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Short communication

Participatory methods for the assessment of the ownership status of free-roaming dogs in Bali, Indonesia, for disease control and animal welfare

M.K. Morters[a,*], S. Bharadwaj[b], H.R. Whay[c], S. Cleaveland[d], I. Md. Damriyasa[e], J.L.N. Wood[a]

[a] Disease Dynamics Unit, Department of Veterinary Medicine, University of Cambridge, Cambridge, United Kingdom
[b] Praxis–Institute for Participatory Practices, New Delhi, India
[c] Faculty of Medical and Veterinary Sciences, University of Bristol, United Kingdom
[d] Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, Glasgow, United Kingdom
[e] Fakultas Kedokteran Hewan, Universitas Udayana, Bali, Indonesia

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ABSTRACT

The existence of unowned, free-roaming dogs capable of maintaining adequate body condition without direct human oversight has serious implications for disease control and animal welfare, including reducing effective vaccination coverage against rabies through limiting access for vaccination, and absolving humans from the responsibility of providing adequate care for a domesticated species. Mark-recapture methods previously used to estimate the fraction of unowned dogs in free-roaming populations have limitations, particularly when most of the dogs are owned. We used participatory methods, described as Participatory Rural Appraisal (PRA), as a novel alternative to mark-recapture methods in two villages in Bali, Indonesia. PRA was implemented at the banjar (or sub-village)-level to obtain consensus on the food sources of the free-roaming dogs. Specific methods included semi-structured discussion, visualisation tools and ranking. The PRA results agreed with the preceding household surveys and direct observations, designed to evaluate the same variables, and confirmed that a population of unowned, free-roaming dogs in sufficiently good condition to be sustained independently of direct human support was unlikely to exist.

1. Introduction

Understanding the characteristics of free-roaming dog populations is essential for the design of effective interventions to control canine diseases, such as rabies, and improve animal welfare. A critical issue relates to the possible existence of unowned, free-roaming dogs that are in sufficiently good condition to be sustained without direct human oversight. Ownership issues are critical for the design of rabies vaccination campaigns. Owners generally facilitate vaccination of their dogs against rabies (Lembo et al., 2010; Knobel et al., 2013), whereas unowned dogs are likely to be more difficult to identify and access for vaccination, potentially reducing effective vaccination coverage (Hampson et al., 2009), particularly if the fraction of unowned dogs is large. There is increasing evidence that most free-roaming dogs are owned and accessible for prophylaxis (Childs et al., 1998; Matter et al., 1998; Butler

* Corresponding author. Tel.: +44 1223 337694; fax: +44 1223 337610.
E-mail address: mm675@cam.ac.uk (M.K. Morters).

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and Bingham, 2000; Estrada et al., 2001; Kayali et al., 2003; Windiyaningsih et al., 2004; Kaare et al., 2009; Lembo et al., 2010; Gsell et al., 2012; Putra et al., 2013). Previous studies, using mark-recapture techniques to evaluate vaccination coverage, generally indicate only a small proportion (<10%) of free-roaming dogs are unowned in a range of urban and rural locations (Fishbein et al., 1992; Matter and Fico, 1998; Matter et al., 1998; Cleaveland et al., 2003; Kayali et al., 2003; Durr et al., 2009; Kaare et al., 2009; Gsell et al., 2012), although estimates with an upper confidence limit as high as 37% have been reported (Vos and Turan, 1998; Matter et al., 2000; Kayali et al., 2003). None of these studies reported the health status of unowned dogs, which remains an important gap in our understanding of these populations. However, there is a perception, implied by the implementation of interventions to reduce reproductive potential of unowned dogs, that these dogs are in sufficiently good condition for the population to be sustained without direct human oversight. An important corollary of this assumption is that it absolves humans from the responsibility of providing adequate care for a domesticated species.

During an intensive three-year study [April 2008–December 2010] in the villages of Antiga and Kelusa, Bali, Indonesia, all identified, free-roaming dogs in the study area were monitored individually by direct observation and household questionnaire every 6–12 weeks (average of 250–300 dogs in each village) (Morters et al., 2014). The study area encompassed most of the village and included every household in the main residential area. Almost all of the identified dogs were owned (i.e. belonged to a household in the study area) and fed regularly by their owner. Consistent with this finding was the observation that the vast majority of the owned dogs were in reasonable or good body condition, and only a small proportion (i.e. Antiga 5.3% and Kelusa 3.1%) "unhealthy" (i.e. with ribs clearly visible and concomitant generalised dermatitis). Only eight of the identified dogs in Kelusa and ten in Antiga did not belong to households in the study areas. All of these dogs were observed on only one occasion over the three year period, and almost all were emaciated (12/16) with severe generalised dermatitis (16/18). The poor condition of these dogs is consistent with the lack of edible refuse in the environment, based on subjective assessment, and householders reportedly rarely feeding dogs other than their own. Therefore, all of the healthy dogs resident in the study areas were identified as owned and fed by their owner, and there was no evidence for a resident population of dogs in reasonable or good body condition not fed daily by an owner.

Similarly, during household surveys the majority (~80%) of householders reported that there were no unowned dogs, with the remainder reporting generally ≤10 unowned dogs at any one time in the community. Householders generally assumed dogs to be unowned based on their health and confinement status (i.e. "thin with bad skin" and "on the street") rather than specific knowledge of an owner. Overall, these results suggested that a sub-group of unowned dogs, in sufficiently good body condition to be sustained independently of direct human oversight, did not exist in these two villages. However, given the implications for rabies control and animal welfare, this study aimed to generate additional evidence relating to the ecology and health of free-roaming dog populations using an alternative approach, specifically community-level participatory exercises.

Community-based participatory methods, termed Participatory Rural Appraisal (PRA), have been used extensively for research purposes by those from outside the community (Chambers, 1994a, 2007) including for veterinary epidemiology (Catley et al., 2012) and rabies control (Okell et al., 2013). These methods facilitate the sharing of local knowledge, and typically involve visualisation tools and ranking or scoring, but may also include group discussion or semi-structured interviews (Chambers, 1994a, 2007; Upjohn et al., 2013). Triangulation, or the comparison of PRA outputs with results generated by gold standard methods evaluating the same variables, is necessary to validate PRA outputs (Catley, 1999; Catley et al., 2012). Historically participatory approaches were developed to address discrepancies between perceived community-level issues determined through conventional surveys and by the community themselves (Catley, 1999). While neither are gold standard methods, PRA outputs have been shown to agree with, and thus verify, key findings from a limited number of conventional surveys designed to assess the same variables (Chambers, 1994b; Upjohn et al., 2013).

From previous studies (Putra et al., 2013), we assume that if a fraction of the free-roaming dog populations in Antiga and Kelusa was indeed unowned and in reasonable body condition, these individuals would comprise <10% of the population. Therefore, we preferred community-based participatory exercises to mark-recapture approaches given that it may be difficult to differentiate a real number of unowned dogs in reasonable body condition from measurement error and statistical variation, which may be large and encompass zero (Matter et al., 2000; Kayali et al., 2003; Totton et al., 2010; Belsare and Gompper, 2013). This may be compounded by violations of mark-recapture model assumptions, such as closed and stable populations. We determined a priori that population size was unlikely to remain constant between marking and recapture through frequent gains and losses of dogs (Morters et al., 2014). Furthermore, the study populations were not closed and were confluent with the other populations in the non-survey areas and neighbouring villages. Free-roaming dogs may travel substantial distances (Garde et al., 2012), therefore owned, unconfined dogs from the neighbouring villages may wander into the research villages.

We used PRA in Kelusa and Antiga, as a novel approach in dog ecology studies, to draw on local knowledge to obtain community-level consensus regarding the food sources of free-roaming dogs according to health and ownership status to infer the existence (or not) of unowned dogs in adequate body condition. Specifically, the PRA aimed to generate additional information about the health and ownership status of free-roaming dogs for triangulation of data from direct observations and household surveys.

2. Methods and materials

Participatory exercises were used to generate banjar-level discussion and consensus on the food sources of four independent categories of free-roaming dogs (owned, unowned, healthy and unhealthy). The exercises were designed to avoid associations between the categories so that ownership and health status were not confounded; thus, ownership status was not defined by health status.

Antiga included three banjars; and Kelusa six banjars, including one banjar not involved in the preceding surveys (Yehtengah). The banjar heads extended an open invitation to every person in their banjar to attend the PRA session. Sessions occurred from April 2011 to April 2012. With the exception of one session in Kelusa with female only participants, all sessions were held in the evening to maximise attendance. Sessions were mixed (male and female) for the Antiga banjars and for one banjar in Kelusa; however, because of cultural differences, sessions were divided into male and female for the remaining Kelusa banjars. Female sessions were run as part of the women's community groups due to a reluctance of women to attend mixed-gender banjar sessions. One banjar (Triwangsa) declined to host a female session, probably because of the caste divide unique to that banjar. The one banjar in Kelusa not involved in the preceding surveys was included in the PRA as a means to determine whether the preceding survey work may have confounded the PRA outcomes. Each session ran for approximately 3 h and included a short video on rabies prevention at the end.

The participatory exercises were developed and implemented by a fully trained, experienced external facilitator from Praxis–Institute for Participatory Practices (India). Exercises were first developed and piloted with a team of seventeen Balinese who worked for three local animal welfare organisations including the one involved in the preceding surveys. All were trained to facilitate the planned PRA exercises as a team by the external facilitator during two sessions the week before starting in the banjars. A team was trained in anticipation of large numbers of participants for each PRA session.

The PRA sessions in the banjars were implemented by the Balinese team, with the external facilitator overseeing implementation by the team in Antiga. The external facilitator was not present in Kelusa. The exercises were carried out in Bahasa and Balinese, and all verbal and written outputs were recorded in English during the sessions. All outputs were drawn by the banjar participants to accommodate the less-literate; outputs were also written by literate participants as desired. Drawings were done on paper (A1 for body mapping and $\sim$15 cm^2 sheets for food source ranking) using coloured pens.

The exercises were in three sequential parts (i) semi-structured discussion at the banjar-level, (ii) visualisation exercises at the group-level with feedback at the banjar-level, and (iii) ranking exercises at the banjar-level (Table S1). The semi-structured discussion regarding dog ownership aimed to prepare the participants for the visualisation and ranking exercises and for open discussion throughout the session. The visualisation exercises involved group-level drawings of healthy and unhealthy dogs, followed by banjar-level discussion of the drawings to establish the body condition of healthy and unhealthy dogs. Finally, food sources for four independent categories of dogs – healthy, unhealthy, owned and unowned were discussed and ranked in order of importance at the banjar-level. For each the participants were asked to ignore the other classification. For example, when ranking food sources for a healthy dog, participants ignored whether the dog was owned or unowned. Ranking was iterative, with rankings re-ordered based on discussion and debate, until consensus on the final rankings was reached. All possible food sources for each health or ownership category were listed. No attempt was made to quantify average volume of each food source in the diet of dogs in each category. With one exception (see Table S3), banjar attendees were divided into at least four groups for the group-level activities, with women in a separate group to ensure their involvement. The exercises were considered culturally appropriate given that Balinese are generally familiar with banjar-level meetings and are artistic.

Table 1
Summary of the three highest ranked food sources for Antiga (derived from Tables S5-S8 which show all the food sources and their ranks for each banjar).

Status	Rank	Food source
Healthy	1	Prepared by owner/owner leftovers
	2	Prepared by owner/offerings
	3	Neighbour leftovers/rubbish
Owned	1	Prepared by owner/owner leftovers
	2	Pig food/rubbish
	3	Offerings/dead animals
Unhealthy	1	Rubbish/faeces/dead animals
	2	Rubbish/dead animals
	3	Rubbish/pig food
Unowned	1	Rubbish/faeces/pig food
	2	Rubbish/pig food
	3	Rubbish/offerings

A summary of the three highest ranked food sources for each health and ownership category and for each village are shown in Tables 1 and 2. The summary is derived from Tables S5-S8. For example, food purchased from a pet shop by the owner and food prepared by the owner for the dog were ranked as the most important food sources for healthy dogs in Kelusa. These two food sources are stipulated in Table 2 as rank 1 for healthy dogs.

The study was approved by the Cambridge University Department of Veterinary Medicine Ethics Committee. Research permits were granted by the Ministry for Research and Technology (RISTEK), Indonesia. Permission for the study was granted by the village and banjar heads.

3. Results

The sessions were well attended, generally ranging from approximately 80–110 participants per banjar in Antiga and 35–95 in Kelusa. Two male sessions in Kelusa were poorly attended - in Peliatan because of torrential rain and in Triwangsa because of the caste divide. In the mixed sessions, the majority of participants were male, with

Table 2
summary of the three highest ranked food sources for Kelusa (derived from Tables S5-S8 which show all the food sources and their ranks for each banjar, including by participants' gender).

Status	Rank	Food source
Healthy	1	Pet shop[a]/prepared by owner
	2	Pet shop/prepared by owner/owner leftovers
	3	Owner leftovers/stolen from the neighbour/stealing poultry
Owned	1	Pet shop/prepared by owner/owner leftovers
	2	Pet shop/prepared by owner/owner leftovers/rubbish
	3	Owner leftovers/stolen from the neighbour/rubbish
Unhealthy	1	Rubbish/faeces/dead animals/vermin
	2	Rubbish/faeces/pig food/dead animals
	3	Rubbish/faeces/pig food/dead animals/vermin
Unowned	1	Rubbish/faeces/stolen from householders/dead animals
	2	Rubbish/faeces/pig food/offerings/dead animals
	3	Rubbish/pig food/offerings/stealing poultry/vermin

[a] The purchase of pet food by owners in Kelusa, but not in Antiga, is consistent with the socioeconomic differences between the villages.

approximately 8–30 female participants and a small number of children or young teenagers (Table S2).

Contrary to the preceding household surveys, during the semi-structured discussions ownership was generally based on behaviour, e.g. with owned dogs identified through being responsive to a specific person, and skin condition, rather than body condition. Only one banjar (Ayah male group) differentiated owned from unowned dogs based on body condition.

At the group-level, body condition was not consistently listed in relation to health status. However, with one exception, at the banjar-level dogs with ribs clearly visible were deemed unhealthy (Tables S3 and S4). At the group-level the number of characteristics related to health ranged from 3–13 (mode 9) and were diverse, including skin condition, behaviour, reproductive health, appetite and body condition, and a range of clinical signs. At the banjar-level, dogs with a runny nose, watering eyes, lameness, ticks and bad skin were classified as unhealthy, except for lameness in Kaler (where opinion was split), runny nose in Roban, and eye discharge in Peliatan (where two participants disagreed with the consensus that these dogs were unhealthy).

Healthy and owned dogs had similar food sources, with food prepared by an owner ranked as the most important for all banjars. Unhealthy and unowned dogs had similar food sources, with rubbish and faeces ranked as the most important overall (Tables 1 and 2). Only two banjars (Kelikikawan and Roban) inferred that unhealthy dogs may be owned and probably neglected (Table S7). The results were similar for the banjar in Kelusa not included in the conventional surveys, and for male and female groups, although the women tended to suggest fewer food sources for owned and healthy dogs, restricted to food provided by an owner (Tables S5 and S6).

4. Discussion

This study demonstrates the benefit of drawing on local knowledge through community-based approaches in dog ecology studies. However, our research also highlights the challenge of definitively identifying resident unowned, healthy dogs, particularly where most of the dogs are owned.

The results from this study were consistent with the preceding household surveys and direct observations which suggested that a resident population of healthy, unowned dogs was unlikely to exist. It had been determined a priori by these household surveys and direct observations that a. all of the healthy dogs resident in the study areas belonged to households and were fed regularly by the householders, b. a minority of dogs belonging to households in the study areas were underweight, c. the majority of the dogs not belonging to a household in the study area were emaciated (although residents in the study area reported that at least six of these dogs were unowned, it was not verified if these dogs were actually owned outside the study areas) and, d. a resident population of dogs in reasonable or good body condition not fed daily by an owner was not apparent. This suggests that healthy dogs were owned and fed by their owners and, consistent with an apparent lack of edible refuse in the environment, dogs not fed adequately by an owner were unable to find sufficient environmental resources to meet their energy requirements.

These a priori observations are supported by the PRA results. Firstly, there was no perception at the banjar-level that the most important food source for healthy dogs was anything other than an owner. Rather, food from an owner was ranked as the most important food source for healthy and owned dogs. Secondly, similar food sources were listed for unowned and unhealthy dogs, suggesting that unowned dogs are indeed unhealthy. The food sources ranked as most important for these dogs included rubbish, faeces and dead animals. Consistent with a priori observations, these food sources probably provide insufficient nutrition for free-roaming dogs and, therefore, unowned dogs are unhealthy through poor nutrition. Taken together, these results imply that it was unlikely that a resident population of unowned, free-roaming dogs in reasonable or good body condition, existed in Kelusa and Antiga that were effectively "invisible" amongst the owned, free-roaming dogs. A key implication of this finding is that, to maintain a reasonable health status, dogs are dependent upon direct provisioning by people; free-roaming dogs should not be considered as "feral" populations and people cannot be absolved from the responsibility of providing adequate care for this species. Results from this study indicate that almost all of the dogs in Kelusa and Antiga are owned and are, therefore, likely to be accessible for vaccination.

Although the key findings from the PRA and direct observations and surveys were consistent and similar to previous studies (Chambers, 1994b; Upjohn et al., 2013),

there were also important discrepancies. A high ranking score indicated that some food sources other than from the owner were perceived to be important (Tables 1 and 2 and S6), which did not accord with the preceding direct observations or survey results. In these surveys generally <2% of dogs were reported to have eaten rubbish or other food outside the household, and owned dogs were infrequently observed scavenging (Morters unpub). The discrepancy may be attributable to the PRA methodology with the participants encouraged to "brain storm" all possible food sources for each category of dog, and no attempt was made to determine the volume or frequency eaten of a particular food type. It may also reflect the contrast between the mixed and male groups and the women's groups. The women generally restricted food sources for healthy and owned dogs to the owner (Tables S5 and S6). These results are more consistent with the preceding survey results and may be more reliable given that generally the women organise the food and feed the dogs in this society.

This study was designed to identify the existence of a resident population of unowned, healthy dogs, if there was one, by inference from local knowledge. An important consideration is that, for ecological studies such as this, PRA is limited to verification of data collected by conventional methods and is not optimal when used as a sole modality. For example, had rubbish been consistently ranked equal to or higher than an owner for healthy dogs then, from this result alone, it would not be possible to differentiate between a. a resident population of genuinely unowned healthy dogs in the study area, b. some or all of the owned dogs in the study area obtaining a proportion of their nutritional requirements from rubbish, or c. the community misidentifying dogs owned outside the study area and that wander into the study area from unowned dogs. However, owner derived food was consistently associated with both health and ownership; this does not directly address the question whether unowned and healthy dogs existed, but failed to provide any evidence for their existence in any banjar. This is also supported by the observation that nutritional sources for unowned and unhealthy dogs were of poor quality and the same as those that would have been available to unowned, healthy dogs had they existed. Had PRA results diverged from results generated by our conventional methods, or had PRA been used as a sole modality, then additional objective methods would have been invaluable to triangulate the PRA results. For the example above, this would involve approaches that might have included further, intensive focus groups, or more technically demanding methods such as monitoring the movement of dogs with GPS collars.

5. Conclusion

This study has demonstrated the value of alternative approaches to mark-recapture to establish the presence of unowned dogs in adequate body condition in free-roaming populations, particularly where the fraction is expected to be small. While questionnaires have been used previously for this purpose (Butler and Bingham, 2000), PRA is a novel approach that can generate additional data to complement conventional surveys designed to evaluate the same variables. This study provides further evidence that there is unlikely to be a population of free-roaming dogs in Bali that is capable of maintaining adequate health without any direct human oversight, with fundamental implications for disease control and animal welfare.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.prevetmed.2014.04.012.

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