

Incidence of dog bites and public attitudes towards dog care and management in Samoa

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Abstract

In many developing nations, dogs (*Canis familiaris*) present a significant issue in terms of human health, safety and animal welfare. We assessed attitudes towards dogs and their management in Samoa, a developing South Pacific island nation, using a questionnaire. It demonstrated that Samoa has one of the world's highest recorded levels of household dog ownership (88%) but a comparatively low rate of vaccination (12%) and sterilisation (19%). Those interviewed believe dogs were important and should be considered part of the family; however most households reported that their dogs were kept for protection (79%). There was a clear skew in the sex distribution. The dog population showed a strong male bias (71%) suggesting females are removed from the population. Of those surveyed only 16% had received any education about dogs and their management and overall the respondents showed a clear disparity between attitudes and behaviour (eg the majority believe dogs should be vaccinated [81%] yet most dogs in this sample [72%] had never been to a veterinarian). Overall, there was a willingness to manage the free-roaming dog population which was considered by many to be a nuisance, however there were few enforceable mechanisms by which this could occur and most dogs were not confined. Harm or killing of dogs was relatively commonplace with 30% of households reporting they knew someone who had harmed or killed a dog and 26% of respondents indicating they believed harming or killing dogs was good for Samoan society, presumably by reducing problems associated with the free-roaming population. Dog bites were relatively frequent in Samoa and reports from two hospitals indicated a frequency of 37 new bites per annum requiring hospitalisation per 10,000 head of population. Furthermore, this paper outlines strategies and further research that could be considered to improve dog welfare and reduce the need to harm or kill dogs, namely improvements in veterinary provision and dog-focused education. It also considers the need for legislative controls and more research and funding to be made available for small developing nations to explore their animal welfare obligations.

Keywords: animal welfare, bite, dog, free-roaming, management, population

Introduction

The association between humans and dogs (*Canis familiaris*) is the oldest and most enduring of our relationships with a domesticated species (Serpell 1995). The origins of which may be in excess of 31,700 years old (Germonpré *et al* 2009). Irrespective of the time-frame, dogs are now ubiquitous (Knobel *et al* 2008) and valued in many human societies. However, specific public attitudes towards dogs and dog ownership and associated welfare issues, are likely to vary from society-to-society (Haupt *et al* 2007). Beyond the broadly applicable influences of cultural or societal differences (Serpell 2004) there are also clear differences in the attitudes of individuals towards pet (dog) ownership dependent upon their age, gender (McKay *et al* 2009), rurality (Knobel *et al* 2008; Ortolani *et al* 2009; Acosta-Jamett *et al* 2010) and previous exposure to dogs (Hsu *et al* 2003).

The strength of the human-dog bond and social perceptions of dogs likely influence how dog populations are managed within any given community. Ironically, many causes of over-population are as direct consequences of the actions of dog owners. This includes low sterilisation rates (Ortega-Pochecho *et al* 2007; Acosta-Jamett *et al* 2010) especially if the relationship is primarily utilitarian (eg for guarding) rather than social (eg companionship) (Faver 2009). Similarly, a lack of education about dogs (Alie *et al* 2007; Ortega-Pacheco *et al* 2007) or not confining animals (Davis *et al* 2007; Fielding 2010) may compound the problems associated with free-roaming dogs. In this regard, a free-roaming dog is defined as "not currently under direct control or is not currently restricted by a physical barrier" (International Companion Animal Management Coalition [ICAM] undated; pp 5).

In the South Pacific region dogs arrived as a result of multiple introductions by human settlers, the earliest of which is estimated at 2,000 years before present (Anderson 2009). Independent Samoa consists of ten islands in total. Of these, the two main populated islands are Savaii and Upolu, which includes the capital Apia. With the exception of a more urbanised population in Apia representing 21% of the total population (Samoa Bureau of Statistics 2008), most Samoans live in village communities around the perimeter of these islands. Anecdotally, dogs are commonly kept for household protection and are mostly free-roaming as few households are fenced.

Free-roaming dogs and their management comprise a major global welfare issue (Hsu *et al* 2003; Dalla Villa *et al* 2010). Large populations of dogs are known to increase the prevalence of canine diseases (Acosta-Jamett *et al* 2010) and likewise, the associated risk of zoonotic infection (Katagiri & Oliveira-Sequeira 2008; Parrado *et al* 2011). The condition of free-roaming individuals is often relatively poor, especially if unsterilised (Totton *et al* 2011). These and other factors may cause the local human population to perceive dogs as a nuisance (Poss & Bader 2007; Slater *et al* 2008; Fielding 2010) leading to direct conflict and human-initiated acts of retaliation.

Territorial aggression (Wake *et al* 2009) and a lack of dog-awareness and behavioural education (De Keuster *et al* 2006) are significant causes of dog bites, many of which are considered avoidable. Bites which occur in public spaces are often associated with dogs that are unfamiliar to the victim (Cornelissen & Hopster 2010) although the majority of bites still result from provoked or unprovoked attacks from dogs known to the victim, usually in or around the victim's home. Dog bites have been shown to be disproportionately reported in less-developed nations (Dalla Villa *et al* 2010). Similarly, bites and fatal attacks by owned or unowned dogs may be more prevalent in rural or low population density environments (eg Canada: Raghavan 2008; Spain: Rosado *et al* 2009) or if dogs are able to form packs as a result of being able to roam (Santoro *et al* 2010). Rural dog ownership is often also associated with acquisition of a dog for protection and may increase the likelihood of an aggressive response to strangers (Ortolani *et al* 2009; Hsu & Sun 2010).

Control of dog population size, aggression and zoonotic disease all require that dogs be restrained or confined to a certain extent. In developed countries a number of legislative strategies have been developed to increase owner compliance and reduce free-roaming dog populations (Slater *et al* 2008; Rohlf *et al* 2010). These may include compulsory registration and licensing and non-compulsory education about responsible ownership. However, this is not necessarily the case internationally and other strategies may be employed. India has used sterilisation or birth control services which target free-roaming individuals (Totton *et al* 2010). Elsewhere, extermination has been used but has proved less effective, especially as the remaining viable population is capable of rapidly reproducing and filling vacant territories (Matter & Daniels 2000). In many nations,

including Samoa, that report problems with free-roaming dogs there is a relative paucity of legislation, funding and education concerning breeding, neutering and responsible dog ownership (Fielding & Mather 2000; Hsu *et al* 2003; Ortega-Pochecho 2007; Fielding 2010).

Island nations, such as Samoa, provide a useful context in which to explore attitudes towards dogs and dog welfare. As they are currently unexplored much of the information concerning their dog populations is unknown. This research seeks to understand how the local population in Samoa perceives, cares for and manages their dogs. Additionally, an estimate of the impact of free-roaming dogs in terms of bites and perceived nuisance is provided. It is hoped these data will support the growing literature concerned with the welfare of free-roaming dogs as well as highlight the ongoing need for research and funding internationally to manage welfare problems in small nations.

Materials and methods

Subjects and procedure

Attitudes of adults towards dogs and dog management in Samoa were explored using an anonymous questionnaire. A total of 327 responses to a set of standard questions were gathered by a number of volunteers from the Animal Protection Society (of Samoa) (APS) and the University of the South Pacific during 2010. Responses were collected in each of the five major geographic regions across Samoa including Apia, the capital of Samoa, as well as outlying villages. Those not attributed to a region were designated as 'unknown' (Table 1).

Questions were answered by a single adult from a given household. Households were selected in each of the five regions, irrespective of dog ownership, with every tenth or thirtieth household being approached dependent upon the housing density of the area. If the occupant declined the next available household was canvassed until a response was obtained. Following agreement to participate, each participant was given an information sheet outlining the questionnaire, its ethical approval status and contact details of the primary researcher. At this point they were then asked if they were prepared to continue and informed that by doing so they gave consent for the anonymous information provided to be used in any way considered appropriate by the researcher. Similar randomised survey-based techniques for assessing individual attitudes towards animals in semi-urban and urban areas have been previously employed (McKay *et al* 2009; Farnworth *et al* 2011), however the technique had not been used to gather a representative sample of households in low population density areas and was therefore adapted for that purpose.

Survey structure and content

The survey consisted of four sections. The first section collected demographic data about the respondent and their household including age, gender, area of residence (village or city), whether they currently lived with dogs and, if so, the reasons they chose to do so, whether the dogs were ster-

Table 1 Age and household location for 327 respondents to a questionnaire concerning attitudes towards, and control of, dogs in Samoa.

Parameter	N	%	% in 2006 census*	Parameter	N	%	% in 2006 census*
Age (years)				Location			
< 20	52	16	11.5	Apia	50	15	21
21–40	114	35	27.2	Savaii	75	23	24
41–60	114	35	18.6	North-west Upolu	72	22	31
61–80	36	11	6.6	West Upolu	55	17	
80+	3	1	1	Rest of Upolu	44	14	24**
No answer	8	2		Unknown	28	9	

* Samoa Bureau of statistics, 2008; ** West Upolu and Rest of Upolu are not separated in census data.

ilised and or free-roaming. Additionally, the respondent was asked whether they thought dogs in general should be free to roam, if they provided care for free-roaming dogs they did not own and whether or not they would consider adopting a dog.

Sections two and three asked 36 questions with 'yes', 'no' and 'don't know' responses which fitted into four broad categories. These were: attitudes towards dogs, their management and the impact of dogs; experience and attitudes concerning the breeding and daily care of dogs; basic information on the incidence of, and response to, dog bites; awareness of and reasons for harming or killing of dogs.

The final section gathered information on up to five specific dogs within the household including breed, sex, vaccination and reproductive status as well as frequency of veterinary care.

Dog bite statistics

Dog bite statistics were compiled from January 2006 until August 2009 at two hospitals in Samoa as directed by The Samoan Ministry of Health and facilitated by APS. These findings are considered alongside the household survey for the reported incidence and source of dog bites. Information was separated by the age of the patient as well as the month of presentation.

Statistical analysis

All data were entered into Statistical Package for the Social Sciences (SPSS) version 18.0 for Windows (IBM Inc, Chicago, IL, USA). If respondents had not answered a question their information was included in the database but the datum point was identified as missing and was therefore not included in any analysis. Primary analysis was descriptive allowing general responses of the sample population to be evaluated. Chi-squared analyses were conducted to identify any major differences in responses relative to dog ownership, age, location and gender of the respondent. Statistical significance was indicated by $P \leq 0.05$.

Table 2 Reasons for dog ownership reported by 287 households in Samoa, open-ended questioning allowed multiple reasons to be provided by a single respondent.

Reason for ownership	N	%
Protection of land/family/home/livestock	227	79
As a pet/companion	14	5
To eat scraps/leftovers	8	3
For hunting/chasing pigs	6	2
Pest control	2	1
No reason given	42	15

Results

Demographics of respondents

Of the total, 149 respondents (46%) were male, 139 (42%) female and 39 (12%) declined to answer. The 2006 Samoan census (Samoa Bureau of Statistics 2008) recorded a male: female ratio of 52:48. Geographical distribution of households and ages of respondents, as well as the associated census statistics, are in Table 1. The proportion of households sampled in a given location is broadly comparable to that found in the 2006 census. The age distribution, if viewed in light of the fact that 39% of Samoans are 15 years old or younger and therefore ineligible to answer this survey, also seems broadly indicative of the populace.

Dog ownership statistics

Of the 327 households; 287 (88%) had dogs totalling 715 individual animals. The median number per household was 2 and the total range of dog ownership in the sample was 1–19. Of these, 507 (71%) were male and 208 (29%) were female and 139 (19%) were sterilised. Additionally, 112 of the 287 households (39%) indicated that their dogs were free-roaming for some or all of the time which represented 309 of the 715 dogs (43%). The primary reason for dog ownership was 'protection' as reported for 227 of the 287 households (76%) (Table 2).

Table 3(a) Responses to questions concerning attitudes towards dogs and their management as reported by 327 respondents. Numbers in parentheses are percentage of total responses.

Question	Response			
	Yes	No	Don't know	No answer
Have you had any education about dogs?	51 (16)	263 (80)	6 (2)	7 (2)
Do you like dogs?	252 (77)	60 (18)	8 (3)	7 (2)
Do you consider dogs 'one of the family'?	269 (82)	31 (9)	15 (5)	4 (12)
Are dogs important to people, villages, towns?	244 (75)	47 (14)	30 (9)	6 (2)
Should dogs be registered and have an identification tag and collar?	257 (79)	46 (14)	19 (6)	5 (1)
Should dogs be chained up?	239 (73)	66 (20)	17 (5)	5 (2)
Should dogs be fenced in?	216 (67)	82 (25)	21 (6)	5 (2)
Should all dogs have an owner?	275 (84)	31 (9)	15 (5)	6 (2)
Should people be responsible for dogs on the street?	183 (56)	98 (30)	37 (11)	9 (3)
Do you think dog numbers need to be controlled?	253 (77)	48 (15)	21 (6)	5 (2)
Do you think dogs are a nuisance?*	210 (64)	80 (25)	30 (9)	7 (2)
Do you think dogs on the streets cause road traffic accidents?	247 (76)	53 (16)	21 (6)	6 (2)
Should there be legislation enforced requiring people to control their dogs?	259 (79)	35 (11)	26 (8)	7 (2)

* Reasons for this response can be seen in Table 3(b).

Table 3(b) Rationale given by 210 respondents to the question 'do you think dogs are a nuisance?'. Responses were not provided by 117 of those canvassed.

Response	N	%
When I am resting/sleeping	56	27
When I am eating/they are hungry	33	16
Not a problem	25	12
When they are sick/they spread disease/they infect children	20	10
If they are aggressive, bite or are poorly behaved	20	10
Don't know	9	4
They are too noisy	8	4
When they are on heat	7	3
When on road/in traffic	6	3
When they cause family feuds	5	2
If they follow/stalk you	4	2
When we have visitors	3	1
When they are neglected/mistreated	3	1
They are hard to care for	3	1
There are too many	2	1
Other	6	3

From the 327 households, 185 (57%) indicated that they cared for dogs on the street that were not theirs. A total 88 of 312 respondents (28%) would consider adopting a dog. Those households that already owned dogs were more likely to consider future adoptions ($\chi^2 = 7.58$, $df = 2$; $P < 0.05$), however households with one or two dogs were

significantly more likely to adopt than those with three or more dogs ($\chi^2 = 23.05$, $df = 4$; $P < 0.01$).

Data were collected for 436 specific dogs (282 males, 116 females and 38 of unreported sex). Only 52 (12%) had received vaccinations and 84 (19%) were sterilised. Only 16 (4%) of the 436 dogs were taken to veterinarians 'often', 67 (15%) 'sometimes' and 314 (72%) had 'never' been. No data pertaining to veterinary care were obtained for 39 (9%) of the individual dogs. Of the 252 households that owned dogs 148 (59%) owned only males and 48 (19%) owned only females. Neither the sex of the dogs (ie owning only males) nor the number of dogs owned had a significant impact on the likelihood that sterilisation occurred ($\chi^2 = 0.088$, $df = 1$; $P = 0.767$ and $\chi^2 = 9.065$, $df = 8$; $P = 0.337$, respectively).

Attitudes towards dogs and their management

Most respondents (252/327; 75%) considered dogs to be important to Samoa and reported that they liked dogs (257/327; 77%). Only a small minority had received any education about dogs (51/327; 16%). A majority of respondents indicated that dogs should be controlled (257/327; 77%) or confined through the use of physical barriers (216/327; 67%) and legislative regulations (259/327; 79%). Most respondents indicated that dogs should be identified using tags and collars (257/327; 79%), that dog numbers required management and that dogs were a nuisance (Table 3[a], [b]).

Thirty-one respondents (9%) 'agreed' that dogs should be on the streets, 25 (8%) 'partly agreed', 233 (71%) 'disagreed' and 20 (6%) 'strongly disagreed', 16 (5%) gave no response. Households that did not have dogs were significantly more likely to indicate that dogs should not be allowed on the streets than those that did ($\chi^2 = 10.335$, $df = 3$; $P < 0.05$). There was no significant difference in

Table 4 Responses to questions concerning care of dogs and reproductive management thereof as reported by 327 respondents to a survey conducted in Samoa. Numbers in parentheses are percentage of total responses.

Question	Response			
	Yes	No	Don't know	No answer
Has your dog ever had pups?	101 (31)	213 (65)	4 (1)	9 (3)
Have you ever intentionally had pups from a dog?	95 (29)	208 (64)	15 (4)	9 (3)
All dogs unless for breeding should be sterilised	182 (56)	93 (28)	41 (13)	11 (3)
Do you think dogs have the right to have pups?	195 (59)	85 (26)	40 (12)	10 (3)
Sterilisation can make dogs lazy	86 (26)	170 (52)	58 (18)	13 (4)
Sterilisation is a risk to the dog's health	98 (30)	159 (49)	59 (18)	11 (3)
Sterilisation makes dogs poor guard dogs	160 (49)	108 (33)	50 (15)	9 (3)
Dogs having pups lets children learn about nature	152 (47)	118 (36)	47 (14)	10 (3)
Cost is the biggest factor when sterilising a dog	170 (52)	114 (35)	32 (10)	11 (3)
Females should have a single oestrus or litter before being sterilised	151 (46)	118 (36)	45 (14)	13 (4)
Should a dog be fed and given water every day?	275 (84)	31 (9)	9 (3)	12 (4)
Do you think dogs should be vaccinated to prevent disease?	256 (81)	41 (13)	10 (3)	11 (3)
Do you think dogs should be exercised every day?	233 (71)	40 (12)	41 (13)	13 (4)
Should you take a dog to the veterinarian if it is sick or injured?	163 (50)	129 (39)	23 (7)	13 (4)

Table 5(a) Age and number of dog bite victims treated in two hospitals in Samoa between January 2006 and August 2009.

Year	Age of patient (years)					Total cases
	0-4	5-14	15-24	25-54	55+	
2006	26	254	119	208	71	678
2007	47	226	107	215	76	671
2008	36	219	121	213	65	654
2009*	24 (36)	111 (167)	68 (102)	159 (238)	39 (59)	401 (602)

* First number is for January–August only. Number in parentheses is mean number of cases across eight months extrapolated to allow a comparison of a 12-month period.

Table 5(b) Responses to questions concerning dog bites by 327 households within Samoa. Percentage of total response is in parentheses.

Question	Response			
	Yes	No	Don't know	No answer
Have you or a family member ever been bitten by a dog?	87 (27)	214 (65)	21 (6)	5 (2)
Did you or that family member go to hospital following the dog bite?*	44 (51)	42 (48)	1 (1)	0 (0)
Was the dog that bit you or your family member in a public place?*	49 (56)	34 (39)	3 (4)	1 (1)
Do you think dogs are aggressive towards people on the street?	92 (28)	215 (66)	15 (5)	5 (1)
Do you think dogs are dangerous animals?	224 (69)	69 (21)	26 (8)	8 (2)
Have you or a family member ever been bitten by one of your own dogs?***	75 (26)	178 (62)	21 (7)	13 (5)

* For these questions, n = 87 (number of households reporting a dog bite); *** For this question, n = 287 (number of dog-owning households).

Table 6(a) Responses for questions concerning the harm or killing of dogs in Samoa. Percentage of total response for each question is in parentheses.

Question	Response			
	Yes	No	Don't know	No answer
Have you known people that inflicted harm or killed a dog after being bitten?	98 (30)	181 (55)	38 (12)	10 (3)
Have you known people that inflicted harm or killed a dog because they considered it a nuisance?	81 (25)	201 (61)	36 (11)	9 (3)
Have you known people that inflicted harm or killed a dog for any other reason?	69 (21)	34 (39)	3 (4)	1 (1)
Do you think it is good for Samoan society if people inflict harm on, or kill dogs?	75 (26)	178 (62)	21 (7)	13 (5)

Table 6(b) Rationales given by 216 respondents to the question 'Why do you think people inflict harm on, or kill, dogs?'. Responses were open ended and therefore each individual could provide multiple reasons. Responses were not provided by 111 of those canvassed.

Response	N	%
Dog was too aggressive/fierce	69	32
Dog was sick or diseased	60	28
Dog was old	28	13
Dog bit/chased or attacked someone	19	9
Don't know why	14	6
Dog stole food/livestock	13	6
Dog was noisy/a nuisance	12	6
Dog was unwanted	12	6
Dog spread an infection	8	4
Not enough money/food to keep the dog	8	4
Dog was poor at guarding/was too fearful	2	1
Dog was to be eaten	1	1

the likelihood that sterilised dogs would be allowed to roam ($\chi^2 = 1.33$; $df = 2$; $P = 0.514$) compared to unsterilised dogs. Only 16 of the 327 households (5%) reported having a fully fenced area of land.

Attitudes towards sterilisation and care of dogs

A narrow majority of respondents (182/327; 56%) indicated that dogs should be sterilised unless being used for breeding. However, of households that owned dogs, 42% (101/287) indicated that their dogs had, either intentionally or unintentionally, sired or mothered pups and 46% of all respondents (151/327) believed bitches should either have a litter or go through oestrus at least once. Some respondents agreed with statements that sterilisation impacted negatively on the behaviour and health of dogs, 26% (89/327) believed it caused laziness, 49% (160/327) believed it reduced a dog's ability to guard and 30% (98/327) thought it caused health problems. Daily care including the provision of food and water (275/327; 84%), vaccination (265/327; 81%) and exercise (233/327; 71%) were consid-

ered to be requirements by the majority of respondents. However, only 50% (163/327) of respondents indicated that the household provided veterinary care for their animal when it was sick or injured (see Table 4).

Dog bites

Dog bites were particularly common in those aged between 5 and 14 years of age. Victims requiring hospital treatment for bites each year were approximately 1 in 270 individuals or 37 new cases each year per 10,000 total population (Table 5[a]).

Twenty-seven percent (87/327) of households reported one or more family members had been bitten by a dog and, of these, 56% (49/87) were bitten in a public place. Of the 287 households that owned a dog, 26% ($n = 75$) reported that either they or a family member had been bitten by one of their own dogs (Table 5[b]).

Harm or killing of dogs

Almost one-third of households reported that they were aware of individuals who had inflicted harm upon, or even killed, dogs after being bitten (98/327; 30%) or because the dog was considered a nuisance (81/327; 25%). The 216 respondents provided a total of 246 responses to the question 'why do people kill/harm dogs?' (Table 6[b]) with the two commonest responses being because the dog was aggressive (28% or 69/246) or because it was sick (24% or 60/246). In addition, 26% of responding householders (112/327) indicated that they believed harming or killing dogs was 'good for Samoan society'. Although this question was not elucidated further, it is likely that it was taken to mean in terms of improving or reducing the issues around free-roaming dogs and their perceived negative impacts upon society (Table 6[a]).

Discussion

Compared with other nations, Samoa has one of the highest recorded rates of dog ownership (New Providence, The Bahamas 47%: Fielding & Mather 2000; Taiwan 23%: Hsu *et al* 2003; Roseau, Dominica 38.6%: Alie *et al* 2007). The current rate of 88% is comparable only to rural areas of Chile (89%) (Acosta-Jamett *et al* 2010). In general, the attitude held by 79% of dog owners, that dogs are kept to guard the household, is more prevalent than in countries with similar levels of ownership (Chile, 48%: Acosta-

Jamett *et al* 2010). Although the minority (17%) thought it was appropriate for dogs to be free-roaming and the majority (67%) believed that dogs should be fenced in, in practice only 5% of households had fences that could curtail dog movements. For Samoa, enforceable requirements, such as fenced areas, may reduce the number of free-roaming dogs and concomitantly the magnitude of the associated problems. Despite the low number of fenced properties the fact that dog owners were more likely to agree that dogs should not roam may provide support for any such initiative. However, implementation should focus on containment that does not compromise dog welfare, particularly as 73% of respondents (239/327) considered it appropriate to restrict movement using a chain.

Samoa's dog population showed a large male bias (71%) suggesting a preference for male dogs, possibly due to a misconception that they function well as guard dogs. Such sex ratios have not been found in other regions with similar levels of ownership (Yucatan, Mexico: Ortega-Pacheco *et al* 2007). This highly skewed sex ratio may reflect disposal of female dogs prior to maturity, which may be perpetuated as a result of the low sterilisation rate and consequent risk of unwanted puppies in the household. Further research should explore the outcome for female dogs within Samoa as, anecdotally, the APS has reported that drowning of female puppies and live interment of lactating bitches have occurred.

The sterilisation rate of dogs in Samoa (19%) is substantially lower than that found in significantly larger Pacific economies such as Auckland, New Zealand (78.5%; McKay *et al* 2009) and Australia (80.4%; Rohlf *et al* 2010). However, it compares favourably with those of other developing nations such as Dominica (8.5%; Davis *et al* 2007) and the Yucatan, Mexico (1.8%; Ortega-Pacheco *et al* 2007). Unintentional or intentional breeding appears to be a common occurrence. In Samoa, 42% of owners reported that breeding had occurred. Given the high proportion of the Samoan dog population that are able to roam it is likely that this is a conservative estimate as a significant number of litters are liable to be born either to unowned bitches or to owned bitches unknown to the owner of the sire. There is also a comparatively low rate of vaccination (12%) and veterinary care (20%). This reported low rate of vaccination is relatively uncommon in the literature, particularly in nations where rabies is endemic (eg Yucatan, Mexico: Ortega-Pacheco *et al* 2007).

The limited availability of veterinary care in Samoa means it is perhaps unsurprising that the few owners that provide dogs with veterinary care do so 'occasionally' or on an as-needed basis. This is dependent on access to APS' veterinary services in Apia or infrequent outreach village clinics. Although APS' services are charged on a cost-recovery basis estimated to be between \$US20–40, for 52% of households surveyed, cost is still a major consideration impacting upon the decision to sterilise dogs. In Samoa, the 2011 *per capita* gross domestic product (purchasing power parity) was \$US6,022 *per annum* (Australian Government Department of Foreign Affairs and Trade 2011) and, with veterinary services only routinely provided in Apia by the

APS, the temporal and monetary costs of travel to the APS clinic remain a significant barrier for most of the population. Associated with this, 72% of specified dogs in this sample had never been provided with veterinary care, well exceeding that seen in Dominica (15.8%) (Alie *et al* 2007). Of potential interest, warranting further exploration, is the apparent gap between what is considered appropriate and what is done to care for dogs. For example, 50% of those canvassed reported one should take a dog to the veterinarian if it was sick or injured, 81% believed dogs should be vaccinated to prevent disease and 56% believed dogs should be sterilised if not having puppies (see Table 4). This is clearly at odds with the specific data collected on 436 owned dogs with only 19% being sterilised, 12% being vaccinated and 20% visiting the veterinarian 'often' (4%) or 'occasionally' (16%). Specific education and services concerning the value of both vaccination and sterilisation could be implemented and their effects upon owner behaviour explored. Uptake would require the provision of additional qualified and accessible veterinarians or animal welfarists on a permanent and sustainable basis. Current provision only by APS limits the scope and effectiveness of veterinary care as a tool for population management. Increased education about sterilisation may reduce the number of females in oestrus and the tendency of males to roam. Any action to increase vaccination rates would also serve to reduce the incidence of infectious canine disease within the population. Each of these issues is identified as a reason for dogs to be considered a nuisance (Table 3[b]).

Given the relatively low rates of owner education in combination with a reduced likelihood that owned dogs will be sterilised or confined, there are clear opportunities for both the owned and unowned dog populations to increase rapidly, even if pup survival is low (Fielding & Mather 2000; Di Nardo *et al* 2007). This is particularly problematic given that the resident population are unlikely to actively adopt dogs. Saturation of available owners, resources and care may occur relatively quickly resulting in an increase in unowned, free-roaming dogs and the associated problems documented herein. Official management processes, such as mandatory registration and identification, if actioned, may address population increase. This could reduce the associated need to control extant dog populations, especially as reactive population management may lead to greater future welfare compromise for the indigent dog population.

The reported low level of dog-specific education is not uncommon in regions that report a high incidence of nuisance dog behaviour, even though education has long been cited as one of the major routes by which social change and improvements in dog welfare can be achieved (eg World Society for the Protection of Animals 1999; Fielding & Mather 2000). The degree of agreement with fallacious statements associated with sterilisation such as 'females should have a single litter before being sterilised' (see Table 4) is far greater than that found in countries such as New Zealand (McKay *et al* 2009) and even basic education concerning daily care of dogs may improve overall welfare.

Education could potentially be targeted at children and focus on care provision for owned dogs as well as dog behaviour and bite prevention. This could include understanding what constitutes cruelty towards dogs and appropriate behaviour for dog bite avoidance. Additionally, it could encourage individuals not to feed free-roaming dogs and therefore reduce conflict with humans (Alie *et al* 2007) especially as most respondents considered dogs to be a nuisance during meal times. Not only may an educational programme therefore reduce the incidence of dogs bites (De Keuster *et al* 2006) but anthrozoologically based education programmes have been shown to foster more positive attitudes towards animals in general (Mariti *et al* 2011). Such programmes, therefore, have the potential to reduce nuisance dog behaviour as well as harm and killing of dogs, which was linked to at least 25% of dog bites.

In Samoa the hospital admission rate due to dog bites is almost triple that found in the United States (12.9 per 10,000) (Weiss *et al* 1998) and five times that found in low population density areas of Spain (7.1 per 10,000) (Rosado *et al* 2009). Dog bite victims requiring hospitalisation were more likely to be children or young adolescents (Gilchrist *et al* 2008; Rosado *et al* 2009). This may reflect that currently 39% of the Samoan population are below the age of 15.

In Samoa, dog bites occurred frequently in public places. In New Zealand it is suggested that dog bites are more likely to occur in rural areas where containment is less likely (Wake *et al* 2009). A combination of these factors likely contributed to the high rate of dog bites in Samoa which is ostensibly rural. However, a similar number of respondents reported that either they or a family member had been bitten by one of their own household dogs. Rosado *et al* (2009) report that dog bites are commonly inflicted by young, medium- to large-sized males known to the victim. The specific information about Samoa's owned dogs suggests that this effect may be amplified by the sex skew within the dog population.

Harm or killing of dogs appears to be common and considered appropriate by a substantial minority. In New Providence, The Bahamas, 11% of dog-owning households indicated they had abandoned or shot unwanted animals (Fielding & Mather 2000), in Samoa the incidence is significantly higher. Most of the reported incidents of killing (see Table 6[b]) were due to issues that could either be remedied through education or veterinary care, or are for reasons that veterinarians routinely euthanise dogs. Killing of dogs, if conducted by non-professionals, may be inhumane and could be reduced through an increase in provision of veterinary services.

Animal welfare implications and conclusion

Low rates of vaccination and sterilisation of dogs in Samoa, and the likelihood that a large number are free-roaming, may result in the dog population becoming unmanageable in the medium to long-term. The low provision rates of relevant and appropriate educational and veterinary services that address these issues means that misconceptions and misinformation surrounding dogs, and subsequent neglect or mistreatment, may prove hard to remedy. Furthermore,

the absence of any effective legislation on the control and management of dogs results in an environment which lacks the incentives or impetus to change.

Driving changes in owner behaviour is likely the most effective route by which improvements in human responsibilities and attitudes towards dogs can occur. Any initiatives will require a long-term plan as prior island case studies have indicated that short-term actions are unlikely to succeed (Fielding & Mather 2000). Responses from Samoan households suggest that there is significant public support for improved management of free-roaming dogs and any such actions would have a material effect on improving the welfare of Samoa's dogs which are, in general, seen as an important component of the nation. Any such dog-management programmes should occur based upon research into humane solutions and avoid inhumane lethal methods (eg poisoning) that are disproportionately employed by developing countries (Dalla Villa *et al* 2010). This should be considered using systematic exploration within a framework of cultural sensitivity as espoused by Houtp *et al* (2007). Further research would be useful in exploring whether or not harm or killing of dogs is humane or constitutes abuse, especially given the number of households reporting knowledge of such actions. Samoa offers significant opportunity for exploration of free-roaming dog-management initiatives and social, religious and cultural drivers of behaviour towards dogs.

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