Impact of veterinary assistance on the health of working horses in Nicaragua

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Institutionen för husdjurens utfodring och vård

Examensarbete 321
30 hp E-nivå

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Department of Animal Nutrition and Management

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Handledare: Anna Jansson, SLU
Eva Osterman Lind, SVA
Examinator: Jan Erik Lindberg, SLU

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Table of Contents

Sammanfattning

Arbetande hästar i utvecklingsländer används oftast för transportering. De ägs vanligen av personer med begränsade ekonomiska resurser som saknar tillräcklig kunskap om hur hästarna bör tas om hand och som en följd av detta är problem såsom uttorkning, dålig kroppskondition, sår och parasitinfektioner vanligt förekommande. Syftet med detta mastersexamensarbete var att undersöka om kostnadsfri veterinärvård förbättrade hälsa och vätskestatus hos de arbetande hästarna i Nicaragua. Examensarbetet utfördes som en del av ett projekt som heter ”Gratis veterinärvård för arbetande hästar och träning av deras ägare som veterinära medhjälpare på Nicaraguas Stillahavskust”. Fem parametrar användes för att undersöka huruvida gratis veterinärvård förbättrade hälsan för hästarna i sex städer längs med Nicaraguas Stillahavskust. Parametrarna som utvärderades var kroppskondition, uttorkningsgrad, hematokrit- och plasmaproteinvärden samt parasitägg per gram träck (EPG). Städerna besöktes tre gånger vardera med en månads mellanrum. Mobila veterinärmottagningar upprättades där de arbetande hästarna undersöktes. Totalt 441 hästar undersöktes; av dessa blev 47 hästar undersökta vid alla tre tillfällena, 130 blev undersökta vid två tillfällen och 311 endast en gång. Kroppskondition och uttorkningsgrad bedömdes subjektivt och skalorna 1-5 respektive 0-10 användes. För att mäta graden av uttorkning användes en metod där en bit av hästens hud nyps mellan tumme och pekfinger och tiden det tar för huden att återgå till normalt läge är en indikation för om hästen är uttorkad. Blod- och träckprover togs från hästarna och dessa analyserades sedan på Universitetet för Kommersiell Vetenskap (UCC) i Managua. Av alla de undersökta hästarna klassades 44% som smala eller väldigt smala och 41% bedömdes vara uttorkade. Medelvärdet för hematokritkoncentrationen var vid hästarnas första besök 23 ± 2%, medelvärdet för plasma protein var 72 ± 2 g/l och för EPG 782 ± 393. Av de fem parametrarna var det endast plasma protein som uppvisade en signifikant minskning under studieperiodens gång, detta kan betyda att en förbättrad vätskestatus uppnåddes.

Abstract

Working horses in developing countries are mostly used for transportation. They are often owned by people with limited economical resources and lack of knowledge about how to take care of the horses and due to this the horses often suffer from problems such as dehydration, poor body condition, lesions and parasitic infections. The aim of this master thesis was to investigate if free veterinary care improved the health and hydration status of working horses in Nicaragua and it was performed as a part of a project called “Free veterinary assistance for working horses and training of their owners as veterinary promoters in the Pacific coast of Nicaragua”. Five parameters were used to investigate whether free care improved the health of working horses in six towns along the Pacific Coast of Nicaragua. The parameters used were body condition, dehydration, hematocrit, plasma protein and parasite eggs per gram of faeces (EPG). The towns were visited three times at monthly intervals. For the purpose of the visits, a mobile clinic was set up and working horses were examined. A total of 441 horses were examined; of these 47 were attended all three times, 130 were attended twice and 311 only once. Body condition and dehydration of the horses were scored subjectively using scales of 1-5 and 0-10 respectively. For dehydration a skin tent test was used. Blood and faecal samples were collected and thereafter analyzed at the University of Commercial Sciences (UCC) in Managua. Of all examined horses 44% were classified as thin or very thin and 41% were dehydrated. At the first examination of the horses the mean hematocrit value was 23 ± 2%, the plasma protein 72 ± 2 g/l and the EPG 782 ± 393. Of the five parameters only the plasma protein showed a significant decrease over the study period which could indicate for an improved hydration status.

Introduction

Horses used for work are common in the developing world. They are used for draught, pack, agricultural work and riding (Pritchard *et al.*, 2005, Tadich *et al.*, 2008) and the owners are often from societies with poor economies, with incomes below the international poverty limit of 1 $ per day (Swann, 2006). Because of the limited economic resources, as well as the lack of knowledge about animal management, the possibilities to give adequate care to the horses are restricted (Swann, 2006, Burn *et al.*, 2009). Problems such as lesions, parasitic infections, dehydration and poor body condition are common (Pritchard *et al.*, 2005, de Aluja, 1998).
This study was carried out in Nicaragua, a country located in Central America. The climate is tropical with a dry season from November to April and a wet season from May to October. In the Nicaraguan Pacific coast where the study was performed the average temperature is 26.1°C but days with maximum temperatures above 34°C are common (INETER, 2005). Nicaragua has a population of 5.5 million habitants, out of which 48.3% lived in poverty in 2005, and out of these, 17% lived in extreme poverty with less than 1 dollar per day (INIDE, 2005), making it the second poorest developing country in the western hemisphere (UNDP, 2009).

In 2008, the number of horses in Nicaragua were estimated to 334 610 by The World Organisation for Animal Health (OIE, 2008) while The Food and Agriculture Organization of the United Nations (FAO) estimated 268 000 horses for the same year (FAO, 2008). The proportion of horses that are used for work is not known but they can be seen working in many parts of the country; in the cities running on the streets transporting material or people, on the beaches carrying tourists as riding horses or as carriage horses in popular tourist cities. The horses are also used in rural areas in agriculture and for transport.

The objective of this study was to investigate if the health and hydration status of working horses in Nicaragua were improved when given free veterinary care. The study was performed as a part of an already ongoing project called "Free veterinary assistance for working horses and training of their owners as veterinary promoters in the Pacific Coast of Nicaragua". The project was financed by the *Society for the protection of animals abroad* (SPANA) and performed by the Faculty of Agrarian Sciences at the University of Commercial Sciences (UCC) in Managua. SPANA is an organisation helping working animals worldwide. The organisation provides developing countries with free veterinary care, education for children about animals, emergency help after natural disasters and support for animal welfare projects. The work for a better animal welfare started in 1923 with a donkey project in North Africa. The main office is located in London (SPANA, year unknown).

The Faculty of Agrarian Sciences at the UCC in Managua educates veterinary –and animal science students. Besides the educational part, the faculty also contributes in different animal welfare activities. Students get the opportunity to participate in these welfare projects in order to get practical experience. Some examples of projects are free animal care once a week at the university clinic, free veterinary care for working horses, education for school children, an own radio programme and participation in television.

Methods for assessment of equine welfare

The working conditions of working equines in the developing world are different to the developed countries. The animals carry out different tasks in a different environment and the health conditions are often not the same and because of this also the methods used for the assessment of the welfare have to be adjusted (Burn *et al.*, 2009b). To assess animal welfare two different methods can be used; direct animal-based measures or indirect resource based measures. When using direct animal-based methods, parameters such as body condition, dehydration, lameness and parasitic infections are commonly used. A disadvantage with the animal based measures is that they often are subjective observations of a condition or state and to a great extent are relying on the observer. The advantage is that the direct measures often reflect the reality of the animal, the state of the animal in that moment (Pritchard *et al.*, 2005). To do the animal based measures more objective physiological parameters such as blood can be used for the determination of dehydration (Pritchard *et al.*, 2006). Indirect measures could be a questionnaire to the owner, feeding data or information about housing and management. The indirect measures have the disadvantage that they can be difficult to retrieve through the mobile veterinary clinics, as the time is limited and the animals are not visited in their home. Furthermore, the indirect measures often rely on the owners' point of view and misunderstandings caused by cultural or social differences can occur (Pritchard *et al.*, 2005).

Welfare problems for working equines

Several investigations have been performed in order to estimate the welfare of working equines (horses, donkeys and mules). Swann (2006) investigated the risks of a poor welfare, and he concluded that many equines had apathetic behaviour due to dehydration and chronic pain, and this increased the risk of accidents and injuries. Moreover, the animals were often considered as lazy by their owners when not moving fast enough and therefore beaten. The body condition was also negatively affected for the apathetic horse. As a consequence of missing protective muscles and fat, wounds were often formed beneath the harness (figure 1). Swann concluded that it is important to point out to the owner the advantages that are brought through a better animal welfare. He also emphasized how meaningless it is to improve harnesses and equipments if the behaviour of the owners was not first changed. If the horse remained thin and suffers of other health problems, an improved harness would not reduce the wounds significantly.

a) b)

Figure 1. a) Horse with lesion on the back, caused by harness. b) Horse with lesion on the nose, from homemade halter (Photo: Willgert, 2009).

Another study was made in Jordan with donkeys used for tourists to ride. The objective was to investigate how to decrease the number of tail base lesions. Of the examined donkeys 75% had lesions on the tail base. It was concluded that dirty rump straps and tight fitted padding, could be some of the causes of the lesions. More studies in the area were recommended (Burn *et al.*, 2007).

Lameness because of limb deformities, swollen tendons and joints, hooves in bad condition and other injuries are found commonly among working equines (figure 2).

a) b) c)

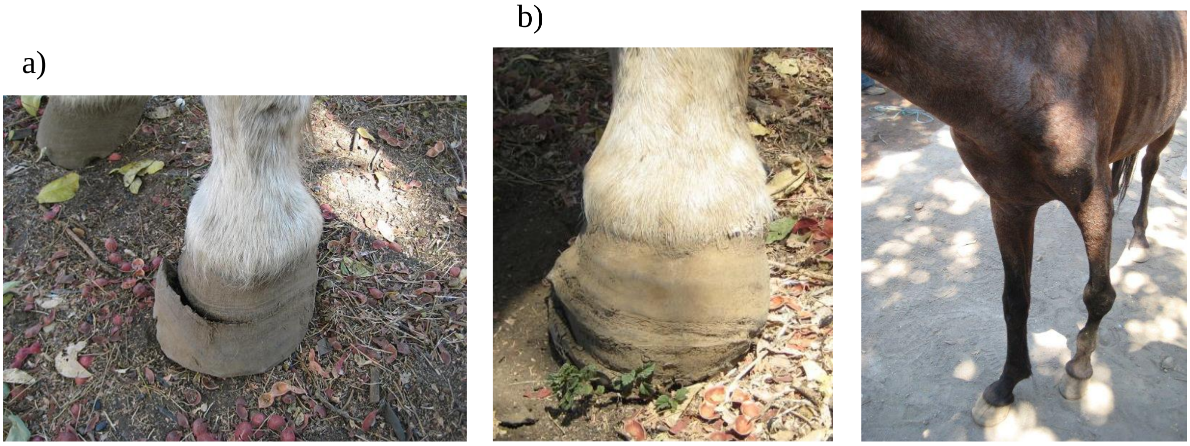

Figure 2. a) and b) Hooves in bad condition. c) Deformed limb (Photo: Willgert, 2009).

Around 90% of examined animals in a study performed by *Brooke's Hospital for Animals* in Jordan, Afghanistan, India, Pakistan and Egypt, had limb related problems. A poor body condition was also common, more than 70% of the examined working equines were considered as thin or very thin. Around 9% of the equines were severely depressed or reflected symptoms of apathy. The objective of the study was to develop a protocol that could be used for assessment of the welfare of working equines. Some criteria to the evaluation were that the horses should be checked in relation to their work routine and that the examination should be carried out in less than 10 minutes (Pritchard *et al*., 2005).

Unlike the study above a study performed in Chile found that only 8% of the working horses had a poor body condition and almost all horses showed an alert behaviour. The main problems found for these horses were the hoof-care and the feeding practices: some of the owners could not provide feeds nutritious enough to cover the requirements of the horses (Tadich *et al.*, 2008).

Another welfare problem in working equines is the starting age when they have to work. Already at the age of 1.5 to 2 years donkeys were put into work and 3 years old horses were pulling heavy loaded carts, according to a study carried out in Mexico (de Aluja, 1998).

Body condition

To measure body condition different scoring systems estimating subcutaneous fat cover can be used. A scale from 1-5 was used in a study where the reliability of the measures was evaluated (Burn *et al.*, 2009b). A score of 1 was classified as very thin and 5 as very fat. For fifty percent of the horses only whole numbers were used and for fifty percent also half-scores, e.g. 1.5, 2.5, 3.5 etc. A good reliability was shown for the measurements of body condition and the reliability was the same if only using whole numbers as if using both whole and half numbers in the scoring system.

Scores from 1-9 were used in a system created by Henneke *et al*. (1983). Score 1 signified extremely poor body condition and 9 that the horse was obese. The scores are explained using the appearance of withers, shoulders, neck, flanks and tail head. Both a visual assessment and palpation are used to score the horse. This system has been used in various studies to assess the health of horses (Burn *et al.*, 2009b; Christie *et al.*, 2006; Suagee *et al.*, 2008). Another commonly applied body condition scoring system was developed by Carroll & Huntington (1988) where a scale between 0-5 is used.

Dehydration

Dehydration occurs when the horse does not consume enough water to fulfil the daily requirements, resulting in malfunctioning intestines and cooling system, reduced transportation of nutrients to the muscle, poor elimination of waste products from the muscles and via the kidneys. As the dehydration progresses other organs will also be affected. The concentration of electrolytes in the blood, mainly sodium, will increase due to a decreased blood volume. The higher electrolyte concentration stimulates the thirst response and the horse will drink water to recover from the dehydration. When sweating, the horse loses electrolytes in addition to liquid. If the electrolytes are not replaced, the thirst response will not be stimulated and the horse will consequently not drink sufficient amounts of water to recover from the dehydration (Thomas, 1999). If the horse is dehydrated it will also need electrolytes to preserve the consumed water (Waller *et al.*, 2009).

To determine if a horse is dehydrated a skin tent test is commonly used where the elasticity of the skin is examined by pinching the skin between thumb and index finger forming a "tent". The time it takes for the skin to return to normal position indicates the level of dehydration (Jones, 2004; Thomas, 1999). The horse is dehydrated if it takes 2-3 seconds for the skin to return and it is very dehydrated if it takes more than 4 seconds (Thomas, 1999). The test can be made on the neck (Jones, 2004) or on the shoulder of the horse (Thomas, 1999).

In a study performed by Pritchard *et al.* (2007) two different scoring systems for skin tent testing were compared; one system with three scores and one system with only two scores. In the system with three scores, the score 0 signified that the skin returned without delay to normal position, the score 1 meant that the skin stayed uplifted for up to 3 seconds and the score 2 that the skin remained in the tent position for more than 3 seconds. In the system with only two scores the variables absent (not dehydrated) or present (dehydrated) were used. The use of only two scores did, however, not result in a higher reliability than reliability of the use of three scores.

Hematocrit and plasma protein

Blood analyses are commonly used to get information about the health status of equines. Diseases and physiological disorders such as dehydration can be discovered investigating levels of for example lymphocytes, hemoglobulin, leukocytes, enzymatic activity, osmolality, hematocrit and plasma proteins (Gul *et al.*, 2007). Hematocrit (Hct), also called packed cell volume (PCV) or erythrocyte volume fraction (EVF), and plasma proteins, also called serum total protein (TP) or plasma total protein, will increase if the horse is dehydrated as a consequence of the decreased plasma volume (Pritchard *et al.*, 2006). Plasma protein, osmolality, sodium and chloride increased in a study by Carlson *et al.* (1979) where normal horses were dehydrated during 72 hours. The hematocrit concentration, however, remained constant in this study. The mean hematocrit value before dehydration was 35.2 ± 3.6% and the mean plasma protein value was 70 ± 9 g/l.

Reference values for biochemical measures such as blood are often based on healthy horses that are used for sport or recreational purposes and the studies usually take place in temperate climates. Since the working horses in developing countries live in a different environment, with different conditions and working tasks, the reference values used for these horses should be modified to fit the scenario. A study by Pritchard *et al.* (2009) was performed with the objective to compare blood values from working horses in Pakistan with reference values of horses from developed countries. The reference values were taken from the Saunders Equine formulary (Knottenbelt, 2006). The aim of the study was also to get reference values of healthy working horses, usable for distinguishing sick working horses from healthy ones and thus only healthy working horses were included in the study. Of 32 tested hematological and serum biochemical parameters 28 had values within the intervals for the reference group. Deviations from the reference group were presented for hematocrit and hemoglobulin, where the concentrations were lower, which also was the case for erythrocytes and albumin. For creatine-kinase the mean value was higher. The mean value for heamtocrite was 32.6% with the limits 25.0-40.3% for the working horses, compared to 35-46% for the reference horses. For the plasma protein the mean value for the working horses remained within the reference values. The mean was 67 g/l and the limits 57-76 g/l for the working horses compared to 62.5-70.0 g/l for the reference group (Pritchard *et al.*, 2009).

In another study also analysing biochemical and haematological values from working equines in Pakistan, the objective was to determine if there existed differences between horses, mules and donkeys for the blood parameters, and between age, sex, body condition and lactation. Some of the differences found were higher hematocrit and hemoglobulin concentrations for the horses and higher total leukocyte count and fibrinogen values for donkeys. Concerning the age, sex, body condition and lactation, no differences in blood parameters were found. Mean hematocrit value measured for horses was 37.75 ± 4.75% and plasma total protein 86.3 ± 9.5 g/l (Gul *et al.*, 2007).

Parasites

The most common intestinal parasites in horses are the small strongyle nematodes, also called cyathostomes or cyathostominae. They can be found in all horses all over the world and can cause the disease *larval cyathostominosis* with symptoms like sudden weight loss, diarrhoea, colic, hair coat in bad condition and reduced performance capacity (Traversa *et al.*, 2007). There are more than 40 cyathostome species, usually 5-10 of these species can be found in the horse (Osterman Lind, 2005). Large strongyles (Strongylinae) are less common than the small strongyles, especially in the parts of the world where controlled use of anthelmintics (dewormers) has been practiced (Traversa *et al.*, 2007). Of the large strongyles, *Strongylus vulgaris* is the most pathogenic species. Migration of *S. vulgaris* larvae in the blood vessels, particularly around cranial mesenteric artery can cause colic and other abdominal problems. If the infection is serious it can result in anaemia or growth problems. Generally, young horses carry larger parasite burdens than older horses and they are also more sensitive to parasites (Osterman Lind, 2005).

To estimate the impact of endo-parasites on the health of the horses, faecal samples can be examined by using a modified McMaster method, which measures the number of parasite eggs per gram of faeces. This method is also used for evaluation of the efficacy of anthelmintic drugs in the Faecal Egg Count Reduction Test (FECRT). A disadvantage with the McMaster method is that the different sub-families of the strongyles cannot be identified. For the identification of *S. vulgaris*, larval cultures have to be performed (Osterman Lind, 2005).

Anthelmintics are used to control the number of strongyle parasites. Three classes of commercial anthelmintics are available; benzimidazoles, tetrahydropyrimidines and macro cyclic lactones. The latter group, including ivermectin and moxidectin is the only anthelmintic group still having sufficient efficacy against the small strongyles. For the other two groups, resistance is more or less a widespread problem. The anthelmintics should reduce the number of eggs by 90% or more to be considered efficient (Osterman Lind, 2005).

Field Study

The aim of the present study was to investigate if free veterinary care improved hydration status and health of working horses in Nicaragua. The results could thereafter be used as an indication of the efficiency of the free care and also to make suggestions for how the resources could be distributed differently.

Material and methods

General description of the project

The study was carried out in Nicaragua during nine weeks, starting on February 5th, 2009. Also data from the period January 13th to 29th, 2009, were used for the study. The time for the investigation coincided with the dry season and no rainfall occurred during this time. Six towns along the country's Pacific Coast were visited three times each, by a group of veterinarians and students from the UCC in Managua, in order to investigate health and offer free care for working horses. The horse owners had been informed in advance about the activity. The visited towns were the following: Chinandega, León, Pochomil, Diriamba, Niquinohomo and Rivas.

Five parameters were used to evaluate the health of the working horses. Body condition and the level of dehydration were assessed. Blood samples were collected to determine the levels of hematocrit and plasma protein, and faecal samples were taken for the measure of parasite eggs. All collected data were analyzed at the Faculty of Agrarian Sciences at the UCC in Managua.

Measurement of body condition and dehydration

Body condition was estimated by a subjective observation and classified on a scale from one to five (table 1) including half scores. A horse with the body condition score one was very thin (figure 3a) and the score two signified the horse was thin (figure 3b). A horse with the score 2.5 was a horse with visible ribs and hip bones beneath the skin, and it was considered fairly thin (figure 4a) while a horse with the body condition score 3 was considered in good condition (figure 4b).

Table 1. Body condition scoring

Score	1	2	3	4	5
Condition	Very thin	Thin	Good	Fairly fat	Fat

a) b)

Figure 3. a) A horse with body condition 1, classified as a very thin horse. b) A horse with body condition 2, classified as a thin horse (Photo: Willgert, 2009).

a) b)

Figure 4. a) A horse with body condition 2.5, classified as a fairly thin horse. b) A horse with the body condition 3, classified as in good condition (Photo: Willgert, 2009).

The dehydration was estimated using a skin tent test where the skin of the horse’s neck was pinched to form a tent. If the skin did not immediately return to normal position the horse was considered dehydrated. The time it took for the skin to return to a normal position was used to estimate the level of dehydration. A scale previously used at the Nicaraguan university was applied; ranging from zero to ten where zero meant the horse was not dehydrated and scores above zero meant the horse was dehydrated. Scores above six meant the horse was very dehydrated.

Blood and faecal samples

After the horses were examined, blood and faecal samples were collected (figure 5). The blood was taken from the jugular vein by puncturing with a needle and holding a tube underneath where the blood was collected. The tube was prepared with anti-coagulating EDTA to protect the blood from coagulation.

a) b)

Figure 5. a) Collection of blood sample (Photo: Olivares, 2009). b) Collection of faecal sample (Photo: Willgert, 2009).

The faeces were collected from the rectum by hand. One to three balls of faeces were taken from each horse. Both the blood samples and faecal samples were stored in a cooler until put in refrigerator (+8 °C).

Analyses of blood and faecal samples

The samples of blood and faeces were processed and analysed during the day after collection. To measure hematocrit and plasma protein levels the tubes with blood were carefully wiggled back and forth to mix the blood before capillary tubes was filled up to 3/4 and centrifuged at 10 000 r/min for five minutes. In the centrifuge, the blood was separated into layers and the hematocrit and plasma protein levels could thereafter be determined. A hand-held refractometer was used to read the plasma protein concentration.

A modified McMaster technique was used to analyse the faecal samples. With this technique, the number of parasite eggs per gram faeces (EPG) was determined. To identify the strongyle nematode sub-families, larval cultures were grown of some of the samples that contained 1000 EPG or more. Faeces from three to five horses from the same town were pooled in plastic cups and then incubated at 25 °C for 10 days. By examining the cultured third stage larvae the occurrence of Cyathostomins and *S. vulgaris* could be established (Thienpont *et al.*, 1979).

The horses were dewormed at each visit. To determine the efficacy of the anthelmintics, the EPG status of the horse at his first visit was compared to the status at the second, and the second was compared to the third. By comparing EPG numbers from two visits, “individual reductions” could be calculated. This was done in order to establish how much the EPG had decreased after the previous deworming. Only horses sampled twice within 30 days and with at least 200 EPG at the first visit were included in the calculations. The following formula was used to estimate individual reductions:

(1-(EPG d30/EPG d0))*100
where d0 is the day of deworming and d30 is approximately 30 days later.

Veterinary care

The veterinary care consisted of a basic examination (figure 6a), deworming and administration of vitamins. The examination included measurements of respiratory and circulatory frequencies, body temperature, observation of the mucous membrane in the mouth and eyes, and estimation of the body condition and level of dehydration. Almost all horses were dewormed with the anthelmintics Albendazole (oral administration) or Ivermectin (oral paste or subcutaneal injection) (figure 6b). Most horses also received vitamins A, D_3, E, B_{12} and B-complex. Antibiotics were administered when required on individual basis. Many of the horses had wounds as result of the equipment. These wounds were cleaned. Problems with hooves or legs were also common. In relation to the examination the horse owners sometimes were given advices about how to take care of their horses, for example that they had to clean the wounds and give sufficient amounts of water and food.

a) b)

Figure 6. a) A veterinarian from the university examining a horse (Photo: Willgert, 2009); b) Oral administration of anthelmintics (Photo: Olivares, 2009).

Statistical analyses

All data were subject to analysis of variance (GLM procedure in the Statistical Analysis Systems package 9.1) (SAS Institute Inc. Cary, NC, USA) using the following model: $Y_{i\,j\,k\,l\,m\,n\,o\,p} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_l + \eta_m + \iota_n + \kappa_o + \lambda_p + e_{i\,j\,k\,l\,m\,n\,o\,p}$ where $Y_{i\,j\,k\,l\,m\,n\,o\,p}$ is the observation, μ the mean value, α_i the effect of sex (gelding/stallion, mare), β_j the effect of age (0-3.5, 4-9, 10-15, 16-20 and > 20 years), γ_k the effect of age (0-4.5, > 5 years), ε_l the effect of town (Chinandega, León, Pochomil, Diriamba, Niquinohomo and Rivas), η_m the effect of examination (1, 2 and 3), ι_n the effect of month (1, 2 and 3), κ_o the effect of the veterinarian doing the examination (five different veterinarians and 10 groups of students), λ_p the effect of reason for the visit (nine different reasons) and $e_{i\,j\,k\,l\,m\,n\,o\,p}$ the residuals; $e_{i\,j\,k\,l\,m\,n\,o\,p}$ ~IND (0, δ^2). The *P* value for significance within and between treatments was < 0.05. Values are presented as least square means ± standard error of the mean for age, town and examination. Two statistical analyses were performed: one including only the horses examined all three times and one including the horses examined one or two times in addition to the horses that were examined three times.

Excel (Microsoft) was used to calculate individual EPG reductions and to calculate correlations between parameters.

Results

The horses sampled

Over the three months that the study was carried out, 441 horses were given free veterinary care. Out of these 311 horses were attended once and 130 twice with either one or two month's interval, in total 47 horses were attended three times. This gives a total amount of 618 treatments.

The majority of the treated horses were either geldings or stallions (81%) and a minor part was mares (16%). For the remaining 3%, the sex was not registered. The horses were of varying sizes and most of them were crossbreeds. Approximately 50% of the horses were 4-9 years old (figure 7).

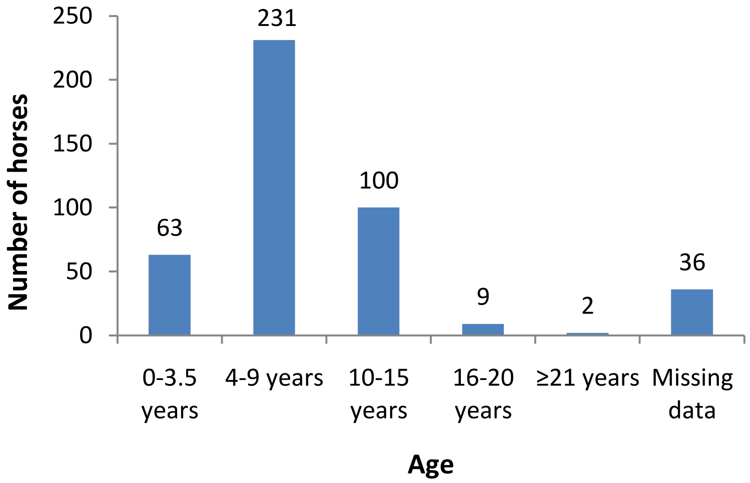

Figure 7. Number of horses aged 0-3.5, 4-9, 10-15, 16-20 and ≥21 years.

The number of horses attended varied from time to time and also varied between the different towns. Most horses were attended by the veterinarians in Rivas (145 horses), followed by Niquinohomo (73), Diriamba (68), Léon (60), Chinandega (51) and Pochomil (44). Almost all horses were used by their owners for transportation, the majority to pull goods carts. Some were also used to draw carriages with tourists. The horses in Pochomil were an exception; they were mainly used at the beach as riding horses for tourists.

Most horse owners brought their horses to have them examined, dewormed and given vitamins (95% of all horses). In addition, some horse owners said the horse was coughing or had nasal secretion (20%) and needed to be examined. Of the horses coughing or with nasal secretion, 93% came between the 20th of January and 10th of February, during which an outbreak of equine influenza was suspected. Other reasons for bringing the horses were, in addition to the general examination, abdominal issues, infections or inflammations, wounds, itching or because the horse was too passive or apathetic.

The veterinarians attended 64% of the horses and the students 24%. It was not noted who attended the remaining 12% of the horses. The author of this paper worked together with one of the veterinarians, they attended 29% of all the horses.

The parameters evaluated

Out of the five evaluated parameters, only the plasma protein showed significant differences between examinations when including only the horses coming all three times in the analysis. Hematocrit had a significant increase between the second and third examination. For the remaining parameters the differences between the horses' examinations were not significant (table 2). On the other hand, if including also the horses coming only once or twice in the analysis, body condition and EPG showed significant differences between examinations but dehydration, hematocrit and plasma protein did not (table 3).

Table 2. The means of body condition, dehydration, hematocrit (%), plasma protein (g/l) and EPG, at three subsequent examinations when comparing only horses being examined at all three occasions, with standard errors in parenthesis

Examination	**Body condition**	**Dehydration**	**Hematocrit**	**Plasma protein**	**EPG**
1	2.8 ^{a} (0.3)	3.1 ^{a} (0.9)	23 ^{ab} (3)	79 ^{a} (3)	369 ^{a} (205)
2	3.0 ^{a} (0.3)	2.8 ^{a} (1.0)	24 ^{a} (2)	71 ^{b} (2)	458 ^{a} (168)
3	3.0 ^{a} (0.3)	2.7 ^{a} (1.0)	27 ^{b} (2)	68 ^{c} (2)	448 ^{a} (159)

$^{a, b}$ Different superscripts in small letters signify differences (P < 0.05) between rows

The level of significance for each parameter when including the examinations of all horses in the analysis is shown in table 3. There were statistical differences depending on if the horse came during the first, second or third month of the study for all parameters except for the dehydration. Which veterinarian that performed the assessment of the body condition and dehydration was also statistically significant, as well as who had taken the blood samples. Only the collection of faecal samples was not affected by the veterinarian who took the sample. The reason for why the horse owner had come with his horse was not statistically significant.

Table 3. Level of significance for the different parameters. All examinations of all horses included in the analysis, also horses with only one or two examinations

	Body condition	**Dehydration**	**Hematocrit**	**Plasma protein**	**EPG**
Sex	n.s.	n.s.	n.s	*	n.s.
Age groups (≤3.5, 4-9, 10-15, 16-20 or ≥21years)	*	**	n.s	*	n.s.
Age groups (≤4.5 or ≥5 years)	n.s.	*	n.s.	n.s.	n.s.
Town	***	***	***	*	n.s.
Examination	**	n.s.	n.s.	n.s.	***
Month	*	n.s.	***	***	**
Veterinarian	***	**	**	**	n.s.
Reason	n.s.	n.s.	n.s.	n.s.	n.s.

n.s. = non-significant ($P \geq 0.05$), * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$

There was no correlation between the different parameters.

Body condition

The observed values for body condition ranged from 1 to 4.5. A mean of 2.6 (SE 0.2) at the first examination of the horses was estimated when all horses from all visits were included in the statistical analysis. Of all examined horses 44% were classified as thin as they had a body condition of 2.5 or lower (figure 8).

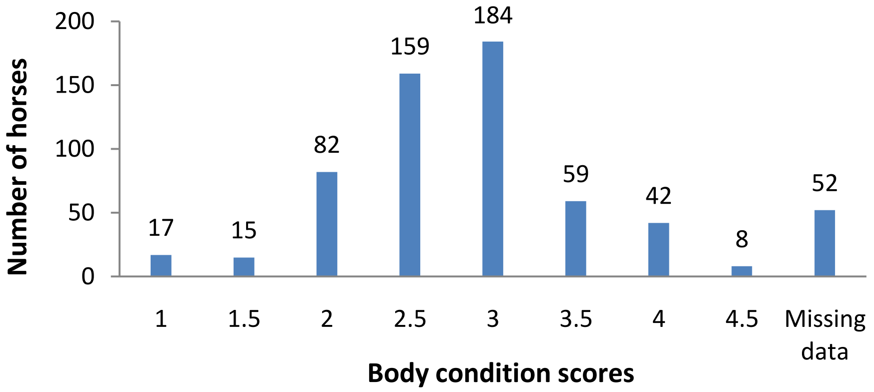

Figure 8. Number of horses with different body condition scores.

Horses younger than 9 years had generally higher body condition scores than horses between 10-15 years of age. Horses aged 0-3,5 years had a mean score of 2.9 (SE 0.20) and 4-9 year old horses had a mean score of 2.8 (SE 0.2), compared to 2.6 (SE 0.2) for the age group 10-15. When comparing the visited towns, Pochomil had the lowest mean for body condition (2.5, SE 0.2) while Chinandega and Diriamba had the highest means (3.0, SE 0.2).

Dehydration

Dehydration scores from 0 to 8 were observed. A mean of 2.4 (SE 0.7) was estimated at the first examination of the horses. Out of all horses, 42% were classified as non-dehydrated (score 0) (figure 9). Horses with values above zero were considered as dehydrated (41%). Out of the dehydrated horses, 19% had a score above six, indicating a very high level of dehydration in the horse.

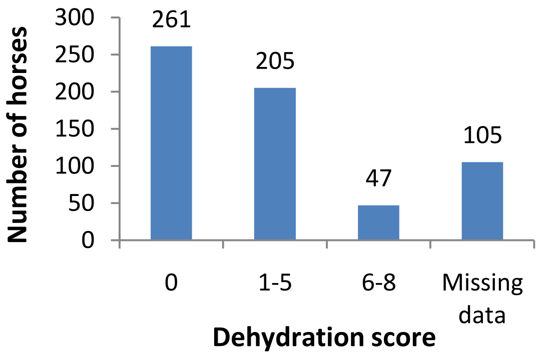

Figure 9. Number of horses with different dehydration scores. Values divided in groups of "not dehydrated" (0), "dehydrated" (1-5) and "very dehydrated" (6-8).

Horses aged 16-20 years were more dehydrated than horses under 15 years. A dehydration mean of 1.1 (SE 0.7) was estimated for horses aged 3.5 years or younger, 1.3 (SE 0.7) for horses between 4-9, 1.9 (SE 0.7) for the group between 10-15 years and 3.4 (SE 1.0) for the horses between 16-20 years, Also, if comparing young horses with the age 4.5 years or lower with the rest of the horses, the difference in dehydration scores was significant. The young horses had a mean of 1.7 (SE 0.8) and the older horses 2.2 (SE 0.7).

There were significant differences between the visited towns. Diriamba and Pochomil had the highest dehydration means, 2.9 (SE 0.8) and 2.8 (SE 0.8), respectively, and Chinandega and León had the lowest dehydration mean, 1.2 (SE 0.8 and 0.8 respectively).

Hematocrit and plasma protein concentration

A mean hematocrit value of 23% (SE 2) was estimated for the first examination of the horses. The horses in the town Niquinohomo had highest hematocrit levels with a mean of 28% (SE 2) while León and Pochomil had the lowest hematocrit levels with the values 22% (SE 2) and 21% (SE 2) respectively.

For plasma protein a mean of 72 g/l (SE 2) was estimated when including the first examination of all the horses in the analysis. All age groups had means within the interval 73-74 g/l (SE 2-3). The towns Diriamba and León had higher plasma protein values than the other towns. Diriamba had 73 g/l (SE 2) and León 74 g/l (SE 3) compared to Niquinohomo, Pochomil and Rivas which had means of 70 g/l (SE 2).

Parasites

Strongyle nematode eggs were the most common parasite eggs found in the faecal samples. Larval cultures showed that these were of the subfamilies *Strongylinae* and *Cyathostominae*. Some eggs of *Parascaris equorum* were also identified in the samples. Larval cultures revealed that *S. vulgaris* was present in 25% of the cultures.

The highest egg excretions at examination 1, 2 and 3 were 7100, 5500 and 1900 EPG, respectively. However, there were no significant differences in EPG means between the examinations. Low EPG values (≤100) could be seen for 35% of the horses, 20% had EPG values between 200-1000 while 13% had more than 1000 EPG. Values were missing for 32% of the horses (figure 10).

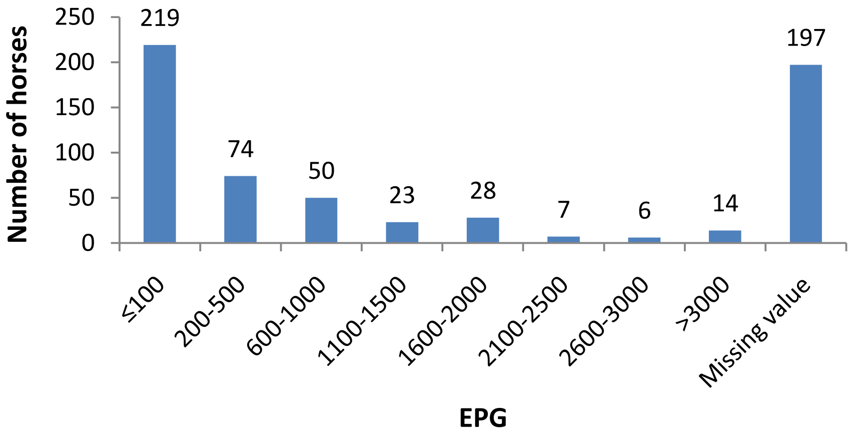

Figure 10. Distribution of EPG.

Mean EPG, if including only all the first examinations of the horses in the analysis, was 782 (SE 393). Of these horses, 27% had low values, 21% had values between 200-1000 and 13% had values higher than 1000 EPG. Almost 40% of the horses were missing EPG values (figure 11).

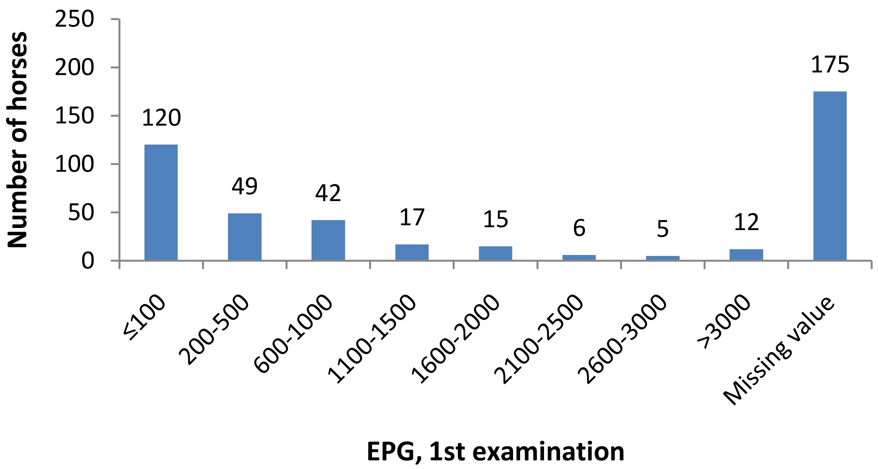

Figure 11. Distribution of EPG at the first examination of the horses.

The horses in Chinandega had the lowest mean of EPG (102, SE 439) whereas Pochomil and Rivas had the highest (695, SE 421 and 559, SE 421, respectively). No difference in values of EPG between different age groups could be observed.

The anthelmintic albendazole was used to deworm 49% of the horses and ivermectin was used to deworm 41%. Which anthelmintic the remaining 10% of the horses received is unknown, they were given either albendazole or ivermectin, whilst some of them were not dewormed at all since the owner already had dewormed them recently.

The efficacy for the two anthelmintics that were used was calculated from the individual reduction numbers. Horses that received ivermectin at the first month had still low values of EPG when examined one month later and the efficacy was 100%, whereas it was lower after the deworming during the second month when it was 78%. Albendazole had an efficacy of 83% after the first deworming while the values of EPG had increased after the second deworming and the efficacy was negative, minus 31%.

Discussion

In this study the effect of free veterinary care was investigated and an improvement of the health and dehydration status was expected. There was a tendency of improved hydration status with a significant decrease of the plasma protein. However, the other parameters did not change significantly during the study time.

Improved values of the plasma protein could be seen between the first, second and third examination of the horses and for hematocrit, improved values were observed between the second and third visit. For the other parameters; dehydration, body condition and the values of EPG, no significant differences could be observed during the three months that the study was performed. This could be due to the limited study time, the horses may require prolonged care if significant changes for these parameters should be observed, in addition to improved owner behaviour regarding handling, feeding and deworming practices. Horses that were given feeds with low nutritional values or too little feed or water in the beginning and throughout the study would obviously remain thin and dehydrated. An addition of electrolytes with the water would improve the water intake if the horse had been sweating a lot during work. Without the electrolytes, the horse may not drink enough water even if offered (Jansson & Dahlborn, 1999). The working capacity of the horse is also affected if the horse is dehydrated, and as a consequence, the owner will earn less money to use for food and care of the horse (Pritchard *et al.*, 2006).

Another possible reason to why no differences were observed between the examinations, could be that the horses brought to the mobile clinics all the three times had owners interested in the well-being of their horses and that these horses already had a good condition at the first visit and thereafter remained the same. A suspected outbreak of equine influenza at the end of the first month and the beginning of the second month could also have been affecting the results. Horses with fewer, coughing and with nasal secretion had probably lower possibilities to improve their health.

January, when the study was started, is in the middle of the dry season. Later in the dry season, even warmer temperatures are common and the pasture becomes dry and less nutritious. April and May are the warmest months of the year at the pacific side of Nicaragua (Ineter, 2010). Improving the body condition during this time could be hard since the access to feeds is limited. Burn et al (2009a) investigated environmental factors affecting working equines in developing countries. They found that animals in warmer climates in general had a lower body condition score.

Geographical differences were observed in the present study. Especially the town Pochomil differed from the others regarding several of the parameters. Pochomil had, together with Diriamba, the most dehydrated horses when using the skin tent test and the town had also the horses with the lowest mean of body condition and the lowest hematocrit values. Concerning the EPG values, Pochomil had the highest mean, even if this difference was only significant compared to Chinandega. In Pochomil the horses were mainly used as riding horses for tourists instead of pulling carts as in the other towns. Wounds were also more common and severe in Pochomil compared to the wounds of the other horses in other towns. In general, the horse owners had a lot of contact among themselves and there were therefore similarities within the towns in the way they treated their horses. There was no large difference in climate between the towns; all were located at the pacific side of Nicaragua and the temperatures did not differ much.

In the present study almost 50% of the horses had a body condition below normal and 41% were dehydrated. These results can be compared to the results of a study by Pritchard *et al.* (2005) where working equines in Afghanistan, India, Egypt, Pakistan and Jordan were examined and given veterinary care. About 70% of the animals were thin or very thin and 50% dehydrated. The measurements were performed during the winter/spring and even higher prevalence of dehydration was expected for the summer season. In a study in Chile, 8% of the horses had a poor body condition whilst 59% had a good body condition (Tadich *et al.*, 2008). Differences in climate and the season of the year could be reasons for the different results in the Chilean study compared to the present study and the study by Pritchard *et al.* (2005). In Chile, the study was performed in the autumn and thus available pasture had increased. Moreover, in the study in Chile many of the horse owners supplied the horses with additional feed (Tadich *et al.*, 2008). The fact that Chile nowadays is considered as an upper middle income country (OECD, 2010) is probably also a reason for the better condition of the horses. In the present study in Nicaragua, the second half of the dry season was ongoing, the climate was hot with no rainfall and the availability of pastures was low. Eight of the horse owners in Nicaragua were asked about the feed given to their horses. Seven of them said the horses had access to pasture. However, the quality of the pasture was not investigated. Concentrate was given by four of the asked horse owners. Examples of feedstuffs in concentrate were wheat, sorghum and corn. Other feeds given were milled rice shells, leaves from banana plants and leftovers from other fruits such as mango and water melon.

To get results reflecting the real state of the horses when assessing subjective parameters such as body condition and dehydration, it is important to have well trained people that have been instructed about the different scores and also have received practical experience before they begin to assess for the study. The less people involved in assessing the horses, the lower is the risk of errors. The assessment protocol should be clear to reduce the possibility of misunderstandings (Burn *et al.*, 2009b). In the present study, all parameters except for EPG were significantly affected by the assessing veterinarian or student. The students had been given lectures on the assessment system, but despite this, a great variation in assessment scores could be seen for both students and veterinarians. The groups of students as well as veterinarians, changed from time to time, and differences in results between the towns could have been due to the change in people. It would have been preferable to coordinate all people participating in allocating scores in order to get more reliable results, or to use only non-subjective parameters, such as hematocrit and plasma proteins, which also can give an idea of the hydration status.

Mottet *et al*. (2009) made an evaluation of Henneke's body condition scoring system to see if there was an agreement between scores measured by experienced horse experts and ultrasonic measurements of fat for the same horses. They also investigated if it was possible to discover changes in body fat tissue using the body condition scoring system. They found an acceptable agreement between scores and the ultrasonic fat measurements while changes of fat were difficult to detect. Furthermore, the system for body condition scoring was developed for quarter horses initially, and might require modifications when used for other breeds (Suagee *et al.*, 2008).

Horses in the age of 16-20 years were more dehydrated than horses younger than 15 years of age. These kinds of age differences could also be seen in a study by Pritchard *et al.* (2008) where older horses were more dehydrated than younger horses. Also in another study of Pritchard *et al.* (2006) more horses older than 15 years had positive skin tent tests compared to younger horses. An explanation to this could be decreased elasticity of skin in older horses. For humans great variations in skin elasticity are common between younger and older persons (Dorrington, 1981). Variation in dehydration depending on body condition and head and neck position was also presented between individuals in the study by Pritchard *et al.* (2006). The aim of that study was to develop a standardised methodology for the use of skin tent test. Blood parameters were used as reference but did not give significant results and the conclusion was therefore that more studies were needed in order to validate the skin tent test. In addition, the study by Pritchard *et al.* (2008) aimed to create a standardised method for assessment of dehydration of working equines. Neither the assessment of mucous membrane nor the skin tent test was possible to repeat with agreeable results when comparing them with the plasma osmolality as a reference. Drinking behaviour was a better parameter to determine if the horse was dehydrated. The horses were offered water ad libitum when arriving to the clinic and had thereafter access to the water during 5 hours. The amount of water was measured after each intake. Almost all horses, 49 of 50 drank immediately when arriving and they drank the largest quantities at this occasion. Due to this fact it was concluded that the amount of water consumed immediately after work could be a good indicator of whether the horse was dehydrated. However, to get more reliable results, it would be better to offer water with optimal salt content and temperature (Pritchard *et al.*, 2008). A problem when using drinking behaviour as an indicator of dehydration could be if the working horse had a chronic deficiency of electrolytes due to prolonged sweating or malnutrition. The thirst response would not be activated and the horse would not drink enough to establish the hydration status (Pritchard *et al.*, 2006). Moisture of coat (Pritchard *et al.*, 2008), place for where the pinching was implemented as well as the power used, affected the results (Pritchard *et al.*, 2006, Pritchard *et al.*, 2008). Exact information about how to translate the pinching time to usable values, was not discussed in the study.

The hematocrit levels obtained in this study were low compared to values from two studies with healthy working horses in Pakistan and also compared to "normal" horses from developed countries with temperate climate. In the present study the mean value of the horses at the first examination was 23 ± 2%. The horses from Pakistan had means of 37.75 ± 4.75% (Gul *et al.*, 2007) and 32.6%, respectively (Pritchard *et al.*, 2009). A "normal" hematocrit value is in the range 35.2 ± 3.6% (Carlson *et al.*, 1979). Compared to another previous study, also with horses from Pakistan, the obtained hematocrit values were more similar to those in the present study. Those horses had a mean of 27.1 ± 3.1% and the study was, unlike to the two other studies carried out in Pakistan, performed with both healthy and sick horses which maybe could explain the difference (Pritchard *et al.*, 2006). Another explanation to the low hematocrit values of the working horses in the present study could be that the horses had adapted to the different conditions found in developing countries. They have to work much, with heavy loaded carts and in high temperatures. Horses used to go long distances for an extended period of time can maintain a low heamotocrit value (Pritchard *et al.*, 2009) unlike race horses trained for short fast distances where the hematocrit can increase from 45% to 65% when exposed to hard exercise (Sjaastad *et al.*, 2003). The horses could also have had sub-clinical anaemia even if they looked and behaved healthy (Pritchard *et al.*, 2009). However, this does not explain why the hematocrit values were not more similar to the values of the working horses in Pakistan.

Another reason for the low hematocrit values could be the sampling of the blood. The blood could have been handled without enough care, causing destruction of the blood corpuscles. Some of the blood samples had coagulated, probably because of non-functioning EDTA. These could not be separated in the centrifuge and therefore not be analyzed. Since new EDTA was made several times during the study, it could have contributed to differences in hematocrit and plasma protein results between the towns. For example, if the EDTA that was used in Pochomil during the second month did not work well, it is possible that these values were lower than they should have been. Variations compared to other data could also be due to differences between equipments in the laboratories (Mori *et al.*, 2003).

Another possible factor affecting the blood values could be if the horse had been drinking large amounts of water recently before the blood samples were taken. Then there is a risk of haemodilution and with that, misleading values of hematocrit and plasma protein (Pritchard *et al.*, 2008).

For the plasma protein, a mean of 72 ± 2 g/l was estimated at the first examination of the horses in the present study which was in the range of the "normal" values 70 ± 9 g/l (Carlson *et al.*, 1979). This could be compared to the three studies from Pakistan mentioned above, which had 86.3 ± 9.5 g/l (Gul *et al.*, 2007), 67 g/l (Pritchard *et al.*, 2009) and 67.4 ± 4.2 g/l (Pritchard *et al.*, 2006), respectively. Of these studies only the study by Pritchard *et al.* (2006) had values similar to the values from the present study and this was also the only study with both healthy and sick horses, where no criteria was used for the selection of horses to the study.

In a study by Sneddon *et al.* (1991) South African riding horses were compared to desert-adapted horses in order to see if there were differences in blood parameters when they were dehydrated during 72 hours. Differences between the horse types in plasma osmolality could be seen but for the other blood parameters there were no differences. Effects of dehydration were shown in both groups for the plasma protein which increased when the horses got dehydrated. For hematocrit, there was an increase during the first 48 hours of dehydration and then the values remained the same during the remaining 24 hours. The plasma protein values decreased between the visits in the present study which could indicate an improved hydration status.

The average EPG value when including all the examinations of all horses in the analysis was relatively high, 575 EPG. This value can be compared to the mean EPG value at the first examination of the horses which was higher; 782 EPG (SE 393). However, the difference between the three visits was not statistically significant when including only the horses coming all three times in the analysis. This lack of difference could be related to low efficacy of the anthelmintics used, especially albendazole. Other reasons could have been that when the faecal samples were collected the following month, the effect of the anthelmintics had already decreased. The horses could also have got an incorrect dose of the anthelmintics. Larva of *Strongylus vulgaris* were found in 25% of larval cultures, this fact together with the high mean value at the first examination suggests that the horses had not been dewormed recently before the first visit.

In the present study, 35% of the horses had low EPG values (≤100), 20% had values between 200-1000 and 13% had more than 1000 EPG. The distribution was similar when including only values from the first examination of the horses in the calculation. The EPG prevalence was relatively low compared to a study with working horses in Lesotho where 48.8% had values higher than 1000 EPG. It is, however, difficult to compare results due to different conditions. The climate, topography, season and the work performed by the horses is probably not the same (Upjohn *et al.*, 2010). Notable is also that in the present study measurements of EPG were not performed for 175 of 441 horses during the first examination. This means a great number of horses without values at the first examination and this could have resulted in incorrect EPG distributions.

Larval cultures were only made from 26 faecal samples in the present study. Compared to the results from a study by Pereira & Vianna (2006) with working horses in Brazil, where horses were euthanized and then examined in order to determine the prevalence of parasites, the values of *S. vulgaris* were low. In the Brazilian study, 70% had worms of *S. vulgaris* compared to 25% of the examined samples in the present study. Of the Brazilian horses, 100% had parasites from the subfamily Cyathostominae, this was also the case for the larval cultures of the Nicaraguan horses where all cultures had Cyathostominae parasites. Other worms found in the Brazilian study were *Oxyuris equi, S. edentatus, S. equinus, Triodontophorus sp, Parascaris equorum* etc.

The anthelmintic ivermectin had an acceptable efficacy whereas the cyathostomin population showed resistance to albendazol. Albendazole is included in the group of anthelmintics called benzimidazoles. Already 30 years ago, resistance in small strongyles was reported for the benzimidazoles and the use in Sweden is very low today. However, it is still used in many other countries (Osterman Lind, 2005). Cases of reduced efficacy against small strongyles have been reported for ivermectin which belongs to the group macrocyclic lactones (Lyons *et* *al.*, 2008), and several studies have shown ivermectin-resistant Parascaris equorum parasite populations, a parasite mainly affecting foals (Osterman Lind & Christensson, 2009). It seems that even though we today have fairly functional anthelmintics, in the future there may be serious problems due to increased resistance against commonly used anthelmintics and the fact that no new effective anthelmintics are available on the market (Lyons *et al.*, 2008; Nielsen *et al.*, 2007).

In a South African paper alternative methods to control the prevalence of parasites of working horses and donkeys in developing countries are discussed. Since the owners often have limited resources and, therefore, do not have financial possibilities to purchase anthelmintics other methods are needed to control the cyathostomes. With the increasing anthelmintic resistance, this field will become a priority in the future. Suggested methods were to remove faeces from the pastures and areas where the horses are held, as well as to use controlled deworming where the horses are dewormed before the winter starts. Another alternative was to use fungi that captures the nematodes and thus reduces the number. However, the fungi-method has to be studied more according to the authors. Also selective chemotherapy was suggested, where criteria are established in order to decide whether the animal should be dewormed or not. For example if samples of faeces show that the horse has less than 300 EPG it should not be dewormed. Nevertheless, the chemotherapy method is expensive as consequence of costs/labour associated with the examination of the parasite status and, thus, the aim of reduced treatment costs would not be achieved (Krecek & Guthrie, 1999). For the horse owners in Nicaragua, removal of faeces could be an option. The faeces could be used as fuel or for composting as in South Africa and it would not be an extra cost for the owners to remove the faeces.

Two studies of donkeys in Ethiopia showed a big difference in parasite burden depending on the season of the year. The highest prevalence of parasites was measured during the rainy season and the lowest prevalence during the warm dry season when it is difficult for the eggs to develop and the parasites to survive (Yoseph *et al.*, 2005; Getachew *et al.*, 2008). The present study was carried out during the dry season. It could be assumed that the EPG values would have been higher if the study should have been carried out during the rainy season instead. Since the body condition of the equines was correlated with the number of parasites in one of the Ethiopian studies, it was suggested to deworm the animals when their body condition was poor (Yoseph *et al.*, 2005). Deworming of all individuals at the end of the dry season or beginning of wet season was also recommended to avoid the development of parasites (Yoseph *et al.*, 2005; Getachew *et al.*, 2008). This type of controlled deworming practices could be useful in Nicaragua as well in order to minimize the use of anthelmintic drugs and, delay the development of anthelmintic resistance. Differences in parasite prevalence between seasons and climates have also been assessed in a study by Nielsen *et al.* (2007). In hot and tropic climates, the prevalence of parasites was low at higher temperatures whilst in colder climates the prevalence was lower during the cooler season since the parasites have difficulties to survive the frost. This difference between climates is important to bear in mind when discussing how to control and prevent parasitic infections. A method applied in Sweden may not work in Nicaragua.

To get an idea of how expensive it is to buy a working horse in Nicaragua some owners were asked about purchase prices. They all said a working horse costs 40-250 USD depending on the condition of the horse. The cheapest horses are usually very thin and with several health problems and the most expensive horses were of a good quality. Compared to the cost of a car, a horse is cheaper and therefore often an alternative for people with limited economical resources. A cheap car in bad shape costs from 250 USD (Personal communication, Mars 2009). Krecek & Guthrie (1999) points out that in Africa the price of a donkey is about the same as a dewormer dose, 20 USD, and therefore one can understand why the owners do not deworm their horses often enough.

Many of the horses in Nicaragua had wounds on the head, withers, breast and places of the girth. These lesions were cleaned as part of the examination. However, to achieve prolonged improvement, information to the owners about how to avoid lesions could contribute to healthier horses. Information and education could be given in the form of seminars or courses as suggested by Swann (2006). The lesions are often caused by inadequate equipment but also of lacking body fat. Many of the owners in the present study seemed to have understood the importance of not letting flies and dirt enter the lesions, but if they also were more aware of the factors causing the lesions, a greater improvement could be achieved. How to best support the horses and horse owners in developing countries has been discussed in several scientific articles. Programmes where horse owners are trained to take care of basic animal health problems to improve the welfare are common and have been proved to be effective. Also projects where school children are educated about animals and their welfare have been carried out in many places. An advantage of teaching children is that they can deliver the information to the parents and that they hopefully will be better prepared when they one day will have their own animals. There are benefits of free veterinary care but preventive efforts are also very important in order to achieve health improvements (Pearson & Krecek, 2006). Preferably, resources should be focused on education about feeding, harnesses, and parasites in the future, because without knowledge about how to better care for the horses, no long-term changes can be expected for the horses in Nicaragua.

Conclusions

Only the parameter plasma protein showed significant improvements between the three examinations. This could indicate that the horses became less dehydrated but the improvement was, however, not supported by the results of the skin tent test where no significant difference in dehydration status was presented. The other parameters: body condition, hematocrit and parasite eggs per gram in faeces (EPG) did not differ significantly. Three months may not be enough time to observe prolonged changes in health parameters for working horses in Nicaragua. For the individual horse, the veterinary care surely was valuable but it would be more valuable to focus on the owners, to inform them about how the horses could be of better use by improving the welfare and health status.

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