

Welfare assessment in pet rabbits

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Abstract

One million pet rabbits are kept in The Netherlands, but there are no data available on their behaviour and welfare. This study seeks to assess the welfare of pet rabbits in Dutch households and is a first step in the development of a welfare assessment system. In an internet survey, housing systems, general up-keep and behaviour of pet rabbits were reported by their owners. The answers of 912 respondents were analysed with behavioural observations carried out on 66 rabbits in as many households. The rabbits were observed in their home cage and during three fear-related tests: a contact test, a handling test and an open-field test. The survey revealed that the average lifespan of the rabbits is approximately 4.2 years (the maximum potential lifespan is 13 years) and solitary housing appears to reduce lifespan. Close to half of respondents subjected their rabbit(s) to solitary housing and the majority housed them in relatively small cages (< 5,000 cm²). Health risks may arise from a failure to inoculate rabbits and via inappropriate diet. During the contact test, solitary-housed rabbits made more contacts with a human than group-housed rabbits and rabbits in a small housing system made more contacts than those in a large system. Observations in the home cage differed greatly compared with the natural time budget of rabbits, ie displaying increased stereotypic behaviour and decreased foraging and, in solitary-housed rabbits, a complete lack of social behaviour. Nearly 25% of rabbits displayed strong resistance to being picked up, indicating socialisation problems. During the open-field test, solitary-housed rabbits sat up more than social-housed rabbits suggesting increased fearfulness. These findings indicate that the conditions in which pet rabbits are kept often have a negative impact on their welfare, further underlining the need to study this in greater detail.

Keywords: animal welfare, behaviour, fear tests, housing conditions, pet rabbits, welfare assessment

Introduction

Rabbits are a common pet in many western European countries and in The Netherlands their numbers are estimated at 980,000 spread throughout 462,000 households, making it the third most popular pet mammal after cats and dogs (RDA 2006). Pet rabbits are descended from European wild rabbits (*Oryctolagus cuniculus*), expressing similar behaviour (Lehmann 1991) and are likely to have similar behavioural needs. There is an implication that the radically altered living conditions of the pet rabbit, compared to their wild ancestors, may give rise to welfare problems, although, in truth, little is known of the living conditions of pet rabbits.

European wild rabbits are social animals that live within a colony in stable breeding groups of individuals sharing a home range and warren. Groups range in size from pairs to twenty or more, typically with a skewed distribution of more females than males. Within a colony, warrens have been reported to be as large as tens of meters apart and the sizes of the ranges occupied by individuals are found in the

range of 0.7 ha for males and 0.4 ha for females (Cowan 1987a). Much time is spent underground (Nelissen 1975), and foraging appears the main reason for surfacing. Outside their burrow, rabbits may be within 10 m of another individual, 40 to 50% of the time, with about twice as many associations between opposite sexes than the same sex (Cowan 1987b). Domestic rabbits observed under (semi-) natural conditions and wild rabbits behave very similarly, except that domestic rabbits tend to be less aggressive, vigilant and fearful (Stodart & Myers 1964; Kraft 1979a,b; Lehmann 1991). In order, therefore, to ensure a high level of welfare in domesticated rabbits it may be that these basic needs that are fulfilled in the wild should also be fulfilled in captivity. Further, that the induction of fear by humans and management procedures should necessarily be avoided. Since there is little known regarding the conditions in which pet rabbits are kept, their level of welfare is unknown. Guidelines for the housing of pet rabbits have been set, however, and Table 1 shows the minimum housing sizes that different NGOs recommend. Other NGOs, such as the UK-based Pet Advisory Committee (PAC undated) and the

Table 1 Minimum rabbit housing sizes recommended by NGOs.

NGO (Country)	Minimum indoor cage size (cm ²)	Minimum outdoor hutch size (cm ²)	Minimum run size (cm ²)	Source
RSPCA (UK)	16,200	16,200	–	RSPCA (2007)
RWAK (UK)	–	9,000	29,800	RWAF (2004)
Blue Cross (UK)	9,000	9,000	40,000	Blue Cross (undated)
SKB (NL)	5,000	9,000	40,000	SKB (2009)
ASPCA (USA)	7,400	–	–	ASPCA (undated)
HRS (USA)	5,400	5,400	–	HRS (undated)

RSPCA (Royal Society for the Prevention of Cruelty to Animals).

RWAF (Rabbit Welfare Association and Fund).

SKB (Stichting Konijnen Belangen).

ASPCA (American Society for the Prevention of Cruelty to Animals).

HRS (House Rabbit Society).

Table 2 Housing conditions of the observed rabbits.

Location	System	Size	Number observed
Indoor	Solitary	Small	4
		Medium	9
		Large	6
	Social	Small	1
		Medium	1
		Large	6
Outdoor	Solitary	Small	11
		Medium	7
		Large	6
	Social	Small	0
		Medium	6
		Large	9
Total number of rabbits			66

Dutch Animal Protection Society (Dierenbescherming undated) do not provide exact sizes, but state merely that housing should be large enough to allow the rabbit to perform natural behaviour. Other recommendations include the freedom to exercise regularly, either in a run or freely indoors or outdoors, and keeping rabbits together, which may make it necessary to castrate or sterilise them.

The aim of this study is to provide knowledge on the conditions in which Dutch pet rabbits are kept, using a survey on housing and behaviour, filled in by pet rabbit owners. Additionally, field observations on the behaviour and fear reactions of pet rabbits are performed, in an attempt to evaluate whether NGO guidelines and, more importantly, the assumed basic needs of rabbits as derived from behaviour in wild rabbits, are being adequately met.

Materials and methods

Survey

A survey comprising 46 questions was made available on the internet. A first part dealt with general information regarding the household, such as owner's sex, age, composition of the household, and area of residence. A second part, included questions on numbers of rabbits being kept, housing condition and care given by owners. In a third part, owners were then asked to describe the personality and behaviour of one of their rabbits in greater detail. Owners could indicate whether the experimenter would be welcome to visit and observe the behaviour of one of their rabbits. The survey was advertised by placing announcements on 18 websites and posting flyers in 18 pet shops and veterinary practises around the city of Gouda, The Netherlands. The survey was online between 31 August and 4 December 2006.

Behavioural observations

For the animal-based assessment of the rabbits' welfare, the undisturbed home cage behaviour and fear-related behavioural responses were measured in a subset of rabbits. One rabbit per household was observed in the period between 19 September and 1 December 2006 ($n = 66$). Table 2 shows how these rabbits were housed; either indoors or outdoors, solitary or social, and in a small, medium or large housing system. The housing system size is derived from a combination of the size of the cage or hutch (small [$< 5,000$ cm²], medium [$5,000$ – $7,000$ cm²] or large [$> 7,000$ cm²]), the size of the run (small [$< 5,000$ cm²], medium [$5,000$ – $7,000$ cm²] or large [$> 7,000$ cm²]) and the time the rabbit is allowed to run free (never, rarely, often, always). For example, a rabbit with a small cage without a run that is allowed to run free always is classed as having a large housing system.

The most commonly used fear tests in domestic animals are novel object, restraint or handling and arena tests (Forkman *et al* 2007) and similar procedures were applied in the present

Table 3 Ethogram for behavioural observations.

Behavioural category	Behavioural elements and description
Active	Chewing toy, Chewing other (chewing anything that is not part of the cage or is a toy), Licking toys, Licking other (licking anything except cage items or toys or drinking nipple), Throwing toy
Comfort	Grooming self, Scratching, Stretching (this may include yawning)
Digging	Pawing toy (digging in a toy or sand)
Exploration	Rearing (standing or sitting on hindlimbs with both forelimbs off the ground), Sniff (sniffing the environment)
Inactive	Lying alert (lying down with at least one hindleg stretched out with the eyes open and responding to the environment whilst remaining relatively inactive), Sitting down (differs from lie down in that the hindlegs are not stretched out), Sitting up (the forelimbs are not folded beneath the body but are straight so the thorax and abdomen are clear of the floor and visible), Sleeping
Locomotion	Frisky hopping (very rapid circling or leap accompanied by a secondary behaviour which includes one or more of the following; shaking or twisting of the body, flicking of the head and kicking at walls with hindfeet), Hopping, Running
Maintenance	Eating, Drinking, Defaecation, Coprophagy
Social	Grooming rabbit (grooming another rabbit)
Stereotypy	Chewing cage, Licking cage, Nosing (rabbit pushes its nose between the bars of the cage and may or may not slide it up and down or back and forth), Nudging (pushing loose objects around with the head), Pawing cage (digging vigorously in some part of the cage or surrounding), Throw cage (throwing cage objects other than toys around).
Other	Biting rabbit, Building nest, Chasing, Chin-marking (rubbing of the chin over any object), Invisible (rabbit is invisible to observer), Jumping, Rolling (rabbit throws itself onto one side and then lies or sleeps), Shaking, Sneezing, Thumping, Urine marking, Mounting object, Mounting rabbit, Other (all other behaviour)

study. The test was made up of four consecutive stages: (1) a novelty test (or contact test); (2) home cage observations; (3) a restraint test (or handling test) and (4) an arena test (or open-field test). During the contact test, the experimenter put her hand within sight of the rabbits against an area of the housing system for five minutes (Bilkó & Altbäcker 2000). The contacts, ie the number of times rabbits touched and/or sniffed the hand with their nose were recorded. Rabbits that ran around freely, were put in their housing system during this test. Home cage observations lasted one hour using continuous focal sampling and an ethogram of behavioural elements grouped into ten behavioural categories (Table 3), derived from Gun and Morton (1995) and Hansen and Berthelsen (2000). Data recording was computer-assisted using Observer® 5.0 (Noldus, Wageningen, The Netherlands) software and a Workabout® (Psion, Mississauga, Canada). The observer remained 2 m from the home cage and was in sight of the subject.

The handling test consisted of picking up a rabbit in a standardised way; one hand placed on the scruff of the neck and one hand beneath the posterior to support the rabbit's weight, holding the rabbit against the experimenter with its head under one arm. The test ended by putting the rabbit back down. The degree of resistance was scored on a scale from 1 to 4 with ascending numbers indicating, respectively: (1) no struggling at all; (2) only struggling when first being picked up; (3) struggling when first being picked up and when being put down again and (4) continuous struggling from first being picked up until being put down again.

The third fear test was an open-field test, with locomotor activities being the main readout parameter (Daniewski & Jezierski 2003). A mobile pen was placed in an area unknown to the rabbit. The pen consisted from six panels made of metal bars (85 × 63 cm; width × height). Together, they formed a hexagon covering an area of 8,740 cm². The rabbits were placed inside for five minutes. During this time, continuous focal sampling was performed using the same ethogram as for the home cage observation.

Data processing and analyses

All data were analysed using Microsoft Excel® (version 2003) and SPSS® for Windows (version 15.0) software.

Survey

The survey did not stipulate that every question was to be answered and a number of questions only applied to subsets of participants. Consequently, the number of entries varied per question and results will be presented as percentages of these entries.

Behavioural observations

The behaviours recorded during the contact test were expressed as the total number of contacts for the five-minute period. The one-hour home cage observation of the rabbits' behaviour yielded a time budget expressed as percentages of observation time. The handling test data were ordinal with scores being 1, 2, 3 or 4. From the open-field test, the frequency of behaviours was analysed. The Mann-Whitney *U*-test was used to analyse differences between

Table 4 Survey answers to questions about rabbit housing systems.

Rabbit housing information (per household)	Level	Records (n)	(%)
Number of rabbits	One	286	31
	Two	335	37
	More	288	32
Housing of rabbits	Indoors	323	35
	Outdoors	525	58
	Indoor and outdoors	62	7
Number of rabbits kept in one housing system indoors	Single	218	67
	Duo	78	24
	More	5	2
	Unknown	15	5
Number of rabbits kept in one housing system outdoors	Single	192	37
	Duo	178	34
	More	46	9
	Unknown	109	21
Allowed to run free	Outdoors	533	58
	Indoors	505	55
	Never	193	21
Frequency allowed free	Daily	479	54
	Weekly	155	17
	Rarely	256	29
Durations per session	> 120 min	402	54
	30–120 min	282	38
	< 30 min	65	9

indoor/outdoor housed rabbits and between solitary-housed rabbits or those housed socially. The Kruskal-Wallis test was used to analyse differences in the behaviour of rabbits kept in small, medium or large housing systems (Table 2). If housing size effects were significant, the Mann-Whitney *U*-test was used for testing specific contrasts.

Results

Survey

Respondents

Most of the respondents were women (90% of 911 entries, hereafter referred to as *n*) older than 18 years (88%), representing households that consisted, on average, of 2.9 (\pm 1.6) members. Fifty-one percent (*n* = 910) of the participating respondents lived in a city, with the remainder living in a village (41%) or in the country (8%).

Rabbit origin and housing

Most rabbits had been purchased from a pet shop (33%, *n* = 887) and the others had been obtained from breeders (15%), asylums (14%), family (11%) or born into the household (7%). Table 4 provides a detailed overview of the rabbits' housing conditions and here some main points are singled out. Thirty-one percent of the respondents only owned one rabbit and 37% owned two. Thirty-five percent of the respondents kept their rabbit(s) strictly indoors. Owners that housed their rabbits indoors typically kept them solitary (67%). The sizes of the indoor housing systems, excluding runs, were in 22% of cases 'small' (< 5,000 cm²), in 38% 'medium' (5,000–7,000 cm²) and in 40% 'large' (> 7,000 cm²), with the median size being 6,000 cm². In 37% of the outdoor housing systems, rabbits were solitary. The sizes of outdoor housing systems, excluding runs, were typically large (66%), with the median size being 9,000 cm². Twenty-one and 13% were medium and small, respectively. The majority of respondents let their rabbit(s) walk free on occasions, in the garden (58%) or house (55%), whereas 21% never let the rabbit(s) run free. The latter category involved rabbits that were mainly housed outside (90%), as opposed to inside, in relatively spacious housing systems of approximately 9,600 cm² (median) and 10,000 cm², respectively. Approximately half of the respondents that allowed their rabbit(s) out did so on a daily basis (54%, *n* = 890) or allowed their rabbit(s) out for more than 2 h per session (54%).

Management

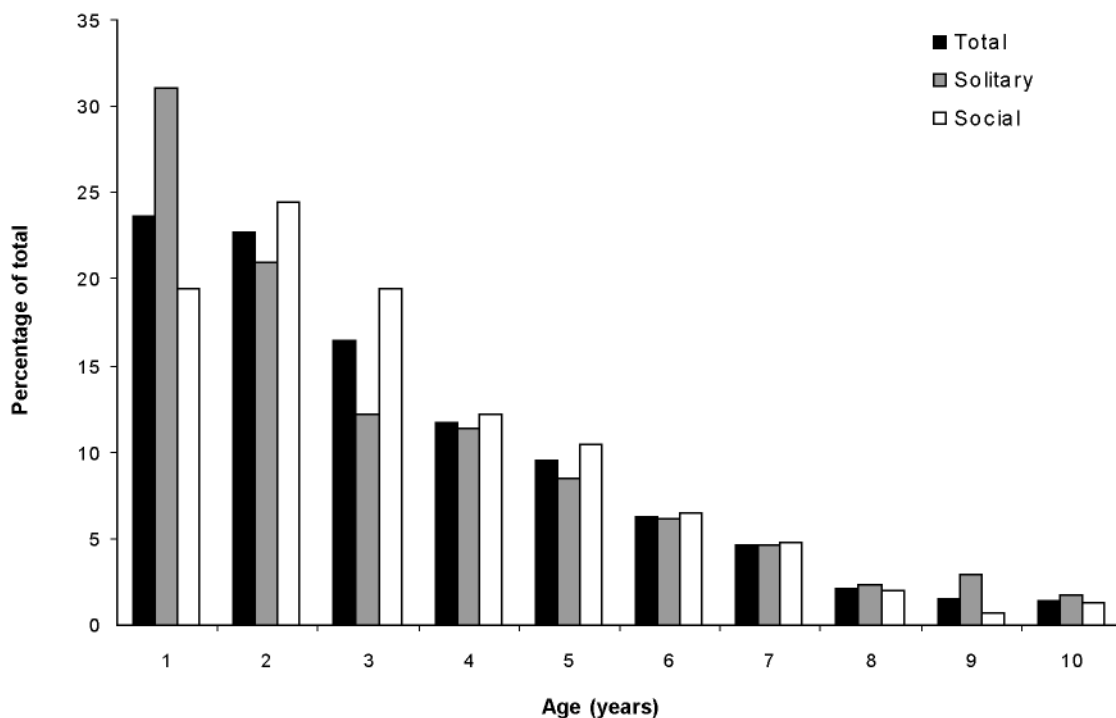
Housing systems were cleaned at a frequency that varied from daily (9%, *n* = 909) to weekly (79%) to less than weekly (12%). Housing systems that were cleaned less than once a week were, in 73% of cases, outdoor systems sized approximately 8,400 cm² (median) and in 27% of the cases indoor systems measuring around 5,400 cm².

Owners were asked whether their rabbit(s) had been inoculated earlier that year. In 44 and 46% of households in 2006 (*n* = 908), rabbits had not been inoculated against myxomatosis and rabbit haemorrhagic disease (RHD), respectively.

Seven percent of the respondents (*n* = 899) had never handled their rabbit, 53% picked it up by putting one hand around the chest and one hand under the posterior for support, and 25% held the rabbit by the scruff of the neck whilst supporting the posterior with the other hand. The majority of respondents indicated that rabbits stayed calm when being picked up (43%, *n* = 842) or struggled lightly (44%).

A total of 886 respondents provided information on the diets of their rabbit(s). Types of food that were given on a daily basis were hay (85% of respondents), dry food (63%), vegetables/fruit (54%), bread (17%), and candy/snacks (12%). The percentages of respondents that fed these types of food: (i) on a weekly basis were, respectively, 8, 5, 28, 21 and 13% and (ii) never to less than once a month, 5, 32, 11, 48 and 66%.

Figure 1



Percentage of rabbits per age category. The x-axis represents the maximum age for a given category, with rabbits older than 9 labelled as 10. Results are presented for all the rabbits (black bars) and separately for rabbits that were reported to be frequently in contact with other rabbits (white bars) and those that were not (grey bars).

Age of rabbits

For one of their rabbits, the respondents answered questions regarding its age and behaviour. The average age of the rabbits was $2.8 (\pm 2.3)$, ($n = 901$) years with the oldest rabbit being 12.5 years. The proportion of rabbits younger than 1 year was 23%. This means that, when mortality prior to the age of one is ignored and the population is assumed to be stable, the mean age at which pet rabbits die is approximately 4.2 years (ie $100/23.6$). The social living conditions of the rabbits could influence their life expectancy and age distributions were calculated separately for rabbits that had contact with conspecifics regularly and those that were kept solitary (Figure 1). The estimated age at which solitary- and socially-housed rabbits die is 3.3 and 5.1 years, respectively.

Rabbit behaviour

Questions concerning how often specific behaviours were performed were answered by at least 818 respondents. Repetitive behaviours (stereotypies) regularly demonstrated were 'digging' on a solid surface (47%), gnawing on parts of the housing system (17%), and the manipulation of food trays (28%) or water bowls/spouts (22%). Behaviours that we assumed to be related to fear and/or aggression were biting humans, which occurred regularly in 2% of the rabbits, biting other rabbits (3%) and thumping the hind legs on the ground (18%). Regarding resting behaviour, lying fully stretched was reported as a common behaviour for 91% of the rabbits.

Behavioural observations

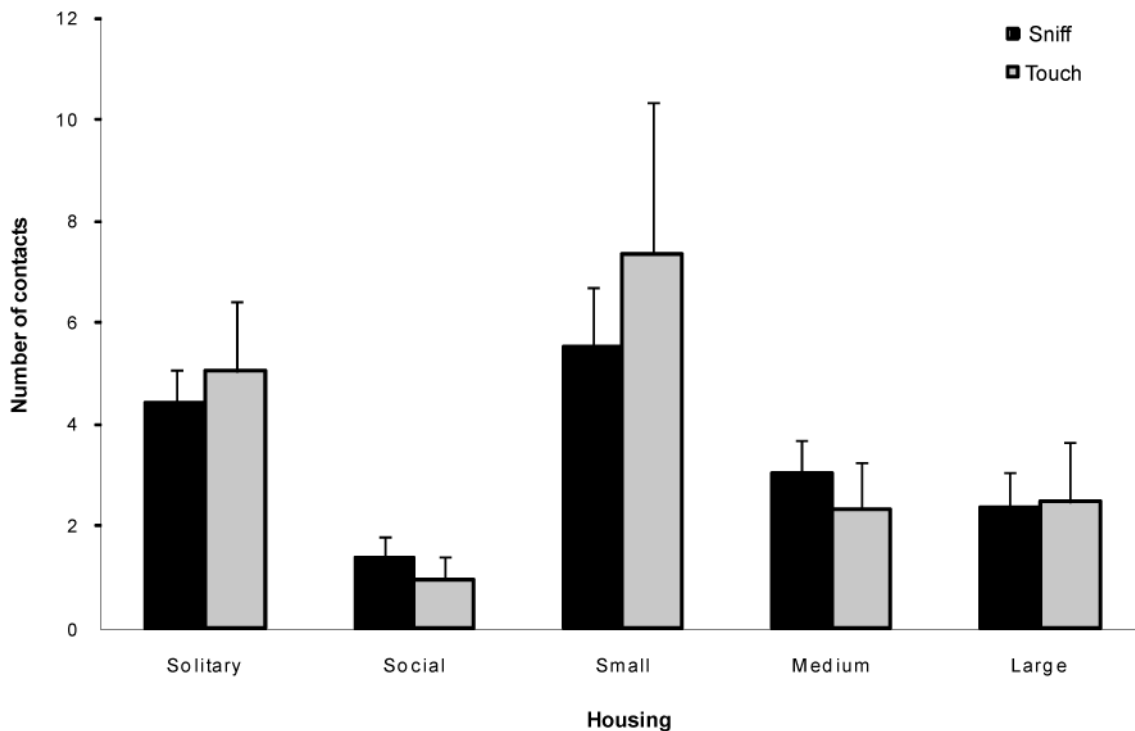
Contact test

In the contact test, there were no differences between indoor ($n = 27$) or outdoor ($n = 39$) rabbits regarding the number of times the experimenter's hand was sniffed or touched. In comparison with rabbits housed together ($n = 23$), solitary individuals ($n = 43$) showed more sniffing (Mann-Whitney $U = 259$; $P = 0.001$) and touching ($U = 274.5$; $P = 0.001$) (Figure 2). Kruskal-Wallis tests showed that rabbits from differently-sized housing systems showed differences in the number of sniffs (chi-square = 7.62; $P = 0.022$), but not touches (chi-square = 4.57; $P = 0.102$). Rabbits from small housing systems ($n = 16$) showed relatively high levels of sniffing compared to rabbits from large housing systems ($n = 27$, $U = 109.5$; $P = 0.006$) (Figure 2).

Home cage observation

The behaviour performed by rabbits in their home cage was observed for one hour. The time budgets of indoor- and outdoor-housed rabbits are shown in Figure 3. Time budget data on rabbits living under (semi-) wild conditions, as reported by Selzer (2000), are added for comparison. Selzer (2000) observed wild rabbits in nature, covering an area of 5.3 ha; wild rabbits in a 150 m² enclosure surrounded by a 2 m high wooden wall and containing several objects that act as bold holes (eg plastic

Figure 2



The number of times (per 5 minutes) that rabbits sniffed (black bars) and touched (grey bars) the hand of the experimenter during the contact test. Results are presented separately for rabbits kept solitary or social and for rabbits kept in different-sized systems as defined in Table 2 (small, medium or large).

pipes); and domestic rabbits in a similar enclosure as the wild rabbits. No significant differences were found between time budgets of rabbits housed outdoors or indoors, housed solitary or socially (except for social behaviour) or housed in small, medium or large systems. Some stereotypic behaviour was noted in this study: 1.74% in solitary-housed rabbits ($n = 43$) and 0.26% in those socially housed ($n = 23$), however this difference was not significant.

Handling test

The percentage of rabbits ($n = 66$), ranging from those that did not struggle when being handled to those that struggled constantly were 51, 27, 12 and 10%, respectively. There were no significant differences in the intensities of struggling between rabbits kept indoors and outdoors, solitary and socially or in small, medium and large systems. There was a tendency for outdoor-housed rabbits to struggle more than those housed indoors ($U = 336$; $P = 0.090$) and six out of seven rabbits struggling constantly were housed outdoors.

Open-field test

Solitary-housed rabbits sat up more in the open-field (mean 12.4, $n = 43$) than socially-housed rabbits (mean 9.4, $n = 23$, $U = 309.5$; $P = 0.023$). There were no differences between rabbits housed indoors and outdoors or between rabbits housed in small, medium and large housing systems.

Discussion

Pet rabbits are kept under living conditions that differ greatly from those of their relatives the European wild rabbits (*Oryctolagus cuniculus*), and this raises questions concerning their general level of welfare. The latter has been scarcely studied and for the purposes of this study, a welfare assessment was carried out via a survey on the housing and behaviour of pet rabbits which was completed by owners.

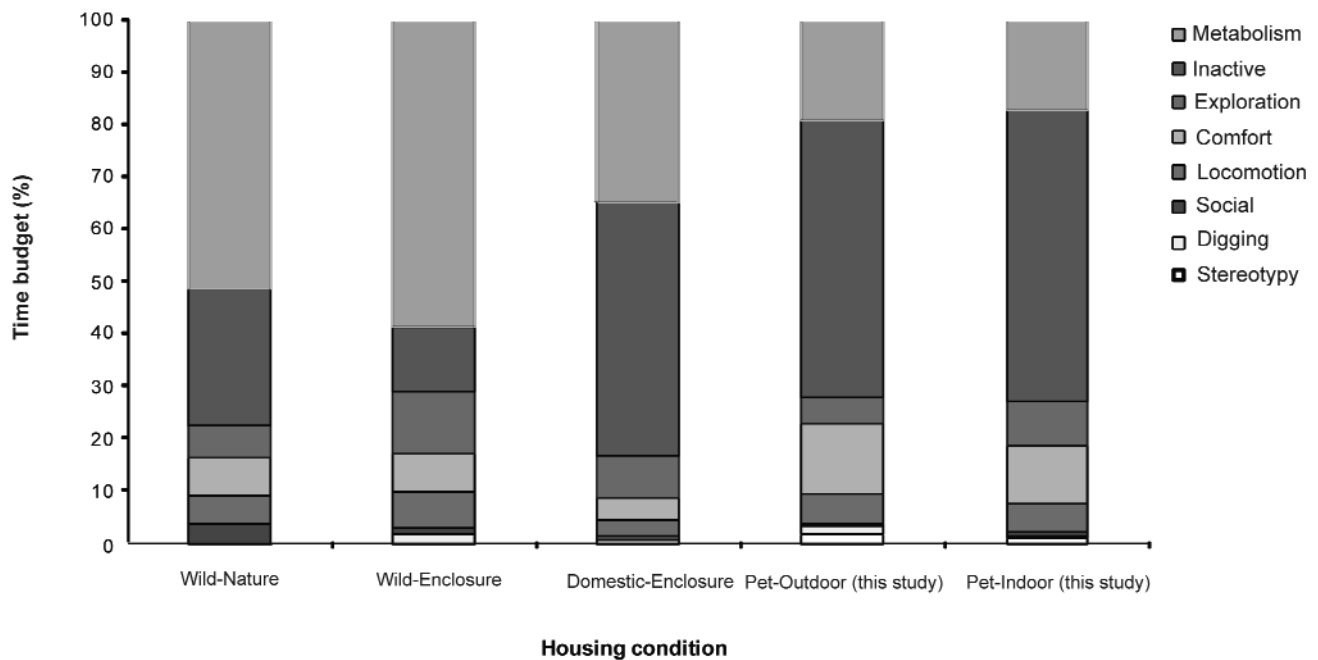
Survey

The internet survey yielded 912 entries, representing as many households, with the vast majority of respondents being females (90%). Respondents participated on their own initiative, reacting to recruitment advertisements and, in doing so, almost certainly showed themselves to be more interested in the behaviour and welfare of pet rabbits than the average rabbit owner. Consequently, the present results on housing conditions and behaviour will be on the positive side of the spectrum.

Rabbit housing

An earlier survey held amongst 80 Swiss people indicated that most (55%) kept their rabbit(s) outdoors (Muser Leyvraz *et al* 2007) and the present survey confirms this to be the case for The Netherlands (58%). Approximately one-fifth (22%) of indoor-housed rabbits live in housing systems sized less

Figure 3



Time budget of wild and domestic rabbits in different environments. The first three bars represent data from Selzer (2000). 'Wild-nature' concerns wild rabbits in nature, which cover an area of 5.3 ha, 'Wild-enclosure' concerns wild rabbits in a 150 m² enclosure surrounded by a 2 m high wooden wall and containing several objects that act as bolt holes (eg plastic pipes), 'Domestic-enclosure' concerns domestic rabbits in a similar enclosure as 'Wild-enclosure'. 'Pet-Outdoor' and 'Pet-Indoor' concern the pet rabbits in the present study.

than 5,000 cm² (classed as small in this study). Such conditions are in stark contrast with the hundreds of square meters occupied by wild rabbits (Cowan 1987a) and could attribute to poor welfare. Outdoor housing systems were typically one-and-a-half times larger than indoor systems, with a median size of 9,000 cm², and only 13% of the outdoor housing systems were considered 'small'. A subset of respondents were visited and the housing systems were measured. On the one hand, rabbit living space had been underestimated somewhat as a number of them had (intermittent) access to a run or were let out on a regular basis, whilst, on the other, owners had overestimated the size of the housing systems. Hence, the actual percentage of people that keep their rabbits in a large housing system is probably lower than results suggest. Regarding the guidelines offered by different NGOs in The Netherlands, the UK and the USA (Table 1) it would appear that about 20% (ie, when adapting a minimum size of 5,000 cm²) to 40% (ie, when adapting a minimum size of 7,000 cm²) of pet rabbit housing systems are too small.

Rabbits are group living, social animals (Cowan 1987a) and it has been previously argued that they should not be solitarily housed (Held *et al* 1995; Chu *et al* 2004; Jones & Phillips 2005; Seaman *et al* 2008). However, in line with the work of Muser Leyvraz *et al* (2007), the results of the present survey indicate that almost half (48%) of households are guilty of this. Given that about 462,000 households keep rabbits (RDA 2006), this would mean that over

220,000 are solitarily housed in The Netherlands. The number of pet rabbits affected by social deprivation would appear to represent a significant welfare issue, although, clearly, unanswered questions remain regarding the precise implications of being denied contact with another rabbit and, for example, the degree to which this can be compensated for by human contact.

Dutch NGOs, such as 'Stichting Konijnen Belangen' (SKB 2009), state that a rabbit should run free at least three hours each day, which makes sense from the perspective of the wild rabbit behavioural repertoire. Only 54% of respondents allowed their rabbit(s) out of the home cage daily and, as most people do not have a large housing system for their rabbits, it would appear that a considerable number have suboptimal freedom to move around, explore and exercise. One-fifth of respondents indicated that they never allowed their rabbits out of the home cage, but this typically involved outdoor systems (90% of cases) of considerable size (median of 10,000 cm²).

Management

NGOs (eg SKB [2009] and the PAC [undated]) recommend that faecal and urinary waste should be removed daily from the designated area of the housing system with the entire system being cleaned once a week. Generally, it appears that these guidelines are being followed as only 12% of respondents cleaned the housing system less often than weekly.

Rabbits are vulnerable to the deadly diseases myxomatosis and rabbit haemorrhagic disease (Fenner & Fantini 1999), which are transmitted by biting insects and physical contact. Annual inoculation of all rabbits is recommended (preferably in spring), regardless of whether they are housed indoors or outdoors. Almost half of the respondents (45%) did not inoculate their rabbit(s) against these diseases in 2006, identifying a serious liability in times of widespread disease outbreaks.

Less than a tenth of the respondents (7%) never handled their rabbit(s). One quarter picked rabbits up in the recommended manner, namely by the scruff of the neck and placing one hand beneath the posterior to provide the rabbit with support while ensuring a good grip to prevent it from falling should it struggle. An appropriate way of holding the rabbits may help in accident prevention as 57% of the owners reported that their rabbit(s) struggled (somewhat) when picked up.

The daily menu of pet rabbits included hay (reported by 85% of respondents), dry food (63%) and/or vegetables/fruit (54%). The provision of hay on a daily basis aids digestion and helps prevent stereotypic behaviour (Lidfors 1997; Hansen & Berthelsen 2000); and in 15% of households this basic requirement was not met. Approximately one-third of respondents failed to provide vegetables on a daily basis. Moreover, a range of 10–20% of owners admitted to feeding their rabbits bread, rabbit treats (high in sugar) and human snacks: food items all capable of leading to obesity and resultant health problems.

Age of rabbits

Our results suggest that pet rabbits in The Netherlands reach a mean age of 4.2 years, which appears to fall well short of the 13-year lifespan potential of rabbits (Altman & Dittmer 1972). Only 4% of respondents had a rabbit older than eight years. Solitary housing could be one of the main contributing factors as Figure 1 demonstrates that rabbits allowed daily contact with conspecifics show a different age distribution and higher maximum lifespan potential than solitary-housed rabbits. Restrictions in living space and exercise, sub-optimal feeding and a lack of protection against diseases are other factors identified as potential causes of premature death in our study.

Rabbit behaviour

Rabbit behaviours that have been linked to poor welfare include pawing or scratching the housing system, gnawing at the bars, pulling or biting the drinking spout, throwing or pushing the food bowl, thumping of hindfeet and not lying down fully stretched (Gun & Morton 1995). These behaviours were reported to occur regularly in a large number of rabbits: adding to the impression that a considerable proportion of the pet rabbit population experience suboptimal welfare.

Behavioural observations

The selection of rabbits observed was guided mainly by respondents' willingness to co-operate, and the subset of

rabbits was not representative of the population as a whole regarding factors such as type of housing system. This suggests that behavioural findings should be regarded merely as being explorative, leading to further investigation, rather than conclusive. However, Würbel and Garner (2007) argue that environmental standardisation results in pseudo-replication, as it increases the dependency between the experimental subjects and hides poor external validity. Thus, despite the fact that these results should be interpreted with caution, they do provide an impression of rabbit behaviour under a variety of housing conditions.

Home cage observation

The one hour recordings of rabbits' time budgets were collected with the observer in sight of the rabbit being studied and, as such, this may have influenced behaviour, ie these results should be interpreted with caution. Rabbits spent more than 50% of their time inactive — a substantial proportion compared to natural behaviour as measured by Selzer (2000), in an open area of 5.3 ha and an enclosure of 150 m². Under free-ranging conditions, increased activity levels result from metabolism-related behaviour (mainly eating). The domestic rabbits studied by Selzer (2000), in an enclosure of 150 m² showed levels of activity and metabolism-related behaviour intermediate to the wild rabbits and the pet rabbits studied here. The time budget of the pet rabbits, compared to those that are free-ranging, suggest welfare problems in that rabbits are inactive, have short foraging times, perform stereotypic behaviour and, when housed in solitary, cannot perform social behaviour.

Fear-related tests

Solitary-housed rabbits sniffed and touched the observer's hand significantly more often than rabbits housed together. According to Bilkó and Altbäcker (2000), this means that solitary rabbits are less fearful of an unknown human than rabbits living together. An alternative explanation is that solitary rabbits are highly motivated to seek social interaction as they are more deprived of these compared to rabbits living together. Also, housing system size was associated with the number of sniffs that rabbits demonstrated during the contact test, with relatively high scores for rabbits in small housing systems. This suggests that these rabbits are less fearful of an unknown human, but an alternative explanation would be simply that they were closer to the hand of the observer. In the handling test, almost a quarter of the rabbits struggled and this was observed relatively frequently for rabbits housed outdoors. Such struggling can be considered a sign of fear of (unknown) humans and indicative of suboptimal socialisation. In the open field, solitary-housed rabbits sat up more than those kept together and, thus, appeared more alert and fearful in strange situations. Although this provides some indication for solitary-housed rabbits being relatively fearful, it may be context specific and even reversed in (social) situations, such as the human approach test.

Conclusion and animal welfare implications

Outcomes of the survey demonstrate that although conditions in which pet rabbits are kept in The Netherlands vary considerably, they frequently harbour threats to rabbits' welfare. Housing conditions are inadequate, in that cages are typically small and rabbits are solitary housed. The latter is associated with decreased lifespan. Health risks may arise from a lack of veterinary care (inoculations) and inappropriate diets deficient in hay and abundant in sugar. Behavioural observations indicate substantial discrepancies from a (semi-) wild rabbit's time budget, especially in the reduced time spent on foraging behaviour. Owner-reported prevalence of abnormal behaviours add to the impression that the behavioural needs of rabbits are often not fulfilled. The observed fear of humans and novelty may point to inadequate socialisation of rabbits to a domestic environment. This study is the first step in the assessment of pet rabbit welfare and our results demonstrate it to be a matter of importance that should be studied in greater detail.

Acknowledgements

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