

Article

## What's in a Dog's Breakfast? Considering the Social, Veterinary and Environmental Implications of Feeding Food Scraps to Pets Using Three Australian Surveys

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**Abstract:** Diverting food waste away from landfills is one way to minimise its serious environmental impact. Given that over a third of Australian households have at least one pet, the feeding of food waste to dogs constitutes one potentially significant waste diversion path. However, the proportion of dog owners that feed food waste to their pets is unknown. Moreover, there has been no investigation into any relationship between practices of feeding scraps to pets and the animals' body condition, living arrangements (inside or outside) and exercise regime. To provide some insight, this paper presents findings from three surveys across two Australian studies. The first reports both pet and dog-specific findings from two surveys within a wider food waste research project ( $n = 1017$ ), establishing that 28% of respondents fed leftovers to pets as a main food waste minimization strategy, yet in only 5% of households did this constitute more than half of the household's food scraps. This modest diversion of

food scraps from landfill to feeding pets was reflected in the finding that there was no significant difference seen in the claimed level of food discards to the waste stream for households feeding food scraps to dogs and those that did not. The second—a dog owner specific study ( $n = 355$ )—found that almost half (44%) of respondents reported feeding table scraps to dogs. They were more likely to be females, owners of medium sized dogs, and in larger households. There was no significant difference in self-rated dogs' body condition scores between respondents who fed table scraps to their dog and those who did not. Further multidisciplinary research is recommended to reconcile the social, veterinary and environmental risks and benefits of feeding food waste to animals.

**Keywords:** pets; livestock; livestock; companion animals; dogs; food waste; leftovers; informal waste stream; domestic; household; sustainability; waste management

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## 1. Introduction

Whilst food security is of increasing global concern, so too are issues of food waste. It is estimated that up to a quarter of food brought into the home is subsequently discarded uneaten [1], representing a significant waste of environmental and economic resources [2–4]. When meat is wasted, this represents a concomitant waste of animal life. Approximately 16% of Australian household food waste is animal meat [3].

Food waste occurs across the food supply chain, from “paddock to plate”. This is mirrored to some extent in the domestic sphere, where food waste can occur at key stages related to the purchase, preparation, consumption and disposal of products intended for human consumption [5].

Councils, waste collectors and recyclers routinely collect data on the quantity and composition of household waste, including household organics. However, these metrics are limited to formal waste disposal streams. A number of informal waste disposal streams are also used in households. Reynolds and colleagues detailed and estimated five informal food waste disposal streams used in Australian households: home composting, sewer disposal, giving to charity, dumping or incineration, and feeding scraps to pets [6]. Together, these streams represented 20% of Australian household food waste flows [7]. The amount of food waste redirected to pet alimentation by the average Australian household was estimated at 200 grams per week. If sent to landfill, this additional food waste would generate approximately 60,000 tonnes of greenhouse gasses every year [8].

The redirection of food intended for human consumption to pet alimentation has occurred since humans began domesticating animals around 10,000 years ago [9]. As a supplement to their main food sources, scraps have been fed to animals to support their production of meat, eggs, milk, wool and transport for human benefit [10]. In post-medieval Britain for example, “almost every family kept a sty pig that was fattened on household scraps and then recycled as ham, pork, bacon and dripping” [9]. However, not all human societies fed animals their food scraps as a deliberate act. In some cases, humans simply tolerated animals that have taken advantage of excess human food. For instance, Egyptian artwork depicts cats poised under chairs, often eating from bowls or feeding on scraps [11]. However, cats really started making themselves at home around human settlements during the rise of agriculture. Darwin [12]

noted 200 years ago that domestic cats have longer intestines than wildcats, a trait he attributed to them as an adaptation to being fed on kitchen scraps.

Indigenous Australians maintained populations of dingoes (and later dogs) for companionship, security, hunting assistants (in select cases), play objects, and for spiritual purposes [13]. These dogs were occasionally given food intended for humans, but this was usually when there was excess (note, the ability to store food was limited), and typically reserved for the dogs considered “favourites”. These canids provided the added benefit of acting as campsite cleaners, with both dingoes and dogs constantly scavenging around camp for food scraps and human faeces (that contain potentially harmful pathogens). Some consider this scavenging behaviour to have been essential in maintaining a sanitary and clean site, extending the period that humans could remain in a specific location [14–17]. Although domestic animals can benefit from being fed (arguably more consistently than they would in the wild), in the majority of the scenarios presented here, food and food scraps given to animals were always low in quality, and competition amongst the animals high [9]. In the case of Indigenous Australian cultures for instance, dogs were often in poor physical condition [13], and there was a never-ending battle for food [18].

There are potential benefits of re-routing food waste from landfill to pet food, especially relevant at a commercial level in relation primarily to the economic benefits of producing additional products with “waste” and/or negating the costs of waste disposal. However, the risk of zoonoses is significant, with examples such as bovine spongiform encephalopathy [19]. The BSE epidemic in the UK was caused by the feeding of recycled and processed waste products of cattle, some of which were infected with BSE, to other cattle [20]. The difficulties in responding to BSE involved the complex interrelationships between animal feed and cattle production, slaughter and meat processing, together with the rendering of inedible offal and international trade in animal products [19]. A UK ban on feeding ruminant protein to ruminants in 1988 resulted in a delayed decline in new cases by 1992, due to the long incubation period of the disease [20]. It is also illegal in most countries to feed food waste to pigs due to the risk of disease transmission; for example, pig industry experts in Australia considered the risk of spread of infectious diseases from south-east Asia to be mostly related to disposal of food waste [21]. In a review, Sapkota *et al.* [22] discussed the risks due to presence of bacteria, antibiotic-resistant bacteria, prions, arsenicals, and dioxins in feed and animal-based food products, and concluded there are insufficient surveillance systems to monitor these risks [22].

Benefits and risks also apply to the practice of feeding scraps to pets in domestic spheres. Environmental benefits may arise from redirecting food scraps from landfill to pets, especially when the feeding of scraps leads to a concomitant reduction in the purchase of other feed. At the same time, there may be risks of obesity, toxicity or other poor animal health outcomes [22,23].

In general, the pathway from “paddock to pet” or “paddock to plate-licker” takes two forms according to the intention of the ingredients at point of preparation. The most widely accepted is the billion-dollar pet food industry based on ingredients originally intended for pet consumption and subject to rigorous market research. The other form is food originally intended for human consumption. Whilst the former is considered preferential for pets, the latter could be preferential for the environment. However, little research has considered the implications of the redirection of food waste to pet alimentation. This paper considers the social, veterinary and environmental implications of feeding food to animals that was originally intended for human consumption. These complex issues are explored empirically in relation to dogs.

*Food Waste and Dogs*

Over one third of Australian households own a dog [24]. As omnivores, dogs—more than cats—are the recipients of household scraps. Dogs and humans have shared their living spaces for thousands of years, developing complex patterns of biological and behavioural interactions. The grey wolf that was the progenitor of the domesticated dog probably began to live close to human settlements in order to scavenge for food [25]. Today's domestic dog relies almost entirely on humans for food. The first commercial dog food was a dog biscuit, produced and sold in 1860 [26]. In 2009, Australian dog owners were estimated to spend over 1.1 billion dollars on pet food and increasing, consistent with increases in both the US and the UK [24], and mirroring the movement of dogs into our hearts, houses, and families. We involve dogs in all basic human activities. We sleep with them [27], we eat with them, and sometimes we cook for them [28].

Dog owners have basically two options for feeding: a homemade diet, commercial food or a combination. Commercial pet foods may be dry, wet or semi-moist [29]. To cater to a wide range of customers (where customers are dogs as well as their owners), a variety of commercial foods have been developed, using natural and organic foods, raw food diets and vegetarian products. Commercially prepared foods compared with homemade foods offer convenience, consistency, reasonable assurance of quality and nutritional balance, plus potential cost savings [30]. In the US and Australia, non-commercial foods, which included table scraps, are fed to 30% of dogs [31]. Practices may differ between working or rural dogs and household pets. For example, a study of working farm dogs in New Zealand found the most common diet fed was a combination of dry food and “home kill”, which was fed by 328/542 (61%) of owners during peak and 313/542 (58%) during off-peak periods of work [32].

While it was estimated in 2004 in the US that most dogs received 90% of their nutrition or more from commercial foods [30], confidence in commercial pet foods was shaken in 2007 when widespread contamination with melamine in commercial pet foods in the US led to many deaths due to acute renal failure [33]. In an exposé of how this crisis was mishandled, Nestle highlights how many different pet labels from cheap to expensive brands were all produced in the same factory, a fact most consumers would have been unaware of if not for the need to recall the affected brands [33]. This may have resulted in more dog owners using homemade diets, although data on the feeding practices of dog owners is lacking. Stockman and Kass [34] reviewed two hundred recipes for homemade diet from 34 sources, and concluded that few contained all of the essential nutrients at sufficient concentrations [34]. While raw food diets have become increasingly popular and there is a growing number of pet food cook books [35], the lack of evidence and consensus on what is best to feed dogs makes it difficult even for veterinarians to make informed feeding recommendations to owners [36].

As well as providing dogs with the nutritional requirements to grow and remain healthy, feeding practices also express different kinds of relationship with a co-habiting species. This is reinforced by sociological studies that have determined that human feeding practices are symbolic of relations of reciprocity, care and love [37,38]. However, kindness can kill and in some cases, humans are responsible for obesity in dogs. In Australia, the prevalence of overweight and obesity in dogs is estimated at 41% [39]. Obesity is associated with a persistent low-grade inflammation and increased oxidative stress, which is thought to have a role in chronic diseases such as osteoarthritis, cardiovascular disease, and diabetes mellitus [40]. Generally, obesity is associated with increased morbidity, and early mortality [41]. Many

owners of overweight companion animals treat their pet more like a human than as a typical companion animal, and as such have a strong bond with their pet [23]. Owners who share a strong bond may be less likely to perceive their pet as overweight or obese [42]. Indeed, one study found that owners who fed more table scraps had overweight dogs [43]. Regardless of body condition, 59% of dogs received table scraps, which constituted 21% of daily caloric intake. The nutrient density of scraps fed was variable and did not meet the National Research Council's recommendations for micronutrient adequacy. Feeding high fat table scraps to dogs may also put them at risk of pancreatitis, with a study of risk factors for canine pancreatitis in the United States reporting dogs that ingested table scraps the week before diagnosis (OR, 2.2) or throughout life (OR, 2.2) had increased odds of having pancreatitis [44].

While there is some information relating to the feeding of table scraps to dogs, there is little understanding of the proportion of owners feeding food waste to their pets, their demographics, their decision-making processes, household composition, and the types of dogs more likely to be fed food scraps. In particular, there has been no investigation into any relationship between practices of feeding scraps to pets and the animals' body condition, living arrangements (inside or outside) and exercise regimes. However, this information is essential to the success of environmental or public health campaigns designed to optimise the practice of feeding food waste to pets.

This paper reports on two studies. The first marketing study reports pet feeding practices from a wider food waste research project, establishing some early findings for the feeding of food waste to dogs and pets more generally. The second veterinary study focuses explicitly on dog owners and addresses the role of table scraps in dog feeding and to the dog's health. Together, the two studies synthesise information that enables a consideration of the environmental considerations of feeding food scraps to pets.

## **2. Study 1: Food Waste and Pets**

This study examines the incidence of feeding food scraps to pets in general and to dogs specifically. It profiles the household of those using this as an additional food waste diversion stream and estimates how much discarded food is fed to pets or animals.

### *2.1. Data and Method*

The first study comprises two surveys aiming to establish the incidence of food waste behaviours and attitudes across households. The first survey was conducted by telephone and the second used two pre-established online panels of householders in Adelaide, a major metropolitan city of Australia. The research covered a broad range of food waste issues pertaining to householders, without delving into any single issue in great depth. Both surveys included questions on the practice of feeding food scraps to pets.

For the telephone survey, 401 householders were randomly recruited across metropolitan and regional areas of South Australia. Screening questions were used to ensure that all participants had some responsibility for either household food shopping or food preparation, because of the relevance of these activities to the creation and management of food waste. The data was broadly representative of the general South Australian population.

The online Community Panels of householders within two large metropolitan council areas in South Australia were used for the second survey. In total, 616 completed surveys were collected. All panel

members were invited to participate, however, screening questions were again used to ensure that respondents had some responsibility for either the food shopping or food preparation in their household. Of eligible respondents, 87% completed the questionnaire. The panels had been validated prior to the food waste research for being representative of their respective council populations both demographically and in terms of key attitudes and behaviours. These data are also broadly reflective of the general metropolitan population of householders.

All data was analysed using SPSS 21, with descriptive statistics, such as frequencies and means, being primarily used to address the research questions. Multivariate analyses of cross tabulations were used for the analyses.

## 2.2. Results and Discussion

### 2.2.1. Respondents, Pet Ownership and Pet Feeding Practices

In the telephone survey, 66% of respondents reported owning a pet. Dog owners comprised 46% of respondents ( $n = 186$ ), with the main others being cats (25% of all respondents), birds (12%) and fish (8%). Pet owners were more likely to be regionally based (34% vs. 23%,  $p = 0.02$ ), over 65 years of age (38% cf. 16%,  $p < 0.00$ ) in single person households with no children (18% cf. 8%,  $p < 0.00$ ). Children were also more likely to be present in households with pets (46% cf. 28%,  $p < 0.00$ ) and consequently the households were larger (33% four or more in the household cf. 16%,  $p < 0.00$ ). The online survey did not include a specific question identifying pet ownership, but instead measured food scrap diversion to feeding pets.

Pet owners fed their pets commercial food in 66% of cases, made their own in 6% and provided a combination in the remaining 28%. This indicates that food made for pets from the household's own supplies occurred in a third of households with pets. Dogs more than cats were found to be the recipient of food scraps (20% cats cf. 40% dogs,  $p = 0.03$ ).

### 2.2.2. Dog Feeding Practices

Amongst dog owning households, 59% reported feeding their dog solely on commercial food, 7% made their own food on which their dog was exclusively fed, while the remaining 33% used a mix of commercial and own food. The 40% of respondents feeding their own food (including both table scraps and food bought specifically to make animal food) is more consistent with the 30% reported by Laflamme [31] than the 59% reported by Heuberger *et al.* [43].

The 7% of dog owners producing their own dog food were profiled to see if they differed from those using commercial food demographically and in terms of other food waste behaviours. Those feeding their dogs with their own food were no more likely to be a "Committed Food Waste Reducer" (a metric developed by WRAP UK and defined by claimed low levels of food discards coupled with strong feelings of concern for what little they did discard) than those who bought commercial food. That is, differences in the practices of feeding food discards to dogs did not appear to impact the overall level of household food discards.

Respondents in regional areas were suspected to be more likely to make their own pet food as the options to buy commercial food are fewer and the access to own-kill meats greater. However, this was

not supported by the data. This is in contrast to the prior findings of Singh [32] that regionally located households had greater reliance on non-commercial food sources, especially own-kill, for their dogs. The difference may be explained, by the current study's inclusion of domestic pet dogs as well as working dogs whereas Singh's study was restricted to just working dogs.

An unanticipated finding was that when the respondents were examined according to what they fed their dog (own food, commercial or mix), there was no difference in the mean claimed cups of discarded food by that household, on a per person basis. It is reasonable to expect that if food scraps are being diverted to pets then the discard levels amongst these "own food" households would be lower than in those households that use commercial food exclusively or as at least a part of their pet's diet.

This finding could be explained by the claimed rather than objective discard food measure used in the study. Alternatively, those making their own food for pets may not necessarily use food scraps diverted from the waste streams. This would seem to suggest that food waste is not avoided by the presence of pets and the making of pet food in the home. This explanation is supported by the finding that almost half of all of the dog owners (46%) considered feeding food scraps to their pets as a key strategy to minimise food waste supports. Moreover, this suggests at least an attitudinal link amongst these dog owners to feeding scraps to pets and food waste prevention, rather than making food for the dog using non-discarded food sources. However, the majority of dog owners who fed scraps to avoid waste (70%) also said they used commercial food for their dog as opposed to making their own, or using a mix of own and commercial food. It appears that food waste diversion is still a minority behaviour in terms of the dogs' overall dietary requirements. This supports prior findings that food scraps still constitute a minority of calorie intake for most dogs being feed table scraps [30]. More insight into this issue is provided by results from the online survey.

Questions about pets in the online survey were fewer and more focussed on food waste. For instance, respondents were asked about "food scraps" rather than "own food". In the online survey, 28% of all respondents claimed to feed leftovers to pets. This is similar to the estimated 30% of "table scraps" found in Laflamme and colleagues' study (2008).

Again, a significant proportion of respondents (33% of all online respondents, without pre-screening for declared pet ownership) stated that feeding scraps to pets was one of their main food waste minimisation strategies. To obtain a measure of food scrap quantities diverted to pets, respondents were provided with a list of possible disposal outlets for their food discards, and asked to approximate the proportion of their food discards that were generally directed to each outlet. Possible responses for outlet types were: the garbage bin, compost bin or heap, bio basket system/green organics bin, worm farm, food digester, and feeding animals or pets. While 43% claimed they fed scraps to pets or animals to some extent, few did so with more than half of their food waste. Many (26%) disposed of a quarter or less of their food scraps in this way (Table 1).

**Table 1.** Participant estimates of how much discarded food is fed to pets or animals.

<b>Discarded</b>	<b>n</b>	<b>%</b>
None	311	57
Up to 10%	86	16
11%–25%	57	10
26%–50%	57	10
51%–75%	12	2
76%–90%	13	2
91% or more	7	1
Total N	543	100
Average %	12	
Standard Dev.	22	

Few households (5%) disposed of more than half their food scraps to animals or pets.

In conclusion, Study 1 established the incidence of feeding pets, and specifically dogs, food that is made in the home and specifically food scraps. It also confirms prior findings that the feeding of food scraps accounts for only a small proportion of the animals' total diet. It is unsurprising then that the overall reported levels of food scraps entering the waste stream do not differ significantly from households giving food scraps to dogs than other households.

### 3. Study 2: Food Waste and Dogs

#### 3.1. Data and Method

A mixed-methods research project was conducted to understand the dog feeding practices of owners in South Australia. Following approval from the Human Research Ethics Committee at the University of Adelaide, a questionnaire on dog feeding practices was promoted via Facebook, email, vet clinics and multiple newsletters in Adelaide, South Australia, between June and August 2010. The questionnaire comprised 25 questions and was based on a survey developed by Bland, Guthrie-Jones, Taylor and Hill [45].

Respondents were asked to complete an additional questionnaire for each dog they owned, but only 13 per cent of respondents with two or more dogs did so (*i.e.*, 6% of the cases in the total sample are for the same respondents but different dogs). The following descriptions are based on unique respondents rather than the total number of cases.

The data were analysed using SPSS Version 22 with standard parametric and non-parametric tests as appropriate to the measurement level of the variables of interest.

#### 3.2. Results and Discussion

##### 3.2.1. Respondents and Their Dogs

There were 355 responses to the questionnaire. Three quarters (76%) were female, so the analyses have been weighted by gender. Their average age was 36 years; the age distribution is shown in Table 2. Most (78%) lived in urban areas, with 4% and 18% living in peri urban and rural areas, consistent with the geographic distribution of the general population in South Australia and Australia in general ([46] Census). Almost all (93%) respondents resided in South Australia, with the remaining cases distributed

evenly between the more populous states of New South Wales, Victoria, Queensland and four in Western Australia. Just under two thirds (63%) of the sample had one dog, 30% had two and 8% had three or more. This approximates the distribution of dog ownership reported by The Dog and Cat Management Board, a statutory body reporting on the status of dog and cat management in South Australia [47].

**Table 2.** Respondent age distribution.

Age group	N	%
18–25	132	38
26–35	56	16
36–45	50	15
46–60	93	27
61+	16	5
Total	347	100.0

The average age of the dogs was 6 years, ranging between 1 and 17 with a standard deviation of 3.8. Most (83%) were de-sexed although males were more likely to be entire—see Table 3. Again, these figures closely match those reported more generally reported for dog owners [47].

**Table 3.** Sex of dogs.

Sex	N	%
Female—entire	25	7
Female—desexed	169	46
Male—entire	36	10
Male—desexed	134	37
Not stated	2	6
Total	367	100

Dog breeds reported by owners were categorised by size and typical energy level, both on scales of 1 to 3 by five independent raters with professional experience with a range of breeds. The raters included two small animal veterinarians, three dog trainers, and two other animal professionals (Table 4). Inter rater reliability was very high for dog size with most correlations in the matrix exceeding  $r = 0.8$  (and the rest exceeding  $r = 0.7$ ), all  $p$  values  $<0.001$ . Inter rater reliability was not as strong for activity or energy levels typical for the breed with correlations between the raters' scores ranging from  $r = 0.3$  to  $r = 0.7$ , all  $p$  values still less than 0.01. The highest correlations were between one of the veterinarians and the dog trainer and the lowest between the other veterinarian and one of the animal professionals.

Examples of breeds classified as small included Jack Russell Terriers, Maltese and whippets. Medium size breeds included kelpies, Labradors and beagles. Large breeds included Rottweilers, German Shepherds and Greyhounds. Low energy breeds included King Charles Cavalier spaniels, Greyhounds and Basset Hounds. Medium energy breeds included beagles, Dalmatians and Labradors. High energy breeds included Kelpies, Border Collies and Jack Russell Terriers.

**Table 4.** Size distribution and typical energy levels of breeds in sample.

Size	N	%
Small	126	34.5
Medium	159	43.6
Large	80	21.9
Total	365	100.0
Energy Level	N	%
Low energy/sedate	28	7.7
Average energy	241	66.0
High energy	96	26.3
Total	365	100.0

### 3.2.2. Prevalence of Feeding Table Scraps

When asked if they fed one or more of a range of foods including packaged dry food, raw meat or sausage, tinned food and home cooked food, just under half (44%) of respondents reported feeding their dogs “table scraps”. None fed table scraps only and only 7% nominated table scraps as part of their dog(s)’ main meals. Around one third (33%) of respondents reported using food when training. 14% gave their dogs some of their own food when eating. This rate could be influenced by response bias. Furthermore, it is unknown how many dogs were allowed inside, how often main meals were taken outside the home, which households allowed dogs to be in the vicinity of humans taking their meals and how the term “table scraps” may have been interpreted by respondents differently to the arguably more general term “food waste”.

### 3.2.3. Characteristics of Respondents Who Fed Table Scraps to Dogs

There was no difference between males and females in frequency of feeding table scraps (*i.e.*, as snacks, rewards or waste disposal). Two thirds of the 24 respondents who fed table scraps as part of regular meals were female but the difference was not statistically significant (Chi-square < 3.841,  $p = 0.12$ ).

There was no difference in the ages of respondents who fed scraps in general and those who did not (both were approximately 36 years old). The average (estimated) age of respondents who fed scraps as part of main meals was 40 years ( $n = 24$ ), compared to 36 years for those who did not ( $n = 323$ ), but the difference was not statistically significant ( $t = -1.394$ ,  $df = 27.5$ ,  $p = 0.174$ , equal variances not assumed).

Respondents who fed scraps as snacks or treats, rewards or waste disposal had significantly larger households than those who did not, (mean number of persons who fed the dog was 2.5 vs. 2.1,  $t = -3.67$ ,  $p < 0.001$ ) but there was no difference in household size between those who fed scraps as part of main meals and those who did not. Those who fed scraps had 2.23 persons feeding their dog(s) and those who did not feed scraps had 2.06 persons ( $t = 1.066$ ,  $df = 29.2$ ,  $p = 0.295$ , equal variances not assumed). The questionnaire did not elicit details on household composition, but given the ages of respondents it is likely that larger households have children who are more likely than adults to leave meals partially uneaten. This hypothesis is supported by the mean number of persons feeding the dog being larger for households with respondents aged 36–45 (the age group most likely to have school aged children who

are capable of feeding the dog) at 2.24 persons, compared to 2.08 for households with the respondents aged 46–60 and 1.65 for households with respondents aged over 60.

Those who did feed scraps as part of regular meals were less likely to have followed veterinary advice on feeding (37.1% of all respondents) than those who did not feed scraps (43.4%), but the difference was not statistically significant (Chi-square  $(0.362) < (3.841)$ ,  $p = 0.547$ ). There was no difference in source of feeding information between those who fed scraps as snacks, treats, rewards or waste disposal and those who did not.

Respondents who did feed scraps as part of their dog's main meals were more likely to use the dog's appearance as a feeding guide (77.1%,  $n = 19$ ) than those who did not (43.8%) but the difference was not statistically significant (Chi-square value  $(0.391) < 3.841$ ,  $p = 0.532$ ). They were also less likely to use dog food package information as a guide (22.9%) than those who did use the labelling information (31%) but again the difference was not statistically significant (observed Chi-square value  $(0.716) < (3.841)$ ,  $p = 0.397$ ).

Respondents who did not feed scraps were more likely to monitor their dog's weight than those who fed scraps as snacks. Those who fed scraps as part of main meals were much less likely than the other two groups to monitor their dog's weight (Table 5). Even with the small number of cases in the “scraps part of main meal group”, this difference was statistically significant (Chi-square value  $(10.44) > (5.991)$ ,  $p = 0.005$ ).

**Table 5.** Whether dog's weight is monitored by whether scraps are fed.

Do you Monitor your Dog's Weight?	Scraps Not Fed	Scraps as Snacks	Scraps as Part of Main Meal
Yes	75	70.7	42.9
No	25	29.3	57.1
	100	100	100
N	320	147	21

There was no difference in the number of dogs per respondent between those who fed table scraps as snacks, rewards or waste disposal and those who did not feed scraps at all. Respondents who fed scraps as part of main meals were slightly more likely to have more than one dog (mean = 1.54) than those who did not feed scraps (mean number of dogs = 1.48) but the difference was not statistically significant ( $t = -0.44$ ,  $df = 27.8$ ,  $p = 0.66$ , equal variances not assumed).

### 3.2.4. Characteristics of Dogs Fed Table Scraps

As depicted in Table 6, larger dogs were more likely than other dogs to be given scraps as snacks, training rewards or waste disposal, but medium sized dogs were more likely than other dogs to be fed table scraps as part of the main meal (caution is advised in interpretation due to small numbers in the “feed scraps as part of main meal” group).

**Table 6.** Whether dogs fed scraps <sup>1</sup> by size distribution of dogs.

Size	No Scraps Fed	Fed Scraps as Snack, Reward or Waste Disposal	Fed Scraps as Part of Main Meal	N in Size Group
Small	36.6	30.6	17.1	126
Medium	45.1	41.3	62.9	159
Large	18.3	28	20	80
Total	100	100	100	
N	208	158	24	

<sup>1</sup> 20 cases were included in the snack, reward or waste group and the main meal group.

Breeds with an average level of activity were less likely than either sedate or sedentary breeds and highly active breeds to be given table scraps as part of main meal (Chi-square (11.775) > (5.991),  $p = 0.003$ ) but there was no difference between breed activity levels in whether or not dogs were given scraps as a snack, reward or as waste disposal Chi-square (2.046) < (5.991),  $p = 0.36$ ). The proportions of each activity level grouping for dogs given scraps as main meals were quite low compared to dogs given scraps as snacks, rewards or waste disposal (Table 7).

**Table 7.** Whether dogs fed scraps <sup>1</sup> by activity level distribution of dogs.

Size	No Scraps Fed	Fed Scraps as Snack, Reward or Waste Disposal (n)	Fed Scraps as Part of Main Meal	N in Activity Level Group
<b>Sedate</b>	12.8	25.7	13.6	28
<b>Average</b>	63.6	33.3	4.1	241
<b>Energetic</b>	22.7	38.7	14.3	96
<b>N</b>	225	118	28	365

<sup>1</sup> 20 cases were included in the snack, reward or waste group and the main meal group.

There was no significant difference in self-rated dogs' body condition scores between respondents who fed table scraps as snacks and those who did not ( $t = -0.799$ ,  $df = 346.65$ ,  $p = 0.425$ , equal variances not assumed), nor between respondents who fed table scraps as part of main meals vs. those who did not ( $t = 0.052$ ,  $df = 26.986$ ,  $p = 0.959$ , equal variances not assumed).

There was no difference in response between the table scrap groups and in whether their dogs were prone to putting on weight. Respondents with inside dogs were three times more likely to feed their dogs table scraps as part of a main meal than respondents with outside dogs. (Chi-square value (6.113) > (3.841),  $p = 0.013$ ). Similarly, nearly a quarter (23.4%) of respondents with inside dogs reported that they gave treats to their dogs to "show how much they love them", compared with 17% of respondents with outside dogs. Whether or not feeding treats to inside dogs is a symbolic expression of love or a practical repercussion of dogs "being in the right place at the right time" requires further investigation.

Dogs that were walked less than one hour per day were more likely to be fed table scraps as snacks than dogs walked an hour or more daily but less likely to be fed scraps as part of main meals. However, these differences are not statistically significant (Table 8).

**Table 8.** Relationship between feeding table scraps and dog's exercise level.

Exercise	Table Scraps as Snacks	Table Scraps as Part of Main Meal
Walked less than 1 h/day	45.1	6.2
Walked 1 or more h/day	36.2	9.5

In sum, Study 2 has shown that a considerable proportion (44%) of respondents fed table scraps, but very few fed scraps as a main meal. Feeding scraps as part of the dog's main meal was associated with a tendency to pay little or no attention to the dog's weight and with a larger number of persons in the household. Type of dog also influences propensity to feed scraps, but the motivations may differ between owners of sedate vs energetic breeds. Owners of calm, sedate breeds which are more likely to spend time indoors may have a different type of attachment or attitude toward their dogs compared with owners of highly active dogs who may feed scraps thinking their calories will be readily used up during exercise.

Overall, these studies provide descriptive statistics about the prevalence of feeding food scraps to animals, in particular dogs. It also suggests that while feeding pets is considered by some pet owners to be a waste diversion strategy, it does not account for the majority of pets' diets and has a modest impact in diverting food scraps from other disposal methods.

#### 4. Conclusions

In the absence of research on the topic of feeding food to pets that was originally intended for human consumption, namely food scraps, the aim of this paper was to understand what proportion of owners fed scraps to their dogs, their demographics, decision-making, household composition, and types of dogs. We also sought to determine relationships between practices of feeding scraps to pets and the animals' body condition, living arrangements (inside or outside) and animal exercise regime.

Overall, most respondents did not feed table scraps and, where they did, the amounts did not constitute much of the total food discards of that household. The tendency to refrain from feeding scraps was associated with a tendency to monitor dogs' weight. People who fed scraps did not generally include them as part of their dog's main meal.

People feeding scraps as part of main meals were more likely to be in larger households. It is likely that larger households (especially those with children) produce sufficient quantities of scraps throughout the day to be aggregated into a pet meal. Females and those who owned medium sized dogs were also more likely to engage in feeding table scraps to pets. Moreover, larger households may make it difficult to monitor food given to dogs.

Although these factors require further investigation with a larger sample, they suggest that females and owners of medium sized dogs might benefit from veterinary information about "safe" and "healthy" pet feeding practices. The same information would be worth including in information for owners about more environmentally sustainable pet feeding practices.

The surveys reported in this paper indicate Australian pet owner practices of feeding food waste and table scraps as pet alimentation. However, they rely on subjective measures of household food waste and the dogs' body condition. Moreover, the dog-focused survey did not elicit data on how many meals the

dog received in a typical day. Such data is required to reveal correlations between people and practices that could in turn inform the development of successful sustainable pet feeding interventions.

Of particular limitation, the survey tools reported here used key terms uncritically. Research on the psychological and socio-cultural determinants of household food waste has highlighted various assumptions around the meanings of terms such as “food waste” or “scraps” [5]. There is often incongruity between householders’ definitions of food waste and researchers’ calculations. Peelings or other items considered (culturally) “inedible” are often discounted by the former but included by the latter, despite the environmental impact being relatively equal. There is often confusion about the inclusion of liquids in the category of food waste or whether it is restricted to solids, complicated by a natural process of liquidation that occurs to organic solids such as food products.

Avenues for food waste disposal vary between councils, regions, states and countries. These may be accompanied by cultural, social and geographic differences in relation to feeding practices and animal ownership. For example, dog owners in remote Australian Indigenous communities have little access to commercial food. In some central European countries such as Slovakia, scraps are the main source of food for dogs [48–51]. Furthermore, the processes of domestic food purchase, preparation and housework (which would include clearing away dirty dishes and scraps) is traditionally considered “women’s work”. Further research should consider these important structural, geographic, social and cultural differences in pet feeding practices and the role of food waste.

Whilst the research on humans consuming animals spans both the social and natural sciences, research on humans feeding animals is largely relegated to issues of animal nutrition, health and safety. However, there is a real need for the social sciences to engage in research on “feeding animals”. Following the aforementioned socio-cultural dimensions of human-to-human feeding practices, there remains a need to consider how human practices of feeding pets and other animals symbolise, perform or create relations; which kinds of relations and for what purposes. These relational dimensions of human practices of feeding animals could be accessed by social scientists using animal attachment scales as well as more qualitative methodologies. *In situ* ethnographic research would bolster such findings by triangulating stated and revealed behaviours [52].

It is not only domestic pets that help humans dispose of food. Whilst the data presented in this paper relates to small animals most likely to share human domestic spaces, large companion animals like alpacas, llamas, goats, pigs, camels and horses also warrant attention in relation to their potential role in food waste disposal. Larger animals also can be fed on the leftovers or offcuts of food intended for human consumption, often substituting commercial stock feed [53]. In industrialised countries, this usually occurs during times of drought when traditional feed is scarce. Nonetheless, there is a clear need to understand how human practices of feeding animals differ according to different kinds of animals. This includes differences along species lines, as well as differences in the social construction of different kinds of animals. For example, animals can be categorised as pets, companion animals, livestock, or wildlife. Domestic animals are bifurcated categorically into pets or livestock; the former kept primarily for love and the latter for money. Whether an animal is kept primarily for love, lifestyle or livelihood may impact the owner/guardians’ willingness or reluctance to provide “food waste” to those animals.

These suggested categories are of course purely academic; livestock producers and horse owners frequently report feelings of love for their large animals, and some guardians of small animals would see them as having a utilitarian work function akin to that of many horses. However, there is a need to move

beyond the pet/livestock binary to consider different types of relationship with different kinds, sizes and uses of animals, if not only for understanding what contributes to decisions about how and what they are fed. Whilst livestock and livestock may not be an obvious diversion stream for food waste, understanding the social dimensions of how humans provide them with food will become increasingly important to the sustainable feeding of animals relying on broad-acre cropping and commercial grain production.

Overall, this paper is framed by the assumption that feeding food waste to pets is a more environmentally sustainable alternative to purchasing pre-packaged, commercial pet food. However, commercial pet food can be made from ingredients that would otherwise have been treated as waste products. It could also have produced waste, as might owners who prepare their own meals for pets. In saying this, however, we know little about the health implications of feeding table scraps to animals. For example, animal owners need more education on the calories of such food and whether they are feeding their animals too much, and what foods are harmful to dogs. There may be misunderstandings or differences in the perception of what foods are suitable for dogs. We therefore need to audit knowledge and beliefs. For example, should we be feeding dogs food that we consider unfit for human consumption, or should they only eat food suitable for human consumption? The time and place of feeding scraps also needs to be considered [54]. For example, feeding scraps while preparing meals, or when eating at the dinner table might encourage undesirable behaviours such as begging (often resulting in increased intake of food), or dangerous behaviours such as aggression or “stealing” food from vulnerable infants or fragile elderly. Information could be distributed through pet adoption centres, registration bodies, puppy preschool classes, or local councils.

Finally, the greenhouse gas emissions potential of animal manure produced from eating scraps of food originally intended for humans is thought to be lower than that of rotting food scraps [55]. An environmental accounting perspective is required to provide a broad systems understanding of these issues. Part of this requires a supply chain approach to understand the ramifications of feeding food waste to pets across the whole food chain. Whilst feeding food waste to pets may reduce the amount of food going to landfill, there may be little impact on food waste related to purchasing and storage. Answering the questions identified throughout this paper will require mixed methodologies and multi-disciplinary collaborations involving experts such as social scientists, environmental mathematicians, nutritionists, veterinarians, behaviour change experts and animal owners and carers themselves. Whilst companion animals sustain the psychological, social and cultural wellbeing of almost two thirds of households in developed countries, research is required to make sure that sustaining pets is itself a sustainable practice.

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## Author Contributions

This article was conceived by Kirrilly Thompson, who prepared the background and discussion and coordinated the writing and research team. Data for Study 2 was collected by Tegan Hadley during an Honours project supervised by Susan Hazel. It was analysed, interpreted and reported by Lisel O'Dwyer. Anne Sharp contributed the collection, details, analysis and reporting of Study 1. Christian Reynolds provided expert discussion on measuring food waste. Susan Hazel provided expert context on veterinary issues. Bradley Smith contributed to the discussion of pet feeding practices across history and cultures.

## Conflicts of Interest

The authors declare no conflict of interest.

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