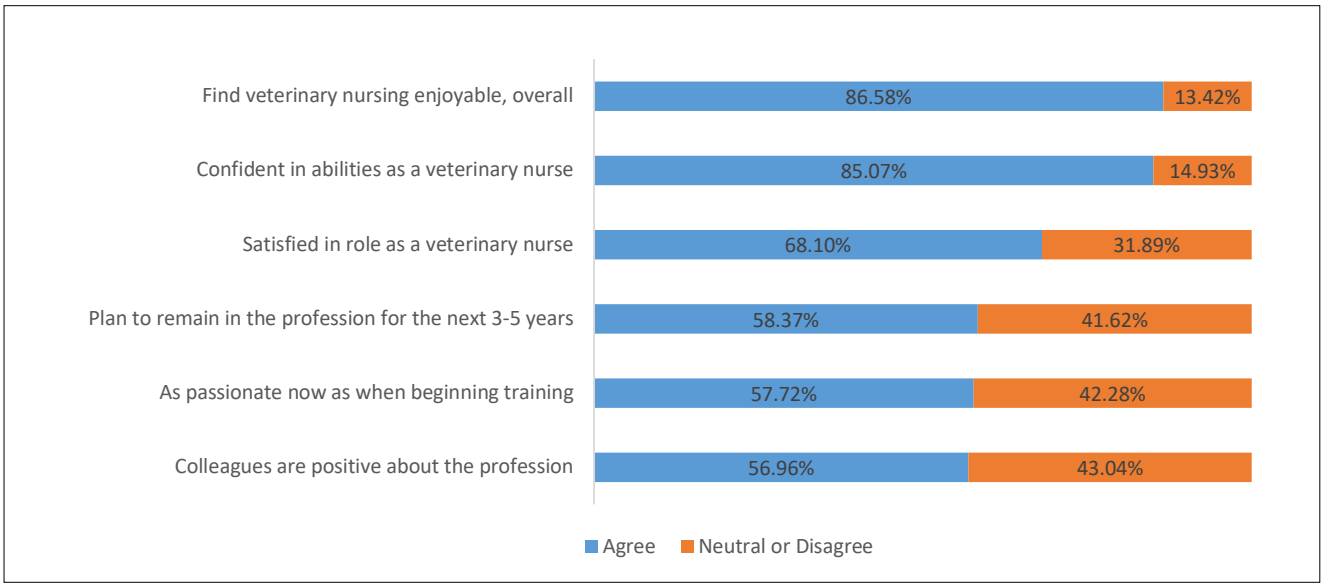

Figure 6. Percentage of respondents that selected 'Agree' (strongly agree and agree combined) or 'Neutral/Disagree' (neutral, disagree and strongly disagree combined) in response to statements on job outlook and satisfaction.

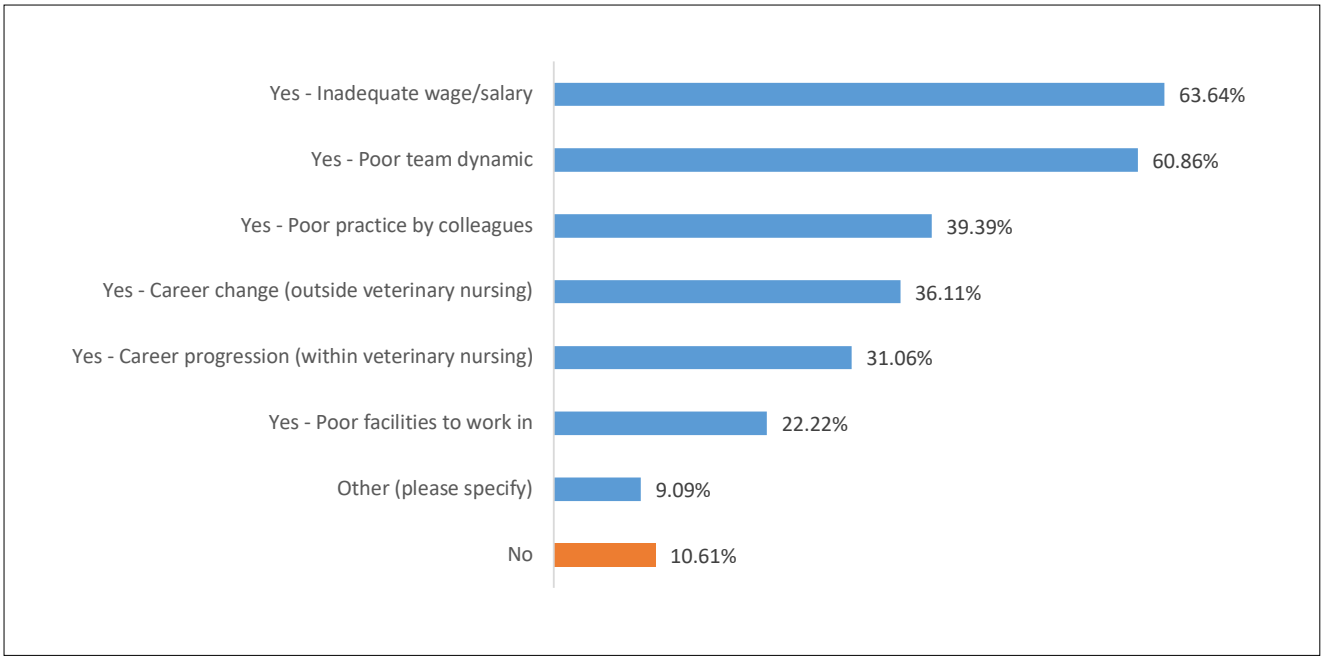

Figure 7. Reasons given for respondents having changed, or considered changing, their place of employment.

leave, holiday, or annual leave in their current or most recent clinic at least 'Occasionally', while 41.37% of these respondents felt this way at least 'Weekly'. In response to the negative statement 'Your colleagues display intimidating behaviour(s) (e.g., Finger pointing, invading personal space, shoving)', 25.12% of respondents selected that they are at least 'Occasionally' subject to this behaviour, indicating it has occurred before in their current or most recent clinic, with 7.36% reporting experiencing this behaviour at least 'Weekly'. More than 50% of respondents indicated that they were at least 'Occasionally' subjected to negative behaviours such as the withholding of information by colleagues (65.74%), being shouted at or the target of spontaneous abuse (59.89%), experiencing teasing or sarcasm (57.11%), having rumours and gossip spread about them (51.02%) and having their responsibilities removed or replaced with more trivial and unpleasant duties (50.05%) (Figure 5).

Considering statements on career outlook and job satisfaction (Figure 6), 86.58% of respondents agreed that they still found veterinary nursing enjoyable overall, and 85.07% agreed that they were confident in their own abilities as a veterinary nurse. Of respondents, 42.28% were neutral or disagreed when asked if they remained as passionate about veterinary nursing now as they did when they first started training, and 43.04% felt neutral or disagreed that their colleagues felt positive towards the veterinary nursing profession. When asked whether they were likely to remain in the veterinary nursing profession for the next 3–5 years, 58.37% agreed and 41.62% disagreed (Figure 6).

Regarding job retention, most respondents indicated that they had changed, or considered changing, their place of employment in the veterinary industry for a variety of reasons (multiple selections permitted) (Figure 7). Only 10.61% of survey respondents had never changed, or considered changing, their place of employment for any reason. Most respondents indicated that they have changed or considered changing their place of employment due to 'inadequate wage or salary' (63.64%) and 'poor team dynamic' (60.86%) (Figure 7).

Discussion

This study highlights the occurance of bullying behaviours within the veterinary nursing industry in Aotearoa New Zealand. The majority of respondents were female and aged under 35, reflecting both industry trends, and previous studies in this area (Kongara et al., 2016; Harvey and Cameron, 2019). Tenure responses indicate a high turnover of veterinary nurses within the industry, with 45% of respondents having been in their current job less than two years; however, as approximately 20% of respondents are recent graduates, the level of turnover is likely to be slightly lower.

Results show a high level of self-reported bullying behaviour, either directly experienced by the respondent, or that respondents observed being directed toward colleagues. Most bullying behaviour was instigated by veterinarians, followed closely by veterinary nurses/

technicians. These findings align with a UK survey by Everitt (n.d.), in which respondents identified 'Veterinary Surgeons' as the most common perpetrators of bullying behaviour, indicating this isn't an issue unique to Aotearoa New Zealand.

The 'Negative Acts Questionnaire – Revised' (NAQ-R) contains 11 positively framed statements and 11 negatively framed statements. The 'positive' statement results are encouraging, with the majority of respondents indicating they experience these on a daily or weekly bases, including over 90% of respondents stating they felt trusted by their colleagues (on a daily or weekly basis). Notably, 35% of respondents indicated receiving constructive feedback on a daily or weekly basis. Constructive feedback helps to promote ongoing learning, essential to providing high-level patient care. Learning how to give constructive feedback, however, is a skill, and these results may indicate a lack of skill in those wanting or needing to provide feedback, rather than a lack of desire to do so (Omer & Abdularhim, 2017). Also of note is the low number of respondents whose management recognises the need for a healthy work–life balance (with less than half experiencing this at least weekly), and that one in 10 (10.13%) respondents are never praised for their work. Numerous studies, spanning multiple professions, agree that positive feedback and praise contributes to higher job satisfaction (Anseel & Lievens, 2007; Morsiani et al., 2017) and improved performance, and validates staff perception of success (Pfister et al., 2020). A study concerning millennial nurses in the human sector shows that positive feedback and praise are highly valued and enhance job satisfaction (Tyndall et al., 2019), while, contrastingly, a lack of such feedback is identified as a predictor of burnout and ultimately professional disillusionment by Kelly et al. (2015). As most respondents in this study (approximately 70%) would be categorised as 'millennials', born between 1981 and 1997 (Frey, 2018), it is especially important for employers to provide authentic praise to veterinary nursing employees. Improved job satisfaction across the sector may contribute to a reduction in negative behaviours, but further research is required to support this.

Of the 'negative' statements, experience on a daily or weekly basis is fortunately low, which is encouraging; however, over 87% of respondents stated they felt guilty at some point for taking sick or paid annual leave, despite this being protected by Aotearoa New Zealand law (Holidays Act 2003). Existing research implies that inadequate uptake of annual leave represents significant risk to mental and physical wellbeing, with one study reporting an increase in the occurrence of heart attack and coronary death in otherwise healthy women (Eaker et al., 1992; Skinner & Pocock, 2013). Promoting the uptake of paid annual leave encourages employees to accomplish a more sustainable work–life balance, spend time with friends and family, and participate in enjoyable extracurricular activities, all of which may lessen symptoms of depression, anxiety and burnout (Joudrey & Wallace, 2009).

Over half of respondents have been shouted at, experienced teasing and/or had gossip or rumours spread about them, with 65% having had key information withheld. The prominence of such direct bullying behaviour indicates a negative workplace culture that needs addressing to improve the mental and physical wellbeing of employees. The negative impacts of workplace bullying include job insecurity, absenteeism or low productivity, and physical health issues (including insomnia and mental health concerns) (Glambek et al., 2014; Magee et al., 2017). Previous studies have highlighted the trends of recording poorer mental health in female respondents compared to their male counterparts when participating in surveys addressing such topics (Heath, 2002; Fritschi et al., 2009). Although this study has not investigated the intricate details of the respondents' mental health, this is an important consideration to acknowledge when assessing the working environment of veterinary nurses – an industry that is predominantly female-driven. The implications of this are not limited to employee wellbeing but potentially impact patient care due to despondent or exhausted employees.

Disillusionment can be described as an individual realising job misconception (Bedford & Anscombe-Skirrow, 2018), resulting in becoming dissatisfied, unmotivated, performing poorly and ultimately causing individuals to leave their place of work (Glambek et al., 2014; Laschinger & Fida, 2014; Glambek et al., 2018). The positive association between bullying and disillusionment, that is, that increased prevelance of bullying increases likelihood of an individual leaving their job (Huntington et al., 2011), has been repeatedly reported by various authors (Everitt, n.d.; Hogh et al., 2011; Glambek et al., 2014; Laschinger & Fida, 2014; Gardner & Rasmussen, 2018), although this has been investigated sparingly within the veterinary nursing profession (Bedford & Anscombe-Skirrow, 2018).

In an open letter presented by Clarke et al., it was surmised from the authors' previous studies that recent

graduates highlighted "insufficient pay and poor work/life balance together with a 'lack of management and support by bosses'" as contributing to their disillusionment (Clarke et al., 2016, p. 603). This is an interesting finding when considering 'indequate wages/salary' was a common reason for respondents to consider leaving their current job, indicating alignment with Clarke et al.'s (2016) results. Considering the economic need to retain veterinary nursing staff due to a veterinarian shortage within Aotearoa New Zealand (New Zealand Veterinary Association and Veterinary Council of New Zealand, 2021; Careers NZ, 2022), it is concerning that responses relating to a positive career outlook and remaining in the industry were responded to the least positively. If the sector is to retain veterinary nursing staff and to do so with effective support systems, it is essential that work is done to improve career outlook and maintain a passion for veterinary nursing work. Most respondents agreed that they enjoy veterinary nursing work and so it could be possible that the 'Positive outlook' statement reflects their current clinic of employment, which may not be an enjoyable environment.

Interestingly, more respondents reported observing a colleague subject to bullying within their current clinic, than those self-reporting being bullied. Identifying bullying in a workplace can be challenging due to the subjective nature and differing perceptions on definition (Nielsen et al., 2010; Bedford & Anscombe-Skirrow, 2018). The varying percentages of respondents self-reporting an experience of bullying versus those observing a colleague subject to the same issue raises an important limitation of identifying and reporting on bullying in the workplace. Respondents may not easily recognise their experiences as 'bullying' and may be concerned, consciously or subconsciously, about a perceived stigma if labelling themselves as being bullied. Furthermore, a misunderstanding of what these behaviours are may also contribute to a lack of forthcoming information about bullying. The Negative Acts Questionnaire (Revised) was used as an objective measure to combat this; however, it did not seem to entirely mitigate bias. In addition, an individual's self-esteem, mental wellbeing, and personal values may also contribute to a lack of forthcoming information surrounding aspects of bullying within their own lives.

Based on the findings of this survey, it is apparent that bullying-type behaviour is present within the veterinary nursing industry of Aotearoa New Zealand. Respondents to the survey highlighted a negative career outlook among peers and uncertainty as to whether they would stay in the profession. Of those respondents that indicated they were recipients of bullying, the majority reported veterinarians as the perpetrators of the issue, followed closely by veterinary nursing colleagues. Respondents identified they lacked the receipt of constructive feedback, receiving praise for their work and achieving a work–life balance. Additionally, respondents reported feelings of guilt for taking annual leave for which they are entitled, failing to achieve optimal outcomes in their work due to colleagues withholding information, and experiencing teasing and sarcasm at their place of work. A high turnover in staff between clinics (of the respondents) was apparent, with most respondents selecting '2–5 years' regardless of their experience. This finding aligns with the high turnover of registered nurses in Aotearoa (Moloney et al., 2018).

The high incidence of bullying identified in the Aotearoa New Zealand veterinary nursing industry by this study warrants further investigation, as current data supports the proposition that workplace culture and bullying is prevalent in Aotearoa New Zealand veterinary clinics. The negative responses on career outlook and job satisfaction may suggest that the incidence of bullying reported in this study could have a significant impact on employee retention rates and job satisfaction. Further research to understand the effects of bullying on physical and mental wellbeing, job satisfaction, disillusionment and job retention in Aotearoa New Zealand veterinary nurses is, therefore, recommended.

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A small-N study of body weight during free-feeding in the brushtail possum (*Trichosurus vulpecula*)

Kristie E. Cameron, Lewis A. Bizo and Nicola J. Starkey

Abstract

Animals in captivity can develop physiological characteristics such as obesity that could negatively affect their health. In the captive brushtail possum (*Trichosurus vulpecula*), it is unknown what effect long-term free-feeding has on body weight. In this study, which took place over 12 months, three possums were fed according to a free-feeding regime. Food intake was measured daily, and the possums were weighed every four days. The possums all gained weight but showed bouts of stable body weights across the year. Stability was evaluated using mathematical models. It was concluded that long-term free-feeding is not recommended for animals-in-waiting for use in operant experiments to mitigate weight gain due to overeating.

Keywords

Brushtail possum, *Trichosurus vulpecula*, free-feeding, captive animals

Background

Captive animals on farms, in zoos and laboratories with relatively small enclosures and barren environments can develop physiological conditions such as obesity that negatively affect their health and welfare (Dawkins, 2004; Rooney et al., 2014). For this reason, laboratory guidelines, such as those for rodents and rabbits, indicate that animals should have enriching environments; that is, housing (and husbandry) that increase natural behaviour and improve animal welfare (National Research Council, 2011; Ratuski & Weary, 2022). Various studies have investigated the use and effects of natural environmental stimulation in laboratory animals such as mice and rats (Ratuski & Weary, 2022), and in zoo animals such as primates (Brent 1995; Nelson & Mandrell, 2005). The latter animals are heavier in captivity than in the wild (Leigh, 1994), due to an abundance of food sources (Swaisgood et al., 2005), or treats given without consideration for nutrition obtained in the daily ration and in enrichment programmes promoting foraging, which are not always measured (Coleman & Novak, 2017; Pierre et al., 2020).

The brushtail possum (*Trichosurus vulpecula*) is a pest species in Aotearoa New Zealand that negatively affects agriculture and indigenous flora and fauna. Pest management is required to kerb the prolific population because of abundant food availability and a lack of predation (Brockerhoff et al., 2010). It is for these reasons that researchers keep captive colonies of possums to investigate their feeding behaviours (Cameron et al., 2013; 2015a; 2016), and psychophysical (Cameron et al., 2015b; Bron et al., 2003) and cognitive abilities (Clarke et al., 2022), as well as methods for eradicating the pest species (McGlone et al., 2014). As a laboratory animal, the possum should receive the same welfare considerations as the typical traditional laboratory rat or mouse (Ator, 2004). However, providing enrichment to the brushtail possum, a large mammal with similar tractability to a feral cat, is difficult in an experimental setting where the dual-purpose cage functions as the home and experimental chamber. The door functions as the operant panel. Stimulation often relies on food variety, a nest box, a possum companion next door (although possums do not live in social groups in the wild and have a dominance hierarchy) (Spurr & Jolly 1999), and an ability to climb from the bottom of the cage to the top of the cage to pull leaves through the holes, albeit a short vertical distance (Signal et al., 2005).

The University of Waikato's Learning, Behaviour and Welfare Research Unit maintained a colony of possums for 20 years. For most of this time, adult possums were used as subjects in operant experiments and kept on food-restricted diets (Signal et al., 2005). It was not known, however, how *ad libitum* food regimes and long-term captivity affect possum body weights and whether seasonal variation in body weight observed in the wild occurs in the laboratory.

A longitudinal field study measuring population health and growth in two locations within the Orongorongo

Valley near Te Whanganui-a-Tara Wellington found seasonal variation in possum body weights (Bell, 1981). Female body weights changed substantially by season, with peak body weights occurring in autumn (Location A) and winter (Location B), with the lowest body weights in winter (with no young) and summer for possums rearing young (Location A), and spring (Location B). This difference was attributed to the variations between the two areas, such as the availability of food (Bell, 1981).

Animals in captivity, such as laboratory or zoo animals, are provided with nutrition appropriate for their species and provided environmental enrichment to allow for behaviours observed in the wild, such as foraging (Newberry, 1995). This has resulted in weight gain in rats (*Rattus norvegicus*) housed in a semi-barren laboratory environment (Johnson et al., 2004), due to overuse of a foraging device and possibly a lack of other stimulation. In addition, zoo animals such as Sclater's lemur (*Eulemur macaco*; physiologically similar in size to the possum), provided with *ad libitum* food as enrichment, rather than encouraged to forage, became lethargic and inactive (Goodchild & Schwitzer, 2008).

The present study used a small number of animals to limit the negative impact of our feed regime on the health and welfare of possums in the colony. To examine the effect of free-feeding on body weight, the food intake and body weights of three captive free-fed brushtail possums were monitored over 12 months. It was expected that the possums would initially gain weight, but show bouts of stable body weight throughout the free-feeding regime and possibly some seasonal variation in their weights.

Method

Three wild-caught brushtail possums (two females, P21 and P22, and one male, P23) aged between 2 and 9 years had been housed in captivity for 2–8 years. Possums were housed in custom-built individual wire-netting cages (540 mm wide x 1050 mm high x 470-mm deep) with a nest box on top and a thick branch from the surrounding forested area to rub and scent mark. The possums also used it to jump and climb up to their nest box. The rooms were in a 12:12 h reversed dark/light cycle beginning at 0930 h. Cleaning and maintenance occurred during the light rotation. The possums had constant access to water. Possums received a minimum of 200 g of each food type: dock (*Rumex obtusifolius*) (placed on top of the cage to be pulled through the bars), apple, and specially made low-calcium possum pellets (Camtech Manufacturing Ltd) in a food tray at 1030 h each day. At 0800 h each morning, any leftover food was weighed. To balance wastage with constant food availability, the daily ration of each food type was then increased if less than 50 g or decreased if more than 100 g was left when the foods were replenished. Ethics approval was obtained from the University of Waikato Animal Ethics Committee (Protocol 865).

Possums were weighed every four days as per Cameron et al. (2014). The procedure involved carrying the possums in a metal carry cage from their home cage to a scale before returning them to their home cage, where they received their daily food ration.

The data was analysed using a mathematical model (Killeen, 1978) and using the methodology from Cameron

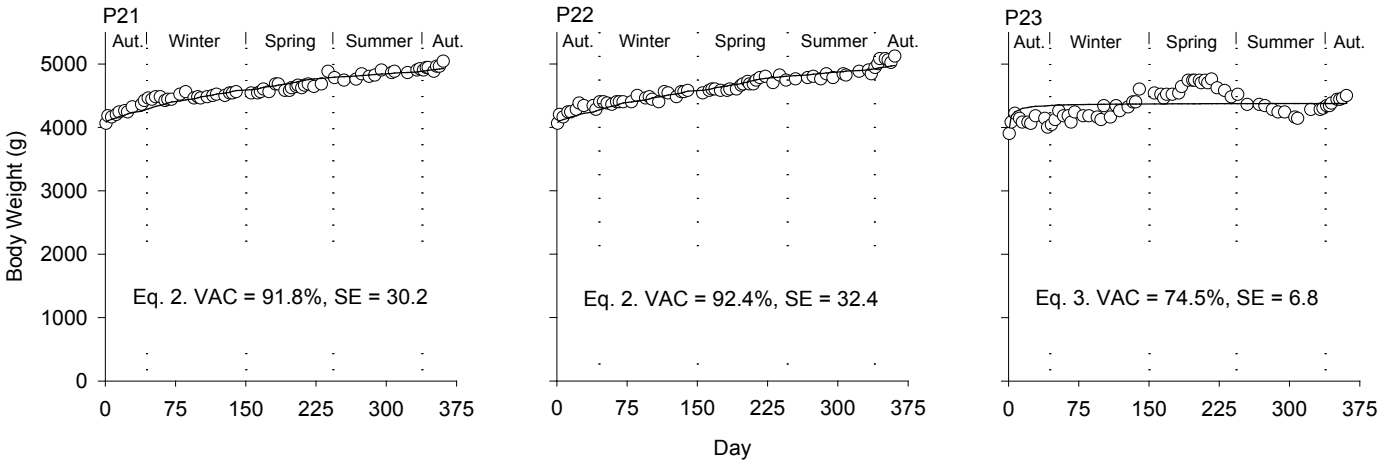

Figure 1. Bodyweight (g) of P21, P22, P23 across days and season (Aut. = Autumn; VAC = variance accounted for; SE = standard error of the mean).

et al. (2014) in which stability was based upon no more than three consecutive increases or decreases in weight within 2.5% of the previous weight. The 5% variation was used because it is a usual increment of the common 85% free-feeding body-weight model (Signal et al., 2005) and because it ensured a sensitive measure to body-weight change.

Result

All three possums gained weight during the 12 months (Figure 1). Food intake fluctuated daily, with average daily difference in food eaten varying across possums: P21 (M = 57.5 g, σ = 52.2 g); P22 (M = 73.3 g, σ = 63.0 g); and P23 (M = 105.4 g, σ = 91.7 g). P23 (the male) had the highest and most varied daily food intake and the greatest fluctuation in body weight.

A mathematical model used to estimate when response-rate curves were stable was applied to the body-weight data to identify when the weights were mathematically stable. The following equations were used to model termination points in the stability of response rates in pigeons (Killeen, 1978). Equation 1 has two parameters (J = number of days and C = a time constant derived by the model that describes rate), R is the predicted body weight and dependent variable, and A is the asymptote or point of stability. Equation 2 includes a parameter where the dependent variable's starting point does not have to be zero. Equation 3 has been used to estimate body weights in possums (Cameron et al., 2014):

$$R = A(1 - e^{-\frac{J}{C}}), \quad (1)$$

$$R = A(1 - e^{-\frac{J}{C}}) + x, \quad (2)$$

$$R = \frac{A.J}{C + J}. \quad (3)$$

Non-linear least squares regression determined the best fits of the equation to the data (see Figure 1). Equation 2 approximated the body weights of P21 and P22 well (VAC = 92.1%). Equations 1 and 3 were poor fits to body weights for P21 and P22 (M = 45.1%, σ =11.2). The derived asymptotes predicted that 99% of body weights would reach a stable value after approximately 299 weighing sessions. Equation 3 approximated the bodyweight of P23 moderately well (the variance accounted for was 74.5%); however, this indicated that stability was reached in 0.5 weigh sessions, which is not accurate looking at Figure 1. Equations 1 and 2 were poor fits to body weights for P23 (M = 23.3%, σ =26.2).

Across weigh sessions, most body weights of P21 and P22 were within 2.5% of the previous weights. This indicates that there were bouts of stability during the 12 months, but overall body weight continued to increase. For P23, there were fewer bouts of stability compared to the other possums, with the most extended bout between 140 and 210 days.

Discussion

The measurement of possum body-weights over 12 months on a free-feeding regime suggests that possums will continue to gain weight with short bouts of stability. There was no indication that the possum body weights in captivity for the two female possums were related to the season, as is previously reported for wild possums (Bell, 1981). The third possum had some variation across seasons, being heaviest in spring. The artificial environment and controlled lighting conditions in the room in which the possums were housed likely attributed to the differences in weight (at least for the male possum) across seasons.

This short communication indicates that long-term captivity under free-feeding leads to weight gain and possibly 'obesity' in laboratory possums. We say this with caution as 'obesity' in possums has not been categorised by a body-weight condition paradigm due to a lack of physiological information, including what 'normal' might look like in a possum. This means that to maintain healthy animals in the laboratory, researchers will need to be aware of the propensity of possums to gain weight on free-feeding regimes long term, especially when housed singly and in small operant cages. Also, keeping animals for future experiments could adversely affect their body weight and possibly health, if being overweight as a possum leads to the same health issues as in dogs and cats, such as diabetes or heart problems (Grazian, 2015); and could present risks to welfare in captive animals where they cannot perform natural behaviour (Dawkins, 2004; Rooney et al., 2014).

Whether eating is likely to function as enrichment or as a source of stimulation in an otherwise impoverished

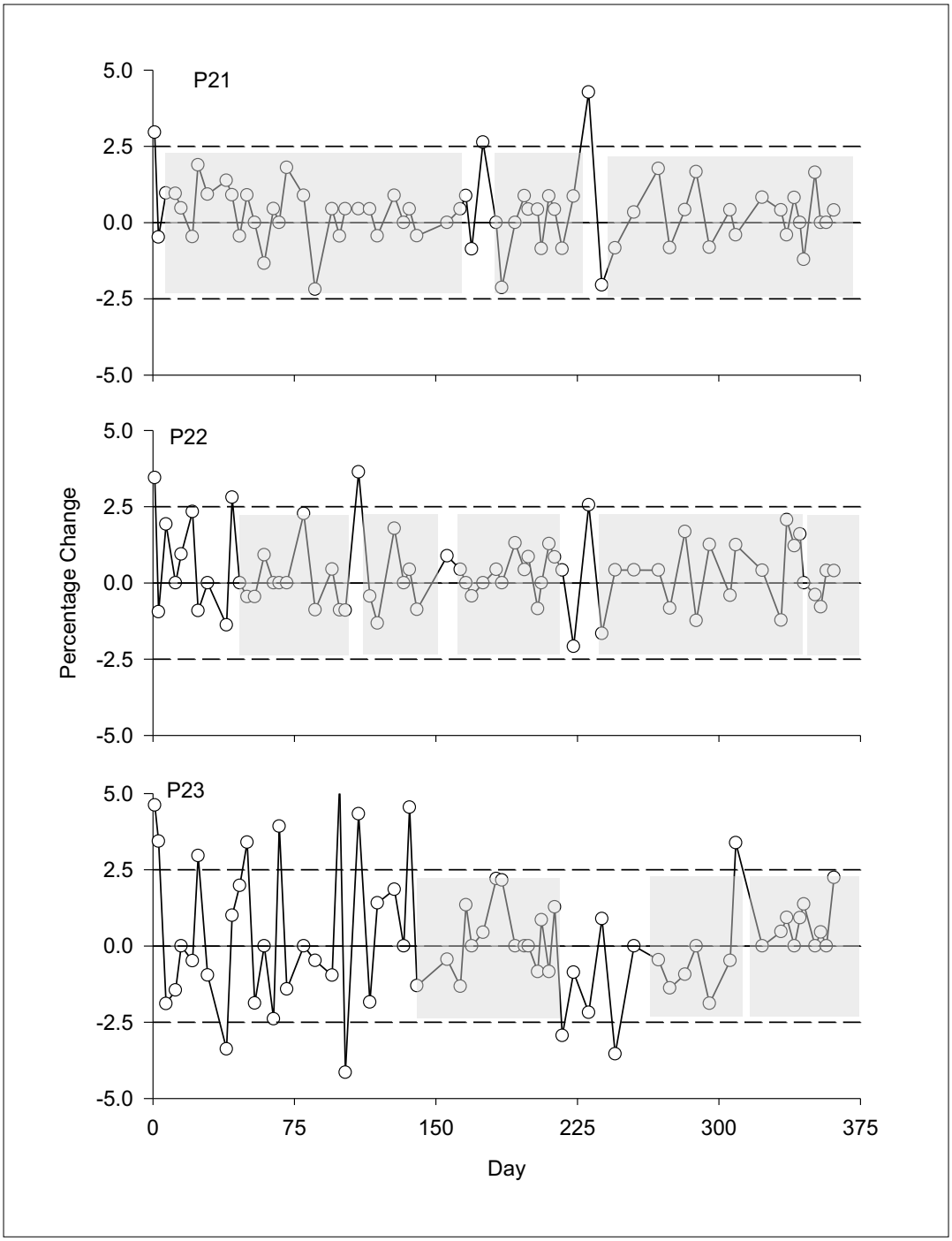

Figure 2. Percentage change in body weight between weigh days. The dashed lines represent ±2.5% change from the previous weight. The grey bands indicate bouts of stability.

environment is presumptuous to propose as the sole factor of increased body weight. Animals in captivity, however, that experience prolonged periods of inactivity (Rooney et al., 20014) and a reduction in environmental complexity, including the need to forage with food easily obtained, gained weight (Brent, 1995; Goodchild & Schwitzer, 2008). Laboratory possums 'in-waiting' should be kept on a restricted diet delivered via an enhanced feeding scheme where animals need to earn food by interacting with a stimulus but also not obtain food too easily. An outdoor colony system would need to be large, to accommodate each possum's need for territory and to ensure foraging and feeding opportunities for all animals (Spurr & Jolly, 1999). Individual systems with a threshold for difficulty would need to be trialled, as possums are opportunistic (Cameron et al., 2013) and will give up if the effort required to obtain food is too great for a food of low value (Cameron et al., 2015, 2016).

In conclusion, long-term free-feeding may put the health of captive possums at risk, as they are likely to

continue to gain weight. Therefore, careful planning and monitoring is needed to balance the nutritional requirement and ability for possums to maintain their health and welfare by performing naturalistic behaviour such as foraging to mitigate instances of overeating and weight gain in captivity or in artificial environments

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Author Instructions

Scope

Perspectives in Animal Health and Welfare is a multi-disciplinary electronic journal of research papers, and other outputs, covering all aspects of animal health and welfare, including, but not restricted to: animal diseases (including zoonotic diseases), parasites, nutrition, behaviour, anaesthesia and analgesia, breeding and reproduction, One Health and social sciences related to the animal industry.
The journal primarily publishes:

- Research papers of 2,000 to 5,000 words
- Short notes of 1,000 to 2,000 words
- Reviews of 5,000 to 7,000 words
- Case studies of 2,000 to 5,000 words

Due to the multi-disciplinary nature of animal health and welfare, other output types, including creative and multimedia, may be considered at the discretion of the editors.

All papers and other outputs are subject to anonymous double-blind peer review prior to acceptance and publication. Accepted manuscripts requiring revision must be returned within two months of the date of the request for revision. Manuscripts received after this date will be considered as new submissions. Papers are published online after acceptance and all corrections have been made.

Manuscript submission

Manuscripts should be submitted as Microsoft Word documents to epress@unitec.ac.nz with Perspectives in Animal Health and Welfare in the subject field. All documents must be:

- In English
- Double spaced
- Pages and lines numbered continuously

Please confirm in your submission that:

- All authors have approved the submission
- All relevant animal and/or human welfare permissions have been obtained (i.e. animal and/or human ethics approval)
- All graphic imagery permissions have been attained and appropriately attributed to the source
- Contact ePress at epress@unitec.ac.nz if you wish to submit files that cannot be emailed due to size.

Style of papers

Papers must use SI units, UK English and the appropriate macrons in Māori (please visit http://www.maoridictionary.co.nz/ for guidance on using macrons in Māori words).

Research papers and short notes are to include the following elements:

- Title: Informative and concise description of the content of the paper.
- Authors: Include the names of all authors who have had a significant role in the research. Include the addresses of all authors and the email address of the corresponding author/s.
- Abstract: A summary of the main findings of the paper (up to 300 words).
- Key words: Up to ten key words.
- Text: The main headings will normally be: Introduction, Materials and Methods, Results, and Discussion. It is permitted to have a combined Results and Discussion section.
- Acknowledgements: Acknowledge all those who provided significant assistance to the research, sources of funding, details of Animal Ethics approvals, permit numbers and landowner approvals for research and/or specimen collection.
- Conflict of interest: Authors must state any relationships or interests that may inappropriately influence or bias their work. Conflict of interest may include employment, grants, honoraria, part or full ownership of an entity related to the work, personal and/or professional relationships. Any conflicts of interest should be stated before the References list.
- References: Use APA 7th. Please ensure all citations and references are accurately formatted, and all references have a relevant DOI or URL where

available. It is the authors' responsibility to maintain accurate and up-to-date referencing and citations. Contact ePress if you require further instruction.

- Tables: Each table should be on a separate page after the Reference section, numbered with Arabic numerals, in the same order as they are referred to in the text of the paper, and with a short title at the top. Please do not use vertical lines. Horizontal lines should only be used at the top and bottom of the table and between the headings and the body of the table.
- Figures: These can be photographs, line drawings, maps or graphs, and must be submitted initially on separate pages, and numbered to follow their order they appear in the text. Figures must be clear and easy to interpret. Colour figures are accepted as this is an online publication. Figure legends should be presented after the references in the initial submission. Reviews and other output types will follow some of the above conventions, but due to their nature, there will be some differences. All figures must be supplied electronically as separate .jpg files, as large as possible.

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Process

Once you have submitted your work following the submission guidelines detailed above, you will be sent an email of receipt. Your work will then be viewed by the editorial team and you can expect to have a response within two to four working weeks. If the editorial team has decided to steer your work towards publication, it will undergo the double-blind review process, which can take up to three months. Reviewer feedback will be collated and sent to you.

Acceptance

Authors will be asked to email the revised manuscript (including any responses to referee comments) as a Microsoft Word document within two months of receiving an acceptance email. Page proofs will be sent by email to authors for approval and papers will appear online as they are approved.