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Health survey of pet guinea pigs in Norway

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LIST OF ABBREVIATIONS

NFSA – Norwegian Food Safety Authority

NGPC – Norwegian Guinea Pig Club

CSM – Colonic Separation Mechanism

1. INTRODUCTION

Guinea pig (*Cavia porcellus)* are popular house pets in Norway, especially among families. However, their social and biological needs are frequently underestimated. There is a common misconception that guinea pigs are considered easy to care for, compared to other more popular pets such as dogs and cats. Despite their small size, guinea pigs require a considerable amount of time and care in order for them to flourish. They thrive in a spacious environment with an abundance of social interactions, possibilities for mental stimulation and opportunities for exercise.

Unfortunately, numerous well-intentioned owners may not fully understand the extent of their guinea pigs' actual needs, leading to potential issues related to loneliness, boredom and inadequate care. Veterinarians, breeders and other communities with relevant expertise have an important role in educating current and future owners about the specific requirements of what is considered good guinea pig husbandry and welfare. This includes a well-balanced diet, social companionship, environmental enrichment and proper healthcare to avoid preventable diseases and aberrant behaviours.

The Norwegian Food Safety Authority (NFSA) has a free downloadable information booklet called “Guide to guinea pig keeping” on their website. This booklet was developed mainly for owners and intended to be a reliable source of information, describing both the biological and physiological needs of guinea pigs and their husbandry. However, as no official regulations regarding pet guinea pigs in Norway currently exist, it also serves as a basis for potential future legislations on guinea pig husbandry and keeping. The booklet was developed and published by the NFSA, with the help of influential contributors within the guinea pig community, the most important one being the Norwegian Guinea Pig Club (NGPC).

2. LITERATURE REVIEW

2.1. Nutritional physiology of the guinea pig

The domestic guinea pig breeds belong to the *Cavia porcellus* species in the *Cavia* genus of the *Caviidae* family, originating from the grasslands and Andes mountains of South America. They were first introduced to Europe by Spanish colonialists back in the 16th century, and have since then been commonly kept as pets or as a food source, in addition to being extensively used in medical research as laboratory animals [22]. Considering the

environmental habitat of their origin, their diet consists mainly of grasses *(Poaceae)*, often dry and rich in undigestible cellulose depending on the seasons.

The oral cavity of guinea pigs is longitudinally narrow with a large tongue. The dentition consists of 20 teeth in 4 arcades, 1 incisor, 0 canines, 1 pre-molar and 3 molars in each. All the teeth are hypsodontic, aradicular and elodontic, with a large crown that can be divided into a clinical and a reserve crown. The teeth do not create roots and the apex remains open, meaning that they will grow continuously throughout the guinea pigs lifespan [10]. Hence, without sufficient wear through a fiber-rich diet, severe malocclusions may occur which again may ultimately lead to an inability to eat, and starvation as a result.

Guinea pigs are monogastric animals and the stomach can be divided into the same four regions as most small mammals, namely the cardia, fundus, corpus, and pylorus. The average gastric emptying time is approximately 2 hours, with a total overall gastrointestinal transit time typically averaging at 20 hours when referring to dry faecal pellets. Guinea pigs differ from rabbits in that they have inherent lactobacilli and primarily generate propionic acid as their main fatty acid [6]. In addition, guinea pigs are more efficient at digesting fibre. Satiety is not determined by the amount of calories consumed, but rather by distension of the gastrointestinal tract. Up to 65% of the total gastric contents are contained within the caecum, which is the largest part of the guinea pigs' gastrointestinal tract.

The guinea pig is classified as an obligate herbivorous hindgut fermenter, practising a form of coprophagy termed caecotrophy. Caecotrophy may be performed as much as 150-200 times a day. The contribution of this practice to the guinea pigs' nutritional needs has not yet been fully characterized as opposed to rabbits. Coprophagy requires a digestive mechanism through which more valuable small particles and bacteria are separated from less valuable components of the digesta, often indigestible or that are hard to digest. This mechanism has been termed the colonic separation mechanism (CSM). [13] The specific CSM guinea pigs use is termed the “mucous-trap”, referring to how bacteria originating from the caecum are trapped in the mucous of the colon with little to no food particles before they are returned to the colon by antiperistalsis.

The caecotrophs or soft faeces is a separate type of faeces compared to the normal dry faeces which are made from mostly insoluble fibrous waste. They are nitrogen-rich and contain essential amino acids and short-chain fatty acids, in addition to essential vitamins such as vitamin K and B12 which are produced by the bacterial flora of the gut [18]. Caecotrophs are generally produced during inactive or resting periods, opposite to feed intake and they are consumed directly upon exiting the anus. However, certain health conditions, such as obesity, pregnancy or arthritis, can prevent the guinea pig from directly ingesting the caecotrophs due to physical difficulties in reaching the anus.

2.2. Nutrition of pet guinea pigs

Current readily available diet recommendations are primarily based on nutritional guidelines for laboratory animals and drawing conclusions from other small hindgut fermenters, such as rabbits, leading to inconsistent dietary guidelines. This is currently a matter of concern within the veterinary field, animal welfare organizations, and pet food manufacturers [12].

Nutritional requirements may also vary according to age, breed, sex, season or climate, and husbandry. According to current dietary recommendations proposed by the NGPC, *ad libitum* hay of good quality should be the primary source of nutrients, representing at least 80% of their diet. In general, the crude fibre level of the average adult guinea pig diet should be approximately 10-16%, unless the individual is either still growing or lactating in which the crude fibre level should be increased to 18-20% [11] The hay should be free from dust, mould, yeasts and other contaminants or additives, and it should be harvested at an appropriate stage of maturity. Silage should not be fed due to its acidic pH negatively affecting the balance of the bacterial gut flora.

Generally, grass hay or grass blends are recommended over legume hay such as alfalfa, due to the excess amounts of energy and calories of legume hay. In addition to being very energy-dense, alfalfa or lucerne (*Medicago sativa)* also contains high amounts of proteins and calcium. Feeding a high-calcium diet has been suggested to contribute to the formation of uroliths, which is a frequently encountered problem in pet guinea pigs [3]. Out of the grass hays, timothy (*Phleum pratense)* is considered the best choice of feed for adult guinea pigs. Timothy hay replicates the appropriate calcium-to-phosphorus ratio observed in natural forages, promotes gastrointestinal motility, and assists in obesity prevention.

Another important dietary requirement of guinea pigs is an external source of ascorbic acid or vitamin C. Similar to humans, guinea pigs lack the enzyme L-gluconolactone oxidase, which is essential to synthesize ascorbic acid from L-gluconolactone. Hypovitaminosis C, commonly referred to as scurvy, typically manifests after a period of as short as two to three weeks of inadequate dietary vitamin C intake [22]. The guinea pig needs to consume approximately 10 mg/kg or 1 mg/100g of vitamin C per day, a requirement that can be met through a well-balanced diet, or by supplementing it in the feed or drinking water.

Approximately 15% of the guinea pigs' diet should consist of fresh greens and vegetables. It is important to offer the guinea pig small amounts of a variety of greens and vegetables when they are still young, as they become neophobic with age [4]. The remaining 5% of the dietary recommendations may consist of concentrates. Fresh water should be provided daily, presented based on the preferences of the guinea pig. Water can be presented either in nipple drinkers or in bowls. If the water source is changes, it should happen gradually, as guinea pigs are known to die from dehydration if the watering systems are changed from bowls to nipple drinkers suddenly [4].

2. 3. Housing of pet guinea pigs

Currently, there is no regulated minimum requirement regarding the size of the permanent housing of pet guinea pigs in Norway. However, the NGPC (2023) suggests that the cage or enclosure should measure at least 120x60 cm. Guinea pigs are social beings naturally living in small herds or colonies, hence in order for them to thrive, at least one other guinea pig companion is a precondition for decent guinea pig welfare. The permanent housing should be big enough, for all the individual guinea pigs living there, to be able to explore, exercise and distance themselves from the others in case of conflict. There should be enough food and water sources, hiding places and environmental enrichment to prevent competition relating to resources. If the size of the permanent housing is too small, it can lead to endocrine stress reactions, causing fighting or bullying and discrimination towards the lower-ranking members of the hierarchy.

Based on basic research into the guinea pig's social life and welfare, there are certain recommendations on social housing and herd composition. Usually, housing in pairs works well, regardless of the sexes, especially if they are brought up together or there is a considerable age difference. Housing in harems is also appropriate, agonistic interaction may

occur between the females, however, aggression is rare and of low intensity. Aggression between females in all-female groups is slightly higher than between females living in harems, however, it rarely escalates. Even though agonistic behaviour between two males living together rarely occurs, larger groups of males tend to show agonistic behaviour when the individuals reach 3-4 months of age. Mixed-sex groups are, from a biological point of view, the favoured housing condition. This way, the individuals learn social skills necessary for interactions, with there being both dominant and subordinate individuals [8]. However, such groups should have a varied age structure, and require the males to be castrated in order to prevent unwanted offspring.

2.4. The most important diseases of pet guinea pigs

Vitamin C deficiency

In numerous epidemiological studies, suboptimal levels of vitamin C have been linked to increased morbidity and mortality from health conditions such as cancer and cardiovascular disease [5]. Inadequate dietary intake of vitamin C can lead to clinical signs of hypovitaminosis or scurvy within two to three weeks. Initial symptoms include lameness or joint pain as a consequence of intra-articular haemorrhage, as well as anorexia, weight loss, and a general decline in health, which may potentially lead to death if left untreated. In some cases, diarrhoea may also occur. Scurvy can also occur subclinical, manifesting as a generalized reduction in immune function, increasing the incidence of acute enteritis, bacterial pneumonia, and skin infections [22].

Dental disease

In guinea pigs with dental disease, the most common clinical presentation is malocclusion of the premolars and molars, commonly referred to as cheek teeth. The mandibular teeth will extend into the oral cavity, forming a distinctive ‘bridge’ entrapping the tongue. Consequently, incisal malocclusion may occur secondarily but rarely exists without trauma or simultaneous overgrowth of the cheek teeth. Enamel spurs may form on the cheek teeth, facing either the buccal or lingual surface, causing mucosal trauma and pain. Dental disease may also occur secondarily to other diseases such as hypovitaminosis C or metabolic bone disease and cause gastrointestinal disorders such as dysbiosis and stasis [15].

Gastrointestinal hypomotility, stasis and dysbiosis

As a hindgut fermenter, a common concern in the guinea pig is the risk of developing gastrointestinal stasis. The aetiology is multifactorial, and typical causes for hypomotility, and potential stasis include a nutritionally inappropriate or an abrupt change in diet, antibiotic administration, toxins and stress. The gut flora is generally sensitive to any type of environmental change, potentially reacting with pathogenic bacterial overgrowth and dysbiosis. Diarrheal disease often develops secondarily as a consequence of dysbiosis. Clinical symptoms range from mild changes causing soft stools, to more severe changes, causing significant enteritis and possibly life-threatening enterotoxaemia [2].

Urolithiasis

Urolithiasis is a common disorder in pet guinea pigs. Underlying causes and preconditions are not completely understood, however, it is likely associated with a high-calcium diet, low water intake and possibly a genetic predisposition. The caliculi of guinea pigs are most often composed of calcium carbonate, and clinical signs may include pollakiuria, stranguria, hematuria and vocalizing when urinating [20].

Respiratory infections and pneumonia

Pneumonia is one of the most prevalent diseases in pet guinea pigs. Clinical signs vary from symptoms such as sneezing, coughing and nasal discharge, to severe dyspnea, lethargy and potentially death. It can be caused by several bacteria, including Staphylococcus, Streptococcus and Bordetella. These bacteria may be naturally harboured by the guinea pig, acting as an asymptomatic carrier without exhibiting any clinical signs. They are categorized as opportunistic bacteria, infecting susceptible individuals, proliferating and inducing illness if conditions are favourable, often triggered by periods of stress [19].

Dermatophytes and ectoparasites

Trixacarus caviae are sarcoptid mites, typically causing intense pruritus, even to the extent of seizure development. *Gyropus ovalis* and *Gliricola porcelli* are common lice species, infested individuals may be pruritic, but are usually symptomless. With severe infestations, poor coat quality and alopecia may develop. Non-pruritic, sporadic hair loss may be associated with dermatophytosis or ringworm, most commonly *Trichophyton mentagrophytes.* Lesions appear scaled and circular, commonly found on the face and head.

Due to the zoonotic potential of these fungal organisms, caution is advisable when handling individuals suspected of having ringworm [20].

3. AIMS

The purpose of the Norwegian Animal Welfare Act is to promote good animal husbandry and for the population to respect the fact that animals have an individual, intrinsic value. Using the current act as a fundamental aspect, new more detailed regulations regarding the husbandry and keeping of certain animals are made. However, there are currently no specific laws or regulations covering the basic biological and social needs of pet guinea pigs. This study aims to research the current husbandry, health, and welfare of pet guinea pigs in Norway based on the public recommendations of the Norwegian Food Safety Authority, the Norwegian Veterinary institute and the Norwegian Guinea Pig Club.

4. MATERIALS AND METHODS

4.1 Data collection

An online questionnaire was published in the two largest Norwegian pet guinea pig interest groups on Facebook. The biggest of the two is called “Norsk Marsvinklubb - NMK”, administrated by the Norwegian Guinea Pig Club, with approximately 3300 members, and the other group is called “Vi som elsker marsvin” with approximately 1500 members. An Instagram account called “Marsvinhjelpen” with around 1200 members, having an influential voice within the community, chose to share the questionnaire. Data collection lasted from February to August 2023.

The questions were developed based on a publicly available booklet published by the Norwegian Food Safety Authority (NFSA) called “Guide to guinea pig keeping”, and the website and booklet of the Norwegian Guinea Pig Club (NGPC). None of these guidelines are currently legally binding, but they are intended to educate the public on what is considered good pet guinea pig care and husbandry. The questionnaire consisted of 100 questions in total, which were both open and closed in nature, and presented single-choice, multiple-choice and free text formats. Certain questions functioned as follow-up questions, hence not obligatory. Questions were presented in sections concerning owner demographics, guinea pig particulars, housing conditions, feeding routines, current guinea pig health, guinea pig behaviour, human-guinea pig interactions and costs of keeping.

As guinea pigs are rarely kept alone, the owners were told to answer the guinea pig-related questions with regard to their oldest owned guinea pig in order to avoid favouritism. Having the owners only answer the questions with regards to one guinea pig, would result in more consistent and coherent data, as each answer relates only to that particular guinea pig. All questions except follow-up questions were made obligatory. This might have heightened the threshold of participation for potential respondents, but ultimately improved the coherency of the data for authentic comparison and statistical analyses.

4.2 Statistical methods

Fisher's exact test and R statistical program (version 4.3.1, 2023) was used to evaluate the association between the age (< 3 years old, > 3 years old), breed (mixed breed or other), or gender (male or female) and the number of diagnosed health problems (≤ 2 or more) and diseases. The same test was used to check the association between neutering status and obesity. The p-values lower than 0.05 were significant. The descriptive statistics were made with Excel and R4.3.1.

5. RESULTS

5.1 Owner demographics

After almost exactly 6 months of data collection, the survey had been completed by 284 pet guinea pig owners. Most of the respondents identified themselves as female (95.4%, n=271), and 3.9% (n=11) identified themselves as male. **Figure 1** displays the age and geographical distribution of the respondents. Most of the participants were aged between 25 and 54 years of age, following a normal distribution, and all Norwegian counties were represented.

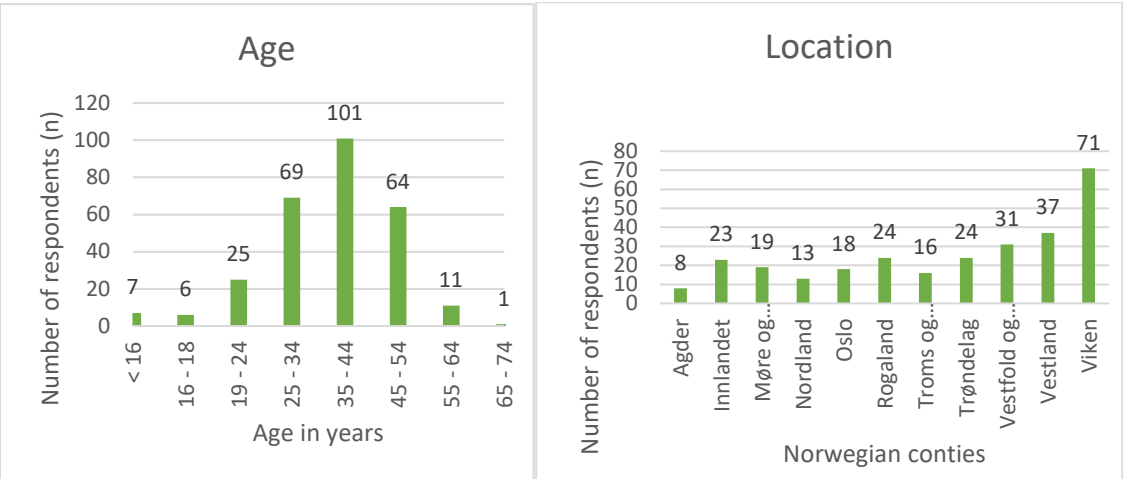

Figure 1: Age and location of the respondents

The respondents' educational statuses are listed below in **Table 1**. Regarding education, the largest group consisting of 91 participants (32%), were those who had completed a bachelor´s degree, while the second largest group consisted of those who had completed upper secondary school (25%, n=71) as their highest level of education.

Table 1: The highest level of completed education

Highest level of completed education	***n***	**Percentage**
Less than upper secondary school	20	7%
Upper secondary school	71	25%
Certificate of apprenticeship	49	17.3%
Business school	4	1.4%
Bachelor´s degree	91	32%
Master´s degree	43	15.1%
PhD or higher	6	2.1%

The civil status of the respondents is listed in **Table 2**. Being in a relationship (39.4%, n=112) was the most common response among the participants, followed by being married (33.5%, n=95) as the second most common response.

Table 2: Civil status of the respondents

Civil status	***n***	**Percentage**
Single	66	23.2%
In a relationship	112	39.4%
Married	95	33.5%
Separated	4	1.4%
Divorced	6	2.1%
Widow / widower	1	0.4%

Out of the 284 respondents, close to half (43%, n=122) of them stated that no children under the age of 16 are currently living in the household. Among the remaining respondents, having 2 to 4 (34.9, n=99) children under 16 living in the household was the most common,

followed by 1 (21.5%, n=61) and two respondents (0.7%) currently had 4 or more children under 16 in the household.

Table 3: Number of children under the age of 16 currently living in the household

Children under the age of 16 living in the household	***n***	**Percentage**
None	122	43%
1	61	21.5%
2-4	99	34.9%
More than 4	2	0.7%

5.2 Guinea pig information

In total, 20 different registered breeds were represented, although most of the guinea pigs were reported to be either crossbreeds (36.6%, n=104) or of unknown breeds (36.6, n=104). Out of the purebreds (26.8%%, n=76), the most commonly represented breeds were Teddy (7.7%, n= 22) and Abyssinian (5.3%, n=15), followed Alpaca (1.8%, n=5). Several different breeds were represented by one participant only (**Figure 2**),

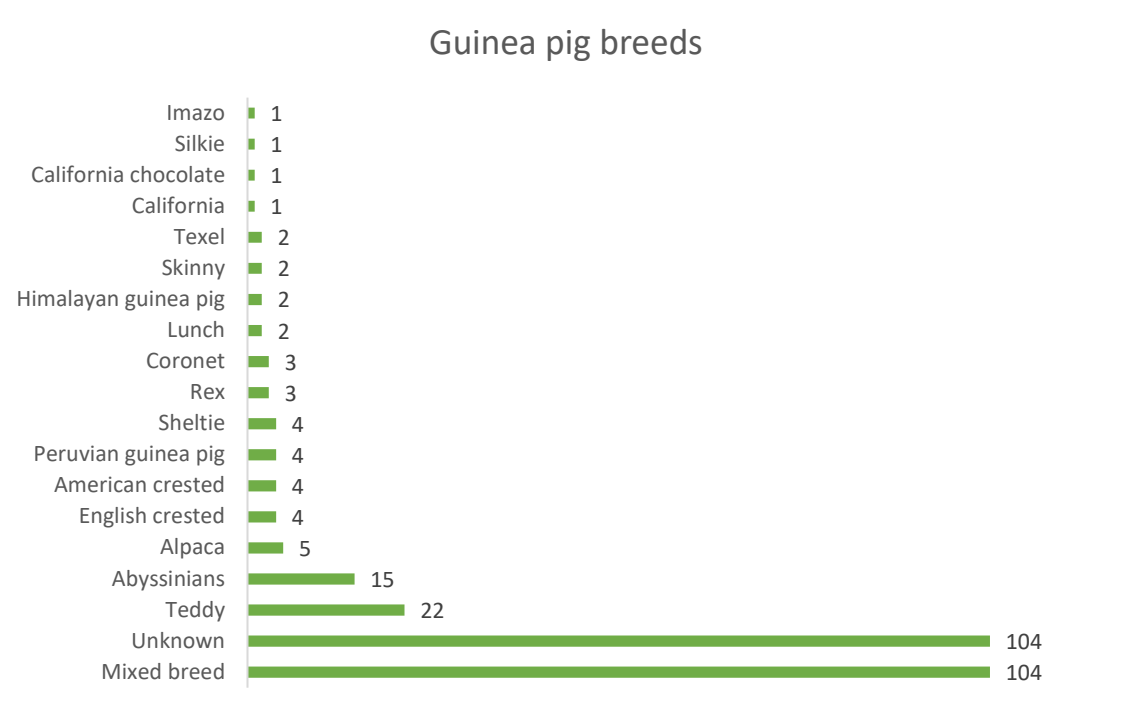

Figure 2: Breed categorization of the particular guinea pigs

Regarding the age of the guinea pigs (**Figure 3**), most were between one and four years of age (67.2%, n=191).

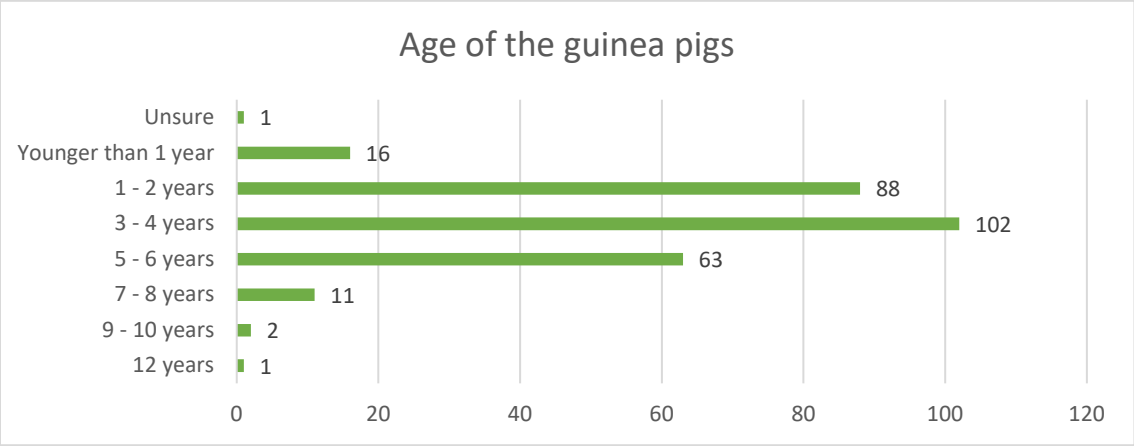

Figure 3: Age of the guinea pigs

The sexes of the guinea pigs were relatively equally distributed with 56.3% (n=160) being female and 43.7% (n=124) being male. Only 12% (n=34) of the guinea pigs were already neutered, and 2.8% (n=8) of the respondents were planning to neuter the guinea pig in the future. The remaining 85.2% (n=242) were not neutered nor will be in the future.

The respondents belonging to the group owning a guinea pig that was already neutered or planned to be neutered in the future, were offered a follow-up question about their reasoning, where several answers were possible. The response with the highest frequency was to prevent unwanted pregnancy (40. 3%, n=31).

Table 4: Distribution of the respondents different reasonings behind the already performed or planned neutering.

Reported reasons for neutering	***n***	**Percentage**
To prevent unwanted pregnancy	31	40.3%
To control unwanted behaviour	9	11.7%
To prevent fighting	7	9.1%
To prevent cancer development	7	9.1%
Recommendation from the veterinarian	6	7.8%
Medical reasons or disease	7	9.1%
Unsure / No specific reason	10	13%

5.3 Guinea pig acquisition

Table 5 presents the respondents' main reasons for acquiring a guinea pig or guinea pigs, several answers were possible. The option gaining the most responses was Personal companionship (67.3%, n=191), followed by Rehoming or adopting (31.3%, n=89), while 6.7% (n=19) acquired the guinea pig to participate in shows. 40 (14.1%) reported that they got the guinea pig in order to give it to a family member. Examples from Others (6.8%, n=17) include adopting following a foster service (0.4%, n=1), due to dogs and cats not being allowed where housed (0.4%, n=1) and due to taking over the main responsibility from another family member (0.4%, n=1). When asked whether or not the guinea pig or guinea pigs were considered family members, 88.4% (n=251) answered yes, and 6% (n=17) answered no. The remaining 5.6% (n=16) reported of being unsure.

Table 5: Respondents reasons for acquiring a guinea pig or guinea pigs

Reasons for guinea pig acquisition	***n***	**Percentage**
Personal companionship	191	67.3%
Received as a gift	8	2.8%
Found as a stray	7	2.5%
Rehoming	89	31.3%
Appearance, interest	76	26.8%
To give it/them to a family member	40	14.1%
Persuasion form others	37	13%
Companionship for already owned guinea pig	71	25%
For breeding purposes	21	7.4%
To participate in shows	19	6.7%
Other reasons	17	6.8%

When questioned about acquisition sources, several answers were possible, ranging from Pet shops (38.7%, n=110) and Breeders (38.7%, n=110) to Adopting from animal welfare organisations (7.4%, n=21) and Received as a gift (2.5%, n=7). 29 of the responders (10.2%) reported being breeders, obtaining the guinea pig or guinea pigs from a self-produced litter. Common sources according to the respondents are listed in **Table 6**.

Table 6: Guinea pig acquisition sources

Acquisition source	***n***	**Percentage**
Pet shop	110	38.7%
Breeder	110	38.7%
Personal breeding	29	10.2%
Found as a stray	3	1.1%
Rehoming	132	46.5%
Animal welfare organisations	21	7.4%
Received as a gift	7	2.5%
Other sources	17	6.7%

5.4 Housing

The guinea pig housing conditions are presented in **Figure 4**, with any additional area represented in **Figure 5.** Permanent housing where the guinea pig or guinea pigs spend the most amount of time daily, was defined as the primary living area. The most common housing condition in the primary living area was Indoors (64.1%, n=182), followed by Mainly indoors, with access to outdoor area when weather and temperature allow it (29.9%, n=85).

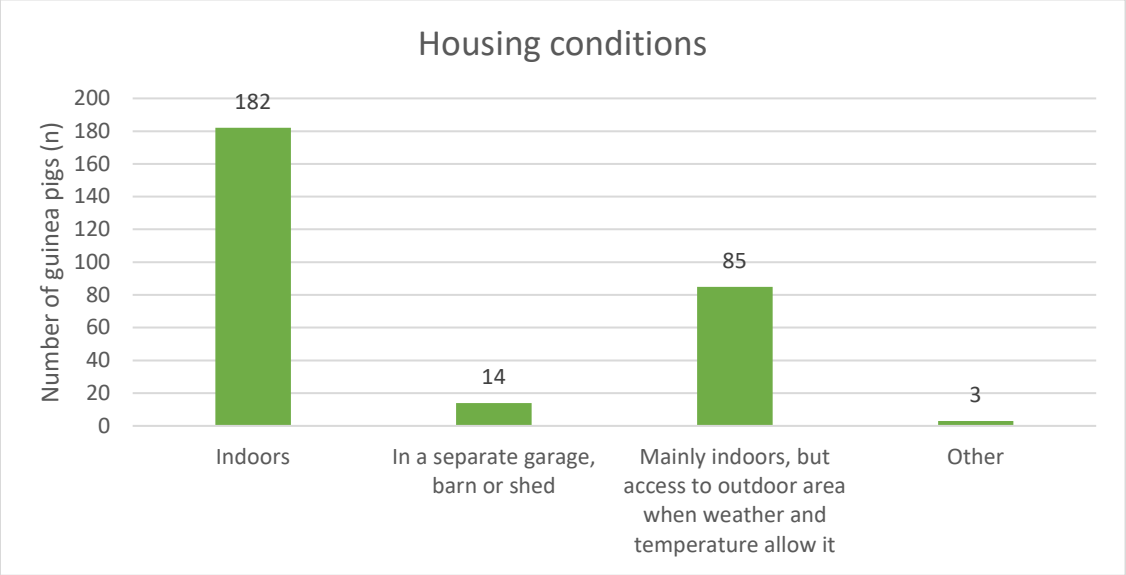

Figure 4: Most common guinea pig housing conditions

Most of the primary living places consisted of homemade cages or enclosures (46.5%, n=132). Out of the approximate half that remained, 15.5% (n=44) were housed in cages from pet stores, 12% (n=34) of the guinea pigs lived in an enclosed area within the house or the apartment, while 13.4% (n=38) had a primary living area consisting of a combination of pet store cages and permanent enclosure or extension. Twelve (4.2%) guinea pigs were housed in a separate barn or shed, while 4.6% (n=13) were free-roaming within the house, apartment or designated room. Most primary living places had only one floor (80.3%, n=228) and over half of them (52.8%, n=150) had no designated roof, while the majority of the remaining places had a roof height of between 50 and 100 cm (40.7%, n=116). The majority of the respondents used blankets (60.9%, n=173) as their substrate, followed by wood shavings (25.4%, n=72). Out of the remaining respondents (13.7%, n=39), the most common substrate was wooden pellets (3.2%, n=9).

Regarding the size of the primary living area, respondents were told to only include enclosures or runs if the guinea pigs had a permanent access to it. There was a great variation of which 20.1% (n=57) of respondents reported the size to be 200x100 cm, followed by 250x120 cm (19.4%, n=55) and 200x60 cm (12.3%, n=35). Only one of the respondents reported having a primary living area with measurements below 100x50 cm (0.4%). Possible alternatives for sizing were decided based on measurements of common pet store cages and typical cage-building materials within the guinea pig community.

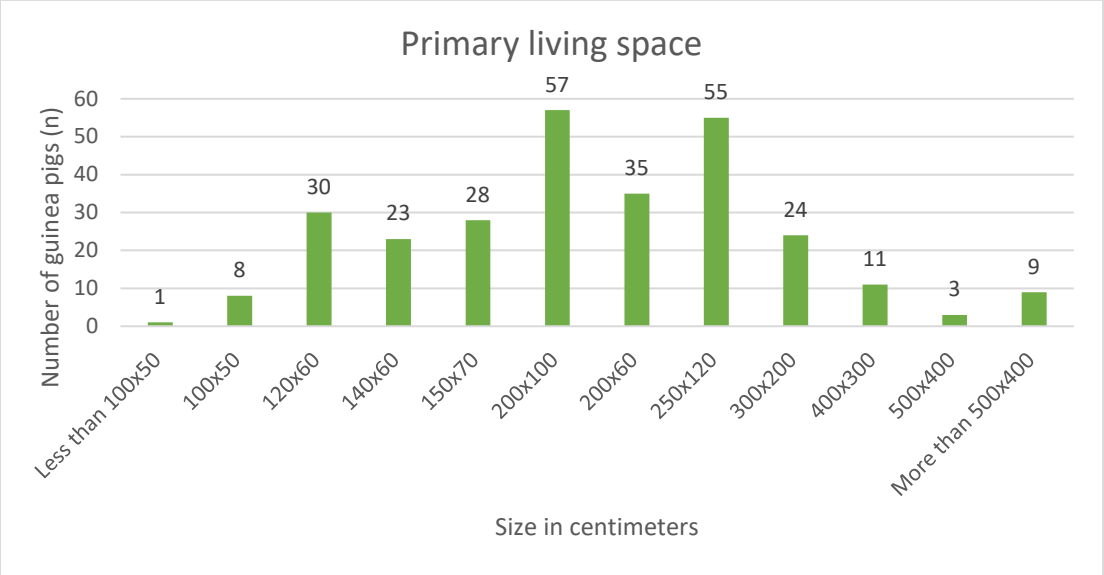

Figure 5: Size of the primary living area in centimetres

Even though the sizing of the primary living areas varies greatly, the majority of the respondents (94%, n= 267) reported that their guinea pigs had access to an additional area, with different frequencies. The possible options for sizing slightly differed from the sizing options of the primary living areas, and the distribution can be viewed in **Figure 6.** Impressively, the majority of the owners reported the size of the additional area to be more than 500x400 cm (33.3%, n=91). The frequency at which the guinea pigs were allowed to access the additional space, and the average time spent there each time, can be viewed in **Figure 7.**

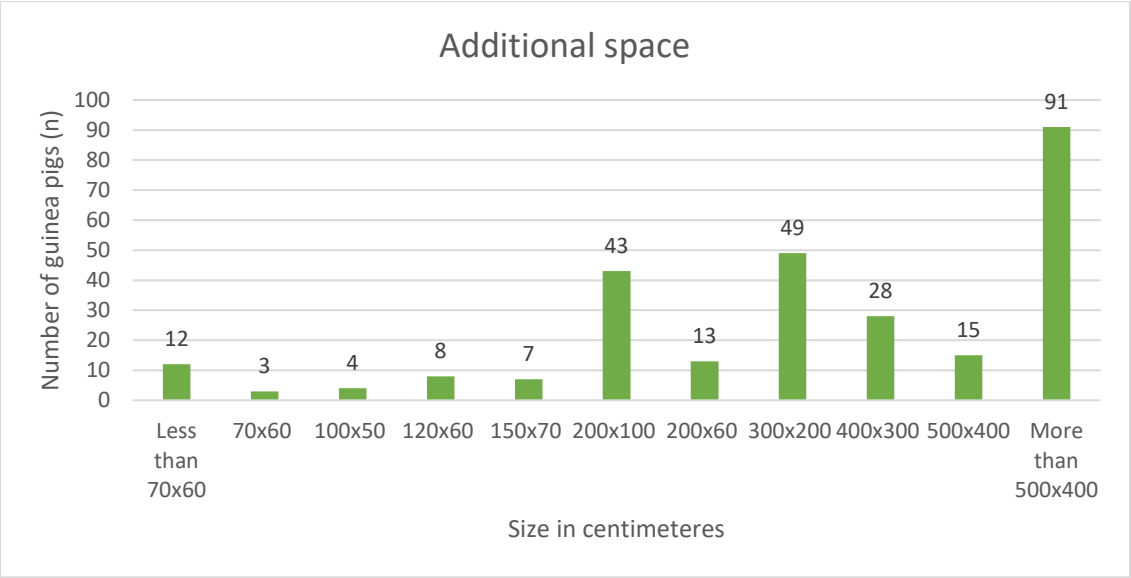

Figure 6: Sizing of additional space

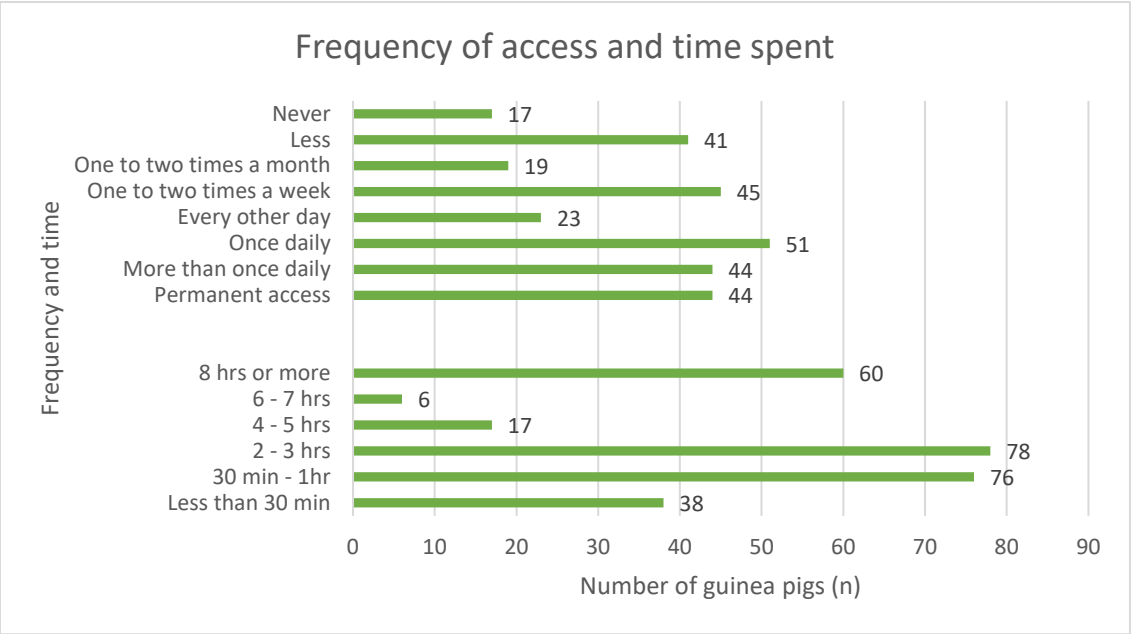

Figure 7: The frequency at which the guinea pigs were allowed to access the additional space and the average time spent there on each occasion.

5.5 Environmental and social enrichment

Figure 8 illustrates the proportion of guinea pigs whose primary living place allowed for specified natural behaviours to be expressed. More than 80% of the guinea pigs surveyed were able to perform all the different activities examined. The environmental enrichment of which the least of the guinea pigs were provided, was having access to different surfaces, with 55 (19.4%) guinea pigs not having access. Having the possibility to hide was the most

commonly provided environmental enrichment, only lacking for 3 (1.1%) of the surveyed guinea pigs.

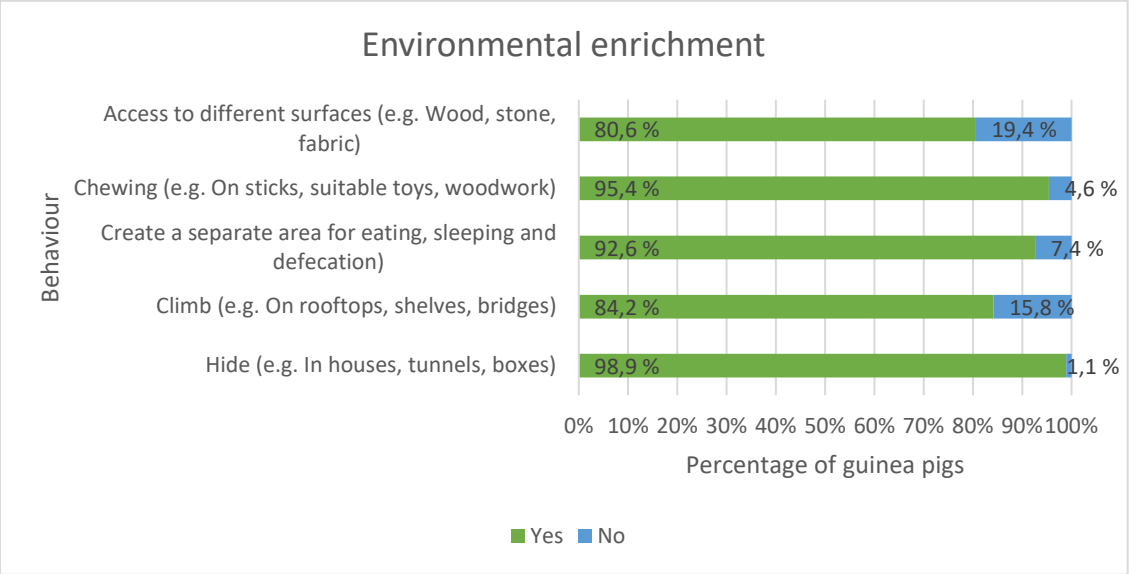

Figure 8: Percentage of pet guinea pigs with access to certain activities considered environmental enrichment in their primary living place

Living together with another guinea pig or guinea pigs is considered the most important social enrichment, and 96.5% (n=274) were reported to do so, with a varied number of companions, ranging from one (53.5%, n=152) to more than five (9.5%, n=27). **Table 7** lists the different herd compositions surveyed, where having two or more unneutered females (46.8%, n=133) was the most common.

Table 7: Most common herd compositions of the surveyed guinea pigs

Herd composition	***n***	**Percentage**
Two or more unneutered females	133	46.8%
Two or more unneutered males	82	28.9%
Two or more neutered males	3	1.1%
Neutered male(s) and unneutered female(s)	38	13.4%
Other combinations	19	6.6%
The guinea pig lives alone	9	3.2%

The respondents who had two or more guinea pigs living together were asked to describe how often they observed positive and negative interactions between them. Frequencies of observation was ranked on a scale from one to five, where 1 represented never and 5 represented very often. Up against half of the respondents (44.4%, n=126), reported to have observed positive interactions between the guinea pigs very often, while 6.3% (n=18) owners never observed negative interactions. Some owners (1.4%, n=4) never observed positive reactions, while 3 owners (1.1%) observed negative interactions very often. **Figure 9** illustrates the distribution between positive and negative interactions, observed by the owners, in percentages.

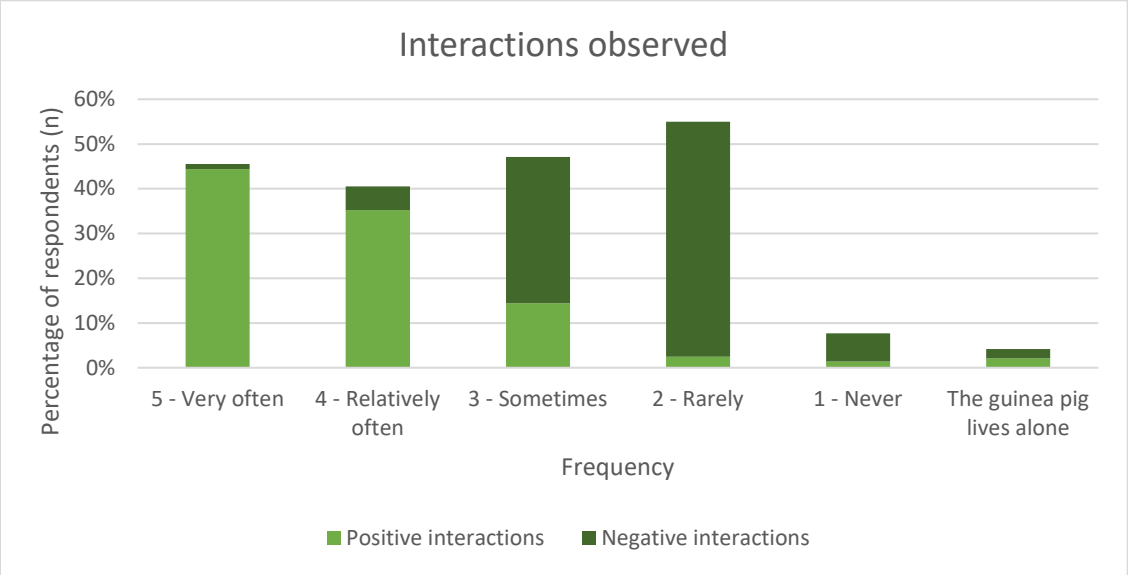

Figure 9: The frequency of which the respondents observed positive and negative interactions between the guinea pigs living together

5.6 Nutrition

Almost all the respondents (93.3%, n=265) reported that their guinea pigs had access to hay *ad libitum.* Some owners (4.6%, n=13) provided access to fresh hay two times a day or more, while only one respondent (0.4%) provided fresh hay less than one to two times a month. The most commonly reported hay type was timothy (49.6%, n=141), followed by hay bought directly from a farm or stable (22.9%, n=65) and mountain or meadow hay (13.4%, n=38). Some owners provided hay from their own production (3.5%, n=10), while only 8 owners (2.8%) fed their guinea pigs with alfalfa hay. The most common way of presenting the hay to the guinea pigs where in bundles directly on the substrate (62.3%, n=177), and 82 owners (28.9%) presented the hay in a rack. Most owners replaced the hay once a day (42.3%,

n=120), while 2.5% (n=7) reported that they never replace the hay. The majority of the respondents reported that their guinea pigs have access to fresh grass during spring and summer (89.8%, n=255).

The type of concentrate that was most commonly fed was complete feed or pellets (80.6%, n=229), while 15.1% (n=43) fed their guinea pigs mixed feed or muesli type. Out of the remaining owners, 6 of them (2.1%) reported that they never fed their guinea pigs concentrates. Out of the ones who do, 43.7% (n=124) give it once daily, 31.7% (n=90) provide *ad libitum* access and 45 owners (15.8%) feed the guinea pigs concentrate twice a day or more. The type of concentrate and its frequency of feeding is presented in **Figure 10.**

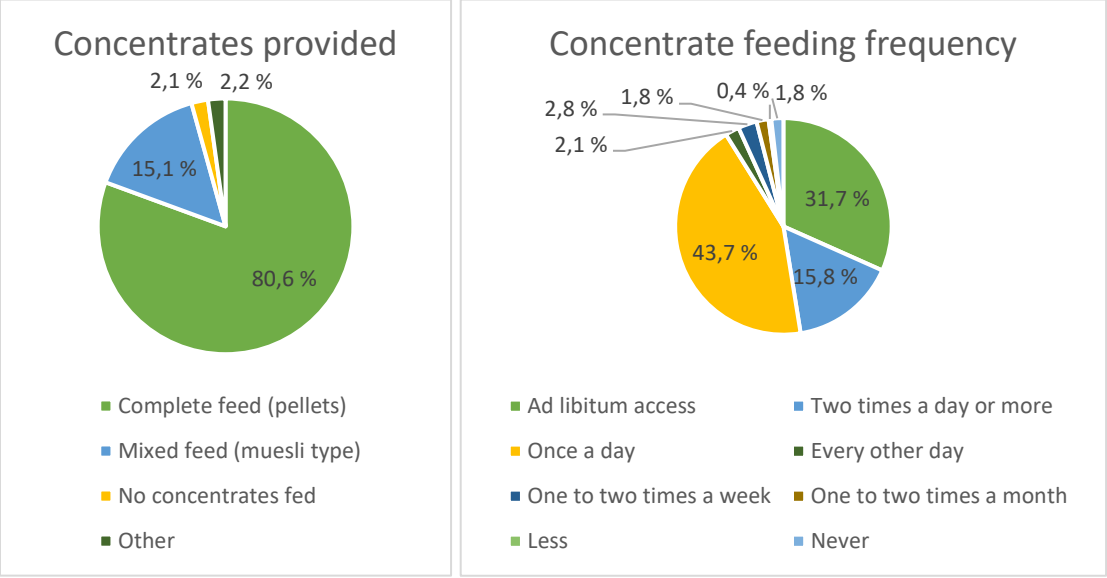

Figure 10: Type of concentrate fed with feeding frequency provided

Regarding the question about feeding frequencies and access to fresh vegetables, most respondents (59.2%, n=168) responded that they provide fresh vegetables twice a day or more, followed by once a day (35.9%, n=102). Only one of the owners (0.4%) said that they never provide fresh vegetables, while 2 owners (0.7%) provide *ad libitum* access. The remaining owners (3.9%, n=11) provide vegetables every other day or less frequently. Commonly fed vegetables are listed in **Table 8**. Out of the respondents, 94.7% (n=269) provide their guinea pigs with other snacks and treats as well, most commonly being fed with a frequency of one to two times a week (37%, n=105). Commonly fed snacks or treats are listed in **Table 9**.

Table 8: Most frequently fed vegetables, with more than one answer being possible

Vegetable	***n***	**Percentage**
Carrot	217	76.4%
Bell pepper	274	96.5%%
Cucumber	192	67.6%
Broccoli	205	72.2%
Cauliflower	109	38.4%
Peas	10	3.5%
Dandelion	178	62.7%
Romaine lettuce, Arugula	78	27.5%
Iceberg lettuce	97	34.2%
Spinach	59	20.8%
Kale	147	51.8%
Cabbage	101	35.6%
Corn	20	7%
Tomato	76	26.8%
Fresh herbs (parsley, basil, cilantro etc)	119	41.9%
Does not get vegetables	1	0.4%
Other vegetables	38	14.9%

Table 9: Most commonly fed treats, with more than one answer being possible

Treat	***n***	**Percentage**
Treats marketed towards guinea pigs	159	56%
Fruits (fresh or dried)	176	62%
Berries (fresh or dried)	121	42.6%
Granola or other blends	21	7.4%
Nuts and/or seeds	6	2.1%
Homemade treats (e.g. online recipe)	17	6%
Pea flakes	9	3.3%
Does not get treats	3	1.1%
Other treats	23	8.2%

Figure 11 illustrates the feeding frequency of fresh vegetables in relation to treats. Only one of the owners never gave fresh vegetables, while no owners gave *ad libitum* treats.

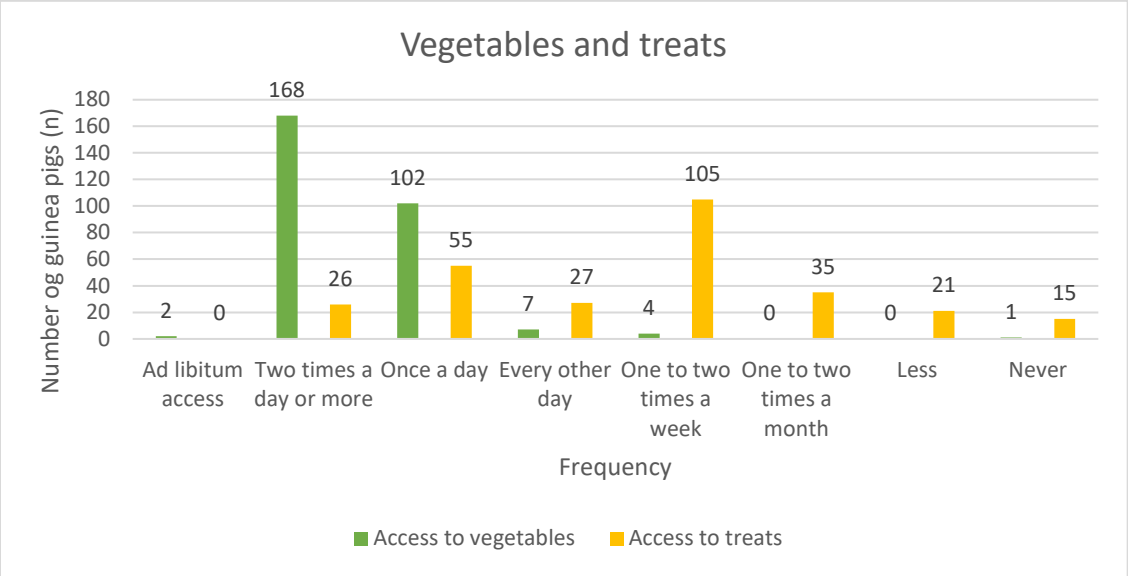

Figure 11: Frequency of access to fresh vegetables in relation to treats

Out of all the respondents, 63.7% (n=181) never provided any form of vitamin C supplement, while 15.5% (n=44) provided supplements only sometimes or if especially needed. As a follow-up question directed toward the owners who regularly or occasionally provide vitamin C supplement, different options for types of supplements used were added. **Figure 12** shows the distribution of the different alternatives of vitamin C supplements used.

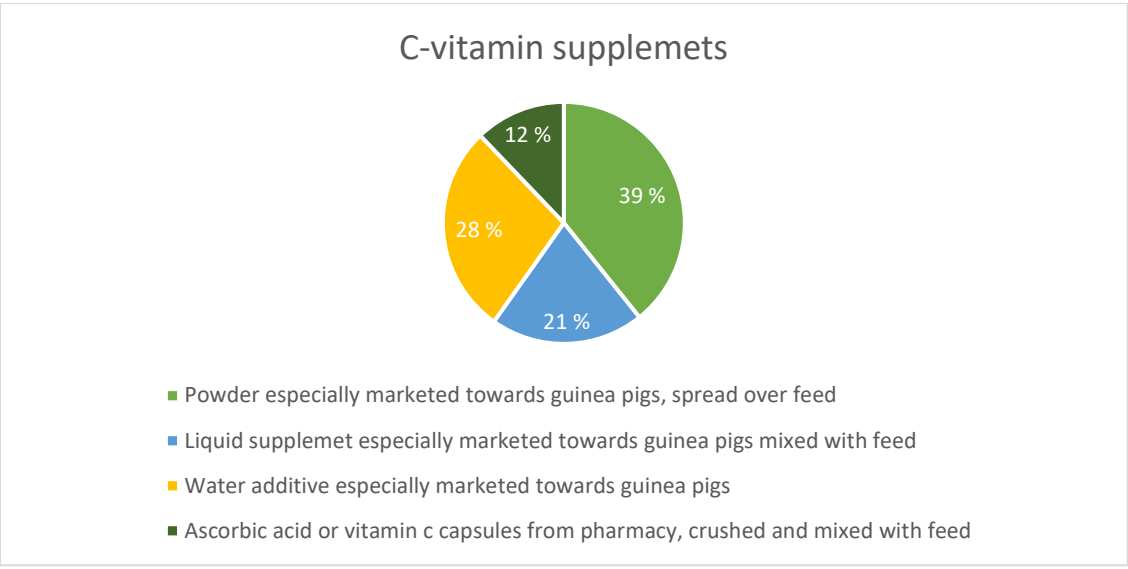

Figure 12: The distribution of the different type of C-vitamin supplements used

5.7 Guinea pig health

Nearly all (96.5%, n=274) of the owners considered their guinea pigs healthy at the time surveyed. Out of the remaining respondents, 2 (0.7%) were unsure about the current health status of the guinea pigs. On the next question, the owners were asked if any of their guinea pigs currently were being treated for any diseases or other health problems, where 19 (6.7%) responded yes. As a non-obligatory follow-up question, the owners who responded yes were encouraged to elaborate on the concern in question. **Table 10** illustrates the different diseases or health problems that the guinea pigs in question were treated for. One guinea pig was treated for two problems simultaneously (n=2), having grinded down overgrown teeth and daily eye drops due to an eye injury. Another owner (n=1) reported that their guinea pig previously had urinary caliculi, hence are now getting daily medication for preventing reoccurrence.

Table 10: Diseases and health problems of the guinea pigs currently being treated

Disease or health problem	**n**
Ovarian cysts	2
Eye problems (injury, dry eyes, infection)	4
Emaciation or anorexia	2
Urinary tract infection	2
Urinary caliculi	2
Teeth problems (overgrowth, malocclusion)	2
Dermatitis	1
Unknown mass	1
Abcess	1
Gastrointestinal problems (enteritis, dysbiosis)	2
Osteoarthritis (stiff gait, lameness)	1
Ectoparasites (fur mites)	1

Figure 12 shows the most common diseases and symptoms observed and experienced by the guinea pig owners in the past. Depending on the number of guinea pigs owned, for the owners reporting several problems, it is highly unlikely that all symptoms occurred in the same guinea pig. Out of the surveyed diseases and symptoms, ectoparasites (21.1%, n=60) were the most prevalent, followed by coughing and/or sneezing (19.7%, n=56) and abcesses

(12.7%, n=36). 76 owners (26.8%) reported that they have never experienced any of the symptoms or illnesses. A significant association was found between the age and number of diseases ($p<0.0001$) as guinea pigs over 2 years of age had more health problems. The ovarian cyst was also more frequent ($p = 0.001138$) in guinea pigs over 2 years of age. Besides these no other significant association was found between the examined parameters.

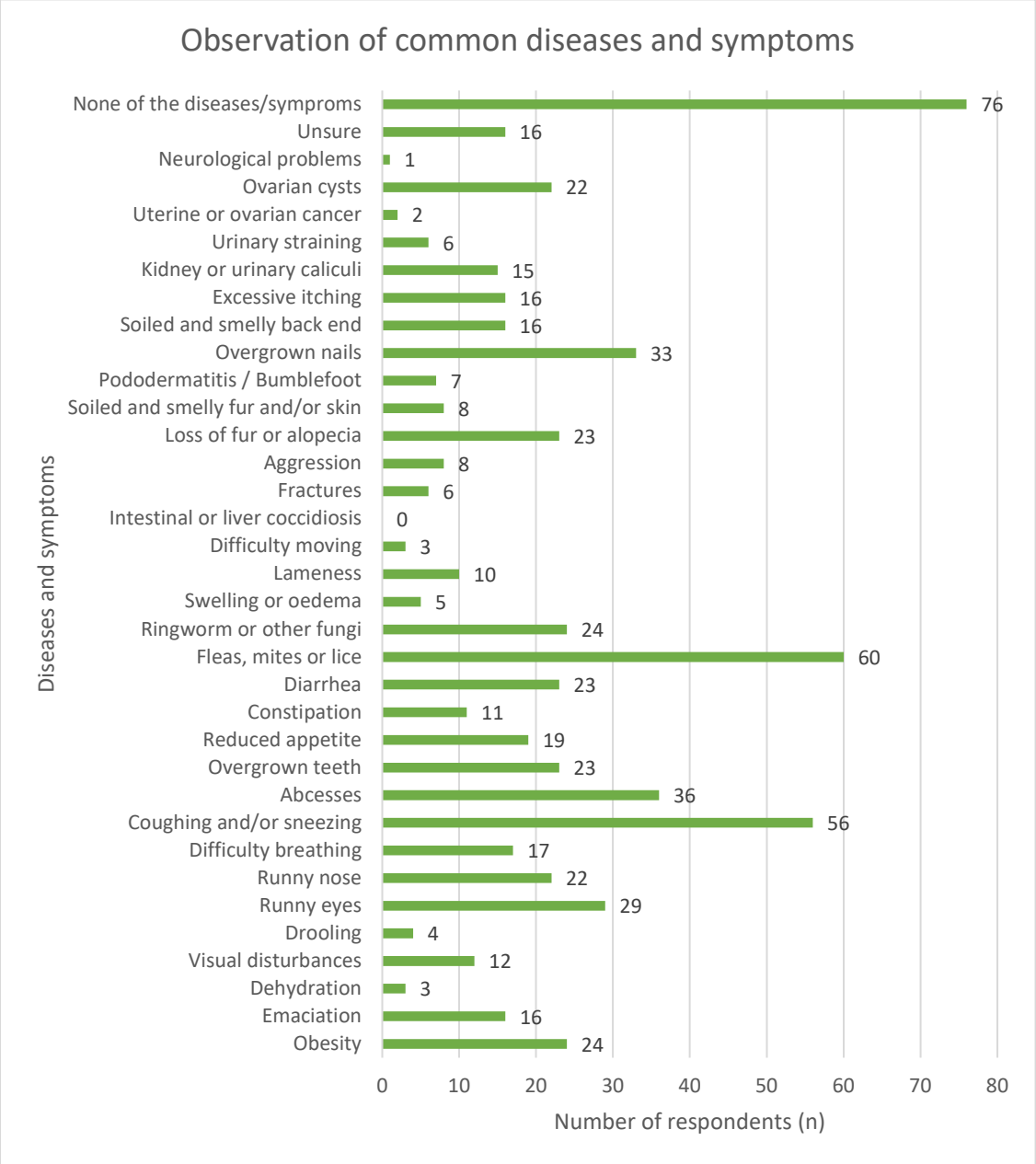

Figure 12: Common diseases and symptoms and the frequency of which the guinea pig owners have observed and experienced them in the past

5.8 Owner experience

The owners' experience with guinea pig keeping ranged all the way from one year or less (14.1%, n=40) to ten years or more (32%, n=91), which is illustrated in **Figure 13.**

Figure 13: Owner experience of owning guinea pigs in years

Only 18 (6.3%) of the owners do not actively seek new external information and knowledge about guinea pig keeping and husbandry, while 76 (26.8%) only do so when seeking answers to specific questions. The most common source where owners seek information and knowledge was through the internet (80.3%, n=228), followed by the NGPC (71.8%, n=204) and social media (65.8%, n=187). Other sources of information can be seen in **Figure 14**.

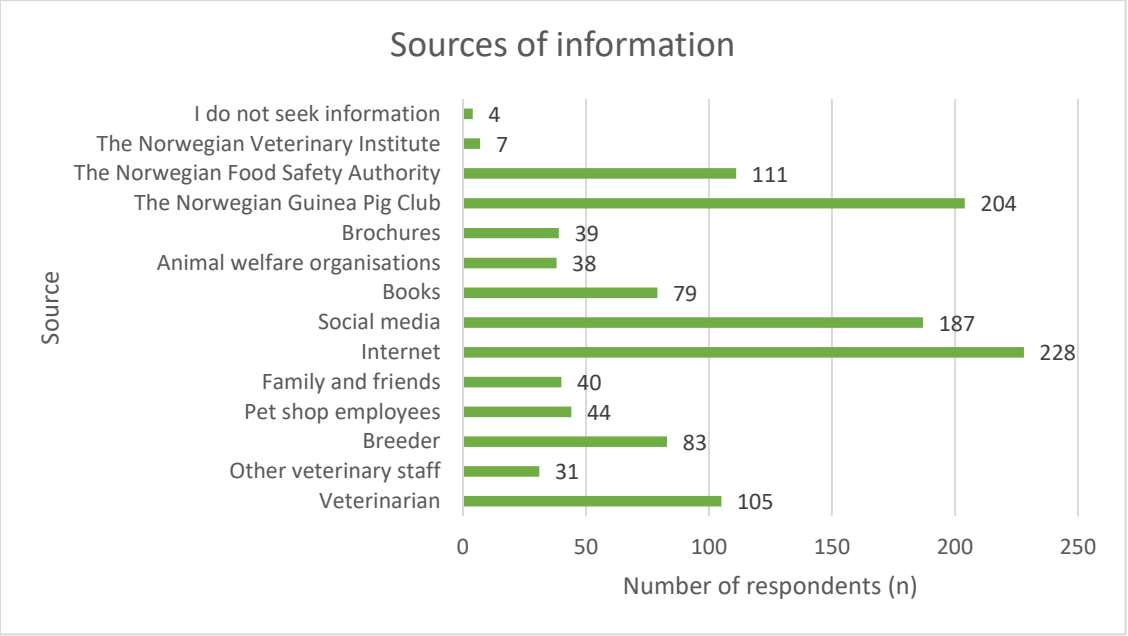

Figure 14: Sources of information used to acquire knowledge on keeping and husbandry

5.9 Guinea pig behaviour

The respondents were asked to rank the frequency of 16 different behaviours exhibited by the guinea pigs in the primary living place, where 10 of the behaviours are considered positive or natural, two are considered neutral depending on situation, while the remaining four are considered negative or undesirable. Frequency ranges on a scale from one to five, where one represents never and 5 represents very often. Curious behaviour and contact seeking were experienced by almost all owners. All owners reported good appetite as a common occurrence, with 92.3% (n=262) responding with very often, and the remaining 7.7% (n=22) responding with relatively often. No owners reported to never or rarely observing the guinea pigs having normal defecation. Only one owner (0.4%) never observed their guinea pig laying down and relaxing, while 64.8% (n=184) very often did this observation. One hundred ninety-five owners (68.7%) never observed stereotypical or repetitive behaviour, while one owner (0.4%) reported such type of behaviour to happen very often. A full overview of the frequiencies of which the surveyed behaviours were expressed can be found in **Figure 15.**

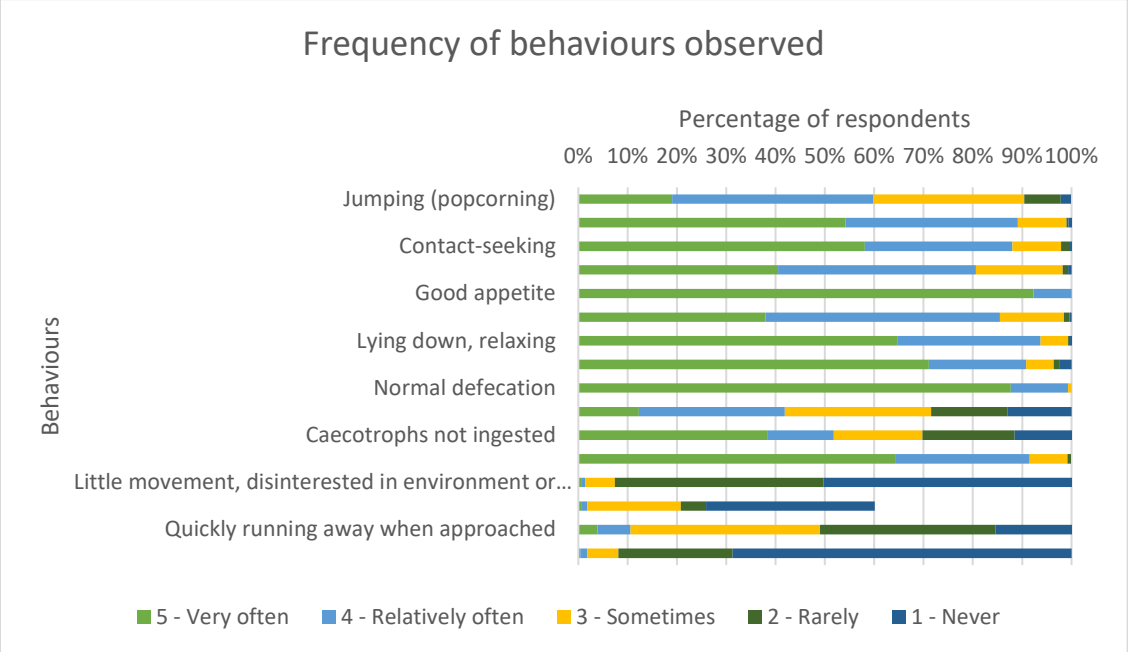

Figure 15: Frequencies of which the owners have observed the surveyed behaviours expressed in the primary living space

Due to potential differences, behaviours expressed during human interaction were investigated separately from the behaviours expressed in the primary living place. **Figure**

16 illustrates the tendencies of the guinea pigs to express certain behaviours when lifted, compared to when being handled. When being lifted, 35.6% (n=101) of the guinea pigs were reported to very often being calmed and relaxed, compared to 17.6% (n=50) when being handled. Interestingly, biting was generally more common when being handled than when being lifted, with all values except never being slightly higher with handling. Paralysation was not common in either case, with zero guinea pigs becoming paralyzed very often, neither with lifting nor handling. Only one (0.4%) becomes paralyzed relatively often when being handled, and zero guinea pigs when lifted. Even though severe struggle was not reported to happen frequently in either case, it was slightly more common with handling than with lifting, as 13.7% (n=39) of the guinea pigs sometimes severely struggled when handled versus 6.7% (n=19) when lifted.

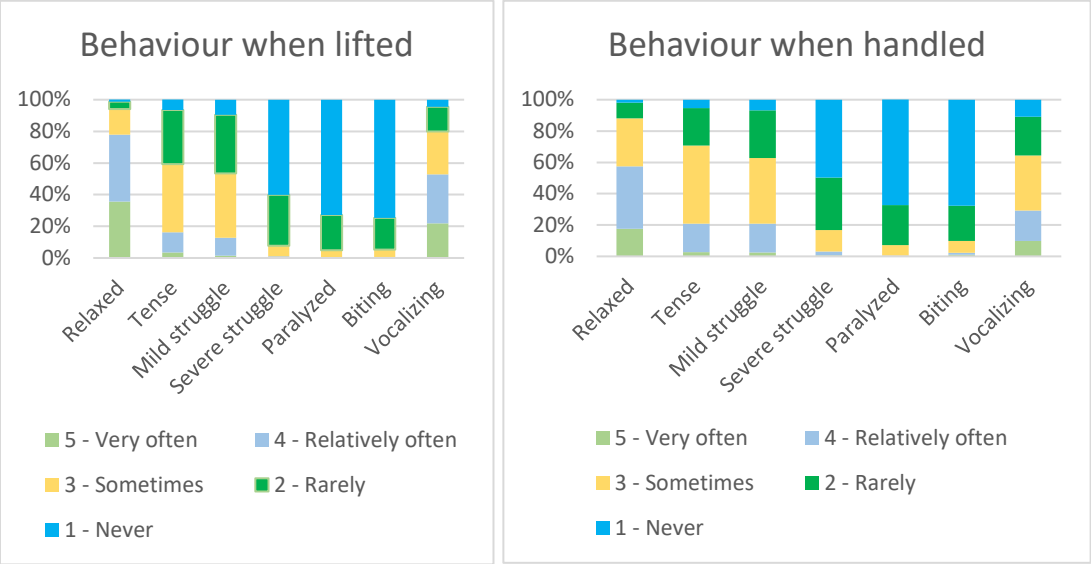

Figure 16: Comparison of the behaviours expressed when being lifted versus handled, with amount of guinea pigs expressed in percentages.

5.10 Costs related to guinea pig keeping

Owners were asked to give an approximate of how much money in NOK they spend each month on basic equipment such as feed, substrate and bedding material, enrichment and other necessities. The price ranged from less than 100 NOK (2.5%, n=7) to 1000 NOK or more (16.5%, n=47) worth of spending each month. However, most of the respondents belonged to the group between 400 and 699 NOK (34.2%, n=97). **Figure 17** shows the distribution in percentages between the different spending groups.

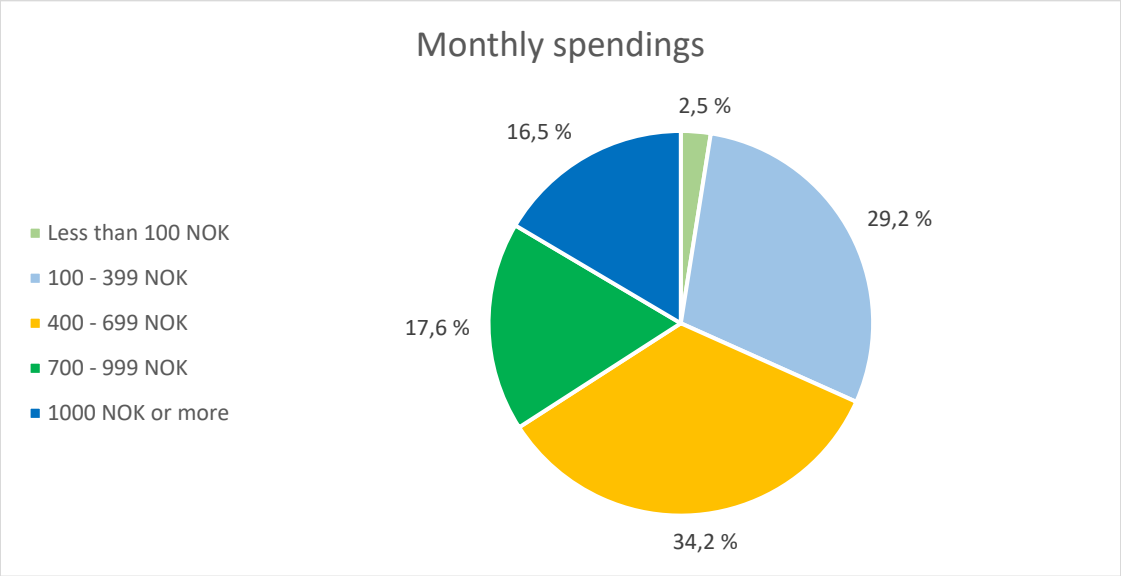

Figure 17: Average monthly amount in NOK spent on basic equipment

Participants were also asked to share the approximate amount of money in NOK spent each month on veterinary services and eventual medicinal equipment and medicines. The majority of the owners paid 500 NOK or less (90.5%, n=257), while none of the participants reported to pay 5000 NOK or more. **Table 11** illustrates the monthly amount used for veterinary expenses in more detail.

Table 11: Average monthly amount in NOK spent on veterinary services, medical equipment and medicines

Amount in NOK	***n***	**Percentage**
500 NOK or less	257	90.5%
500 – 999 NOK	17	6%
1000 – 1999 NOK	5	1.8%
2000 – 2999 NOK	2	0.7%
3000 – 3999 NOK	1	0.4%
4000 – 4999 NOK	2	0.7%
5000 NOK or more	0	0%

Based on the monthly amount spent on veterinary services, owners were asked whether they had pet insurance for the guinea pigs or not, to which 20.4% (n=58) answered yes. Out of the remaining respondents, forty-five (15.8%) owners reported that their guinea pigs were not currently insured, but they plan to pay for insurance in the future. The rest of the owners (63.7%, n=181) did not have any form of insurance and do not plan to insure in the future either. Insurance status of the respondents' guinea pigs can be viewed in **Figure 18.**

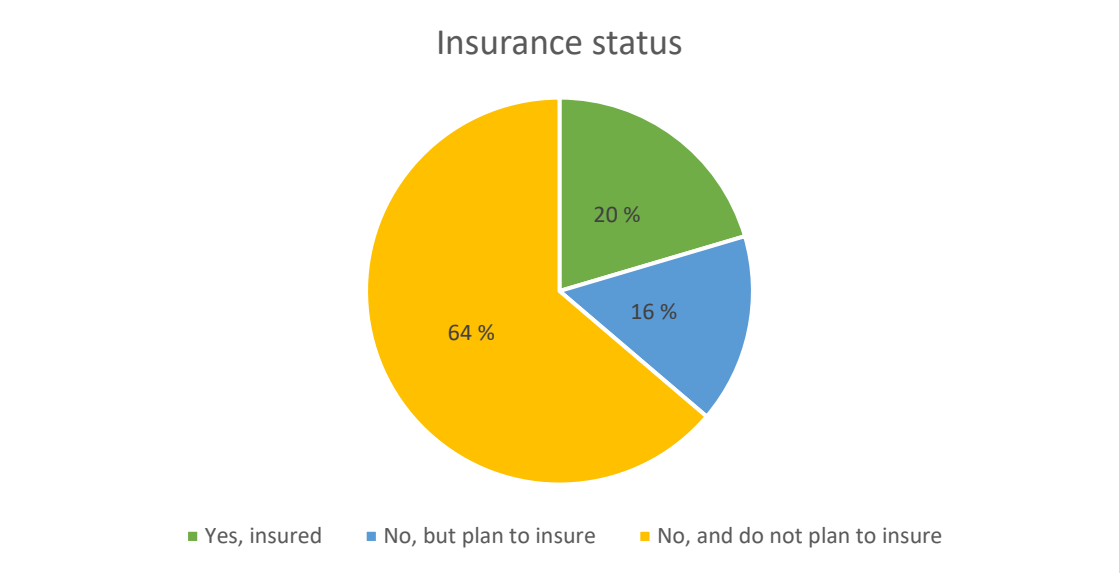

Figure 18: Current insurance status of the surveyed guinea pigs expressed in percentages

6. DISCUSSION

6.1 Owner demographics

By publishing the questionnaire on dedicated guinea pig interest groups on Facebook, there was a wide geographical reach of participants across Norway. However, there is a high probability that the data gathered presents a bias towards exceptionally committed guinea pig owners, as the participants have actively joined the groups in question in order to share experiences and seek advice and knowledge on responsible guinea pig husbandry. Although the questionnaire was also shared through Instagram, the outreach is still limited to owners actively using social media and being able to participate in an online survey.

Regarding the age of the 284 respondents, the age group with the highest percentage were between 35 and 44 years old (n=101, 35.6%). According to the Norwegian Animal Welfare Law, no person under 16 years of age is allowed to have the main responsibility of an animal. Hence, it was considered whether or not participants under 16 should be excluded from the

questionnaire. It was decided to allow their participation, adding younger than 16 as an option, yielding 2.5% (n=7) of the total number of respondents. In a previous study concerning housing of pet guinea pigs in New Zealand conducted by Cameron, Holder and Connor, a similar pattern can be seen. here were 410 respondents, out of which 319 (77.8%) were over 21 years of age. Seventy-two respondents (17.6%) were reported to be between 11 and 20 years of age [1].

Out of the respondents, the majority (43%) reported there to be no children under the age of 16 in the household. One hundred sixty (56.4%) participants had between 1 and 4 children under 16 living in the household, while 2 (0.7%) respondents had more than four. In the same study conducted by Cameron, Holder and Connor, most owners households consisted of adults only (36.8%, n=151), followed by adults and children under 13 (33.4%, n=137), adults and teenagers (14%, n=57) and adults, teenagers and children (15.9%, n=65) [1].

6.2 Guinea pig information

Regarding the sex of the guinea pig, the female-to-male ratio was close to 50-50, with 56.3% (n=160) of the particular guinea pigs being female. A minority of the guinea pigs were neutered (12%, n=34), while 2.8% (n=8) were not currently neutered but planned to be neutered in the future. The remaining 85.2% (n=242), were not neutered nor will be in the future. Similar results were reflected in a previous study done by Pantelejev discussing obesity in Estonian rabbits, guinea pigs, rats and mice. Out of the collective survey group consisting of 177 animals, 73 of them were guinea pigs, where 41.56% were reported to be females and 32.44% were males. Out of the surveyed guinea pigs, 9.12% of them were reported to be neutered [16]. In the survey conducted by Cameron, Holder and Connor, 197 out of the 410 surveyed guinea pigs were female (48.1%) and 201 (49%) were male, twelve (2.9%) of the respondents did not answer. Most of the respondents (40.39%, n=166) did not know the breed of the guinea pig [1], similar to the 32.7% (n=93) of the owners' responses in this study.

6.3 Guinea pig acquisition

On questions about the origin of the guinea pigs, several answers were possible, with the most common source being rehoming (46.5%, n=132), followed by a tie between pet shops and breeders, accounting for 38.7% (n=110). When selecting the ‘other’ alternative, owners were asked to please specify their source of origin. Several owners listed ‘Finn.no’ as their

source of acquisition, which is the most popular online marketplace for buying and selling goods and services in Norway. Under the pet animal category of the website, advertisements for guinea pigs in need of new homes due to different circumstances are listed regularly. Such advertisements are often shared through social media and in the different interest groups within the guinea pig community, encouraging members to adopt. Several of the respondents reported getting the current guinea pig from their own breeding facility (10.2%, n=29). The NPGC is actively working on suggesting guidelines and promoting the breeding of healthy individuals, and there is a growing list of registered reputable breeders publicly available on their official website.

6.4 Housing

In this study, 64.1% (n=182) of the guinea pigs were housed indoors all year round, living in a cage or an otherwise enclosed area within the house. Secondly, 29.9% (n=85) of the guinea pigs were mainly housed indoors, but with access to an outdoor area when the weather and temperature allow it. The optimal temperature for housing of pet guinea pig is between 18 and 24 degrees Celsius. In this temperature range, they are active most of the time. Physiologically, guinea pigs are better at handling cold than heat, and once the environmental temperature rises to between 25 and 30 degrees Celsius, they become inactive for longer periods [17]. However, due to the generally cold climate in Norway, it would be impossible to keep the guinea pigs outside during the winter season. Some respondents reported keeping their guinea pigs in a separate barn, shed or garage (4.9%, n=14), where the guinea pigs can be insulated and protected from extreme temperatures through all seasons, without being housed in the home itself.

Even though there are no current regulations for minimum requirements of housing of guinea pigs in Norway, housing recommendations found on websites belonging to animal welfare organisations internationally suggest a minimum cage size, housing a pair of guinea pigs, to be approximately between 0.37 and 0.72 square meters [1]. The NGPC suggests a minimum size of 120x60 cm or 0.72 square meters for the primary living space. Out of the respondents, only 3.2% (n=9) reported having a primary living space of less than 0.72 square meters. In the study conducted by Cameron, Holder and Connor, the sample group for housing size consisted of 284 respondents out of which 60 (21.1%) owners reported having a primary living space measuring less than one square meter. Other commonly reported measurements were between 1 and 1.9 square meters (26.8%, n=76) and between 2 and 2.9 square meters

(20.6%, n=59) [1]. These numbers show considerable similarities with the numbers obtained in this study, with 20.1% (n=57) reporting measurements of 200x100 cm or 2 square meters, and 19.4% (n=55) reporting measurements of 250x120 cm or 3 square meters.

Approximately half of the respondents' guinea pigs (49%, n=139) had access to an additional space outside of their primary living space at least once daily, while 23.9% (n=68) provided access at least on a weekly basis. In Cameron, Holder and Connor's study, slightly more guinea pigs had access to an additional space on a daily basis (59.4%, n=189) out of sample group consisting of 318 respondents, while 28% (n=89) had access to such an area on a weekly basis. Out of the remaining, only 5.7% (n=18) of the surveyed guinea pigs never had access to an additional space outside of their primary living area [1]. Similarly in this study, 6% (n=17) of the guinea pigs never had access to such an area.

6.5 Environmental and social enrichment

Guinea pigs have a long history as companion animals and the pet guinea pigs owned today are highly domesticated. However, even though the domestication and breeding processes have altered the frequency and circumstances under which they display certain behaviours, they still possess certain instincts inherited from their wild ancestors [9]. Guinea pigs are prey species, which either flee or hide as their primary defence mechanism, in addition to freezing behaviour as a response to sounds. Unlike rabbits, they do not dig their own burrows or build their own nests, but instead find other pre-existing shelters or inhabit the burrows of other animals [9].

Almost all the guinea pigs (98.9%, n=281) surveyed had access to a hiding place, which is the most important out of all the enrichment behaviours surveyed. Guinea pigs are not considered nocturnal and do not have periods of extended sleep, however, they can be sensitive to intensive light and sudden or abrupt sounds or movements in the environment. The two least provided environmental enrichment opportunities were access to climbing and having access to different types of walking surfaces, with 45 (15.8%) of owners reporting that their guinea pigs had no opportunity to climb and 55 (n=19.4%) not having access to different surfaces. While these two types of enrichment behaviours may not be determinantal for the guinea pigs well-being directly, the ability to climb will aid in muscle building and creating space between herd members in case of conflict. Having access to different surfaces

may aid in the comfortability of resting places, potentially preventing pododermatitis and pressure sores, and in case of stone, healthy wear of the guinea pigs' nails [9].

Social enrichment is determinantal for the well-being of guinea pigs, whereas the most important is the ability to communicate with other guinea pig companions. The most common number of guinea pigs currently owned was 2, accounting for 53.5% (n=152) of the responses. No more than 3.5% (n=10) of the owners reported currently having only 1 guinea pig. Guinea pigs are social animals that ideally should not be kept alone, as they naturally form groups for survival and these herd instincts are still deeply imprinted in the domestic guinea pigs' lives [21]. Studies suggest that social support and bonding between guinea pigs significantly reduce endocrine stress responses and reduce hormonal output from the adrenal glands [17]. The study conducted by Cameron, Holder and Connor presented similar results, however, slightly more guinea pigs were reported to live alone (9.7%, n=32) [1].

6.6 Nutrition

Out of the 284 respondents, two hundred sixty-five (93.3%) reported that their guinea pigs have *ad libitum* access to fresh hay, which is the most important component of the guinea pig´s diet. Out of the remaining respondents, 5.3% (n=15) provided fresh hay at least once daily. Similarly, in the study conducted by Pantelejev, 98% of the guinea pigs surveyed had *ad libitum* access to hay.

As guinea pigs cannot synthesize vitamin C by themselves, they depend on an external vitamin C source through their diet. High-quality dietary sources of vitamin C include fresh root vegetables such as carrots and beetroot, as well as bell peppers, broccoli, herbs, and leafy greens such as kale, cabbage, and even dandelions. However, several of these also contain relatively high amounts of calcium, especially kale, and herbs such as parsley and thyme, and should therefore be fed with caution. If the guinea pig is fed sufficient amounts of vitamin C through the dietary recommendations on a daily basis, usually no complementary supplements are needed. Specific indications for artificial vitamin C supplements may include periods of illness, or increased stress, such as pregnancy and lactation [14]. This could explain the results obtained in the study, as the majority of the owners (63.7%, n=181) reported that they never provided any form of supplements, while 15.5% (n=44) only did so occasionally or when especially needed. At the same time, 95.8%

(n=272) of the surveyed guinea pigs were provided fresh vegetables at least once daily, with bell peppers (96.5%, n=274) and broccoli (72.2%, n=205) being some of the most commonly fed.

Artificial vitamin C supplements include water or powder additives directly marketed towards guinea pigs, or even ascorbic acid tablets sold at pharmacies. Out of the group of owners who reported to giving Vitamin C supplements, either regularly or occasionally, 10.6% (n=30) said they gave water additives. If using water additives, there is a concentration-dependent degradation of approximately 20 to 50%. This percentage is temperature dependent, as the degradation rate is increasing with increased temperature [22]. Due to this degradation, it is often difficult to determine the exact amount of vitamin C the guinea pig will consume. Moreover, water additives may also add a sour taste to the water itself, making it less appealing to the guinea pig, hence decreasing the water intake. However, if water additives are being used, it is important to keep the degradation rate in mind, meaning that the water should ideally be replaced at least once daily. For powder or tablet additives, to which 14.8% (n=42) and 4.6% (n=13) reported giving, the shelf life should be strictly adhered to in order to ensure that the actual intake will be sufficient [22].

Almost all the owners reported that they feed their guinea pigs concentrates, with only six (2.1%) participants reporting that they never feed any form of concentrates. It is important to opt for brands especially marketed towards guinea pigs to ensure that the basic nutritional needs are met, regarding the specific ingredients. These types of feed generally also contain the necessary amount of vitamin C, however, the levels may decline over time. It is therefore important to follow the manufacturer´s recommendations for storage and shelf-life. When asked about which type of concentrates were fed, 80.6% (n=229) fed complete pelleted feed, while 15.1% (n=43) fed mixed muesli-type feed.

It is recommended to feed a homogenous type of pelleted feed, as this will prevent the guinea pig from favoring certain pieces of a blend or mixed feed, which may lead to an imbalance in the nutritional intake. Seed-based diets should be strictly avoided due to being high in fat and low in fiber, and exclusive feeding of such diets may inevitably lead to dental disease. Commercial rabbit feed is low in vitamin C, high in vitamin D and may contain coccidiostats, which have been associated with stunted growth and death in guinea pigs [4].

The frequency of which the different concentrates were given varied from ad libitum access (31.7%, n=90) to never (1.8%, n=5). Compared with the study performed by Pantelejev, 68% of the surveyed guinea pigs had *ad libitum* access to complete pelleted feed, while 19% had *ad libitum* access to muesli-type feed. When asked which feed types were only occasionally given, 20% reported that they occasionally fed complete pelleted feed, while only 6% occasionally fed mixed muesli-type feed. However, in some cases, the owner had ticked off the same type of feed for both permanent and occasional access. This may, according to Pantelejev, reflect that not all of their pets had equal access to the same type of food items, as some owners had several of the different species surveyed, but most likely represents a misinterpretation of the questions [16].

6.7 Guinea pig health

Out of the surveyed diseases and symptoms, ectoparasites (21.1%, n=60) were the most commonly reported, followed by coughing and/or sneezing (19.7%, n=56). In a previous study published by Minarikova and others, disease prevalence was recorded in a sample group consisting of a thousand pet guinea pigs presented to the author's own clinic. The sample group was divided into three different subgroups related to age; under two years, between two and five years and above five years. The most commonly represented condition was dental disease, affecting 36.3% (n=363) of the surveyed guinea pigs, followed by skin diseases (33.1%, n=331) and ovarian cystic disease (21.9%, n=100/456). Dental disease was most prevalent in the middle age group, skin disease was most prevalent in the young age group and ovarian cystic disease was most prevalent in the old age group [14].

Out of the 331 guinea pigs that presented to Minarikova´s clinic with skin diseases, 99 individuals were treated for mange mites (*Trixacarus caviae).* The second most common ectoparasite that was detected was *Gliricola porcelli,* and other ectoparasites detected associated with skin diseases were *Chirodiscoides caviae, Gyropus ovalis* and *Ctenocephalides felis.* The significant portion of skin diseases caused by ectoparasites correlates with the percentage of observed ectoparasites in this study. Other comparable disorders which belonged to the skin disease category were dermatophytosis, pododermatitis (n=30) and skin abscesses (n=20). In this study, 24 (8.5%) reported to have observed dermatophytosis, 7 (2.5%) owners had observed pododermatitis or bumblefoot, while 36 (12.7%) owners reported having experienced abscesses, being the third most commonly

reported disorder. However, it remains unclear how many of these were actual skin abscesses compared to other types such as dental abscesses.

Dental disease was not as prevalent in this study as in the one conducted by Minarikova. Only 23 (8.1%) of owners in this study reported to have observed dental problems, versus 363 (36.3%). However, it is important to consider the fact that the dental disease sample group of Minarikovas´ study were actually diagnosed by a veterinarian at a clinic, while results in this study are based on the owners' observations, without knowing if the problem was diagnosed by a veterinarian or not. In addition, several of the other symptoms reported can occur secondarily to undiagnosed dental problems, such as emaciation (5.6%, n=16), reduced appetite (6.7%, n=19), constipation (3.9%, n=11) and diarrhoea (8.1%, n=23) among others.

Cystic ovarian disease was reported by 22 (7.7%) in this study, compared to Minarikovas´ sample group of 21.9% (n=100/456). However, the prevalence was the highest in the old age group consisting of guinea pigs five years or older. In this study, the majority of the owners reported their guinea pigs to be between zero to four years of age (72.8%, n=207) and the number of female guinea pigs out of the remaining 26.8% (n=76) reported to be between 5 and 10 years of age remains uncertain. Ovarian cystic disease is a common disease in female guinea pigs, with an estimate of 66-75% of guinea pigs between three months and five years of age potentially being affected [14]. There is a potential for ovarian cysts to be widely underdiagnosed as they may manifest asymptomatically, not presenting with typical clinical signs such as anorexia, weight loss and hip and flank alopecia [14].

Coughing and sneezing (19.7%, n=56), potentially as signs of respiratory disease were commonly reported. Out of Minarikovas' surveyed patients, only 4% (n=40) belonged to the respiratory diseases group, where 22 of them were diagnosed with pneumonia and 10 were diagnosed with rhinitis. Other respiratory diseases included sinusitis (n=3), pulmonary oedema (n=2), bronchitis (n=2) and intranasal foreign body (n=1). In this study, the exact reason for the coughing and sneezing is unknown. Possible reasons do not have to be infectious agents, it can also stem from environmental causes, such as dust from substrate and hay in the environment. Another possible reason behind respiratory disease is inadequate

intake of vitamin C, as it may increase the probability of respiratory infections due to the guinea pig being immune suppressed [7].

6.8 Owner experience

In general, the respondents appear to be well-educated in both keeping and husbandry, and as many as 32% (n=91) reported having ten years of experience or more with owning guinea pigs. Over half of the owners (66.9%, n=190) said they were actively searching for new information and knowledge on how to provide the best possible care for their guinea pigs. The internet (80.3%, n=228), the NGPC (71.8%, n=204) and social media (65.8%, n=187) were the most commonly reported sources where owners have sought and currently seek information. In comparison, only 37% (n=105) listed the veterinarian as an information source. In general, there are few veterinarians specialized in small mammals in Norway. Guinea pigs have become cherished members of many households, and owners are in general more inclined to invest in their guinea pigs' wellbeing. This proves the need for more specialized veterinarians within the community, to hopefully increase the number of owners' trust towards the veterinary profession, being a valuable source of information and knowledge.

6.9 Guinea pig behaviour

“Popcorning” is a commonly used phrase within the guinea pig community, and it refers to the guinea pig performing a sudden jump and flailing in the air. This is usually a display of excitement and joy, often performed when the guinea pig is let outside. Out of all the respondents, 59.8% (n=170) reported observing this type of behaviour either very often or relatively often. The high frequency of contact-seeking and curious behaviour indicates that the guinea pigs surveyed actively engage with the environment and seek interaction with their companions and owners. Two hundred sixty-two (92.3%) owners reported a very frequent appetite, suggesting that these guinea pigs are generally healthy and well-nourished. The observation of guinea pigs frequently lying down and relaxing is indicative of a comfortable and stress-free living environment. Out of the surveyed guinea pigs, 64.8% (n=184) were reported to express this type of behavior very often. There was a low incidence of stereotypical behaviour, with 68.7% (n=195) saying they never observe this behavioural pattern. This might correlate with the rich environmental stimuli provided by the owners, and the fact that all of the surveyed guinea pigs were housed together with at least one other companion except from nine (3.2%)

The specific results regarding guinea pig behaviour during human interaction in the form of lifting and handling might shed some light on important considerations regarding handling techniques and the stress level of the guinea pig. Following the general trend of the ranking from one to five, where one is never and five is very often, the surveyed guinea pigs appeared to be more relaxed when lifted than when handled directly. This may suggest that owners can reduce the anxiety felt by the guinea pig by initially lifting them, creating a sense of security before further handling. There was also a higher incidence of biting when being handled, as 1.1% (n=3) did this very often, versus no guinea pigs when being lifted, emphasizing the need for calm and gentle handling. Guinea pigs may bite when they feel uncomfortable or even threatened. Owners should respect their guinea pigs´ boundaries and use positive reinforcement to introduce handling gradually. Rare instances of paralysation in either case are reassuring, as it can signal severe stress or health issues. No owners reported their guinea pigs to very often become paralyzed, neither when lifted nor handled.

6.10 Costs related to guinea pig keeping

Owners were typically not spending a lot of money on guinea pig essentials on a monthly basis, with the majority spending between 100 and 699 NOK (63.4%, n=180). For veterinary services, medicines and medical supplies, most owners (90.5%, n=257). This may show a weak correlation with the number of owners who currently had pet insurance (20.4%, n=58) for their guinea pigs. However, as 42.9% (n=122) of the owners reported that they currently have between three and six guinea pigs or more, ensuring all of them when exceeding a certain number might not be as beneficial from an economic point of view. In general, the owners seem to take great responsibility for their guinea pigs, being observant and paying for veterinary treatment when warranted. Even 6.7% (n=19) reported currently treating a disease or condition at the time of the survey, after getting the diagnosis at a veterinary clinic. The willingness of owners to spend more money on their guinea pigs might be driven by a combination of different factors, including a deeper understanding of their guinea pigs' biological needs and a desire for companionship. It might also be linked to the fact that the majority of the owners (88.4%, n=251) said they considered their guinea pigs as family members.

7. CONCLUSIONS

Despite the fact that keeping conditions were reported to be of high standards, pet guinea pigs continue to suffer from preventable husbandry-related diseases, and veterinarians play a crucial role in educating the owners. The education should emphasize the importance of proper feeding practices and the owners' ability to recognize guinea pig behavioural patterns and health concerns. This way, the owners will be able to take proactive steps to ensure optimal care for their guinea pigs. It is important for the veterinarian and owner to form a partnership based on mutual respect in order to collectively work towards the prevention of husbandry-related diseases. Ultimately, this collaboration will not only enhance the life quality of the guinea pigs, but also strengthen the bond between them and their caregivers.

8. ABSTRACT

Guinea pigs (*Cavia Porcellus)* are popular pet animals in Norway. This study aimed to research the current husbandry, health, and welfare of pet guinea pigs in Norway.

An online questionnaire consisting of 100 questions was shared with two of the largest Norwegian guinea pig interest groups on Facebook, having 3300 and 1400 members respectively. In total, the questionnaire yielded 284 responses originating from guinea pig owners representing all the different Norwegian counties. Data were collected between the 7th of February and the 10th of August 2023.

According to the results, the most common source for guinea pig owners to acquire knowledge about keeping and husbandry is through the internet (n=217, 21.9%), with social media following closely behind (n=182, 18.3%). Most owners have acknowledged the social needs of the guinea pig, as just 3.5% (n=10) currently only have one guinea pig. Almost 60% of the participants (n=168, 59.3%) reported that their guinea pigs are fed fresh vegetables at least twice daily, hence 63.7% (n=181) never feed any form of vitamin-C supplement. When asked about health status, 96.5% (n=274) were considered healthy at the moment. Of the surveyed health conditions ectoparasites (n=102, 20.2%), coughing and/or sneezing (n=47, 9.3%), and overgrown nails (n=31, 6.2%) were the most commonly reported symptoms.

Despite maintaining high-quality living conditions, pet guinea pigs continue to experience avoidable health issues associated with their care. It is crucial for the veterinarian to play a significant role in educating guinea pig owners with a particular emphasis on proper feeding practices and helping owners recognize and address guinea pig behaviour and health concerns.

9. ÖSSZEFOGLALÓ

A tengerimalac (*Cavia porcellus)* népszerű hobbiállat Norvégiában. A dolgozat célkitűzése volt, hogy adatokat gyűjtsön a Norvégiában kedvtelésből tartott tengerimalacok egészségi állapotáról és tartási körülményeiről, beleértve az állatjólléti szempontokat is.

A 100 kérdésből álló online kérdőív a két legnagyobb, 3300, illetve 1400 tagú norvég tengerimalac tartó Facebook csoportban lett megosztva. Összesen 284, Norvégia egész területéről származó állattartó válaszolt a kérdésekre. Az adatgyűjtés 2023. február 7. és augusztus 10. között történt.

A tengerimalacok tartásával kapcsolatos legfontosabb információforrás az internet (n=217, 21,9%) és a szociális média (n=182, 18,3%) volt. A tulajdonosok többsége tisztában volt a tengerimalacok társas mivoltával, mivel csupán 3,5%-uk (n=10) rendelkezett csupán egy állattal. A válaszadók 60%-a (n=168, 59,3%) legalább naponta biztosított a tengerimalac számára friss zöldséget, ennélfogva 63,7%-uk (n=181) nem alkalmazott C-vitamin kiegészítést. Az adatgyűjtés időpontjában az állatok 96,5%-a (n=274) egészséges volt. Az egészségügyi problémák közül a külső élősködők (n=102, a tünetek 20,2%-a), a köhögés és/vagy tüsszentés (n=47, 9,3%), és a túlnőtt karom (n=31, 6,2%) voltak a leggyakoribbak.

Az alapvetően megfelelő tartási körülmények ellenére a tengerimalacoknál felmerültek a tartási körülményekkel összefüggő, ezáltal elkerülhető egészségügyi állapotok is. Fontos lenne, hogy az állatorvosok szerepe játszanak a tengerimalac tartók oktatásában különös tekintettel a takarmányozásra és arra, hogy az állattartók képesek legyenek felismerni a viselkedési és egészségügyi problémákat.

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Thesis progress report for veterinary students

Name of student: Elena Olsen

Neptun code of the student: DT4CBC

Name and title of the supervisor: Nikoletta Hetényi, research fellow

Department: Department for Animal Nutrition and Clinical Dietetics

Thesis title: Health survey of pet guinea pigs in Norway

Consultation – 1st semester

Timing				Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023	02	03	Questionnaire content	
2.	2023	02	24	Online consultation: literature review	
3.	2023	04	21	Online consultation, questionnaire result	
4.	2023	06	12	Results	
5.	2023	06	14	Table of contents	

Grade achieved at the end of the first semester: 5

Consultation – 2nd semester

Timing				Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2024	08	16	Survey results	
2.	2024	09	13	Results, Materials and Methods	
3.	2024	09	24	Literature review	
4.	2024	10	17	Plagiarism check	
5.	2024	10	23	Final thesis	

Grade achieved at the end of the second semester: 5

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

Dr. Matz Nadja
signature of the supervisor

Signature of the student: Elena Olsen

Signature of the secretary of the department: Bolcsi Ivett

Date of handing the thesis in: 23.10.23

Thesis statement for TDK thesis

I, the undersigned Nikoletta Hetényi, as the supervisor, declare that I have read and approved the thesis " Health survey of pet guinea pigs in Norway" of the student Elena Olsen, 6th year, and support her participation in the Scientific Student Conference of the University of Veterinary Medicine in 2023. Furthermore, I declare that the uploaded TDK thesis has been successfully checked for plagiarism and that any matches found comply with the University guidelines/rules.

Budapest, 2023. 10.17.

Dr. Hetényi Nikoletta

supervisor

DECLARATION

I hereby declare that the thesis entitled **Health Survey of Pet Guinea Pigs in Norway** is identical in terms of content and formal requirements to the TDK research paper submitted in 2023.

Date: Budapest, ..15... day.....11.....month..2023..year.

.....Eliesa Oh.....

name