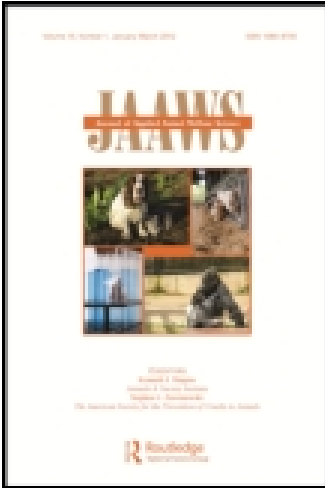


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### Stress Assessment in Small Ruminants Kept on City Farms in Southern Germany

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## ARTICLES

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# Stress Assessment in Small Ruminants Kept on City Farms in Southern Germany

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Sheep and goats are frequently used in nonhuman animal-assisted activities on city farms. There are few data available on this type of usage of small ruminants. Health evaluations, behavioral observations (feeding, resting, comfort, explorative and social behaviors), behavioral tests (human approach tests and touch test), and measurements of fecal cortisol metabolites and heart rate were performed to assess stress levels in 25 sheep and 32 goats on 7 city farms and 2 activity playgrounds in Germany. No evidence was found that the animals suffered from major distress. Health evaluations, behavioral observations, and behavioral tests proved to be the methods of stress assessment most suitable for routine on-farm checks in these settings.

*Keywords:* stress assessment, small ruminants, animal-assisted activities, fecal cortisol metabolites

City farms and activity playgrounds (hereafter, “farms”) offer room for autonomous playing and learning for children growing up in an urban environment. They try to include everyone, and in many cases, a farmlike setting is chosen as it offers a large variety of easily understandable and rewarding tasks. The institutions run on a nonprofit basis and offer children contact with small groups of livestock and other nonhuman animals to enable empathy from firsthand experiences with these species. Sheep and goats are two species regularly kept on city farms for animal-assisted activities, which are part of the farms’ extensive program.

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Animals can either have passive roles in these activities, like being watched, or they can actively be involved—for example, in walks, currycombing, and learning tricks. All activities on these farms are supervised by pedagogical professionals (Bund der Jugendfarmen und Aktivspielplätze e.V., 2010). Direct human–animal interactions occur sporadically during the farms’ opening hours. Individual interactions are usually brief. Throughout a day, the sheep and goats spend about 2 hr in contact with humans (personal observation).

It is unknown whether the activities or housing conditions on city farms are notable stressors for small ruminants. It is therefore difficult for veterinary practitioners and officials to assess whether such employment is a threat to animal welfare. In this study, we assessed whether sheep and goats on city farms showed signs of distress. Stress due to human–animal contact in these settings would most likely be of a chronic, intermittent nature, while poor housing conditions would cause chronic stress. We tried to base our conclusion on which sort of stress assessment would be most suitable to use for veterinarians who are counseling or inspecting these farms routinely.

## ANIMALS, MATERIALS, AND METHODS

### Subjects

Fifty-seven small ruminants (25 sheep, 32 goats) were available for this study. They were kept on seven city farms and two activity playgrounds in Bavaria and Baden-Wuerttemberg, Germany. Farms 1 and 6 only kept goats. Farm 1 had at the time of our study 4 female goats, while Farm 6 had 2 neutered males and 4 females. The other farms kept sheep and goats. On Farms 4 and 5, both species shared an enclosure. Farm 4 had 2 female goats and 4 female sheep, and Farm 5 had 3 neutered male goats, 3 female goats, a neutered male sheep, and 2 female sheep. Farms 2, 3, 7, 8, and 9 provided separate enclosures for both species.

Pasture and free-ranging areas outside the main enclosures were used for both species with direct contact of both species occurring on Farms 2, 3, and 9. Farm 2 had one neutered male and three female goats as well as three female sheep. Farm 3 had two female goats and five female sheep. Farm 7 had a male, neutered goat, a female goat, and two female sheep. Farm 8 had two female goats and one male, neutered sheep along with two female sheep. Farm 9 had two neutered, male goats and two female goats, as well as one neutered, male sheep and four female sheep. Further details on the housing conditions on each farm can be found in Schilling (2013).

### Health Evaluation

Sex and age of each animal were noted, and a veterinarian (A.-K. Schilling) performed a visual examination. She followed the standard veterinary protocol as described in Baumgartner (2005), which included evaluation of body posture, alertness, coat, hooves, joints, the occurrence of discharge from eyes or nose, cleanliness of the perianal region, and general health and care status. Furthermore, she scored the animal’s body condition using lumbal and sternal score in goats and just the lumbal score in sheep (Leeb, Wolf, Pattis-Klingen, Böhm, & Prosl, 2007).

## Behavioral Observations

Direct observations were conducted from April 2010 to September 2010. Camera installation was rejected by the farms. There had been previous litigation when children were filmed without parents' consent. Periods between visits to each farm varied to avoid observation impairment by constant bad weather conditions on individual farms. The observer allowed the animals to get accustomed to her presence for about an hour prior to starting behavioral recordings. Basic behavior—for example, feeding, ruminating, resting, comfort (e.g., autogrooming and object-assisted grooming; Hoy, 2009)—and explorative behavior were recorded by 10-min scan sampling (Martin & Bateson, 1993) for 6 hr twice in each group of animals (sheep and goats separately).

These observations took place on all farms. Twelve hours of behavioral data per animal were collected in this manner. The only exceptions were the two female goats kept on Farm 8. Here the second observation on a rainy day had to be canceled, as the animals focused solely on the observer even after more than 3 hr of adaption time and regardless of the position the observer took. For these animals, only 6 hr of behavioral data were available. An additional 24-hr recording took place on the seven farms (Farms 2, 3, 4, 5, 6, 7, and 9) where fecal samples were collected for measuring fecal cortisol metabolites (FCM). Social interactions were not recorded on these occasions. During the dark hours, a small head lamp was constantly operated. The authors do not think this influenced the animals' behavior. Data were separated into "day" (8 a.m.–6 p.m.) and "night" (6 p.m.–8 a.m.). Special attention was paid to whether abnormal behavior (e.g., stereotypic licking of surfaces, other animals, or their own bodies; wool eating; automutilation; or cannibalism) occurred in individual animals.

## Intraspecies Social Behavior

In each group of animals, intraspecies social behavior and human–animal interactions were continuously recorded during the two 6-hr observations. Social behaviors were grouped into "flight," "agonistic without physical contact" (including stamping with front legs, approaching with head held sideways, tongue playing, or threatening to head-butt), and "agonistic with physical contact" (including frontal and sideways head butt, pushing, kicking, body slamming, following, or fighting) in sheep, and into "agonistic without physical contact" (including erecting of neck hair, pushing the ears back, threatening to bite, or head-butt) and "agonistic with physical contact" (including frontal and sideways head butts, pushing, biting, following, or fighting) in goats.

## Human–Animal Interactions

Human–animal interactions were separated into interactions started by the animal that were "friendly" (including licking, leaning against, or curiously following a person), "agonistic without physical contact" (same as intraspecific), "agonistic with physical contact" (same as intraspecific), or "avoiding" (including moving away from an approaching person), and interactions started by a human that were "friendly" (including stroking, resting a hand on the animal), "feeding from the hand," or "unclear" (including behaving in a way that could be perceived as threatening or asking for a play fight by the animal or behaving in a way congenial to harming the animal). Every behavioral sequence lasting for more than 3 s was noted as one

event. If behavior was interrupted for more than 10 s and then shown again, it was counted as a new event.

### Behavioral Tests

The tests were conducted under field conditions. The animals remained in their social groups within their normal environment. Tests were scheduled at times when neither visitors nor staff members were passing by. Behavioral tests have been used successfully to assess anxiety toward humans in small ruminants (e.g., Hoy, 2009; Waiblinger et al., 2006).

For the *forced-human-approach test*, a man of average stature approached each animal individually starting at a distance of about 5 m. He walked upright, kept his face relaxed and friendly, and his eyes were fixed on a point above the animal's head. The distance at which the animal adjusted his or her behavior as a reaction to the man's approach was noted along with the reaction shown (e.g., stopping to look at him, approaching, moving away, or threatening). The man stopped at this point for 3 s and then moved toward the animal again, thus building up pressure. Again the animal's reaction was noted.

After a break of at least 15 min during which the test person was invisible to the animals, a voluntary-approach test was performed. The test person reentered the animal's paddock, walked to its center gazing at the ground, knelt down, and remained in this position for 15 min. The time passing until each animal approached and sniffed the person was recorded. If the animals did not approach the person within 15 min, it was noted whether they appeared to be disinterested (e.g., engaged in other activities) or fearful (e.g., constantly keeping an eye on the person and disrupting their normal behaviors).

Following the *voluntary-approach test* or, if appropriate, at another time following a set of behavioral observations, either the test person or the observer slowly approached each animal in a squatted posture until he/she could touch the animal with an outstretched hand. Animals were touched on the side of the head, neck, back, crupper, abdomen, and legs facing the person. It was noted whether the touch was tolerated or avoided or if it provoked an agonistic reaction. If the animal moved backward beyond reach, the test was interrupted for a short recovery period before the person approached again, while trying to touch the next location.

### Fecal Cortisol Metabolites

In small ruminants, FCM reflect the plasma cortisol levels about 12 hr before testing (Kleinsasser et al., 2010; Palme, Robia, Messmann, Hofer, & Möstl, 1999). Spontaneously voided feces were collected from each animal during a total of 24 hr at five city farms and the two activity playgrounds (i.e., from 22 sheep and 26 goats). The animals were allowed to step away from the site of defecation and not directly approach it to avoid an impact of sample collection on stress levels. Collection started at the end of a regular farm day during which the animals had the possibility of interacting with visitors. The animals were not observed during the 12 hr prior to collection to avoid alterations and due to practical reasons. It was assumed that the day resembled the regular farm days witnessed during the 6-hr behavioral observations. During the 24-hr collection, the animals were continuously monitored.

A sample of approximately 5 g to 10 g was collected from each spontaneous defecation, labeled (animal, farm, date, and time), and immediately frozen at 20°C. At the end of each 24-hr collection, all samples were transported to the Chair of Animal Welfare, Ethology, Animal

Hygiene and Animal Housing at Ludwig-Maximilians-University Munich, where they were stored at  $-20^{\circ}\text{C}$  until analysis.

A total of 0.5 g of each well-homogenized sample was extracted with 5 mL of aqueous methanol (80%) by being shaken (30 min in a shaker) and centrifuged (15 min; 2,500 g) as described previously (Palme & Möstl, 1997; Palme, Touma, Arias, Dominchin, & Lepschy, 2013). An aliquot (30  $\mu\text{l}$ ) of the supernatant was transferred into Biorad vials containing 270  $\mu\text{l}$  of assay buffer. It was then frozen and transported on dry ice to the Institute of Medical Biochemistry in Vienna, Austria. FCM in the extracts were measured in an 11-oxoetiocholanolone enzyme immunoassay (EIA; for details of the EIA and its validation for sheep and goats, see Kleinsasser et al., 2010, and Möstl, Maggs, Schrötter, Besenfelder, & Palme, 2002).

Results were grouped (a) according to species ignoring the time of collection, (b) according to species and hour within which the defecation had occurred, and (c) in relation to the farms' opening hours. This last grouping was chosen to get an idea of whether human–animal contact caused an increase in FCM even though opening hours differed between individual farms (2–6 hr), and it is impossible to know for certain when (if at all) human–animal interactions occurred. To take slight differences in passage of time between individuals into account, we compared a time span of 3 hr prior to opening to the FCM concentration projection for the farms' opening hours. Furthermore, we formed three “postcontact” groups: first 2 hr after closing, 3rd and 4th hr after closing, and 5th and 6th hr after closing.

### Heart Rate Measurement

Heart rate was recorded using commercially available horse-trainer transmitters and S810i-monitors during the behavioral observations (Polar Elektro Oy, Helsinki, Finland). Measurements were only taken from animals who seemed behaviorally unaffected by the belts attaching the electrodes. Equipment was placed on the animals at least 30 min before observations started. One electrode was placed on the left side of the thorax close to the sternum, and the other was placed high-dorsally behind the right shoulder blade. Contact was improved by cutting the wool/fur and using ultrasonic gel. Electrodes were held in place by a customized surcingle that also offered a pocket for the corresponding monitor.

Saving intervals were set to RR mode (recording up to 30,000 consecutive heart beats) or 5 s (one saving every 5 s, recording up to 44 hr and 13 min) on a rotating basis. Data recorded in the RR mode were used for heart rate variability calculations if quality was sufficient. Polar Pro Trainer 5 software (Polar Elektro Oy, Helsinki, Finland) was used for processing data. Interruptions in measurement were cut out, and all data sets with an error rate of 5% and greater were excluded. An error-correcting software filter was run over the remaining data (set to “moderate” for RR data, “auto” for 5-s data). In each data set, the space of time (containing an average of 100 individual measurements) for which a basic behavior had been recorded was marked.

Data blocks were then again scanned for major errors excluding all data sets containing heart rates of less than 40 bpm. Each data block was used to calculate the mean heart rate for the related basic behavior. The nature of the study, trying to gain information on the influence of highly variable factors like contact to humans, did not allow for a standardization of measurements. This impaired data quality. Therefore, data had to be interpreted with an appropriate degree of caution.

## Statistical Analysis

For behavioral observations, the absolute frequency of interactions is given per 10 min to rectify differences in observation time. All data in this study were analyzed using IBM Statistical Package for the Social Sciences Statistics (Version 19, IBM-Germany, Ehningen). The individual animal was used as an experimental unit. Due to the low number of animals per farm, the data were not normally distributed. A chi-square test was used to test if people significantly influenced feeding, ruminating, and resting behaviors. Multiple comparisons (significance level adjusted using the Bonferroni-Holm procedure) were used on social behavior data sets.

Data from forced- and voluntary-human-approach tests were analyzed using a two-sample *t* test. Differences in tolerance behavior were analyzed using Fisher's exact test. FCM data were analyzed using the Wilcoxon signed-rank test. Heart rate data were analyzed using a post-hoc test with Bonferroni correction while keeping the aforementioned limitations in mind.

## RESULTS

### Health Evaluation

Only female or neutered male individuals are kept on the farms (sheep, 22 ewes, 3 wethers; goats, 23 does, 9 wethers). The range in age was large, with an average of 7.3 years in sheep (1–17 years old) and 4.3 years in goats (1–14 years old). Body condition was either slim or ideal in most animals, with 2 sheep and 3 goats being very lean and 3 sheep and 5 goats being slightly obese. Most animals were in good health. Two sheep and 3 goats showed signs of disease. Acute lameness was seen in 1 sheep. The other animals suffered from chronic conditions due to old age or a recurring infection of the mammary glands. All animals received appropriate veterinary care.

### Behavioral Observations

All in all, sheep were observed for a total of 145.5 hr during the day (farms open, 85.5 hr; farms closed, 60 hr) and 83.5 hr during the night. During day observations, animals were on their own for 74.9 hr (51.94%) and had people in sight for 39.4 hr (27.09%), and fenceless contact was possible for 31.2 hr (21.42%). Goats were observed for 173 hr during the day (farms open, 102.5 hr; farms closed, 70.5 hr) and 97.5 hr during the night. For 95.9 hr (55.44%) of the day observations, no person was close to the animals; for 48.4 hr (27.99%), people were in sight; and for 28.7 hr (16.57%), at least one person was either in the paddock or stable or the animals were roaming free on the farm grounds.

On average, sheep fed for 5 hr (20.8%), ruminated for 9 hr (37.5%), and rested for 3.2 hr (13.5%) of the 24-hr observations. Goats spent a median of 6 hr (25%) feeding, 7.75 hr (32.3%) ruminating, and 4.9 hr (20.5%) resting. The presence of people seemed to significantly influence the time spent on these behaviors independent of the species ( $p = .000023$ ) during the day, but if the different amount of hours spent in the presence and absence of people was taken into account, the influence ceased to be significant. On all farms, sheep and goats explored and showed comfort behaviors both when people were present and when people were absent. No animal in this study showed abnormal behavior. Data from all 6-hr and all 24-hr observations were included in these evaluations.



TABLE 1  
Influence of People on Occurrence of Social Behavior

Species Behavior	Goats				Sheep					
	AnoC		AC		F		AnoC		AC	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
People absent	0.33	0.05	0.23	0.05	0.01	0.003	0.03	0.008	0.05	0.013
People in sight	0.33	0.07	0.14	0.03	0.01	0.005	0.01	0.005	0.05	0.016
People in contact area	0.39	0.14	0.14	0.05	0.20	0.087	0.01	0.006	0.01	0.004

Note. Interactions per animal in 10 min. AnoC = agonistic without physical contact; AC = agonistic with physical contact; F = fear; SEM = standard error of the mean.

For the analysis of social behavior, data had been collected during the 6-hr observations only. Sheep interacted less frequently with their conspecifics than with goats. Table 1 shows the absolute frequency (mean, standard error of the mean [SEM]) of intraspecies social interaction events per animal within 10 min.

There was no significant impact of people's presence on agonistic behavior without physical contact in goats ( $p > .05$ ), while agonistic interactions with physical contact significantly decreased when people were present ( $p = .012$ ). While people in sight caused no significant increase in flight behavior in sheep, the presence of people in a position allowing direct, fenceless contact did increase their flight behavior ( $p = .0001$ ). People did not significantly ( $p > .05$ ) influence agonistic behavior without physical contact in sheep. When people were in positions allowing direct animal contact, intraspecies agonistic behavior with physical contact decreased significantly compared with the absence of people ( $p = .003$ ) and compared with situations in which people were in sight ( $p = .012$ ).

Human-animal contact occurred for both species. All events were too rare to allow valid statistical analysis. Tables 2 and 3 give the absolute frequencies of human-animal (mean, SEM) interactions per animal in 10 min. One can see the tendency that friendly or avoidance behavior is most common in sheep, while goats are more likely to threaten people. Unclear behaviors of people seldom occurred.

TABLE 2  
Observed Human-Sheep Behavior With People in Different Positions

Direction Behavior	Animal-Human								Human-Animal					
	Fr		AnoC		AC		AV		FM		FH		U	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
People in sight	0.00	0.002	0.0	0	0	0	0.0	0	0.01	0.007	0.07	0.029	0.00	0
People in contact area	0.26	0.078	0.0	0.002	0	0	0.14	0.035	0.30	0.082	0.32	0.133	0.02	0.015

Note. Interactions per animal in 10 min. Fr = friendly (animal-human); AnoC = agonistic without physical contact; AC = agonistic with physical contact; AV = avoiding; FM = friendly (human-animal); FH = feeding from the hand; U = unclear; SEM = standard error of the mean.

TABLE 3  
Observed Human–Goat Behavior With People in Different Positions

Direction	Animal–Human								Human–Animal					
	Fr		AnoC		AC		AV		FM		FH		U	
Behavior	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
People in sight	0.01	0.004	0.00	0.003	0.00	0	0.00	0	0.03	0.014	0.02	0.007	0.00	0
People in contact area	0.17	0.049	0.40	0.118	0.04	0.019	0.09	0.028	0.61	0.159	0.36	0.130	0.02	0.006

Note. Fr = friendly (animal–human); AnoC = agonistic without physical contact; AC = agonistic with physical contact; AV = avoiding; FM = friendly (human–animal); FH = feeding from the hand; U = unclear; SEM = standard error of the mean.

### Behavioral Tests

The distances at which sheep and goats reacted to the test person in the forced-human-approach test differed significantly ( $p = .0002$ ). Sheep reacted earlier (mean distance of reaction = 2 m) than goats (mean distance of reaction = 0.5 m).

Most animals reacted by receding as the test person approached (goats, 17/32; sheep, 23/25) and repeated or switched to this reaction if forced (goats, 23/32; sheep, 22/25). Only 24 of 57 small ruminants (42.1%) approached the test person in the voluntary-approach test; 19 of these were goats. Additionally, sheep allowed significantly more time to pass prior to their approach ( $p = .001$ ). Goats approached after an average of 2.7 min, whereas sheep waited for more than 10 min (10.6 min). Nonapproaching goats mostly seemed disinterested (12/13); just 1 goat was categorized as fearful. Sheep seemed to be afraid of the test person more often (7/20). Thirteen of the 20 nonapproaching sheep were categorized as “disinterested.”

Goats tolerated touching of the head ( $p = .003$ ) and neck ( $p = .002$ ) significantly more often than touching of the abdomen or legs. Aggressive reactions occurred in goats only. Sheep were significantly more tolerant toward touches on the head and neck than on the legs ( $p = .011$ ). Table 4 lists the absolute number of animals showing a specific reaction in detail.

TABLE 4  
Animals' Reactions to Touching Test

Species	Behavior	Location					
		Head	Neck	Back	Crupper	Abdomen	Legs
Goat N = 32	Tolerate	23	24	21	16	12	11
	Avoid	7	7	7	13	18	18
	Aggression	2	1	4	3	2	3
Sheep N = 25	Tolerate	18	18	16	16	12	9
	Avoid	7	7	9	9	13	16

TABLE 5  
Median FCM Concentration (ng/g) Before, During, and After Human–Animal Contacts

Species	Median FCM concentration (ng/g)				
	<i>cortvk</i>	<i>cortko</i>	<i>cortnk2</i>	<i>cortnk4</i>	<i>cortnk6</i>
Goat	256	353	305	282	317
Sheep	224	281	341	334	298

*Note.* FCM = fecal cortisol metabolites; *cortvk* = 3 hr prior to opening; *cortko* = during opening; *cortnk2* = 2 hr after closing; *cortnk4* = 4 hr after closing; *cortnk6* = 6 hr after closing.

### Fecal Cortisol Metabolites

Due to differences in defecation frequency and in the number of individuals, 215 samples were collected from sheep and 409 were collected from goats. FCM concentrations showed high intraindividual and interindividual variations (lowest concentration in a single sample = goat, 28 ng/g feces; sheep, 8 ng/g; highest concentration in a single sample = goat, 1,195 ng/g; sheep, 2,188 ng/g). The median FCM concentrations of both species were not significantly different (goats, 267 ng/g; sheep, 244 ng/g). Neither sheep nor goats showed significant fluctuations in FCM concentrations during the course of a day ( $p > .05$ ).

Table 5 gives the median FCM concentrations in relation to the farms' opening hours—that is, the opportunity for human–animal contacts.

In goats, the increase (40%) of FCM prior to and during the opening hours was significant ( $p = .003$ ). A significant increase (30%) also occurred in sheep, and it was apparent when comparing to the concentrations prior to and during opening ( $p = .016$ , factor 1.3). However, in this species, the highest concentrations were measured during the first 2 hr after closing. There was an increase of the FCM concentration by a factor of 1.5, and it was significant ( $p = .034$ ) when compared with the prior opening concentrations. It is important to note that on most farms, at least one feeding takes place during the opening hours. Furthermore, some farms allow their animals to roam freely when they are open.

### Heart Rate Measurement

Neither species nor the presence of people had a significant impact on the median heart rate. The overall median heart rate was 102 bpm in goats and 104 bpm in sheep. If people were absent, median heart rate was 95 bpm in goats and 102 bpm in sheep; median heart rate changed to 93 bpm (goats) and 103 bpm (sheep) when people were in sight and to 107 bpm (goats) and 114 bpm (sheep) when people were in positions allowing direct contact. Goats ruminating in a lying position had significantly lower heart rates than goats actively moving around or feeding ( $p = .042$ ). Likewise, sheep had lower heart rates when ruminating ( $p = .005$ ) or resting ( $p = .048$ ) than when they were engaged in more active behavior like moving around or feeding.

Due to the fact that study design and questions did not allow standardized heart rate measurements, few data had the quality to be used for calculating heart rate variability. With the small set of remaining data, further statistical calculations were impossible, but it is still worth noting that even under these “far from perfect” conditions, it was possible to demonstrate that root mean square successive difference (RMSSD) was lower when animals were engaged in

activities like moving or feeding than when they were ruminating in a lying position. For example, goats had a mean RMSSD of 52.65 ms ( $SEM = 5.78$  ms) when they were active compared with 70.88 ms ( $SEM = 7.83$  ms) when they were lying down and ruminating. Sheep had an average RMSSD of 76.92 ms ( $SEM = 8.34$  ms) during active behavior, while RMSSD showed greater individual variations when ruminating in a lying position ( $M = 130.82$  ms,  $SEM = 51.07$  ms).

## DISCUSSION

### Health Evaluation

It has been proposed that chronic stressors can have immune-suppressing effects, which can lead to increased morbidity (Blache, Terlouw, & Maloney, 2011; Gregory, 2004; Jones & Boissy, 2011; Moberg, 2000). The small ruminants in this study are likely to live to old age in good health and be well cared for. Individual (minor) ailments can occur in any herd of livestock, even under generally good conditions. Therefore, our health evaluation does not present evidence that small ruminants on city farms are chronically stressed. However, one has to bear in mind that health evaluation reveals compromise to animal welfare only if it is severe enough to cause obvious pain, suffering, or physical harm (Moberg, 2000). Thus, it is a good parameter for a counseling veterinarian to unveil severe shortcomings in animal husbandry, but it offers no clue to minor problems in daily practice. Health evaluation should always be a part of a veterinary visit to a city farm, but it should not be the only parameter assessed.

From what we saw in our study, it is common practice for small ruminants on city farms to have sufficient resting time within a group of conspecifics away from human contact. It is more likely that the animals spent days with very little or no contact with visitors than it is that they were used for more than 2 hr a day in interactions with humans. Their employment on these farms can therefore be seen as modest and should not inherently be a threat to animal welfare (Fredrickson-MacNamara & Butler, 2010).

### Behavior and Behavioral Tests

Sheep and goats in this study showed species-specific basic behavior and spent sufficient amounts of time ruminating and resting (Hoy, 2009). The animals spent less time feeding than the species average (Hoy, 2009). This is most likely due to the easy availability of nutrient-rich hay. As feeding is one of the main natural occupations for small ruminants, a general recommendation can be made to design husbandry systems and hay racks in a way to slow down feed intake to get the animals to spend more time there. The absence of abnormal behavior is an indicator that small ruminants in this study do not experience major compromises to their welfare (Gregory, 2004; Hoy, 2009; Jones & Boissy, 2011).

Sheep and goats showed relatively low rates of intraspecies agonistic behavior (Addison & Baker, 1982; Andersen & Boe, 2006). Sex as well as the small group size might have had a certain influence here. There is no evidence that general practice on the city farms leads to higher rates of agonistic behaviors that could be indicators of (social) stress (Fernández, Alvarez, & Zarco, 2007). The fact that intraspecies agonistic behavior was rarer when people were within the animals' enclosure might have been due to the additional behavioral options—for example,

interaction with humans. The increasing flight rates in sheep might have also been due to the fact that humans were perceived as potential threats, which made the animals postpone their intraspecific conflicts to stand together as a group during the potential danger. Sheep and goats who see even well-known humans as a potential danger are not qualified for employment in animal-assisted activities, as they may experience serious stress (Fredrickson-MacNamara & Butler, 2010).

Behavioral observations are easy to perform and need little technical equipment in the field. Therefore, they are available for every veterinarian visiting a city farm. Behavior reflects physical as well as emotional health, and it can be a valid parameter in stress assessment (Beausoleil, 2006; Olsson, Würbel, & Mench, 2011; Rushen, 2000). To gain valid information from behavioral observations, the observer's experience and adequate duration of the observation period are crucial (Rushen, 2000). Based on the authors' personal experience, a veterinarian using this tool for stress assessment in small ruminants on a city farm should spend at least two 15-min periods exclusively watching the behavior of each flock and should monitor at least one feeding per group.

The results of our behavioral test imply that the sheep and goats in our study tended toward a neutral to slightly positive attitude toward humans, with few individuals being actually fearful (Hoy, 2009; Jones & Boissy, 2011; Waiblinger et al., 2006). The fact that most animals chose avoidance over aggressive reactions toward humans intruding on their personal space is positive, especially in the context of animal-assisted interventions. This general character trait can help with avoiding accidents. Still, frequent, positive contact with caregivers and children visiting the farms should be provided for all sheep and goats. This will help to implement a positive human–animal relationship and give time to train the animals in some basic skills, like being haltered, touched, or walked. These skills make daily handling easier and help with avoiding risks in human–animal contacts (Centers for Disease Control and Prevention, 2011; Waiblinger et al., 2006).

Behavioral tests are applicable for veterinary practitioners visiting city farms and offer valid information on the human–animal relationship. Therefore, they should be used to assess whether there are fearful or aggressive individuals in a flock. These individuals can be stressed even by brief contact with humans and can be threats to both conspecifics and visitors. They should be singled out and either be given special, constant training to implement and obtain positive human–animal relationships, or they should be removed from the farms (Fredrickson-MacNamara & Butler, 2010; Waiblinger et al., 2006). A careful preselection of sheep and goats for animal-assisted interventions is important (Fredrickson-MacNamara & Butler, 2010).

### Fecal Cortisol Metabolites

FCM are a valid parameter for assessing stress in sheep and goats (Kleinsasser et al., 2010; Lexen, El-Bahr, Sommerfeld-Stur, Palme, & Möstl, 2008; Möstl et al., 2002; Palme, 2012). FCM concentrations in our sheep and goats are in line with the baseline values found in other studies, and so are the massive individual variations (Lexen et al., 2008; Möstl et al., 2002; Nordmann et al., 2011; Palme et al., 1999; Patt et al., 2012, 2013). The increases registered during the farms' opening hours (goats and sheep) and shortly after (sheep) can be explained by the higher activity levels the animals showed in the afternoon, and they might also have been caused by the feeding occurring at the end of the opening time on most farms (Lexen et al., 2008;

Nordmann et al., 2011). The prolonged increase in sheep might have been due to a lag in FCM excretion (Patt et al., 2012). The increase in both species is mild compared with increases caused by known stressors like disease, transport, and clipping or adrenocorticotrophic hormone injection (Kleinsasser et al., 2010; Lexen et al., 2008). We therefore conclude that stress imposed upon sheep and goats by housing conditions and employment on city farms is mild.

Proper application of FCM in routine counseling and inspection of city farms can be difficult. If acute stress caused by a specific human–animal interaction is to be assessed, frequent sampling 12 hr to 15 hr after the incident would be necessary (Palme, 2012; Patt et al., 2012). As relevant human–animal interactions are most likely to occur during the farms’ opening hours (noon until 6 p.m. in many cases), this would require the practitioner or an assistant to collect samples in the middle of the night, as we did in this study. If we presume there is chronic stress in the flocks kept on a city farm due to poor housing conditions or repeated human–animal contacts, a single FCM sample can be a valuable tool (Palme, 2012). When the number of individuals on a farm is low (some farms keep no more than two sheep or goats), we need to be very careful in applying this tool though. The high individual variations we saw in our study may account for lower concentrations in a single sample even in stressed individuals. When FCM are used for stress assessment in small sheep and goat flocks on city farms, it is even more important than in other settings with larger numbers of animals to look at the results in a broader context, including a thorough examination of the housing conditions and assessment of behavioral and health parameters.

### Heart Rate Measurement

Heart rates in our study were higher than the average given in textbooks for sheep and goats but were in line with other studies using comparable equipment (Aschwanden, Gyax, Wechsler, & Keil, 2008; DaCosta, Leigh, Man, & Kendrick, 2004; Nordmann et al., 2011; Reefmann, Bütikofer Kaszàs, Wechsler, & Gyax, 2009). Discrepancies might have therefore been caused by the measuring system. Both heart rate and heart rate variability (represented by the RMSSD) are interference-prone parameters that need further research to be ready for practical applications in free-ranging animals (Aschwanden et al., 2008; Gregory, 2004; Reefmann et al., 2009; Sztajzel, 2004; von Borell et al., 2007).

Only a small proportion of the data we recorded were suitable for evaluation, thus not allowing for statistically validated assertions. But even under the present terms, results are in line with what one would predict looking at the other parameters of this study. This could be seen as a hint that with further technical development, heart rate and heart rate variability parameters may become good, noninvasive tools to be used by practitioners in herd health monitoring of small ruminants in animal-assisted interventions. This “live” recorded data could support and substantiate behavioral observations.

## CONCLUSION

Employment in animal-assisted activities on city farms does not appear to be a major stressor for small ruminants. Both sheep and goats can cope well with the requirements as long as suitable housing conditions, enough appropriate conspecifics, and proper habituation to humans are guaranteed. Veterinary practitioners and officials who are controlling and counseling regarding

such enterprises should use health evaluations, behavioral observations, and behavioral tests to assess the situation on individual farms. Where larger flocks are available or combined with the methods just mentioned, FCM can be added as a physiological, more objective parameter. Other physiological measurements like heart rate and heart rate variability may be used in the future but are not ready for practical application under city farm conditions today.

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