The well-being of Post-Traumatic Stress Disorder (PTSD) service dogs

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Master thesis

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Summary

Background: Service dogs are very helpful for veterans with post-traumatic stress disorder (PTSD). Veterans with PTSD does have a lot of problems. PTSD service dogs are helping with these problems. A lot of researches support the use of a service dog as an complementary treatment for veterans with PTSD. However, service dogs may be exposed to some stressors, which may influence the welfare of these dogs. There are no researches to the welfare of PTSD service dogs. This research will investigate the well-being of PTSD service dogs in a subjective and objective way.

Methods: In this study, 20 service dogs and 19 companion dogs were used. Owners fill in a questionnaire about the quality of life for their dogs. Saliva samples were collected on five timepoints for two days to measure the stress response. Cortisol is the stress parameter, which will be measured in saliva. Further, each dog carries a accelerometer in their collar for 48 hour to determine the activity. Statistical tests are used to investigate the differences in variables between service dogs and companion dogs.

Results: There are some significant differences in variables in the questionnaire between service dogs and companion dogs. There is a significant difference in ‘gender’, ‘is the dog healthy’, ‘how often walks the dog per day’, ‘the time a dog walks per day’, ‘the time a dog can rest per day’, ‘the time a dog can sleep per day’ and ‘the time the dog is home alone per day’. Furthermore, there are statistical differences in performing tasks, such as emotional support. Results also revealed a significant difference in overall cortisol levels between service dogs and companion dogs. The activity levels between service dogs and companion dogs were not significant. At last, variables from the questionnaire did not have influence on the cortisol levels.

Conclusion: Results indicate that there are some significant differences in subjective variables in the questionnaire between service dogs and companion dogs, but these variables are not correlated with the objective data. From these data it looks like the welfare of PTSD service dogs and companion dogs is comparable.

Contents

1. Introduction

In the First World War animals, such as dogs, pigeons and horses, had a lot of tasks by the military (Houtert et al., 2018). Dogs were used to attack the enemy, to protect the camps, as mine detectors or as couriers (Krol, 2012). Another role of the dogs was being a social and emotional friend to the soldiers during stressful circumstances. Since the Second World War, the animals were not that much needed anymore, but the interest in the emotional bond between humans and animals remained. Professions have recognized the health benefits of the human-dog relationship. As a result, dogs were used as a assisting treatment method for people with health and mental problems. For example, people with Post-Traumatic Stress Disorder (Houtert et al., 2018).

1.1 Human-animal connection

One of the basic concepts of the human-animal interaction is the 'biophilia-effect'. In 1984 Wilson invented the term 'biophilia'. Biophilia describes the affinity of humans to animals and nature in general. Biophilia arose during the evolutionary history, because humans always lived together in contact and in the same surrounding with animals. It was important that humans pay attention to the animal in order to survive. Animals could be a source of food and they warned the people for danger. Humans learn to understand the behavior of the animals. When the animals were calm, they interpret that as a sign of a safe environment. This can reduce stress reactions and promotes a feeling of security in humans (Beetz, 2017; Beetz et al., 2019).

The human-animal interaction can develop between a person and a friendly animal, like a dog or horse. The presence of an animal, can reduce the feeling of loneliness, has a calming effect, and is linked with an increased level of oxytocin, an anti-stress agent (Scotland-Coogan, 2019; Yount et al., 2013). These levels of oxytocin were found in both animals and humans. This suggests that an animal is able to increase oxytocin levels in the owner (Scotland-Coogan, 2019).
Oxytocin is produced in the hypothalamus. During sensory stimulation, such as breastfeeding, sex, labor, warmth, touch and stroking, the hormone will be released into the brain and circulatory system (Beetz, 2017; Beetz et al., 2012). Oxytocin has a lot of positive effects on humans (table 1). Increases in oxytocin depends on the human-dog relationship. The closer

the relationship, the more oxytocin is released from the hypothalamus (Beetz et al., 2012; Stern et al., 2013; Whitworth et al., 2019; Yount et al., 2013).

Table 1: *Positive effects of oxytocin on humans, because of the human-animal interaction*

Physical effects	**Effect on behavior[b]**
↓ Heart rate[a]	↓ Depression
↓ Blood pressure[a]	↑ Social interaction
↓ Cortisol levels[a]	↑ Empathy
	↑ Trust
	↑ Positive mood
	↑ Eye contact
	↑ Pair bonding and bonding to offspring
	↑ Social interaction

Note.

[a] Beetz et al. (2019)

[b] Beetz (2017), Beetz et al. (2012)

1.2 PTSD

PTSD is a disorder, related to trauma and stress (Stern et al., 2013). It is caused by the experience of traumatic occasions and violence. Risk factors, such as being younger at the time, a previous mental disorder and life stressors may help to develop PTSD. (Furst, 2015; Krause-Parello et al., 2016). Members of the military, police, firefighters, first aid and people living in war zones are more likely to experience traumatic events (Beetz et al., 2019). PTSD is defined by negative mood, intrusion, periods of anxiety and depression, hypervigilance, anger, irritable behavior and sleeplessness (APA, 2013). People with PTSD also have an increased risk for general medical problems, like obesity, hypertension and raised blood sugar (Stern et al., 2013). Further, they are linked to use drugs, alcohol or tobacco, to get suicidal and can be aggressive to other people (Houtert et al., 2018; Krause-Parello et al., 2016). These problems cause that those people avoid public spots, avoid strangers and that they got disengaged from relationships (APA, 2013). The clinical presentation of PTSD may vary, but the most important symptoms are that veterans reliving the traumatic event over and over again through flashbacks and/or nightmares (Mclaughlin & Hamilton, 2019).

1.2.1 Different treatment methods

There are multiple treatment strategies for PTSD, like cognitive behavior therapy, prolonged exposure therapy, eye movement desensitization and reprocessing (EMDR), stress management therapies, trauma-focused therapy and reprocessing therapy. These therapies are often provided in combination with pharmacotherapy (Crowe et al., 2017; Furst, 2015; Holman et al., 2018; Krause-Parello et al., 2016; Saunders et al., 2017; Whitworth et al., 2019). Alternative treatments, such as mindfulness, art, yoga, music therapy, massage, drama therapy, hypnosis and dance were also used, but mostly as complementary treatment to primary therapies (Crowe et al., 2017). According to Whitworth et al (2019), half of all veterans with combat-related PTSD do not successfully recover after receiving one of those primary treatments. They do not want to be seen as 'weak' when they ask people for help. When they accept help, there is a lot of distrust towards other humans (Beetz et al., 2019; Whitworth et al., 2019). That is why an investigation in a new treatment is so important. Canine assistance could be used as a complementary treatment to primary therapies to manage PTSD (Kloep et al., 2017; Krause-Parello et al., 2016; Saunders et al., 2017).

1.3 Animal Assisted Interventions (AAIs)

Kruger & Serpell (2006) defined animal assisted intervention (AAI) as 'any intervention that intentionally includes or incorporates animals as part of a therapeutic or ameliorative process or milieu.' AAI has positive influences on humans. First, humans in general, communicate more positively in the presence of an animal (Beetz et al., 2019). Second, the presence of animals could increase social interaction with strangers. This is called the social catalyst effect (Beetz, 2017). Third, animals may be helpful in preventing stress and depression, by giving a motivation to live (Bergen-cico et al., 2018). A form of AAI is a service dog, which can be used to alleviate the PTSD symptoms in veterans during day and night (Rodriguez & O'Haire, 2018)

1.3.1 Types of dogs

There are four types of dogs for AAI: a service dog (SD), a psychiatric service dog (PSD), a therapy dog (TD) and an emotional support dog (ESD) (Krause-Parello & Morales, 2018). All types of dogs have their own tasks and privileges (table 2).

Table 2. *Types of dogs for animal assisted intervention (AAI)*

	Protected by the Americans with Disability Act (ADA)	**Special access to public facilities**	**Familiar with individuals**	**Specific training to perform to the needs of the owner**
Service dog (SD) *	Yes[a]	Yes[c]	Yes[b]	Yes[b]
Psychiatric service dog (PSD) **	Yes[a]	Yes[c]	Yes[b]	Yes[b]
Therapy dog (TD) ***	No[a]	No[b]	No[b]	No[b]
Emotional support dog (ESD) ****	No[a]	No[b]	No[b]	No[b]

Note.

* SD's are specially for people with a disability, including a physical, sensory, intellectual, mental of psychiatric disability (Krause-Parello & Morales, 2018)

** PSD's are SD's, but they help people with psychiatric disabilities, like schizophrenia and PTSD (Krause-Parello et al., 2016)

*** TD's are trained for contact with people who are in medical facilities, like detention centers. These dogs promote healing and reduce stress (Krause-Parello et al., 2016)

**** ESD's are specifically for companionship, affection and support for people with disabilities. ESD's must be well-socialized and well-behaved to people and other animals (Krause-Parello et al., 2016).

[a] Mims & Waddell (2016).

[b] Krause-Parello et al. (2016), Saunders et al. (2017), Taylor et al. (2013)

[c] Rodriguez & O'Haire (2018)

1.4 Influence of dogs on veterans with PTSD

A PTSD service dog is a psychiatric service dog. They will be selected by bred and specifically trained, because they have to help people with PTSD during day and night (Houtert et al., 2018). Retriever breeds are perfect for this type of work, because of their size, trainability, stable personalities and temperament (Burrows et al., 2008). A lot of research, to the effects of service dogs on veterans with PTSD, has been done already. The results are positive, but there are also a lot of limitations (table 3).

Table 3: *Overview of research into the influence of service dogs on veterans with PTSD with their results and limitations*

Study	Results	Limitations
McLaughlin & Hamilton, 2019	Veterans feel less isolated, more safe and more reconnected Improvement in sleep, because a dog gives a greater feeling of security at night, mood and family interaction Reduction in alcohol and suicide thinking	Subjective study (only interviews), small sample size, no control group
Scotland-Coogan, 2019	Veterans with PTSD and a service dog reported an improvement in sleep disturbance and anxiety symptoms	Subjective study (only interviews), no control group
Husband et al., 2019	The use of medicines (sleeping pills, antidepressants, benzodiazepines against anxiety and opioid analgesics against pain) decreased or remained stable in veterans with PTSD	Subjective study (only interviews), small sample size
Whitworth et al., 2019	Service dogs help veterans to improve their PTSD symptoms, such as anxiety and hyperarousal and to reconnect with family and friends	Subjective study (only questionnaires), not randomized
Crowe et al., 2017	A service dog makes veterans with PTSD more active, increases the veterans confidence, helps to trust again and decreases their anxiety Furthermore, veterans were better able to handle their symptoms and are reintegrating into the society	Subjective study (only questionnaires), only male participants, no control group, no differences between veterans with PTSD only, TBI only, or both.
Stern et al., 2013	Veterans are feeling calmer, less depressed, less lonely, less irritable	Subjective study (only questionnaires), restricted age range, no control group

	and less worried when there is a dog in companionship Furthermore, they feel more reconnected with family and they reported exercising more, because the dog needs to go outside Walking with the dog has also other benefits, like it helps to regularize the sleep-wake cycle, it is better for the physical health, it reduces the feeling of isolation and it encourages reintegration into society	
O'Haire & Rodriguez, 2018	Veterans with a service dog reported a decrease in PTSD symptoms, such as depression, and an increase in social functioning	Subjective study (only questionnaires), not randomized
Krause-Parello et al., 2018	A service dog helps to reduce anger, anxiety, suicidal thoughts, and the use of medication. Furthermore, they give a calming effect and helps to reconnect with family again	Subjective study (only interviews), no control group

The service dogs are trained to recognize behavioral characteristics. A PSD has to wake up and has to respond to panic attacks and fear of the veteran. Other important tasks, of a PSD, are to lick the veteran when the veteran is faced with flashbacks and nightmares, help to remain focused on the present by playing with each other, to accompanies the veteran outside, to stand close when the veteran is nervous or anxious, to detect and middle when the veteran becomes aggressive, maintaining space between the veteran and strangers ('blocking') and alerting the veteran when a stranger is coming close (Lessard et al., 2018; Mclaughlin & Hamilton, 2019; Rodriguez & O'Haire, 2019; Whitworth et al., 2019; Yarborough et al., 2017).

1.4.1 Challenges

There are not only benefits of service dogs, but also challenges. Challenges of a service dog are the animals health, costs, public's reaction, the training sessions and the stress of the animal care. First, the dogs are 'working' 24/7, so they need enough rest, recovery, routine and downtime to remain healthy by themselves (Krause-Parello et al., 2016; Lessard et al., 2018; Taylor et al., 2013). Second, a dog's presence in public spaces could get unwanted attention. People are asking questions, for example they asked the reason why you have a service dog or they ask the owner to leave to place. It is very hard for these people to deal with these questions (Lessard et al., 2018; Yarborough et al., 2018). Third, there are some issues a person can experienced during the training of their animal. For example, when a veteran trains their service dog, the pressure to learn a lot of commands in a short period can result in distress (Yarborough et al., 2018). At last, losing an animal might have a negative impact on the persons mental health. (Beetz et al., 2012; Mclaughlin & Hamilton, 2019; Taylor et al., 2013).

1.5 Animal welfare

The term 'animal welfare' is a broad concept. A lot of animal welfare experts have their own ideas about animal welfare, but most people accept the basic considerations from Brambell, also called the 'five freedoms'. The five freedoms were drawn up in 1965 by Brambell and apply for all animals (Serpell et al., 2010):

1. Freedom from thirst, hunger and malnutrition
2. Freedom from discomfort
3. Freedom from pain, injury and disease
4. Freedom from fear and distress
5. Freedom to express most normal behavior

The University Utrecht describes the welfare of an animal as 'its ability to adapt to the environment to achieve a state that it perceives as positive'. Both positive and negative emotions should be adequately processed to achieve that positive state. So, welfare will be determined by the animal's ability to adapt to these emotions (UU, z.d.).

Animals have their physical- and emotional needs. Both needs are important for the animal welfare. Physical needs are water, food, defecation and urination. Emotional needs are for example, social companionship, predictability, controllability and mental stimulation (Burrows et al., 2008). Animals need the opportunity to adapt to different situations,

discomfort and distress. When this is not possible, a situation will become too stressful and the animal welfare may be affected (Serpell et al., 2010).

Service dogs are working dogs and there can be some negative welfare outcomes for these dogs (Bremhorst et al., 2018). Service dogs may be exposed to some stressors, such as not enough routine, and a lack of rest-recovery time, predictability in a day and recreational activities (Bremhorst et al., 2018; Burrows et al., 2008).

PTSD service dogs help to improve the welfare of the handler, but it is not clear what the impact is on the dog's welfare. A study to the (negative) welfare in PTSD service dog is necessary (Bremhorst et al., 2018; Houtert et al., 2018)

1.5.1 Cortisol

Stress is a natural physiological respons of the body to stressors in the environment. Acute stress can be very helpful. In a stressful situation, the body reacts with a few physiological responses, such as the release of adrenaline and cortisol. These responses ensure that the body is ready for fight-or-flight. So in the first instance, stress has a protective function (Gijsen et al., 2008). Stress can also not be converted into action. Being exposed to chronic stress for too long can exhaust people or animals. Chronic stress is always negative and will have a negative impact on the welfare of the dogs (Verkuil & Emmerik, 2007). A stress-related parameter is cortisol (Beetz et al., 2012; Serpell et al., 2010). Cortisol is secreted from the hypothalamus-pituitary-adrenocortical (HPA) axis in body fluids (blood, saliva, urine). A stressful event will activate the HPA axis and as a result it will release cortisol (Rodriguez et al., 2018; Scotland-Coogan, 2019). As mentioned before, cortisol makes the body ready for 'fight or flight' reactions. When normally the stressor is over, the hormone level will decline to a baseline level. When this does not happen, the hormone level will not decline and the stressor will become chronic (Serpell et al., 2010).

Aim of the study

Quite a lot of research has been done into the influence of service dogs on veterans with PTSD (table 3). There are a lot of limitations of these studies. One important limitation is that all the studies are subjective. At the moment, a PhD study on the influence of service dogs on veterans with PTSD is taking place. The welfare of veterans with therapy resistant PTSD and their service dogs will be measured. This will be done not only by using subjective

measurements like questionnaires, but also objective measurements such as for instance cortisol.

This study is a sub-study from this PhD study. The well-being of the PTSD service dogs has never been researched before. The aim of this study is to investigate the welfare of PTSD service dogs. The following hypothesis is addressed: the welfare of PTSD service dogs is different from the welfare of companion dogs.

2. Materials and methods

2.1 Procedure

To test the hypothesis, two groups of dogs were examined. Cortisol levels and activity in the dogs will be measured, and the owners of the dogs had to fill in two questionnaires about the dogs.

2.2 Participants

As mentioned before, this study is a sub-study of a bigger PhD study. For this study, two groups were used: 1) veterans with PTSD and a service dog, and 2) people with companion dogs. A total of thirty-nine dogs were recruited, twenty service dogs and nineteen companion dogs. All the dogs were recruited before COVID-19. The dogs has to be between the 1,5 years and 10 years old, because then a dog can serve as a service dog. To find participants for group 1, veterans with PTSD and a service dog, the researcher from the PhD study worked together with Stichting Hulphond Nederland. In agreement with the organization and the participants, the participants were signed up for the study. For group 2, the companion dogs, Labrador Retrievers ('Labradors') were needed. This is the control group. Especially Labradors were needed, because mostly all of the service dogs are Labrador. Calls on social media and networking with people, like family and friends, helped to find these Labradors, who lived in a Dutch household.

2.3 Instruments

2.3.1 Questionnaires

The owners of the dogs completed the following questionnaire:

Quality of Life questionnaire for service dogs (SD Qol). The SD QoL is a questionnaire about the quality of life for service dogs. It is based on a dog QoL questionnaire, but contains a few adjustments. The questionnaire has been shortened from 107 to 50 questions (not including sub questions) and questions about the dog training were removed. The SD QoL is divided into different categories: 1) general questions dog, 2) general questions owner, 3) feed of the dog, 4) exercise of the dog, 5) the assistance the dog provides, 6) opportunities for sleep and rest of the dog, 7) social behavior of the dog towards other people and 8) social behavior of the dog towards other dogs. At the end, there are three more general questions (Ortalani & Ohl, 2014).

2.3.2 Saliva collection and determination of cortisol

Saliva samples will be collected from the dogs to determine cortisol levels. We will use the saliva, because that is the easiest way and it is highly correlated with cortisol in plasma (Dreschel & Granger, 2009; Vincent & Michell, 1992). Blood sampling for the measurement of plasma cortisol might also be a stressor itself (Beerda et al., 1996). The saliva samples will be collected at certain times (table 4). The reason for this is that waking up in the morning results in an activation of the HPA-axis, so cortisol will be secreted. Cortisol will be secreted pulsatile via a circadian rhythm, which means that the secretion is not equal at all times of the day. It is highest in the morning and lowest in the evening (Kobelt et al., 2003; Pruessner et al., 1997).

Table 4*: Schedule for taking the swabs of the dogs*

	Awakening (S1)	**15 min after awakening (S1 + 15)**	**30 min after awakening (S1 + 30)**	**60 min after awakening (S1 + 60)**	**Before bedtime in the evening (S2)**
Day 1					
Day 2					

The saliva samples are collected with a cotton swab. The dog has to chew on the swab for 1 minute. The swab is placed in a tube and every swab has his own tube. It is important that the dogs do not eat before collecting the samples. All the tubes (ten in total) should be stored in their home freezer until someone of the study team picks it up. Next, the samples are sent to a laboratory.

2.3.3 Activity

For the measurement of the activity in dogs, the Actigraph GT3-X accelerometer were used. Accelerometers are motion sensors, which monitor the duration, frequency and intensity of all activities in individuals. The accelerometer measures movement in three dimensions (vertical y-axis, horizontal left-right x-axis and the horizontal front-back axis). It is a small (3.8 x 3.7 x 1.8 cm) and lightweight (27 g) sensor (Yam et al., 2011). The accelerometers were developed for humans, but the study from Yam et al. (2011) shows that they could be used in dogs as well. The accelerometer for the dogs is secured inside a special collar. The collar should be around the dog's neck for at least 48 hours. It is not total waterproof. The data from the accelerometers were downloaded and imported in an excel file.

A member of the study team delivered the questionnaire, swabs and accelerometer to the participants home's and the same person picks everything up a week later.

2.4 Statistical analyses

The data was analyzed with the statistical program R-studio to get insight into the difference in characteristics between the two groups. There are two types of variables: continuous and categorical (table 5 and 6). For each of them, there is a different type of test. For all tests a significance level of 5% will be used. To investigate the differences between the two groups for continuous variables independent t-test (test-statistic = t) were conducted. There are some assumptions for the independent T-test. First, the two samples must be independent. Second, the variable should be normally distributed. This can be checked with the Shapiro-Wilk test. Third, the two variances should be equal ('homoscedastic' in statistical jargon). To verify if the two variances are equal, the F-test will be used (appendix 8.2). If all the assumptions are satisfied, independent t-test can be conducted. If the assumptions are not satisfied, alternative non-parametric tests will be conducted, such as the Wilcoxon rank sum test (test-statistic = W). There is one assumption of this test, the variables should be independent and randomly chosen (Petrie & Watson, 2013).

For categorical variables the Wilcoxon rank sum test (test-statistic = W) is also conducted, because the statistical difference in one variable between two groups will be determined (Petrie & Watson, 2013).

Table 5. *Included variables participants*

Variable	Classification	Measurement
Age (years)	Humans: 35-76	Continuous
Gender	Male or Female	Categorical
Marital status	Single, married, living together, committed relationship, divorced, widowed	Categorical
Education	Primary school, high school, vocational education, intermediate vocational	Categorical

	education, higher vocational education, science education	
Housing type	Apartment, farm, houseboat, house with garden, house without garden	Categorical
Kind of environment where people live	City, countryside, village	Categorical
Total number of people in household	1, 2, 3, 4, 5	Continuous
Previous dog ownership	Yes or No	Categorical
Are there other dogs in the house?	Yes or No	Categorical
Are there other animals in the house?	Yes or No	Categorical

Table 6. *Included variables dog*

Variable	**Classification**	**Measurement**
Age (years)	1-12	Continuous
Breed	Labrador or Poodle	Categorical
Gender	Male or Female	Categorical
Weight (kg)	24 – 40	Continuous
Vet visits	0, 1, 2, 3, >3	Categorical
Is the dog healthy?	Yes or No	Categorical
Is the dog on medication?	Yes or No	Categorical
How often walks the dog every day?	0, 1-2, 3-4, 5-6, >6	Categorical
How long walks the dog every day? (hour)	<1, 1-2, 3-4, >4	Categorical
Does the dog run free when walking?	Never, rarely, sometimes, often, always	Categorical
Does the dog walks in the woods/nature?	Never, rarely, sometimes, often, always	Categorical
Does the dog perform any of the following tasks? - Company - Emotional support	Yes or No	Categorical

- Accompany - Additional sense - Replace sense - Behavior mirror		
How many hours can the dog rest per day?	0 – 24	Continuous
How many hours sleeps the dog per day?	8 – 18	Continuous
How many hours is the dog home alone per day?	0, 1-4, 5-8, 9-12, >12	Categorical
How often plays the dog with other people per day (hours)?	0, 1-4, 5-8, 9-12, >12	Categorical
How often plays the dog with other dogs?	Never, <1 x per week, 1x per week, 2 a 3x per week, every day	Categorical

In paragraph 3.4 the correlation between 2 variables will be analyzed. For two continues variables, the Pearson product-moment correlation (test-statistic = t) coefficient will be used. This is a parametric test and the only assumption is that both variables are normally distributed. To find out if the variables are normally distributed, Shapiro-Wilk test will be used. When the variable is not normally distributed, the Spearman's Rank Order Correlation will be used (test-statistic = S). This is a non-parametric test.
For one continue variable and one categorical variable the one-way between groups ANOVA will be used. The assumptions are that the samples are independent and normally distributed. The non-parametric test is the Kruskall-Wallis rank sum test (Petrie & Watson, 2013).

3. Results

3.1 Demographics

A total of 20 veterans with PTSD and a service dog participated in this study. To control group consists of 19 humans with their dog. These people do not have PTSD and the dogs are not service dogs. There are some significant differences between the service dog and companion dog group (table 7 and 8)

3.1.1 People

Table 7. *Background details of humans*

Characteristics (N = 39)	**Number (%) veterans with a service dog (group 1)**		**Number (%) people with a companion dog (group 2)**		**Group difference**	
	Total N	**N**	**Total N**	**N**	**Test statistic**	**p-value**
Age (years)	20	53,15[a] (9,93[b]) 35-76[c]	19	44,53[a] (10,27[b]) 23-55[c]	W** = 276	0,016*
21-30		-		4 (21,1%)		
31-40		3 (15%)		2 (10,5%)		
41-50		4 (20%)		8 (42,1%)		
51-60		10 (50%)		5 (26,3%)		
61+		3 (15%)		-		
Gender	20		19		W = 341	$1{,}046*10^{-6}$*
Male		18 (90%)		2 (10,5%)		
Female		2 (10%)		17 (89,5%)		
Marital Status	20		19		W = 123	0,035*
Married		15 (75%)		8 (42,1%)		
Single		2 (10%)		2 (10,5%)		
Living together		-		8 (42,1%)		
Committed relationship		2 (10%)		1 (5,3%)		
Divorced		1 (5%)		-		
Widowed		-		-		
Education	20		18		W = 104,5	0,022*
Primary school		-		-		
High school		3 (15%)		1 (5,6%)		
MBO		9 (45%)		5 (27,8%)		
HBO		5 (25%)		7 (38,8%)		
Vocational education		3 (15%)		-		
WO		-		5 (27,8%)		
Housing Type	20		19		W = 197	0,804
Apartment		3 (15%)		2 (10,5%)		
Farm		-		1 (5,3%)		
Houseboat		1 (5%)		-		
House with garden		14 (70%)		16 (84,2%)		

House without garden		2 (10%)		-		
Total number of people in the household	20	2,45[a] (1,36[b]) 1-5[c]	19	2,95[a] (1,13[b]) 1-5[c]	W = 142,5	0,174
1		6 (30%)		1 (5,3%)		
2		6 (30%)		7 (36,8%)		
3		3 (15%)		5 (26,3%)		
4		3 (15%)		4 (21,1%)		
5		2 (10%)		2 (10,5%)		
Kind of environment where people live	20		19		W = 185	0,889
City		10 (50%)		9 (47,4%)		
Country		2 (10%)		2 (10,5%)		
Village		8 (40%)		8 (42,1%)		
Previous Dog Ownership	20		19		W = 202,5	0,665
Yes		15 (75%)		13 (68,4%)		
No		5 (25%)		6 (31,6%)		
Other dogs present?	20		19		W = 187	0,930
Yes		6 (30%)		6 (31,6%)		
No		14 (70%)		13 (68,4%)		
Other animals present?	20		19		W = 156,5	0,281
Yes		7 (35%)		10 (52,6%)		
No		13 (65%)		9 (47,4%)		

Note.
[a]Mean [b]Standard deviation [c]Range *p<0.05 ** W = test statistic Wilcoxon rank sum test

Table 7 shows the significant differences in variables between veterans with a service dogs and people with a companion dogs. There is a significant difference in the variables 'age', 'gender', 'marital status' and 'education' between the two groups.

3.1.2 Dogs

Table 8. *Background details of the dogs (N=39)*

Characteristic	**Number (%) Service dogs**		**Number (%) Companion dogs**		**Group difference**	
	Total N	**N**	**Total N**	**N**	**Test-statistic**	**p**
Gender	20		19		X^{2}*** = W = 282	0,003*
Male		16 (80%)		6 (31,6%)		
Female		4 (20%)		13 (68,4%)		
Age (years)	20	3,95[a] (2,10[b]) 1-8[c]	19	5,30[a] (3,89[b]) 1-12[c]	W** = 168	0,544
0 - 2		6 (30%)		7 (36,8%)		
3 - 5		10 (50%)		4 (21,1%)		
6 – 8		4 (20%)		2 (10,5%)		
9 - 11		-		5 (26,3%)		
≥ 12		-		1 (5,3%)		

Breed	20		19		W =	0,356
Labrador		19 (95%)		19 (100%)	180,5	
Poodle		1 (5%)		-		
Weight (kg)	20	31,04[a] (2,75[b]) 26,7-36[c]	18	31,08[a] (5,00[b]) 24-40[c]	W = 196,5	0,638
≤ 29		5 (25%)		8 (44,4%)		
30 – 34		12 (60%)		7 (38,9%)		
≥ 35		3 (15%)		3 (16,7%)		
Vet visits	20		19		W = 163	0,433
0		2 (10%)		1 (5,3%)		
1		9 (45%)		8 (42,1%)		
2		5 (25%)		4 (21,1%)		
3		2 (10%)		2 (10,5%)		
>3		2 (10%)		4 (21,1%)		
Is your dog healthy?	20		19		W = 240,5	0,033*
Yes		19 (95%)		13 (68,4%)		
No		1 (5%)		6 (31,6%)		
Is the dog on medication?	20		19		W = 189	0,979
Yes		2 (10%)		2 (10,5%)		
No		18 (90%)		17 (89,5%)		
How often walks the dog every day?	20		19		W = 259,5	0,011*
0 times		-		-		
1-2 times		-		6 (31,6%)		
3-4 times		17 (85%)		12 (63,1%)		
5-6 times		3 (15%)		1 (5,3%)		
>6 times		-		-		
How long walks the dog every day?	20	2,31[a] (1,10[b]) 1-5[c]	19	1,73[a] (0,79[b]) 0,5-4[c]	W = 260,5	0,045*
<1 hour		-		4 (21,0%)		
1-2 hours		14 (70%)		14 (73,7%)		
3-4 hours		5 (25%)		1 (5,3%)		
>4 hours		1 (5%)		-		
Does the dog run free when walking?	20		19		W = 144,5	0,169
Never		1 (5%)		1 (5,3%)		
Rarely		-		2 (10,5%)		
Sometimes		10 (50%)		3 (15,8%)		
Often		9 (45%)		10 (52,6%)		
Always		-		3 (15,8%)		
Does the dog walks in the woods/nature?	20		19		W = 136,5	0,102
Never		-		-		
Rarely		-		-		
Sometimes		9 (45%)		3 (15,8%)		
Often		8 (40%)		12 (63,1%)		
Always		3 (15%)		4 (21,1%)		

Does the dog perform any of the following tasks?	20		18			
- Company					W = 162	0,186
Yes		18 (90%)		18 (100%)		
No		2 (10%)		-		
- Emotional support					W = 271	$0,760*10^{-4}$*
Yes		19 (85%)		8 (44,4%)		
No		1 (5%)		10 (55,6%)		
- Accompany					W = 287	$0,195*10^{-3}$*
Yes		13 (65%)		1 (5,6%)		
No		7 (35%)		17 (94,4%)		
- Additional sense					W = 250	0,012*
Yes		10 (50%)		2 (11,1%)		
No		10 (50%)		16 (88,9%)		
- Replace sense					W = 207	0,097
Yes		3 (15%)		-		
No		17 (85%)		18 (100%)		
- Behavior mirror					W = 295	$0,102*10^{-3}$*
Yes		15 (75%)		2 (11,1%)		
No		5 (25%)		16 (88,9%)		
How many hours can the dog rest per day (not working)?	12	10,08[a] (4,06[b]) 5-20[c]	17	17,32[a] (0,99[b]) 0-24[c]	W = 54,5	0,035*
0-5 hours		1 (6,3%)		4 (23,5%)		
6-10 hours		7 (43,7%)		1 (5,9%)		
11-15 hours		3 (18,7%)		-		
16-20 hours		1 (6,3%)		2 (11,8%)		
21-24 hours		-		10 (58,8%)		
How many hours sleeps the dog per day?	17	11,41[a] (3,14[b]) 8-17[c]	15	13,53[a] (2,70[b]) 8-18[c]	W = 75,5	0,049*
0-5 hours		-		-		
6-10 hours		8 (47,1%)		2 (13,3%)		
11-15 hours		6 (35,3%)		8 (53,3%)		
16-20 hours		3 (17,6%)		5 (33,3%)		
21-24 hours		-		-		
How many hours is the dog home alone per day?	19		19		W = 60,5	$0,9*10^{-4}$*
0 hours		16 (84,2%)		4 (21,1%)		
1-4 hours		3 (15,8%)		11 (57,9%)		
5-8 hours		-		4 (21,0%)		
9-12 hours		-		-		
>12 hours		-		-		
How long plays the dog with other people per day?	20		18		W = 135,5	0,082
0 hours		7 (35%)		1 (5,6%)		
1-4 hours		12 (60%)		17 (94,4%)		

5-8 hours	1 (5%)	-		
9-12 hours	-	-		
>12 hours	-	-		
How often plays the dog with other dogs	18	19	W = 134	0,181
Never	-	-		
<1x per week	1 (5,6%)	2 (10,5%)		
1x per week	3 (16,7%)	-		
2 a 3x per week	4 (22,2%)	2 (10,5%)		
Every day	10 (55,5%)	15 (79,0%)		

Note.
[a]Mean [b]Standard deviation [c]Range *p<0.05 ** W = test statistic Wilcoxon rank sum test
*** X^2 = Test statistic Chi-Square analysis

Table 8 shows the significant differences in variables between service dogs and companion dogs. There is a significant difference in the following variables: 'gender', 'is the dog healthy', 'how often walks the dog per day', 'the time a dog walks every day', 'performing emotional support', 'performing accompany', 'performing additional sense', 'performing behavior mirror' 'the time a dog can rest per day', 'the time a dog can sleep per day' and 'the time the dog is home alone per day' between the two groups.

3.2 Cortisol

Saliva samples were taken to determine the cortisol levels in service dogs and in companion dogs (table 9 and 10).

The last five samples of the service dogs and the last four samples of the companion dogs are not analyzed. The laboratory were the samples are analyzed was closed, because of COVID-19.

Table 9. *Cortisol levels from the service dogs in group 1 (n=20)*

Service	**Day 1**					**Day 2**				
dog	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
001	-	-	1,13	-	-	-	-	-	-	-
002	1,1	0,9	1,0	0,8	1,0	1,5	1,7	0,8	0,9	1,9
003	-	-	0,7	-	0,65	-	-	1,01	-	0,76
004	2,8	3,9	5,5	3,5	5,4	3,4	3,6	4,0	3,8	2,6
005	-	-	-	-	-	-	-	-	-	-
006	3,4	1,0	0,6	2,0	2,2	1,5	3,5	1,4	-	-
007	6,73	-	-	-	-	6,85	-	-	-	-
008	-	-	3,5	3,5	4,5	18,3	4,4	3,0	4,1	19,6
009	-	1,89	3,06	-	0,54	-	-	-	-	-
010	1,24	0,82	2,44	-	0,86	-	1,44	1,53	-	-
011	2,27	0,95	1,38	1,43	0,63	0,66	2,01	-	-	1,79

012	1,93	-	0,86	1,04	-	-	0,75	-	0,98	1,05
013	4,00	0,76	-	0,58	0,47	1,37	1,11	2,00	0,58	0,64
014										
015										
016										
017										
018										
019										
020										

Note.

C11 - C15 = day 1, C16 - C20 = day 2

C11 + C16 = time at awakening

C12 + C17= 15 minutes after awakening

C13 + C18 = 30 minutes after awakening

C14 + C19 = 60 minutes after awakening

C15 + C20 = before bedtime

Table 10. *Cortisol levels from the companion dogs in group 2 (n=22)*

Companion dogs	**Day 1**					**Day 2**				
	C11	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**
001	5,92	3,57	4,65	1,17	1,19	-	-	-	-	-
002	1,66	1,82	0,93	4,26	0,63	-	-	-	-	-
003	2,3	3,3	-	2,2	2,1	3,5	5,8	1,5	1,9	2,3
004	-	8,4	12,9	6,5	-	-	22,0		3,4	
005	10,8	-	-	-	-	4,1	3,3	4,0	-	15,7
006	2,12	4,77	1,81	2,80	6,81	6,15	4,82	8,05	1,79	6,74
007	2,50	3,58	2,43	2,28	1,84	2,71	2,59	1,99	2,21	1,53
008	-	0,76	0,51	1,38	-	0,84	0,93	0,97	1,68	-
009	-	-	0,8	-	-	-	-	-	-	-
010	-	1,0	1,7	-	-	-	-	-	-	-
011	1,0	0,9	0,6	2,1	2,9	-	-	-	1,8	0,8
012	55,93	35,38	29,98	113,55	25,76	36,64	96,89	11,85	14,42	136,27
013	1,35	1,92	-	-	-	-	-	-	-	-
014	1,65	1,71	0,74	0,92	1,03	0,46	0,59	0,60	0,63	1,60
015	-	-	-	-	-	-	-	-	-	-
016	-	6,26	0,59	2,02	1,63	-	1,59	0,79	1,15	-
017	1,62	1,33	1,32	1,23	-	0,95	-	3,63	1,72	4,05
018	2,97	1,76	1,02	1,16	-	-	4,74	1,53	3,39	3,36
019										
020										
021										
022										

Note.

C11 - C15 = day 1, C16 - C20 = day 2

C11 + C16 = time at awakening

C12 + C17= 15 minutes after awakening

C13 + C18 = 30 minutes after awakening

C14 + C19 = 60 minutes after awakening

C15 + C20 = before bedtime

Number 12 in table 10 had red colored saliva, what indicates that there is a contamination with blood. This explains why the cortisol levels are so high. These values are rejected from the study. In general are any values above 15 rejected, because of possible blood cortisol contamination. These values are red colored in table 9 and 10.

To determine the statistical difference in cortisol, the average cortisol for both groups on each timepoint is necessary. Therefore, CortD is calculated. This is de average cortisol for a dog on each timepoint (table 11 and 12).

Table 11. *CortD[a] between the 2 samples on each timepoint in service dogs*

Service dogs	CortD1[b]	CortD2[c]	CortD3[d]	CortD4[e]	CortD5[f]
001			1.1		
002	1.3	1.3	0.9	0.9	1.5
003			0.9		0.7
004	3.1	3.8	4.8	3.7	4.0
005					
006	2.5	2.3	1.0	2.0	2.2
007	6.8				
008		4.4	3.3	3.8	4.5
009		1.9	3.1		0.5
010	1.2	1.1	2.0		0.9
011	1.5	1.5	1.4	1.4	1.2
012	1.9	0.8	0.9	1.0	1.0
013	2.7	0.9	2.0	0.6	0.6

Note.

[a]CortD = average cortisol for a dog on each timepoint

[b]CortD1 = average C11 + C16 = when owner wakes up

[c]CortD2 = average C12 + C17 = 15 minutes after owner wakes up

[d]CortD3 = average C13 + C18 = 30 minutes after owner wakes up

[e]CortD4 = average C14 + C19 = 60 minutes after owner wakes up

[f]CortD5 = average C15 + C20 = before bedtime

Table 12. *CortD[a] between the 2 samples on each timepoint in companion dogs*

Companion dogs	CortD1[b]	CortD2[c]	CortD3[d]	CortD4[e]	CortD5[f]
001	5.9	3.6	4.7	1.2	1.2
002	1.7	1.8	0.9	4.3	0.6

003	2.9	4.6	1.5	2.1	2.2
004		8.4	12.9	5.0	
005	7.4	3.3	4.0		
006	4.1	4.8	4.9	2.3	6.8
007	2.6	3.1	2.2	2.2	1.7
008	0.8	0.8	0.7	1.5	
009			0.8		
010		1.0	1.7		
011	1.0	0.9	0.6	2.0	1.9
012					
013	1.3	1.9			
014	1.1	1.2	0.7	0.8	1.3
015					
016		3.9	0.7	1.6	1.6
017	1.3	1.3	2.5	1.5	4.0
018	3.0	3.3	1.3	2.3	3.4

Note.

[a]CortD = average cortisol for a dog on each timepoint

[b]CortD1 = average C11 + C16 = when owner wakes up

[c]CortD2 = average C12 + C17 = 15 minutes after owner wakes up

[d]CortD3 = average C13 + C18 = 30 minutes after owner wakes up

[e]CortD4 = average C14 + C19 = 60 minutes after owner wakes up

[f]CortD5 = average C15 + C20 = before bedtime

Statistical analyses were used to determine whether there is a significant difference between service dogs and companion dogs on each timepoint. There are no significant differences (table 13).

Table 13. *Mean, standard deviation (SD) and statistical analysis for cortisol on each timepoint*

Cortisol	**Mean**		**SD**		**Group difference**	
on each timepoint	**Service dogs**	**Companion dogs**	**Service dogs**	**Companion dogs**	**Test statistic**	**p-value**
CortD1	2,625	2,758	1,823	2,097	W* = 51	0,847
CortD2	2,000	2,927	1,289	2,040	W = 51	0,340
CortD3	1,945	2,673	1,285	3,190	W = 88,5	0,775
CortD4	1,914	2,233	1,340	1,229	W = 29,5	0,310
CortD5	1,710	2,470	1,432	1,831	W = 32	0,185

Note.

*W = test statistic Wilcoxon rank sum test

To determine the total difference in cortisol between the two groups, the average on each timepoint will be used (table 13).

These values are plotted against each other in figure 1.

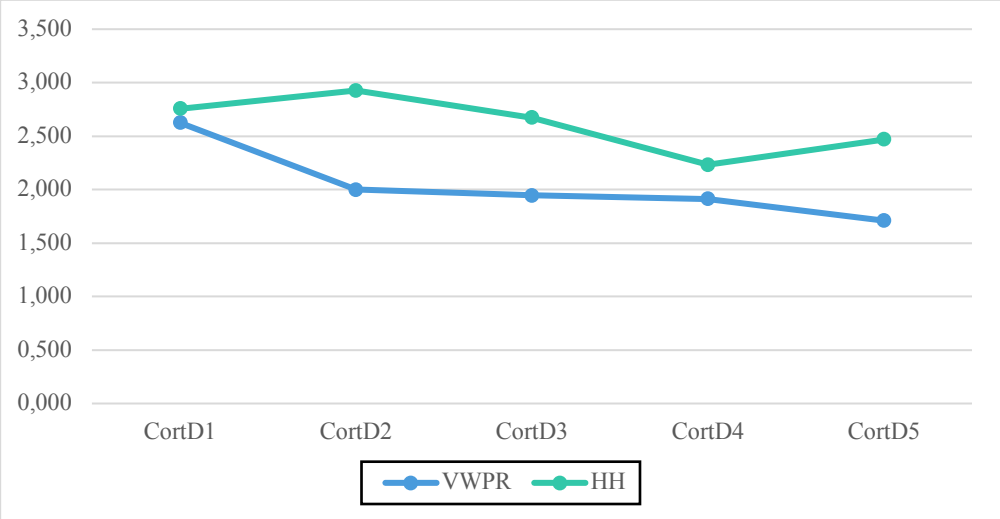

Figure 1. Average cortisol levels on each timepoint

The independent t-test has been used to find out whether there is a significant difference in overall cortisol level during the day. There is a significant difference in cortisol (t = 2,931; p = 0,019) between service dogs (M = 2.030; SD = 0,346) and companion dogs (M = 2,612; SD = 0,268)

3.3 Activity

In this study, the threshold for dog's movements at nighttime according to Hoffman et al., (2020) are used. Movements below 150 counts per minute (cpm) are corresponding with rest (category 1). Movements between 150 and 400 cpm are corresponding with little movements, like the positioning of a body part (category 2). Movements above 400 cpm are corresponding with a complete shift of a body part while lying down, like lifting the head (category 3). Activities, like sitting to lying down etc. are corresponding with 800 cpm (category 4). At last, movements above the 1000 cpm are corresponding with scratching or licking a body part (category 5) .

Table 14. *Mean, standard deviation (SD) and statistical analysis for each activity category*

Activity	Mean (%)		Standard Deviation (SD)		Group difference	
	Service dogs	Companion dogs	Service dogs	Companion dogs	Test statistic	p-value

Cat 1	63,59	66,10	5,803	9,985	W* = 126	0,551
Cat 2	8,18	7,98	1,255	2,380	W = 131	0,670
Cat 3	8,08	7,16	1,833	2,630	t** = 1.197	0,240
Cat 4	2,79	2,50	0,943	1,067	t = 0.850	0,402
Cat 5	17,36	16,27	5,233	5,108	t = 0.613	0,545

Note.

*W = test statistic Wilcoxon rank sum test

**t = test statistic independent t-test

Cat 1 = category 1

Cat 2 = category 2

Cat 3 = category 3

Cat 4 = category 4

Cat 5 = category 5

Table 14 shows that there are no significant differences in activity categories between the two groups.

The average values from table 14 are plotted in figure 2

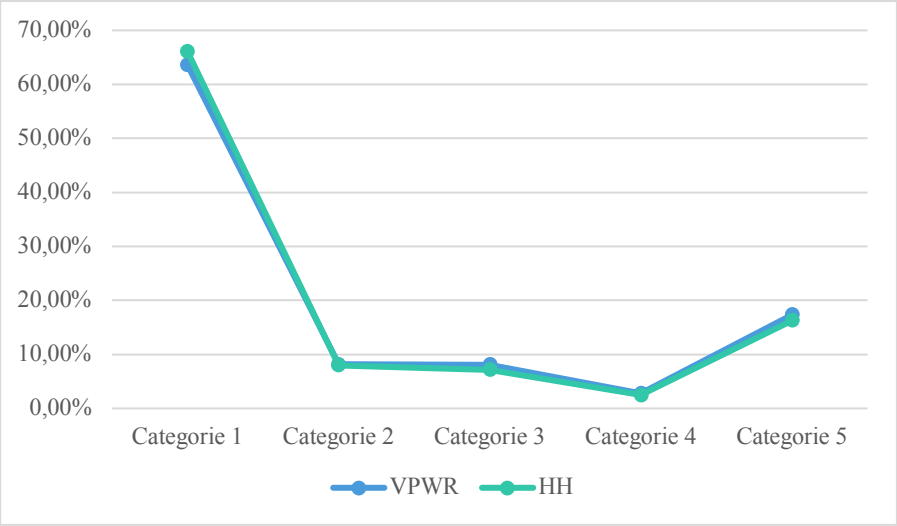

Figure 2. Average (%) activity level in each category.

To determine the total difference in activity between the two groups, the average of all categories together will be used (table 14).

The Wilcoxon rank sum test has been used to find out whether there is a significant difference in overall activity during the day between service dogs and companion dogs. There is not a significant difference in overall activity (W = 15; p = 0,691) between both groups.

3.4 Correlation between different variables

To see if certain variables influence the cortisol levels in dogs, different tests are used (table 15). For all the variables in table 15, the total population of dogs is used. The total population of dogs is used, because when there is a significant difference between two different variables in the total population, it is possible to relate that to the different groups (service dogs and companion dogs).

Table 15. *Statistical analysis between two different variables in one population of dogs*

Variable 1	Variable 2	Type of test	Test-statistic	P-value
Cortisol	Housing type	Kruskal-Wallis test	Kruskal-wallis X^2= 6,99	0,136
Cortisol	Kind of environment where people live	Kruskal-Wallis test	Kruskal-wallis X^2= 4,511	0,105
Cortisol	How many hours is the dog home alone?	Kruskal-Wallis test	Kruskal-wallis X^2= 0,401	0,818
Cortisol	Are there other dogs in the house?	Kruskal-Wallis test	Kruskal-wallis X^2= 1,753	0,416
Cortisol	Are there other animals in the house?	Kruskal-Wallis test	Kruskal-wallis X^2= 1,685	0,194
Cortisol	How long walks the dog every day?	Spearman's rank correlation	Spearman's S = 3620,2	0,242
Cortisol	How often walks the dog every day?	Kruskal-Wallis test	Kruskal-wallis X^2= 1,312	0,517
Cortisol	Does the dog run free when walking?	Kruskal-Wallis test	Kruskal-wallis X^2= 4,092	0,252
Cortisol	Does the dog walks in the woods/nature?	Kruskal-Wallis test	Kruskal-wallis X^2= 2,223	0,329
Cortisol	How often plays the dog with other people?	Kruskal-Wallis test	Kruskal-wallis X^2= 0,343	0,558
Cortisol	How often plays the dog with other dogs?	Kruskal-Wallis test	Kruskal-wallis X^2= 1,949	0,583
Cortisol	How many hours can the dog rest per day?	Spearman's rank correlation	Spearman's S = 1001,3	0,467
Cortisol	How many hours sleeps the dog per day?	Spearman's rank correlation	Spearman's S = 1973	0,613

All the p-values are >0,05, which means that there are no statistically significant differences between cortisol and the different variables. All the variables (housing type, environment, length walking etc.) does not have any influence on the cortisol level in dogs.

At last, the correlation between overall cortisol and activity has been determined in both groups. There is no statistically significant difference between cortisol and activity in service dogs (Spearman's S = 12; p = 0,517) and in companion dogs (Spearman's S = 10, p = 0,450)

3.5 Subjectivity versus objectivity

In this study objective measurements (cortisol and activity) and an subjective measurement (questionnaire) are used. An addition to this study could be to see if the objective results correspond with the subjective questions in the questionnaire. In the questionnaire is an question about 'how much sleeps the dog per day (24 hours)'. Activity category 1 represents sleep and little movements. With the spearman's rank correlation coefficient, the significant difference could be determined. There is no significant difference between the objective data and the subjective question in both service dogs (Spearman's S = 990,61; p = 0,410) and companion dogs (Spearman's S = 576,46; p = 0,917). The same is also possible with activity category 5 and the question 'how long walks the dog every day' in the questionnaire. Activity category 5 represents movements like, scratching, walking etc. There is no significant correlation between the activity in category 5 and the question 'how long walks the dog every day' in the questionnaire in both service dogs (Pearson's t = 0,914; p = 0,374) and companion dogs (Spearman's S = 686,1; p = 0,974).

4. Discussion

The purpose of the study was to find out whether the welfare of service dogs, from veterans with PTSD, is affected more than the welfare of companion dogs. This study uses objective (cortisol samples, and activity parameter) measures and one subjective (questionnaire) measure.

First, variables from the questionnaire between the groups were statistically analyzed. For the humans, there are significant differences in the variables 'age', 'gender', 'marital status' and 'education' between the two groups (veterans with a service dogs and people with a companion dog). For the dogs, there are significant differences in 'gender', 'is the dog healthy', 'how often walks the dog per day', 'the time a dog walks every day', 'performing emotional support', 'performing accompany', 'performing additional sense', 'performing behavior mirror' 'the time a dog can rest per day', 'the time a dog can sleep per day' and 'the time the dog is home alone per day' from the questionnaire between both groups (service dogs and companion dogs). PSD service dogs are trained to wake up or lick the veteran when the veteran is faced with nightmares or flashbacks. The whole day the service dogs are focused on their owner and the owners are asking a lot of their dogs. The dogs provide a calming effect and the owners feel less isolated when their dog is around (Krause-parello & Morales, 2018; Mclaughlin & Hamilton, 2019). This could be an explanation why service dogs can rest and sleep less than companion dogs and why there is a significant difference in 'how many hours can the dog rest per day', 'how many hours sleeps the dog every day', 'the time the dog is home alone per day' and in the performing tasks between the two groups. There is also a significant correlation in the length of walking every day between service dogs and companion dogs and how often the dogs are walking. According to the questionnaire, service dogs are walking more than companion dogs (M = 2,31 vs. M = 1,73). This finding could be consistent with the literature. Service dogs owners are more active and exercising more, because of the dogs. The dogs need to go out, so the owners are feeling less isolated, more safe and more reconnected. (Crowe et al., 2017; Mclaughlin & Hamilton, 2019; Stern et al., 2013).

Second, the cortisol levels were analyzed. Cortisol is pulsatile secreted via a circadian rhythm. Cortisol levels are highest in the morning and lowest in the evening (Kobelt et al., 2003). The cortisol levels in service dogs comply with this principle. Figure 1 and table 13 show this very nicely. In the morning, the cortisol level is the highest and every measuring moment it drops a

little bit. The lowest cortisol level is in the evening. In companion dogs, this is a little bit different. Figure 1 and table 13 show a little increase in cortisol 15 minutes after the owner wakes up (CortD2) and before bedtime (CortD5). It is not sure whether these little increases are a response to stress. Cobb et al. (2016) wrote that exercise could increase the plasma cortisol concentration. Handlin et al. (2011) concluded about the same, namely that a significant increase in cortisol levels in dogs is associated with a short interaction between a dog and its owner is. So, an little increase in cortisol is possibly not always connected with stress. An explanation of the little increases could be, that the dog had a short interaction with their owner between the samples. Another explanation could be, that a few dogs maybe did resist the swab in their mouth, so a little cortisol response may have taken place. This effect on the cortisol concentration only takes place, when the collection procedure takes >4 min (Cobb et al., 2016). Overall, there is a significant difference in average cortisol during the day between service dogs and regular companion dogs. As mentioned before, the significant difference in average cortisol could be, because the companion dogs may have moved a bit more between the samples or, because of the swab in their mouth.

The overall activity between service dogs and companion dogs is not significantly different. There are also no correlations between the categories in the actigraph. For example, there is no significant difference in category 1 (sleep and little movement) between service dogs and companion dogs. A task of the service dogs is to wake the veteran when they are having flashbacks and to help the veterans during the day. It could be expected that service dogs are sleeping less and that there was a significant difference in this category between the two groups. Maybe, the service dogs are sleeping less than companion dogs, but because they were still lying down, the accelerometer will not detect that they were not sleeping. On the other side, it is possible that there is no difference in the percentage the dog sleep per day. Owners may have their service dog for a longer time, therefore the owners are maybe calmer, so the dogs could also sleep better. These are all speculations. To be really sure, that there is no difference in sleep between service dogs and companion dogs, more resources are needed.

Third, the correlation between cortisol and different variables was analyzed in the dogs. For example, the correlation between cortisol and other dogs in the house was analyzed to find out whether the presence of other dogs has an influence on the cortisol and therefore perhaps the well-being of the dogs. This study did not found a positive correlation between cortisol and the presence of other dogs in the house. One of the five freedoms is the freedom to express normal behavior. Lefebvre et al. (2009) researched the human contact and exercise on dog

welfare. Social and physical enrichment are playing a significant role on the welfare of the dogs. The correlation between ‘cortisol’ and ‘how many hours is the dog home alone’, ‘how long walks the dog every day’, ‘does the dog run free when walking’, ‘how often plays the dogs with other people’ and ‘how often plays the dog with other dogs’ was researched, but all the differences were not significant (table 15). Also the correlation between cortisol and activity was analyzed. As mentioned before, according to Cobb et al. (2016) and Handlin et al. (2011) exercise increases the cortisol concentration. In this study there was no positive correlation between those two variables.

At last the objective measurement (activity) versus the subjective measurement (questionnaire) is analyzed. Some questions in the questionnaire were about the activity, so these questions could be linked to an activity category. There were no positive correlations between the subjective questions and the objective activity data, which concludes that there is no relationship between subjective and objective data. Therefore, it could be wondered whether the questionnaires has been completed truthfully. So, it is necessary to use both type of measurements in a study and not only a subjective questionnaire.

5. Limitations and future directions

There are some limitations of this study. First, normally are service dogs between the 1,5 and 10 years old. There is one service dog with an age of 1 year. There are three companion dogs with an age of 1 year and two companion dogs with an age above 10 years . This is not representative for this group. Second, it is a discussion point whether the dogs can eat before the saliva samples or not. A lot of dogs are getting their food when the owner wakes up. When the dogs are getting food between the first two samples, does this have influence on the reliability? Although, when the dogs do not eat, do they not get stress from not eating?

The only stress parameter used in the study is saliva cortisol. This is a physiological parameter. According to Vincent & Michell (1992), it is better to use a combination of different parameters to exclude the presence of stress. Another physiological stress parameter, that could be used, are catecholamines. They reflect the activity of another stress response axis: the sympatho-adrenal-medullary (SAM) axis (Beerda et al., 1996; Beerda et al., 2000). According to Part et al., (2014), the urinary: creatinine ratio is also a valid measure of stress in dog. To increase the reliability, a combination of parameters is recommended. Beerda et al. (1998) uses the combination of saliva cortisol and heartrate as stress parameters. Also the combination of a physiological parameter and an behavioral parameter is a suitable option. Examples of behavioral parameters are: stereotypies, vocalizing, body-shaking, self-mutilation, paw lifting and lowered anxious posture. There is no question about behavioral abnormalities in the questionnaire. A question about the behavior of the dogs might have been an addition to this study. Even better is hanging camera's in the house, so any abnormal behavior is recorded by video.

In this study, cortisol levels are measured during two days. To reduce the variability it is better to take samples on more days (Kobelt et al., 2003). However, as can be seen in table 9 and 10, it is not very easy to collect 5 samples each day, for two days. There are a lot of missing values. Maybe, another option could be the measurement of cortisol in hair. Bennet & Hayssen (2010) found a positive correlation between saliva and hair cortisol, so hair cortisol could maybe be another option for determining basal cortisol in dogs.

As mentioned before, it is an option to place video cameras in the house, so the behavior, but also the activity could be observed in both humans and dogs. This study uses only the counts from the accelerometer, linking 0-150 counts to sleep/rest, but it is not clear whether the dogs are actually sleeping or resting. Owczarczak-Garstecka & Burman (2016) observed each dog for nine days during day and night. In this research a difference between sleeping and resting

has been made. ‘Resting’ is with the eyes open, and ‘sleeping’ is with the eyes closed for at least two minutes. This could only be observed with a camera with night vision. In the end, Owczarczak-Garstecka & Burman (2016) know the number of minutes the dogs slept, rested, and that the dogs were active. For this study, it is relevant to exactly know the time that the dogs were asleep. With this camera, the contact between dog and human could also be observed. Are the dogs able to express normal behavior? Maybe in the future a video camera is an option.

6. Conclusion

The question of this study was if there is a difference in welfare between PSD service dogs and companion dogs. Future research is needed to know exactly whether there is a difference in welfare or not. According to the questionnaire, there is significant difference in sleep and resting between the two groups of dogs, but this is not apparent in the objective data. On the other hand, there is a significant difference in average cortisol level, whether there a small increases in companion dogs. It is not known what caused these little increases. Regardless, the cortisol levels in service dogs are not increased. From these data the conclusion can be drawn that it looks like the welfare of PTSD service dogs and companion dogs is comparable.

7. References

American Psychiatric Association (APA) (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, TX, USA: American Psychiatric Association

Beerda, B., Schilder, M. B. H., Janssen, N. S. C. R. M., & Mol, J. A. (1996). The use of saliva cortisol, urinary cortisol, and catecholamine measurements for a noninvasive assessment of stress responses in dogs. *Hormones and Behavior*, *30*(3), 272–279.

Beerda, B., Schilder, M. B. H., Van Hooff, J. A. R. A. M., De Vries, H. W., & Mol, J. A. (1998). Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science*, *58*(3), 365–381.

Beerda, B., Schilder, M. B. H., Van Hooff, J. A. R. A. M., De Vries, H. W., & Mol, J. A. (2000). Behavioural and hormonal indicators of enduring environmental stress in dogs. *Animal Welfare*, *9*, 49–62.

Beetz, A. M. (2017). Theories and possible processes of action in animal assisted interventions. *Applied Developmental Science*, *21*(2), 139–149.

Beetz, A., Schöfmann, I., Girgensohn, R., Braas, R., & Ernst, C. (2019). Positive effects of a short-term dog-assisted intervention for soldiers with post-traumatic stress disorder — A pilot study. *Frontiers in Veterinary Science*, *6*(June), 14.

Beetz, A., Uvnäs-moberg, K., Julius, H., & Kotrschal, K. (2012). Psychosocial and psychophysiological effects of human-animal interactions: The possible role of oxytocin. *Frontiers in Psychologie*, *3*, 234.

Bergen-cico, D., Smith, Y., Wolford, K., Gooley, C., Hannon, K., Woodruff, R., … Gump, B. (2018). Dog ownership and training reduces post-traumatic stress symptoms and increases self-compassion among veterans: results of a longitudinal control study. *The Journal of Alternative and Complementary Medicine*, *24*(12), 1166–1175.

Bremhorst, A., Mongillo, P., Howell, T., & Marinelli, L. (2018). Spotlight on assistance Dogs - Legislation, welfare and research. *Animals*, *8*, 1–19.

Burrows, K. E., Adams, C. L., & Millman, S. T. (2008). Factors affecting behavior and welfare of service dogs for children with autism spectrum disorder. *Journal of Applied Animal Welfare Science*, *11*(1), 42–62.

Cobb, M. L., Iskandarani, K., Chinchilli, V. M., & Dreschel, N. A. (2016). A systematic review and meta-analysis of salivary cortisol measurement in domestic canines. *Domestic Animal Endocrinology*, *57*, 31–42.

Crowe, T. K., Sánchez, V., Howard, A., Western, B., & Barger, S. (2017). Veterans transitioning from isolation to integration: A look at veteran/service dog partnerships. *Disability and Rehabilitation*, 1–9.

Dreschel, N. A., & Granger, D. A. (2009). Methods of collection for salivary cortisol measurement in dogs. *Hormones and Behavior*, *55*(1), 163–168.

Furst, G. (2015). Prisoners, pups, and PTSD: the grass roots response to veterans with PTSD. *Contemporay Justice Review*, *18*(4), 449–466.

Gijsen, C., Smeets, T., Jelicic, M., & Merckelbach, H. (2008). Acute stress, cortisol en het geheugen: hoe hangen ze samen? *Neuropraxis*, *12*(1), 9–14.

Hoffman, C. L., Browne, M., & Smith, B. P. (2020). Human-animal co-sleeping: an actigraphy-based assessment of dogs' impacts on women's nighttime movements.

Animals, *10*(2), 1–12.

Holman, E., Levy, C., & Kennedy, B. (2018). Palliative care matters: lessons from the loss of a facility dog. *American Journal of Hospice & Palliative Medicine*, 1–3.

Houtert, E. A. E. Van, Endenburg, N., Wijnker, J., Rodenburg, B., & Vermetten, E. (2018). The study of service dogs for veterans with Post- Traumatic Stress Disorder : a scoping literature review. *European Journal of Psychotraumatology*, *9*(3), 12. Retrieved from

Husband, A., Ahmed, A., & Dell, C. A. (2019). An exploratory case study of the impact of psychiatric service dogs on problematic substance use among PTSD-diagnosed veterans. *Journal of Substance Use*, *25*(2), 113–117.

Kloep, M. L., Hunter, R. H., & Kertz, S. J. (2017). Examining the effects of a novel training program and use of psychiatric service dogs for military-related PTSD. *American Journal of Orthopsychiatry*, *87*(4), 425–433.

Kobelt, A. J., Hemsworth, P. H., Barnett, J. L., & Butler, K. L. (2003). Sources of sampling variation in saliva cortisol in dogs. *Research in Veterinary Science*, *75*(2), 157–161.

Krause-parello, C. A., & Morales, K. A. (2018). Military veterans and service dogs: a qualitative inquiry using interpretive phenomenological analysis. *Anthrozoös*, *31*(1), 61–75.

Krause-parello, C. A., Sarni, S., & Padden, E. (2016). Military veterans and canine assistance for post-traumatic stress disorder : A narrative review of the literature. *Nurse Education Today*, *47*, 43–50.

Krol, W. (2012). Training the combat and operational stress control dog: an innovative modality for behavioral health. *The United Stated Army Medical Department Journal*, 46–51.

Lessard, G., Vincent, C., Gagnon, D. H., Belleville, G., Auger, É., Lavoie, V., … Béland, E. (2018). Psychiatric service dogs as a tertiary prevention modality for veterans living with post-traumatic stress disorder. *Mental Health & Prevention*, *10*(February), 42–49.

Mclaughlin, K., & Hamilton, A. L. (2019). Exploring the influence of service dogs on participation in daily occupations by veterans with PTSD : A pilot study. *Australian Occupational Therapy Journal*, *66*(August), 648–655.

Mims, D., & Waddell, R. (2016). Animal assisted therapy and trauma survivors. *Journal of Evidence-Informed Social Work*, *13*(5), 452–457.

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., Von Auer, K., Jobst, S., … Kirschbaum, C. (1997). Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity. *Life Sciences*, *61*(26), 2539–2549.

Rodriguez, K. E., Bryce, C. I., Granger, D. A., & Haire, M. E. O. (2018). The effect of a service dog on salivary cortisol awakening response in a military population with posttraumatic stress disorder (PTSD). *Psychoneuroendocrinology*, *98*(January), 202–210.

Rodriguez, K. E., & O'Haire, M. E. (2018). Preliminary efficacy of service dogs as a complementary treatment for posttraumatic stress disorder in military members and veterans. *J Consult Clinical Psychology*, *86*(2), 179–188.

Saunders, G. H., Biswas, K., Serpi, T., Mcgovern, S., Groer, S., Stock, E. M., … Fallon, M. T. (2017). Design and challenges for a randomized, multi-site clinical trial comparing the

use of service dogs and emotional support dogs in veterans with post-traumatic stress disorder (PTSD). *Contemporary Clinical Trials*, *62*, 105–113.

Scotland-Coogan, D. (2019). Anxiety symptoms and sleep disturbance in veterans with posttraumatic stress disorder: the impact of receiving and training a service dog anxiety symptoms and sleep disturbance in veterans with posttraumatic stress. *TQR*, *24*(10), 2655–2674.

Serpell, J. A., Coppinger, R., Fine, A. H., & Peralta, J. M. (2010). *Welfare Considerations in Therapy and Assistance Animals*. *Handbook on Animal-Assisted Therapy* (Third Edit). Elsevier Inc.

Stern, S. L., Donahue, D. A., Allison, S., Hatch, J. P., Lancaster, C. L., Benson, T. A., … Peterson, A. L. (2013). Potential benefits of canine companionship for military veterans with posttraumatic stress disorder (PTSD). *Society Animalss*, *21*, 568–581.

Taylor, M. F., Edwards, M. E., & Pooley, J. A. (2013). "Nudging them back to reality": toward a growing public acceptance of the role dogs fulfill in ameliorating contemporary veterans' PTSD symptoms. *Anthrozoös*, *26*(4), 593–611.

UU (z.d.). [Program information Behaviour & Welfare]. Retrieved from https://www.uu.nl/en/organisation/faculty-of-veterinary-medicine/veterinary-research/research-programmes/behaviour-welfare/program-information

Verkuil, B., & Emmerik, A. (2007). Omgaan met stress en burnout. *Psychopraxis, 9*(6), 243–247. https://doi.org/10.1007/bf03072389

Vincent, I. C., & Michell, A. R. (1992). Comparison of cortisol concentrations in saliva and plasma of dogs. *Research in Veterinary Science*, *53*(3), 342–345.

Whitworth, J. D., Scotland-coogan, D., & Wharton, T. (2019). Service dog training programs for veterans with PTSD: results of a pilot controlled study. *Social Work in Health Care*, *58*(4), 412–430.

Yam, P. S., Penpraze, V., Young, D., Todd, M. S., Cloney, A. D., Houston-Callaghan, K. A., & Reilly, J. J. (2011). Validity, practical utility and reliability of actigraph accelerometry for the measurement of habitual physical activity in dogs. *Journal of Small Animal Practice*, *52*(2), 86–91.

Yarborough, B. J. H., Owen-smith, A. A., Stumbo, S. P., Yarborough, M. T., Perrin, N. A., & Green, C. A. (2017). An observational study of service dogs for veterans with posttraumatic stress disorder. *Psychiatric Services*, *68*(7), 730–734.

Yarborough, B. J. H., Stumbo, S. P., Yarborough, M. T., Owen-smith, A., & Green, C. A. (2018). Benefits and challenges of using service dogs for veterans with posttraumatic stress disorder. *Psychiatric Rehabilitation Journal*, *41*(2), 118–124.

Yount, R., Ritchie, E. C., Laurent, M. S., Chumley, P., & Olmert, M. D. (2013). The role of service dog training in the treatment of combat-related PTSD. *Psychiatric Annals*, *43*(6), 10.

8. Appendix

8.1 Keywords literature analyses

- Veterans with PTSD
- Veterans with PTSD and a service dog
- Cortisol levels saliva
- Cortisol levels in service dogs
- Actigraph accelerometer dogs
- Animal welfare
- Animal assisted intervention
- Activity service dogs
- Sleep research dogs
- PSD service dogs
- Animal welfare and cortisol
- Acute and chronic stress

8.2 Assumptions statistical tests

F-test for equality of variances (p>0,05)	
Variable	**Sign.**
Age (participants)	0,884
Total number in household (participants)	0,441
Age (dogs)	0,011
Weight (dogs)	0,014
Walk length (dogs)	0,172
Time rest (dogs)	0,007
Time sleep (dogs)	0,585
CortD1 (dogs)	0,732
CortD2 (dogs)	0,195
CortD3 (dogs)	0,007
CortD4 (dogs)	0,775
CortD5 (dogs)	0,475
Cortisol levels (dogs)	0,636
Activity general (dogs)	0,923
Activity category 1 (dogs)	0,034
Activity category 2 (dogs)	0,013
Activity category 3 (dogs)	0,154
Activity category 4 (dogs)	0,619
Activity category 5 (dogs)	0,933

Shapiro-Wilk test for normality (p>0,05))	**Sign.**	
Variable	**Group VWPR***	**Group HH****
Age (participants)	0,938	0,006
Total number in household (participants)	0,012	0,057
Age (dogs)	0,010	0,024
Weight (dogs)	0,240	0,103
Walk length (dogs)	0,111	0,010
Time rest (dogs)	0,167	0,0001
Time sleep (dogs)	0,046	0,372
CortD1 (dogs)	0,010	0,032
CortD2 (dogs)	0,067	0,032
CortD3 (dogs)	0,018	$9{,}694*10^{-5}$
CortD4 (dogs)	0,097	0,019
CortD5 (dogs)	0,011	0,035
Cortisol level (dogs)	0,135	0,923
Cortisol level (all dogs together)	$1{,}395*10^{-4}$	
Activity general (dogs)	0,020	0,015
Activity category 1 (dogs)	0,968	0,012
Activity category 2 (dogs)	0,251	0,001
Activity category 3 (dogs)	0,488	0,235
Activity category 4 (dogs)	0,819	0,648
Activity category 5 (dogs)	0,469	0,303

Note. *Group VWPR = veterans with PTSD and a service dog **Group HH = people without PTSD and a companion dog