The use of routine radiological database from equine practice to determine the prevalence of osteochondrosis and the relation to feeding practice factors in a Dutch warmblood horse population

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Abstract

Osteochondrosis (OC) is a very common disease in Dutch warmblood horses. The dynamic process of the endochondral ossification gets disturbed, which can result in irregular cartilage in equine joints, mostly hock and stifle. This causes economical, emotional and genetic losses in the horse industry in The Netherlands. The multifactorial etiology of the development of OC is still not completely understood. Factors like exercise, genetics, exterior, housing, trauma and feeding seems to play a role. Studies show a possible influence of specific minerals, like copper, zinc and magnesium, fast growth, girth perimeter and weight of the horse on the development of OC. The aim of this study is to determine the prevalence of OC of a veterinary based warmblood horse population and to search for influencing factors from feeding practice. A database was created by the retrospective use of 626 radiological examination reports of warmblood horses (age 1 – 5y), conducted by a veterinary equine clinic. The environmental factors (housing, feeding and management practice) of the 45 farms were collected by the use of questionnaires and statistically tested for significant correlation with the OC-status of the farms. The results show a prevalence of OC of 26,7 %, with the tarsocrural joint most affected; 13,7 %, followed by the metatarsophalangeal joint; 6,0 %, the metacarpophalangeal joint; 5,6% and the femoropatellar joint; 5,4 %. The factors of the feeding practices of pregnant mares, foals before weaning and foals after weaning did not show any significant correlation, except of the amount of concentrates of the weaned foals. More statistical analyses are necessary for any reliable conclusions. This study shows the need of balanced diet for mare and foal. As well as the possibility of the use of a veterinary clinic database to determine the prevalence of OC in a population of warmblood horses.

Introduction

Osteochondrosis (OC) is a very dynamic disease in the horse with a high prevalence. Disturbance of the endochondral ossification in the articular-epiphyseal complex in young horses leads to irregular cartilage in joints, which can result in lameness and pain. (Ytrehus, Carlson et al. 2007) Therefore OC causes major loss of promising sport horses, resulting in economic damage in the horse industry. Already 20

years ago the need for further research was emphasized. Still, after lot of published studies, the multifactorial etiology of OC is not completely understood.(Jeffcott 1991, van Weeren, Jeffcott 2013)

Pathogenesis

Micro-vascular damage in the articular epiphyseal growth cartilage (micro trauma) seems to play an important role in the early development of OC in horses (Ytrehus, Carlson et al. 2007). This was concluded from large-scale research in pigs (Ekman, RodriguezMartinez et al. 1990). At the histological level, scientists (Lecocq, Girard et al. 2008) found a specific vulnerable spot at the junction of the proliferative and hypertrophic zones of the epiphyseal cartilage. They also showed that unborn foals are never affected with OC. The youngest foal ever diagnosed with OC was two days old, explained as a result of the biomechanical influence on the development of OC (Stromberg, Rejno 1978). Despite of these results, there still is no full explanation which declares why one individual will develop OC and others will not.(van Weeren, Jeffcott 2013) The most common locations for OC to occur are the hock, especially in the cranial aspect of the intermediate ridge of the distal tibia, followed by the stifle (midregion of the lateral ridge of the femoral trochlea). (Dik, Enzerink et al. 1999) The treatment of OC (conservative versus using arthroscopy) depends on the location, the severity (clinical sings) and age of the horse. (McIlwraith 2013)

Development and prevalence

Previous research showed the dynamic character of OC and consequently highly metabolic active characteristics of juvenile cartilage, resulting in the fact that the prevalence of OC is difficult to determine in general for growing foals. (Carlsten, Sandgren et al. 1993, Dik, Enzerink et al. 1999, Dabareiner, Sullins et al. 1993) A large Dutch experiment on the development of OC in young foals (age 1 month) showed that spontaneous recovery is possible. Lesions on the intermediate ridge of the distal tibial bone tended to occur in the first month after birth, but most of these lesions recovered spontaneous. At the age of 5 months, most lesions have disappeared and the situation remains stable thereafter. At another predilection site, the midregion lateral ridge of the femoral trochlea, almost all lesions could be diagnosed from 3 months of age and no new lesions developed after the age of 8 months (Dik, Enzerink et al. 1999). This knowledge is expanded by a recent study (Jacquet, Robert et al. 2013) in France which states that the diagnose of OC is most reliable from the age of 18 months old.

As a result of this dynamic process and therefore the importance of the age of the horse at time of inspection, the reported prevalence of OC by several studies show large variations. Most commonly, a prevalence of 20-30% was reported in populations of warmblood horses (Arnan, Hertsch 2005, Dik, Enzerink et al. 1999) However, a recent large-scale study by Grevenhof et al (2009) (Van Grevenhof, Ducro et al. 2009)reported a prevalence of 67.5% in Royal Dutch warmblood horses.

Factors

Besides the age of the horse, there seem to be numerous factors partly responsible for the development of OC like genetics, breed, trauma and management factors (feeding practices, exercise, animal handling). In this study, the focus will be on feeding practices (including growth). An important factor in the prevalence of OC is breed of the horse. Lepeule (Lepeule, Bareille et al. 2008) reported a prevalence of osteochondral fragmentations of 61% in warmblood horses compared to 41% in Standardbred horses and 32% in Thoroughbred horses. All horses in this study were examined at the age of 6 months. It must be mentioned that it seems that OC does occur in wild horse populations, but to a much lesser extent. Radiographic examinations of the left

femoropatellar, both tarsocrural, metatarsophalangeal, metacarpophalangeal were performed on eighty yearling feral horses, resulting in a OC prevalence of 6,25%. (Valentino, Lillich et al. 1999). More recent study (Beckmann, Baltus et al. 2012) reports no incidence of OC (dissecans) in 85 male Dulmener wild horses, after radiological examinations of all the tarsocrural, femoropatellar, metatarsophalangeal and metacarpophalangeal joints. This enforces the theory that the environment plays an important role in the development of OC.

Feeding and growth

A large recent experiment (van Grevenhof, Ott et al. 2011) with 345 pigs discovered a statistically significant lower OC-prevalence at pigs with a restricted amount of food, compared to a larger (20% more) amount of food. Many other researches have also shown that a lot of animal species (like broilers, bulls and dogs) are more affected by osteochondrotic lesions due to fast growth. (Dutra, Carlsten et al. 1999, Poulos, Jr. et al. 1978, Olsson, Reiland 1978, Hedhammar, Wu et al. 1974)

At equine level there appears to be more discussion about the correlation of OC with fast growth, but some similar conclusions could be made. A study (van Weeren, Sloet van Oldruitenborgh-Ooste et al. 1999) also showed a higher prevalence of OC in the femoropatellar joint compared to non-affected animals due to growth-influences. The OC-affected horses had a higher weight gain rate in the third and fifth month, more weight at 11 months and were taller at the withers at 11 months of age. All these factors didn't seem to influence the OC prevalence of the tarsocrural joint (no other joints were taken into this study). Other studies also show the high weight gain rate (in the third to sixth month of age) as an inducing factor of the prevalence OC in the hock, fetlocks and stifle.(Thompson, Jackson et al. 1988, Pagan, Jackson 1996)

A high wither-height also seemed to increase the probability of finding osseous fragments in the limb joint of a population of other warmblood horses in a German study. (Stock, Hamann et al. 2006). Although it is not proven that osseous fragments emanate from OC, a correlation is suggested. In the study of Lepeule (Lepeule, Bareille et al. 2008), it was also suggested that the wither height (and girth circumference) of the horses influenced the prevalence of OC. Sandgren proved that more heavy horses attempt to be more prone to develop OC in the tarsocrural joint, compared to horses with a lower body condition score, but the daily growth rate is not a influencing factor. ((Sandgren, Dalin et al. 1993) Another study with taller horses, German Coldblood, showed a prevalence of OC of 61,7%.(Wittwer, Hamann et al. 2006)

In contradiction to this, a project in France (Donabédian, Fleurance et al. 2006) compared two groups of foals, a high feeding group and a moderate feeding group. The results were a strong suggestion to, but didn't show any statistically significant difference in the prevalence and severity of developmental orthopedic disorders (DOD), including OC, between these groups. However, the study did confirm that the feeding level did not completely control the growth rate, so genetics does play an important role. The way of detection of the DOD, either radiological examinations or necropsy, didn't show homogenic results, so no solid conclusion of correlations could be made.

The suggestions of Donebedian and Lepeule were enforced by a recent study in France (from the same author Lepeule(Lepeule, Bareille et al. 2013)). The results showed an association between the occurrence and/or severity of OC and the growth in girth perimeter, in combination with irregular exercise.

Next to the growth rate, the source of the diet of the foal has also proved to influence the development of OCD.

Back in 1984 a study (Glade, Belling et al. 1984)discovered the consequences of a daily over- versus underdose energy- and protein-intake for foals, as the cartilage in the joints was malformed after

eight months. Later, more specifically research appeals the effect of the high levels of starch and sugar (hydrolysable carbohydrates) in the concretes, as it induces the insulin and insulin-like growth factors. *In vitro* experiments (Henson, Davenport et al. 1997) show that insulin has a negative impact on the cartilage of the joints (of the fetus and foal), as the chondrocytes can be suppressed in differentiation. The results could be supported by in vivo studies, (Ralston 1996, Pagan 2005) by the comparison of glucose and insulin responses to a high carbohydrate meal of healthy horses to horses with OCD.

Minerals

Around 1990, it was thought that copper (Cu) played an important role in the pathogenesis of OC, due to the stimulating effect of Cu on the activity of the key enzymes which are involved in the formation or turnover of cartilage. Many research (Hurtig, Green et al. 1993, Knight, Weisbrode et al. 1990) reported that Cu-supplements could reduce the incidence of cartilage damage. A couple of years later, this conclusion was doubted by new research conducted by Pearce, who didn't saw significant influences of copper. (Pearce, Firth et al. 1998) However, recent research showed that Cu supports the repair of cartilaginous lesion at the enzyme level. (Weeren, Brama 2003, Davies, Pasqualicchio et al. 1996).

Numerous other minerals have been suspected of playing an inducing role in the development of OC, although there is still no straightforward evidence in most cases. Two recent large scale studies (Counotte, Kampman et al. 2014) investigated the effect of a supplementation of magnesium on two groups of foals. A significant reduction in the prevalence of OC could be seen in the younger group supplemented with magnesium (age; 1- 5 months old), but not in the older group (age; 5 – 12 months old).

Furthermore, the role of calcium (Ca) in combination with impaired proteoglycan synthesis was discussed (Hoogen, B. M. van den, Lest, C. H. A. van de et al. 1999), which also plays an important role in the endochondral ossification. The effect of high Ca and phosphorus (P) diets on healthy foals (mean age 4.4 +/- 1.0 months) showed a slight higher prevalence of dyschondroplasia at the high P group, but not for the high Ca group, if compared with the control group. (Savage, McCarthy et al. 1993)

Genetics

As a result of technological DNA improvements during the last decades it was possible to do genetic research on a larger scale. One example is a study conducted by Van Grevenhof (van Grevenhof, Schurink et al. 2009) which included 800 warmblood horses. They scored gradation of OC and the specific joint in which it occurred. One finding included the heritability, which differed at level of animal and level of joint. In the tarsocrural joint the heritability was 0,36 compared to 0,14 at metatarsophalangeal and metacarpophalangeal joints and 0,05 in the femoropatellar joint. The discovered heritability at animal level was approximately 0,23. The more severe form of OC (fragments) seemed to have a higher heritability (0.22) than the mild form (0.08) (irregular flattening of articular cartilage).

Other studies report lower heritability rates, expect for OC in the tibiotarsal joint (0,52) in one study(Grøndahl, Dolvik 1993). Moreover, Distl (Distl 2013)showed large variation in genetic background as a result of the presence of SNPs on 22 different chromosomes involved in OC. The location of these SNPs were correlated to specific joints, type of manifestation of OC, and the breed of the horse. With regards to these findings it can be concluded that there is a large amount of genes which are responsible for the development of OC. This conclusion validates the outcomes of studies (Schougaard, Ronne 1990) conducted in the early nineties which also showed that stallions with OC

could be parent of foals without OC or vice versa.

Variation in Nomenclature

Research in the origin of loose bodies in joints started a long time ago, with theories of Monroe (1726), Laënnec (1817) and Broca (1854). (van Weeren, Jeffcott 2013)The introduction of the term osteochondritis dissecans (presence of loose fragments and signs of inflammation), better known as osteochondrosis (without fragments or 'overt' signs of inflammation), was started by the German medical surgeon König (Brand 2011) in 1887. Ever since that time there has been controversy about the correct nomenclature of the disease. For example in 1993 Jeffcott proposed to change the name into dyschondroplasia. At this moment in time there is consensus about the nomenclature at three different levels of the disease. Firstly, osteochondritis dissecans (ODC) for the disturbance in the process of endochondral ossification. Secondly, Juvenile Osteochondral Conditions (JOCC) for all joint and growth plate disorders (Denoix, Jeffcott et al. 2013). Thirdly, Developmental Orthopeadic Diseases (DOD) for the full range of skeletal conditions in young horses (McIlwraith 2011)

The aim of this study is to determine the prevalence of OC of a veterinary based Warmblood horse population and to search for influencing factors from feeding practice.

Material and methods

Study sample

A retrospective, observational study of the use of a routine radiological database of an equine veterinary practice to determine the prevalence of osteochondrosis of foals and yearlings of a warmblood population. In addition it was attempted to declare some feeding practice factors as potential role-player on the development of osteochondrosis by the use of questionnaires on large horse farms in The Netherlands and parts of Belgium.

Routine radiological database

A veterinary equine practice in The Netherlands, specialized in equine clinical and radiological examinations, collaborated in the study. Five veterinarians were active in performing the examinations, each acknowledged in Equine Examinations by the Royal Dutch Society of Veterinary Medicine. The equine practice provided a digital database of their existing radiological examination reports, from practice.

Radiological examination

The radiographic examinations were all performed with a Gierth HF 400+ mobile computed radiography system and Wireless (C24i) DR detector from FUJI. The images were treated and viewed with K-PAC S DICOM viewing software. If necessary during the examination, the horses were sedated using a combination of detomidine and butorfanol. The exterior status of most horses was scored according to standardized examination protocols, which could either be for a sport/PROK-examination or OC-screening. The radiological examination contained different views of the metacarpophalangeal (front fetlock), metatarsophalangeal (hind fetlock), tarsocrural (hock) and femoropatellar (stifle) joints. The number of total views per horse with different protocols is shown in table 1.

Joint	Views	Sport/PROK	OC-screening
Front fetlock (Metacarpophalangeal)	Dorso 45° lateral-palmaromedial oblique Dorso 45° medial-palmarolateraal oblique Lateromedial	2 2 2	 2
Hind fetlock (Metatarsophalangeal)	Lateromedial	2	2
Hock (Tarsocrural)	Lateromedial Dorsoplantar Dorso 45° medial-plantarolateral oblique	2 2 2	2 2 2
Stifle (Femoropatellar)	Lateromedial Caudo 10° proximal 60° lateral-craniomedial oblique	2 2	2
Total views		18	12

Table 1. Overview number of views per examination protocol

Defining osteochondrosis

All five veterinarians scored the digital radiographs individually. In attempt to ensure the homogeneity of the examination results and in order to use a similar scale for every joint, OC was identified and classified according to a 5-point scoring system, from A to E (Dik, Enzerink et al. 1999). The definitions of this 5-point scoring system are shown in table 2 and figure 1. In this study a horse classified with a 'C; mild, D; moderate or E; severe' for one or more of the joints, was considered as positive for osteochondrosis, compared to an 'A; normal and B; minimal', which resulted in negative. The exact location of the lesion/defect/fragment inside the joint (for example, medial femoral trochlea or sagittal ridge of distal tibia) was not available in the reports. Avulsion fragments, chip fragments and 'dew drop lesions', disorders of the navicular/sesamoïd bone and coffin joint and bone spavin were also described in the reports, but not diagnosed as OC, and therefore not taken into account within this study.

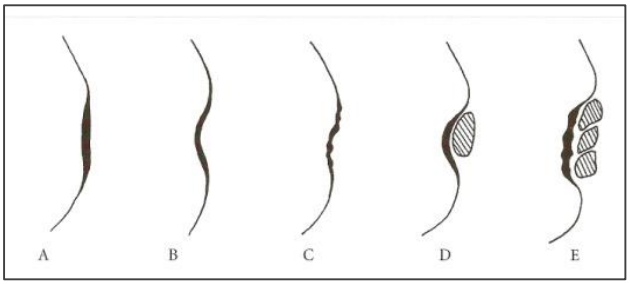


Figure 1. Veterinaire Keuring van het Paard (Sloet van Oldruitenborgh-Oosterbaan, Barneveld et al. 2007)

Grade	Classification	Bone contour	Subchondral bone texture	Fragment(s)
A	Normal	Rounded	Diffuse density	Absent
B	Minimal	Smoothly flattened	Obscure lucency	Absent
C	Mild	Irregularly flattened	Obvious, ill-bordered local lucency	Absent
D	Moderate	Small, rounded/irregular concavity	Obvious, well-defined local lucency	Small fragment(s) (< 5 mm)
E	Severe	Large, rounded/irregular concavity	Obvious, well-defined extensive lucency	Large fragment(s) (≥ 5 mm)

Table 2. Overview definition 5-point scoring system of osteochondrosis

Database 1; General practice

A digital database was composed, by using the program Microsoft Access 2007 to merge all the digital examination reports of the year 2012 and the first 5 months of the year 2013. Specific horses were excluded from the study; trotters and horses < 1 and > 5 years of age at the moment of

radiographic examination.
The database contained the following information per horse: information client; (name, address), information examination (number of radiographs, veterinarian, and date of examination) and information horse (name, transponder/ life number, year of age, breed, sex, fathers' name and the name of the mothers' father). In addition, four joints (stifle, hock, front fetlock and hind fetlock) were separately reported on OC prevalence. The database which now had been created is referred to as **'Database General Practice'**. This database contained 828 horses, spread over 350 farms. The vast majority of the horses (83,4 %) had ≥ 20 examination views. Furthermore, most horses (96,4 %) belonged to the warmblood breed, although various other breeds occurred too (Table 3).

Database 2; Additional data and selection
In order to expend the database, the reports of other years (2008, 2009, 2010 and 2011) were added to Database General Practice. Only reports of potentially 'large' farms were included, which led to a database with farms ≥ 5 horses. The farms containing ≤ 4 horses were excluded from this database. Most of the farms were located in The Netherlands and some others in Belgium.
A number of examinations (80), associated to a farm ≥ 5 horses, missed a digital report (the radiographs were present, but a report was missing). To enlarge the number of examination that could be included, these reports were retrospectively established by one of the veterinarians and added to the database. Only warmblood horses appear in this database. The database which now had been composed is called; **'Database Invited Farms'**, and is shown in Appendix 1. The database Invited farms contained 925 horses, spread over 66 farms.

Information letter and participation
All farms present in Database Invited Farms, were sent an information letter about the study. The information letter informed the farms about: the reason of this study, aim of this study, the methods of this study (a single questionnaire), as well as the potential benefit for each individual farm when participating. The farms were invited to the potential future presentation once the study had been completed, which could give them the opportunity to learn about OC and the relation with environmental factors. The farms were asked to reply to the letter (by using a response card), whether they were wishing to cooperate (and therefore approve the use of the radiological examinations of their horses) or not to cooperate in the study. Whenever the farms did not respond to the letter, they would be contacted personally by telephone. The information letter is shown in appendix 2. The permission was received from 55 (83,33 %) of the farms.

Database 3; Questionnaires of environmental factors; feeding practice
The questionnaire was divided in three major categories of environmental factors; housing conditions, feeding conditions and other management factors. In this study, the emphasis is on feeding conditions. The other two factors mentioned will be analyzed and discussed separately.
The questions about feeding conditions were divided in three sections; feeding conditions of the pregnant mare, the foal before weaning and the foal after weaning till age of 1 year. The farms were asked to define the quantity, composition and possible extra products/supplements of the mares' diet (concentrates and/or roughages) in the last three months of her pregnancy. Furthermore, changes in nutrition during pregnancy and after pregnancy were requested. Followed by the same questions about quantity, composition and possible extra products/supplements of the foals' diet (concentrates and/or roughages), before and after weaning till the foal's age of one year. It was difficult to create the right questions about factors concerning the growth of the horse. The only question for the farms was the way they thought of what body condition score at time of weaning

was right for their horses.

The questionnaire was designed in a way to persist of as many closed questions compared to open questions in order to avoid futile answers. In addition to this, almost all questions were assigned as 'required'. The farms had the opportunity to complete the questionnaire on the internet as well as on paper. The written questionnaire is shown in appendix 3.

Completed questionnaires could be returned to the researchers by using a return envelope. The non-responders would be approached (several times) by telephone or by sending a reminder. The final response rate was 68 % (45 out of 66 farms).

The participating farms formed the third and final database; 'Database Participating Farms'. This database contained 626 horses, kept on 45 different farms. The vast majority of the horses (78,2 %) had ≥ 20 examination views. Furthermore, all horses belonged to the warmblood breed, of which the majority (84,0%) are Royal Dutch Sporthorses. The horse's age at time of examination was mainly 2 – 3 years (85,1 % of the horses). The farms were divided into two groups based on the percentage of OC-positive horses of the farm. If the percentage of OC-positive horses was higher than 25%, the farm was assigned with 'OC-high' status, compared to 'OC-low' farms, which had a percentage lower than 25%. The details of database General Participating Farms are shown in Appendix 1.

An overview of the created databases is shown in table 3.

Database 1; General Practice	Database 2; Invited Farms	Database 3; Participating Farms
- All examination reports of 2012 and part of 2013 - Excluded: trotters and age <1 - >5	- Examination reports of 2008, 2009, 2010, 2011, 2012 and part of 2013. - Excluded: trotters and age <1 - >5 and horses from farms with less than five horses	- selection of database 2 - only farms with ≥5 horses, which had completed the questionnaire

Table 3. Overview of the created databases

Statistical analyses

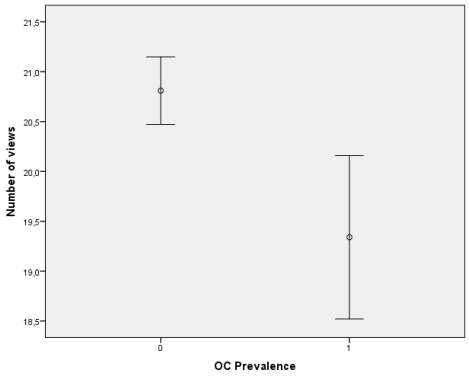
The completed questionnaires were coded and thereby made anonymous to protect the farmers privacy. All the results of the databases and questionnaires were sampled in statistic programs (SAS and SPSS). Several tests were performed to detect duplication of horses, missing values, prevalences and correlations. The results of the prevalence of osteochondrosis, general factors and the feeding practice factors were statistically analyzed by performing univariate tests. The prevalence of osteochondrosis ('OC-Status') acted as dependent variable and was tested for association with feeding practice factors by running the Pearson Chi-Square test and the independent sample T-test with a 95% confidence interval.

Results

OC Prevalence

As shown in appendix 4, the OC prevalence (horses with at least one joint affected with OC) found in this retrospective study in the three databases (populations) is 20,7 – 27,5 %. The number of farms included in the specific database seems to have a significant influence on the OC-prevalence. In all three databases, male horses appear to be more often affected by OC, compared to females, although not significantly (P> 0,05). Neither the year of birth nor the age at time of examination was

detected as a correlated factor for the diagnosis of OC. In addition, there seems to be no significant difference in the development for OC between the different breeds in this study. The number of views per horse does have a significant correlation with the prevalence of OC; less views correlates with a higher OC prevalence (figure 2).



Number of views:

Figure 2 Error bar – Relation between OC prevalence and number of views

Although the examinations are performed by following a similar protocol and scoring system, the results show a variation in the prevalence of OC between the several veterinarians that performed the scoring. In database Invited Farms and Participating Farms, this factor even shows a significant relation with the prevalence of OC.
As for the joints, the hock is with a percentage of 51,2 – 54,4 the most frequently joint diagnosed with OC, followed by the stifle (20,3 – 24,6%) and hind fetlock (20,5 – 26,0%). The front fetlock joint is least frequently discovered with OC (17,5 – 21,0%).

P-values univariate analyses	**Database General Practice**	**Database Invited Farms**	**Database Participating Farms**
Total farms	P = 0,084	P < 0,001*	P = 0,001*
Sex	P = 0,516	P = 0,377	P = 0,271
Year of birth	P = 0,560	P = 0,635	P = 0,825
Breed	P = 0,098	P = 0,178	P = 0,378
Age at time of examination	P = 0,699	P = 0,544	P = 0,363
Number of views	P = 0,022* P = 0,638 (2-tailed)	P < 0,001*	P = 0,002*
Which veterinarian	P = 0,347	P = 0,003*	P = 0,002*

Table 4. Relation between OC and general factors.
Univariate analyses with chi-square test or independent T-test (P< 0,05)

Feeding conditions and the correlation with het OC-status of a farm

The farms that completed the questionnaires could be divided into 22 'OC-low' (48,9%) and 23 'OC-high' (51,1%) farms. The division was made by the prevalence of OC on the particular farm, >25% OC as OC-high and <25% as OC-low. The prevalence of OC of the not-cooperating farms (21) was 27.8 % and could be divided in twelve OC-high and nine OC-low farms. The variation in feeding practice between the farms and the possible relation to the development of OC are reported in the next subchapters.

Feeding practice: Pregnant mare during last three months of pregnancy

Results show little variety in the diet of the pregnant mares during the last three months of pregnancy between the farms. Most of the farms provided information about the mare concentrates (92,9 %) and haylage (73,2%) and few farms gave the mares supplements (19%). However, the brands of the concentrates and supplements (not one brand was recorded more than once) varied greatly. The average amount of concretes on OC-high farms was 3,125 kg, compared to 3,531 on OC-low farms. In addition, the quantity of concentrates intake on all farms ranged between 1 – 6 kg a day, with 50% of the farms between 2 – 3 kg. The main part of the farms (73,2%) provided the horses semi-dry-haylage, compared to the other farms, whom provided normal haylage. The amount of roughage intake of a horse is difficult, if not impossible, to determine reliably in a questionnaire and was therefore not requested. The largest diversity between the farms was shown in the provision of extra products (40,5 vs 59,5 %), like maize, luzerne and oat. Also the changes of diet during the pregnancy (43,9 vs. 46,1 %) and after the mare has given birth (42,9 vs. 57,1 %) seemed to differ between the farms. Due to the statistic analyses, there seems to be no significant correlation between all these different feeding practice factors and the development of OC on farms. All the results of the tests are shown in Appendix 5.

Feeding practice: Foal before weaning

Besides the fact that all foals, if desired, can join the mother's forage, a difference in the specific foals' feeding conditions between farms could be seen. The major one is the provision in concentrates for the foal itself (46,3 %), in comparison with no provision of concentrates for the foal itself (53,7 %). The amount of concentrates varied between 0,2 to 2 kg per day and started at 2 – 12 weeks of the foals' age. The average amount of the foal's own concrete was 0,922 kg on OC-high farms and started at an average age of 5,17 weeks old. On the OC-low farms the average amount of foal's own concretes was 1,33 kg and started at an average age of 4 weeks old. Rarely reported as being part of the foals' diet were supplements or extra products (both 4,8 %).

All these different feeding factors were tested for correlation with the OC-high of OC-low farms, but there wasn't any significant result. All the results of the tests are shown in Appendix 5.

Feeding practice: Foal after weaning till the age of one year

After weaning, the foals on mainly all farms were fed with concentrates (97,7 %) and haylage (79,1 %). Extra products (14,3 %) and supplements (20,7%) were not often reported. The amount of concentrates differed from 0,5 kg to 4 kg per foal a day. The statistics analyses showed a correlation between the amount of concretes for the foals after weaning and the division of OC-high and OC-low farms. The OC-high farms tend to feed the foal a smaller amount of concretes. Nevertheless, one must realize that the amount of concretes each foal eats is an estimation, due to the way of housing the foals after weaning. Most of the farms (59,5%) aimed the foals to be in 'thin' body condition score (be able to feel the ribs, not to see them) at the age of one year old, followed by 'fleshy' (19 %, not able to feel the ribs) and 'poor' (7,1%, be able to see the ribs). Six of the farms didn't have a clear aim for a particular body condition score of the foals/yearlings. All the other different feeding factors were tested for correlation with the OC-high of OC-low farms, but there wasn't any significant result. All the results of the tests are shown in Appendix 5.

An overview of the P-values of the feeding practice factors is shown in table 5.

Factors feeding practice		P-value
Mare, last three months of pregnancy	Concretes yes or no	0,439
	Average amount of concretes	0,358
	Extra products yes or no	0,663
	Supplement yes or no	0,764
	Kind of roughage	0,123
	Changes in diet at the start vs. end pregnancy	0,210
	Changes in diet after partus	0,300
Foal before weaning	Own concretes yes or no	0,453
	Average amount of own concretes	0,209
	Extra products yes or no	0,157
	Supplements yes or no	0,890
Foal after weaning	Concretes yes or no	0,278
	Average amount of concretes	**0,036**
	Extra products yes or no	0,449
	Supplements yes or no	0,541
	Kind of roughage	0,541

Table 5. Overview p-values factors feeding practice

Discussion

The aim of this study was to determine the prevalence of OC of a veterinary based Warmblood horse population and to search for influencing factors from feeding practice.

Prevalence & general factors

As discussed before, we assume that OC does not develop after the horse is 12 months old, (Dik, Enzerink et al. 1999) so horses younger than 12 months of age were not included in this study. Therefore, we didn't see (and expect) any significant correlation between the age of the horse and the prevalence of OC. There were no clues that the year of birth of the horses could make a difference in the prevalence of OC. There is no consensus in the literature if either males or females are more likely to develop OC. This study didn't show a significant correlation of OC between male and female horses, although the percentage of OC-positive males (in proportion with the number of males) is higher compared to females in all three databases. Some studies didn´t find any difference between the sexes of warmblood horses (van Weeren, Sloet van Oldruitenborgh-Ooste et al. 1999), others have proven that males are more often affected. (Stromberg, Rejno 1978, Sandgren, Dalin et al. 1993). Recent study (Wittwer, Hamann et al. 2006) on South German Coldblood horses shows a twofold higher risk for female horses to develop OC in the metacarpophalangeal, metatarsophalangeal and tarsocrural joints.

As for the number of views per horse, a higher number of views didn't show a higher prevalence of OC. In fact, a higher percentage of horses with OC was found in horses in which fewer x-ray views were taken, but is it a reverse result. This can be explained with knowledge of the equine clinic, where often if OC is discovered early in the examination, a further procedure is cancelled to reduce the costs for the owner. In addition, two of the three databases show a significant correlation between the different veterinarians and the occurrence of OC. This is a result of the subjective interpretation in scoring for OC, despite the prescriptive protocol which all veterinarians used. This method is similar as used in the large Breeding, Osteochondral Status and Athletic Career (BOSAC)

project in France, which also used a panel of three experienced veterinarians.(Lepeule, Robert et al. 2013) To correct for this unwanted correlation, all the views of the horses in this study will be examined once again by an independent acknowledged equine radiologist, as is the practice in other large studies (Van Grevenhof, Ducro et al. 2009, Dik, Enzerink et al. 1999).

It is difficult to compare the results of prevalence of OC of this study to other studies, because the study samples vary greatly. To our knowledge, a similar, retrospective, veterinary field design of this study, to determine the prevalence of OC in a population of horses, has been published several times before. This gives a reliable chance of comparison. A large retrospective Dutch study, (Vos 2008), including 1231 Dutch Warmblood horses using the database of an private equine hospital, showed a prevalence of OC(D) of 44.3% at pre-purchase examinations, with the tarsocrural joint most affected (16% of all horses). This prevalence is a lot higher than the prevalence found in this study, even though the same protocol of radiographical examination was used. Another similar study (Jonsson, Dalin et al. 2011)was performed in Sweden, with 879 Swedisch Warmblood horses. An overall prevalence of OC of 13 % was found, with the femoropatellar joint most affected (9% of all horses).

As for the breed of horses in this study, the main part of the horses belonged to the Royal Dutch Sporthorse (82.6 – 85% in the three databases). This large main group of horses led to a non-significant difference in the prevalence of OC between the breeds, particularly when knowing that the other breeds are also warmblood horses. Several other studies discovered differences between breeds, like Lepeule (Lepeule, Bareille et al. 2008) who reported a prevalence of osteochondral fragmentations of 61% in warmblood horses compared to 41% in Standardbred horses and 32% in Thoroughbred horses. However, all horses in this study were examined at the age of 6 months. This is the reason why only warmblood horses were selected for this study, and trotters were excluded. Trotters seem to have a prevalence of OC of 31,5% (Alvarado, Marcoux et al. 1990). The prevalence of OC of 20-25 % is reported in several studies before. (Dik, Enzerink et al. 1999, Carlsten, Sandgren et al. 1993, Arnan, Hertsch 2005)

A much higher prevalence of 67,5 % in a warmblood horse population was found by van Grevenhof (Van Grevenhof, Ducro et al. 2009), possible as a result of larger number of predilection sites of OC scored. Also an unselected population of warmblood horses was used, in contrary to this present study. This emphasizes a certain limitation of our study sample; the horses selected for this study were preselected by the owners. Moreover, only a part of the participating farms (16/66) declines to have all the horses on their farms radiographical examinated. The other farms make a selection, according to several different reasons, due to the individual purpose of the horses (sport, recreation or breeding practices). The horses that didn't fulfill the owner's expectations (too small, lame or other health issues) could have been removed from the farm earlier, and therefore could have reduced the prevalence of OC. Another issue in the different studies is the number of views and gradation of OC, not all studies used the same scoring protocol (Sloet van Oldruitenborgh-Oosterbaan, Barneveld et al. 2007). Some studies only report the prevalence of OCD or include other developmental orthopedic disorders. (Robert, Valette et al. 2013). Also the age of the examinated horses could differ between studies and therefore make it harder to make a proper estimation of the prevalence of the dynamic process of OC, like an age of 6 months. (Lepeule, Bareille et al. 2009)

The tarsocrural joint is the most affected joint with OC in our study (11,2 – 14,0%), which is in accordance to other studies. (Jacquet, Robert et al. 2013) In some other studies however, the femoropatellar joint is also incidentally mentioned as most affected joint.(Stock, Hamann et al. 2006). Unfortunately, because of the fact that the exact locations of OC lesions were not reported on the examinations of the horses in our study, we couldn't define the prevalence of the particular

predilection locations of OC, like in other studies. (Dik, Enzerink et al. 1999, Van Grevenhof, Ducro et al. 2009)

Feeding conditions and the correlation with the OC-status of a farm

As reported in the results of this study, the management and environmental factors about the feeding conditions of the farms show great similarity. The questions were pointing at the year 2012, assuming that the farms keep a constant management throughout the years. If there were made any noteworthy changes in the management, the farms could report it on the survey. Unfortunately, the quantity of the provided concentrates is a subjective issue, and very difficult to define by an owner, so the results about amounts of concretes must be seen as a rough estimate. Because of the same reason, the amount of roughage was not questioned in the questionnaire. An attempt was made to evaluate the variation of the type of concretes (ingredients) between the farms, but the answers were fulfilled too inconsequently to make any reliable conclusions. So unfortunately, no conclusions about specific minerals, like Cu, could be made.

A study in Belgium (Vander Heyden, Lejeune et al. 2013), including 223 warmblood horses aged 21,06 months (+/- 5 months) also conducted a retrospective questionnaire at the owners of the horses about the feeding conditions in the three different periods of the mare and foal, so this study can be compared to the present study. In France also a similar study (Lepeule, Bareille et al. 2013) was performed to determine the potential association of growth and feeding practices with the severity of OC in 378 French foals (41.1 % French Trotter, 33.9 % Thoroughbred and 25 % Selle Francais). This project had a prospective study sample so the nutritional intake of the different mares and foals could be taken into account more specifically, like the calcium/phosphor and zinc/copper levels of the concentrates.

Feeding practice: Pregnant mare during last three months of pregnancy

Although it is difficult to prove in large scale field studies, the nutritional intake of the mare and intrauterine transmission of nutritionals seems to play an important role in the development of the fetus in many ways. Research shows that the energy metabolism and endocrine regulation of the foal in the first weeks postpartum can be influenced by the diet of the mare in late gestation. (Etherton, Kensinger 1984, Forhead, Ousey et al. 2004) The results of our study neither showed great variation in the feeding practice managements of the different farms, nor any significant correlation of the feeding practice factors of the pregnant mares and the prevalence of OC on the farm, in contrary to the study in Belgium. They reported a higher prevalence of OC at the mares fed with concentrates, with or without roughage, in comparison with mares fed with roughage alone. The lack of correlation in our result can be explained by the fact that only three of the 44 farms reported to feed the mares nothing but roughage, no concentrates, so a correlation is not likely to occur. The nutritional requirements of the mare changes in times of pregnancy or lactation. The proper nutritional requirement of a mare (pregnant or lactating) is composed by the Dutch Product Board Animal Feed (PDV). (Productschap Diervoeder., 2013) The PDV invests in knowledge in the area of optimal nutrition of farm animals (see table 6). The body condition score of the mare should be an indicator for the amount of food at all times, but the diet prescriptions from the PDV could serve as a basic guideline. The study in France didn't prove a significant correlation between the different amounts of copper, zinc, calcium and phosphor in the diet of the mare the last three months of pregnancy.

Example diet mare; normal vs pregnant vs lactating

It is difficult to create an adequate example of a diet for the mare (pregnant or lactating), because there are numerous different type of concretes and roughage and its quality varies widely. Furthermore, the nutritional requirement also depends on the body condition score, level of exercise, health status and age of the mare. The concretes brand 'Subli Mare' is common used among the participants of the questionnaire, so this will be used in the example. If we look (only) at the netto energy(EWpa) and copper requirement of the mare (600kg, 8 years old, healthy, no exercise), 1,5 kg of Subli Mare a day in combination with 8,1 kg grass silage (middle) a day, should be an adequate diet. In the last month of pregnancy, the amount of concretes should increase up to 3 kg a day, in combination with 7,8 kg grass silage (middle). In the second month of lactation, mare and foal are housed in the pasture; the mare needs 3 kg of concretes in addition of the grass on the pasture.(Productschap Diervoeder., 2013, Subli Paardenvoeders 2014).
Of course there is a great range of variations for a proper diet, as long as there is knowledge about the quality of the products. Therefore it is important for the farms to check the nutritional values of their concretes and a sample of the current roughage could be send to a laboratory to be analyzed.

Warmblood mare (600kg BW)																		
	Energy[1] EWpa	Protein[2] VREp	Ca [3]	Ph[3]	Mg[3]	Pt[3]	S[3]	Cl[3]	Fe[4]	Cu[4]	Zn[4]	Mn[4]	Co[4]	Se[4]	I[4]	Vit A[5]	Vit D [5]	Vit E [5]
Normal situation	*4.98*	*365*	*31*	*22*	*12*	*39*	*16*	*62*	*624*	*0.6*	*624*	*624*	*0.6*	*1.8*	*3.0*	*18000*	*3960*	*600*
Pregnancy month																		
8	*5.29*	*420*	*40,3*	*29.1*	*12.2*	*39.8*	*16.7*	*62.4*	*624*	*0.6*	*624*	*624*	*0.6*	*1.8*	*3.0*	*18000*	*3960*	*600*
9	*5.59*	*460*	*47.8*	*34.8*	*12.4*	*40.5*	*17.3*	*62.8*	*780*	*60.6*	*624*	*624*	*0.6*	*1.8*	*3.0*	*36000*	*3960*	*600*
10	*5.81*	*515*	*52.5*	*38.4*	*12.6*	*40.9*	*17.7*	*63*	*780*	*60.6*	*624*	*624*	*0.6*	*1.8*	*3.0*	*36000*	*3960*	*600*
11	*6.16*	*595*	*59*	*43.3*	*12.7*	*41.5*	*18.2*	*63.3*	*780*	*60.6*	*624*	*624*	*0.6*	*1.8*	*3.0*	*36000*	*3960*	*600*
Lactation month																		
1	*10.04*	*1115*	*78*	*63*	*16.4*	*56*	*44*	*68.8*	*978*	*36.6*	*780*	*780*	*1.2*	*1.8*	*4.2*	*18000*	*3960*	*12000*
2+3	*10.25*	*1155*	*78*	*62*	*15.5*	*54*	*20.9*	*69*	*978*	*36.6*	*780*	*780*	*1.2*	*1.8*	*4.2*	*18000*	*3960*	*12000*
4+5	*9.16*	*965*	*62*	*50*	*14.4*	*48.8*	*19.3*	*67.9*	*978*	*36.6*	*780*	*780*	*1.2*	*1.8*	*4.2*	*18000*	*3960*	*12000*
Warmblood foal (expected adult weight 600kg)																		
Age in months																		
3	*3.54*	*625*	*57*	*41*	*4.9*	*14*	*6.5*	*19*	*264*	*48*	*212*	*212*	*0.3*	*0.5*	*1.1*	*7325*	*3250*	*325*
6	*4.25*	*580*	*52*	*37*	*6.2*	*19*	*8.3*	*27*	*402*	*72*	*322*	*322*	*0.4*	*0.8*	*1.6*	*11150*	*4950*	*500*
12	*4.79*	*470*	*43*	*30*	*8.0*	*26*	*11*	*40*	*605*	*109*	*484*	*484*	*0.6*	*1.2*	*2.4*	*16750*	*7450*	*750*

Table 6. Nutritional requirements mare and foal in different situations (Productschap Diervoeder., 2013)

[1] The energy is denominated as EWpa; in netto energy; MJ/kg dry matter
[2] The protein is denominated as VREp: digestible crude protein DCP; g/kg dry matter
[3] Grams a day
[4] Milligrams a day
[5] International Units a day

Feeding practice: Foal before weaning

A shortage of minerals (like Cu or Mg) or vitamins could disturb the early cartilage synthesis in the foals' joints. (Jeffcott, Henson 1998). On the other hand, an overdose of, for example, carbohydrates could induce the growth rate of fetus and produce a large foal.(Thompson, Jackson et al. 1988, Savage, McCarthy et al. 1993). In this stage of life, the foal is mainly dependent of its mothers' milk and will slowly begin to eat concretes and roughage on its own. The lactation requires a lot of energy

and nutrition of the mare, so a proper diet is necessary for mare and foal.(Productschap Diervoeder., 2013) Almost half of the farms (18/41) provides the mare the same diet after giving birth, instead of changing the diet to the changed nutritional requirement of the mare. Nevertheless, our results didn't show any significant correlation of the feeding practice factors of the mare and foal after weaning to the prevalence of OC, which is in concordance with the study in Belgium.

Feeding practice: Foal after weaning till the age of one year

Knowing the dynamic process of OC, the disturbance in articular cartilage could still occur after weaning. (Dik, Enzerink et al. 1999). Only the average amount of concentrates of a foal seems to correlate to the prevalence of OC. The OC-low farms report to give their foals more concentrates, compared to OC-high farms. This seems to be in contradiction with the knowledge of high energy concentrates, fast growth rate and high weight and the induction of OC(van Grevenhof, Ott et al. 2011, Sandgren, Dalin et al. 1993). However, as mentioned before, the amounts of concentrates are an rough estimation and the averages differ only slightly, 1,67 kg vs 2,23 kg. Due to housing conditions of many foals after weaning, kept in groups in the field or large stables, it is merely impossible to define the exact concentrates intake of each individual foal.

The lack of proven correlation in our study could be the result of the little variation in feeding practice factors between the farms and the small number of farms (45). Further future research should include more farms and horses to create a bigger population, including a specific feeding logbook for the farms to keep track of the feeding practice over several years, or more sophisticated statistic analyzing methods. The foals from the farm should be examined and scored for OC by one and the same radiologist and be measured for factors that are involved in the growth rate of a foal (like girth circumstance or body weight). As for the feeding practice factors, the specific amount and type of nutrition for the mare or foal should be reported every day in a logbook for a long as the study takes. In that way, a more reliable conclusion about the effect of feeding practice on the prevalence of OC could be made.

Conclusion

This study does show the influence and importance of different nutritional elements on the cartilage of the horse, and therefore emphasizes the need of a proper diet, adjusted to the requirements of mare and foal to reduce the occurrence of OC as much as possible. The retrospective and subjective way of collection the information about the feeding practice factors of this study makes it difficult to make any reliable conclusions, although it does point in a certain direction. As well as the feeding practice, the other possible influencing factors (genetics, exercise and trauma) of the development of OC should be kept in mind as well. The approach by using existing routine database of an equine practice could be replicated with the cooperation of other practices. In this manner, the knowledge about OC prevalence in the Netherlands could be enlarged, without the process and costs of making and collecting new radiological examinations. More statistical analyses are necessary to make reliable conclusions about the feeding practices and the correlation to the development of OC.

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Appendix 1. Overview databases

Horse & farm	Database General Practice	Database Invited Farms	Database Participating Farms
Total horse	828	925	626
Total farms	350	66	45
MNHF*	2,4	14	14
Range	1 - 37	5 - 63	5 - 63
Median	21	22	22

*MNHF = mean number of horses per farm

Sex	%	N	%	N	N	%
Male	48,3	400	59,9	554	56,9	356
Female	51,6	427	40,1	371	43,1	270
Unknown	0,1	1	-	1	-	-

Year of birth	%	N	%	N	%	N
2008	12,1	100	32,3	299	34,2	214
2009	30,3	251	33,3	308	32,4	203
2010	40,2	333	23,7	219	23,2	145
2011	17,1	142	10,2	94	9,6	60
2012	0,2	2	0,3	3	0,3	2
Unknown	-	-	0,2	2	0,3	2

Breed

Total different breeds	20		14		11	
	%	N	%	N	%	N
KWPN*	82,6	684	85,0	786	84,0	526
Zangersheide	4,0	33	4,6	43	5,3	33
Oldenburger	2,5	21	2,3	21	1,6	10
BWP**	1,3	11	1,6	15	2,6	15
Rheinlander	1,2	10	1,5	14	2,2	14
Holsteiner	0,8	7	1,2	11	1,8	11
Hanoverian	1,0	8	1,0	9	0,2	1
Westfalen	0,4	3	0,6	6	0,3	2
Trakehner	1,6	13	0,6	6	-	-
NRPS***	1,0	8	0,5	5	0,3	2
FW****	0,3	3	0,1	1	0,2	1
Fjord	0,1	1	-	-	-	-
Arabofriesian	0,1	1	-	-	-	-
Friesian	1,0	8	-	-	-	-
ANCCE*****	0,2	2	-	-	-	-
Paint horse	0,1	1	-	-	-	-
Quarter horse	0,6	5	-	-	-	-
Welsh	0,2	2	-	-	-	-
Irish	0,1	1	-	-	-	-
Luxemborger	-	-	0,1	1	0,2	1

GRH******	-	-	0,1	1	-	-
Unknown	0,6	5	0,6	6	-	-

*KWPN = Royal Dutch Sporthorse, BWP = Belgium Warmblood Horse, NRPS = Dutch Riding Horse, FW = French Warmblood, ANCCE = Asociación Nacional de Criadores de Caballos de Pura Raza Española, GRH = German Riding Horse.

Years from birth to examination

Mean age	2 years and 8 months	2 years and 3 months	2 years and 4 months
Range	1-5 years	1-5 years	1-5 years
Sd.	0,8 year	0,7 year	0,8 year

Age in years at time of examination

	%	N	%	N	%	N
1	2,8	23	7,2	67	8,3	52
2	45,0	373	65,0	601	61,2	383
3	36,6	303	22,6	209	23,6	148
4	13,8	114	4,0	37	5,3	33
5	1,8	15	1,0	9	1,3	8
Unknown	-	-	0,2	2	0,3	2

Number of views per horse

Mean	20,6 views	20,6 views	20,4 views
Range	2 - 40	2 - 48	2 - 48

Number of examinations by veterinarian

Total	828		925		626	
	%	N	%	N	%	N
Vet 1	33,6	278	53,2	492	52,5	327
Vet 2	50,5	418	21,4	198	24,0	150
Vet 3	15,9	132	22,6	209	20,0	125
Vet 4	-	-	1,4	13	1,9	12
Vet 5	-	-	1,4	13	1,9	12

Appendix 2; Introduction letter

Afzender:
Drs. A.A.J. Geerts
eDigit Mobiel Paardenonderzoek
Steenovenstraat 23
4760 RA Roosendaal

www.edigit.nl
06-53457452
076-5031377

Roosendaal, 20 augustus 2013

Betreft: verzoek om deelname aan een praktijkonderzoek naar de omgevingsfactoren van osteochondrose (OC).

Geachte heer/mevrouw,

Osteochondrose is een gewrichtsaandoening die al vroeg in het leven van een paard ontstaat. Zoals u waarschijnlijk ook bekend is, zorgt osteochondrose (OC) in de knie, sprong of kogel ieder jaar weer voor uitval van verwachtingsvolle, kostbare paarden.

Er is de laatste jaren veel wetenschappelijk onderzoek gedaan naar deze aandoening. Zo is bekend dat er meerdere factoren betrokken zijn bij de ontwikkeling van OC. De genetische component wordt door uw selectie en via het stamboek teruggedrongen.

De omgevingsfactoren die een rol spelen in de ontwikkeling zijn wetenschappelijk gezien nog niet volledig bekend. Daarvoor is er informatie uit de praktijk nodig, dat wil zeggen ook van u !

Met onze mobiele paardenpraktijk eDigit willen we, in samenwerking met de faculteit Diergeneeskunde te Utrecht en de Wageningen Universiteit, de omgevingsfactoren voor OC op onze paardenbedrijven in kaart gaan brengen. Het doel van deze studie is om met behulp van praktijkgegevens de omgevingsfactoren die een rol spelen bij de ontwikkeling van OC te identificeren om zo het aantal gevallen van OC mogelijk nog verder terug te dringen.

Voor deze studie wordt de hulp gevraagd van paardenbedrijven waar meerdere paarden

geröntgend zijn. Met behulp van de bedrijfsgegevens en de uitslagen van de röntgenfoto's zal getracht worden relaties te leggen met factoren die mogelijk van invloed zijn geweest op de ontwikkeling van OC. De bedrijfsgegevens zullen door middel van een enquête, uitgevoerd door studenten van de Universiteit Utrecht (UU) en de Wageningen Universiteit (WUR), worden verkregen en anoniem verwerkt worden. Diverse onderwerpen zullen aan bod komen zoals voeding, weidegang, type stalling enz. op het bedrijf, van invloed op de opfok van geboorte tot het eerste levensjaar.

De deelnemende bedrijven worden aan het einde van het onderzoek uitgenodigd voor een presentatie die op het Departement Paard van de UU in Utrecht zal worden gehouden en waarin de onderzoeksresultaten (anoniem) zullen worden gepresenteerd.

Tevens kan eDigit aan de hand van de resultaten van dit onderzoek als gratis service de deelnemende bedrijven daarna een persoonlijk advies op maat geven, uiteraard op uw verzoek en afspraak.

Wij hopen uiteraard dat u wilt meewerken aan dit onderzoek. Zou u dan de bijgevoegde enquête in willen vullen en willen retourneren in de bijgevoegde retourenveloppe **vóór zaterdag 31 augustus a.s.** Ontvangt u de enquête liever digitaal, dan verzoeken wij u even een email te sturen naar **alfons@edigit.nl**.

Bij vragen kunt u ten alle tijden telefonisch contact met ons opnemen via **076-5031377** of via email reageren (**alfons@edigit.nl)**. Uiteraard zorgen wij ervoor dat de medische gegevens van uw paarden niet openbaar worden gemaakt.

Bij voorbaat vriendelijk bedankt voor uw medewerking,

Drs. Alfons Geerts , mede namens
Anouk van Vilsteren (WUR)
Joëlle Versteeg (UU)
Chris Blok (UU)
Dr. Ilse van Grevenhof (WUR)
Dr. Wim Back (UU)

Universiteit Utrecht

WAGENINGEN UR
For quality of life

Appendix 3; Questionnaire environmental factors

Enquête:

De rol van omgevingsfactoren in de ontwikkeling van osteochondrose in warmbloedveulen in 2012

Geachte heer/mevrouw,

Hartelijk dank dat u mee wilt werken met ons onderzoek!

Deze enquête bestaat globaal uit drie onderdelen: huisvesting, voeding en management factoren.
Er wordt soms onderscheid gemaakt in verschillende perioden van merrie & veulen, zoals voor en na het spenen, of: alleen voeding van de merrie.
Wij vragen u om bij het invullen van deze enquête aan het jaar 2012 te denken.

Mocht er iets niet duidelijk zijn, neem dan contact op met Alfons Geerts.

U gegevens zullen zorgvuldig en anoniem worden verwerkt.

Met vriendelijke groet,

Drs. Alfons Geerts
Anouk van Vilsteren (WUR)
Joëlle Versteeg (UU)
Chris Blok (UU)
Dr. Ilse van Grevenhof (WUR)
Dr. Wim Back (UU)

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I Algemeen

1. **Wat is uw naam en de naam van uw bedrijf?**

   ……..

2. **Hoeveel veulens zijn er geboren in de onderstaande jaren op uw bedrijf en hoeveel veulens heeft u tot 1-jarige leeftijd op uw bedrijf gehad?**

Jaartal	Aantal veulens geboren op uw bedrijf	Aantal veulens tot 1-jarige leeftijd op uw bedrijf
2012		
2011		
2010		
2009		
2008		

3. **Wat is de reden dat u in 2012 een röntgenologisch onderzoek heeft laten doen?**
   Meerdere antwoorden mogelijk

Reden voor aanbieden van een door u (op)gefokt paard voor röntgenologisch onderzoek in <u>2012</u> Indien u geen veulens had in 2012 vul dat de aantallen in van het meest recente jaar.	**Aantal paarden aangeboden voor röntgenologisch onderzoek in <u>2012</u> met deze reden** Indien u geen veulens had in 2012 vul dat de aantallen in van het meest recente jaar.
Standaard screening	
PROK	
Stamboekkeuring	
Verkoopkeuring	
Gezondheidsproblemen/kreupelheid	
Anders (toelichting graag hieronder)	

4. **Toelichting op vraag 3:**
   Anders namelijk……

5. **Wat is de reden dat u geen röntgenologisch onderzoek laat doen?**
   Meerdere antwoorden mogelijk

Reden voor het <u>niet</u> aanbieden van een door u (op)gefokt paard voor röntgenologisch onderzoek in 2012	**<u>Aantal</u> paarden die om deze reden niet zijn aangeboden voor röntgenologisch onderzoek in 2012**
Gezondheidsproblemen/Kreupelheid	
Overige redenen waardoor een veulen niet geschikt is voor de sport of fokkerij	
Hoge kosten	
Anders (toelichting graag hieronder)	

6. **Toevoeging op vraag 5:**
   - Niet van toepassing, van alle veulens wordt een röntgenologisch onderzoek gedaan
   - Anders namelijk……..

II Huisvesting Veulen 2012

Periode: Geboorte tot het spenen

7. Hoe zag de huisvesting van de veulens met merries er globaal uit in 2012?
Periode geboorte tot het spenen

- ○ Dag en nacht buiten → Ga door naar vraag 11
- ○ Dag & nacht binnen
- ○ Combinatie van binnen en buiten

8. Hoe groot zijn de stallen van de veulens met merries (in m²)?
Periode geboorte tot het spenen

Grootte van de stal	Aantal stallen met deze grootte
<10 m²	
10 - 12 m²	
13 - 15 m²	
16 - 18 m²	
19 – 21 m²	
> 22 m²	

9. Welke ondergrond hebben deze boxen en welke bodembedekking gebruikt u in deze boxen? Meerdere antwoorden mogelijk
Periode geboorte tot het spenen

	Bodem	Bodembedekking	Geen van beide
Beton	○	○	○
Rubberen matten	○	○	○
Zand	○	○	○
Stro	○	○	○
Vlas/zaagsel	○	○	○
Anders, toelichting graag hieronder	○	○	○

10. Toelichting op vraag 9:

- ○ Toelichting anders namelijk:……

11. Hoe groot is het weiland waarin de merrie en veulen staan?
Periode geboorte tot het spenen

Grootte van het perceel (ha)	Aantal percelen van deze grootte	Maximaal aantal merrie-veulen combinaties op één perceel

12. **Groepssamenstelling: Staan er nog paarden van andere leeftijdscategorieën in dezelfde weide bij de merries met veulens?** Meerdere antwoorden mogelijk.
    Periode geboorte tot het spenen
    - 1 –en 2 jarige
    - volwassen paarden (exclusief andere veulens met merries)
    - anders namelijk: ……

13. **Vanaf welke leeftijd komt veulen (met merrie) voor het eerst de stal uit?**
    Periode geboorte tot het spenen
    - 0 – 7 dagen leeftijd
    - 8 – 14 dagen leeftijd
    - 15 – 21 dagen leeftijd
    - > 22 dagen leeftijd
    - Anders namelijk:…….

14. **Krijgen de veulens met merries nog andere vormen van beweging, buiten de weidegang om?**
    Periode geboorte tot het spenen
    Denk aan stappen aan de hand, paddock etc.
    - Ja
    - Nee → ga door naar vraag 17

15. Op welke manieren krijgen de veulens met merries beweging, buiten de weidegang om?
Periode geboorte tot het spenen

Bewegingsvorm	**Gemiddeld aantal uren per week**
Paddock alleen	
Paddock met andere paarden	
Stappen aan de hand	
Anders (graag hieronder toelichten)	

16. Toelichting op vraag 15

- Anders namelijk……

Periode: na het spenen tot een jaar

Huisvesting Stal

17. Hoe ziet de huisvesting van de veulens er globaal uit na het spenen?
Periode na het spenen tot een jaar

- Dag en nacht buiten → Ga door naar vraag 22
- Dag & nacht binnen → sla vraag 22 t/m 28 over
- Combinatie van binnen en buiten

18. Hoe groot zijn de stallen van de gespeende veulens (in m²) ?
Periode na het spenen tot een jaar

Grootte van de stal (m²)	**Aantal stallen met deze grootte**	**Maximaal aantal gespeende veulens per stal**

19. Welke ondergrond hebben deze boxen en welke bodembedekking gebruikt u in deze boxen? Meerdere antwoorden mogelijk

Periode na het spenen tot een jaar

	Bodem	**Bodembedekking**	**Geen van beide**
Beton	○	○	○
Rubberen matten	○	○	○
Zand	○	○	○
Stro	○	○	○
Vlas/zaagsel	○	○	○
Anders, toelichting graag hieronder	○	○	○

20. Toelichting op vraag 19:

- Anders namelijk:……

21. Vindt er verandering plaats in de groepssamenstelling in één stal met gespeende veulens?

Periode na het spenen tot een jaar

- Nee, het is een constante groep:
  Er komen geen nieuwe dieren bij en er gaan geen dieren uit de groep
- Ja, het is een wisselende groep:
  Er worden wel dieren uit de groep gehaald en/of er komen nieuwe dieren bij
- Niet van toepassing, de gespeende veulens staan niet in groepen op stal
- Anders namelijk:……

22. Hoe groot is het perceel waarop gespeende veulens staan?

Periode na het spenen tot een jaar

Grootte van het perceel (ha)	Aantal percelen van deze grootte	Maximaal aantal gespeende veulens op één perceel

23. Wat is de leeftijdssamenstelling in de groep waarin de gespeende veulens staan?

Periode na het spenen tot een jaar

- o Alleen leeftijdsgenoten in één groep
- o Paarden van verschillende leeftijden in één groep
- o Anders namelijk……

24. Worden de groepen waarin (ook) gespeende veulens staan ingedeeld op geslacht?

Periode na het spenen tot een jaar

- o Nee (mannelijke en vrouwelijke dieren bij elkaar)
- o Ja (mannelijke en vrouwelijk dieren gescheiden)
- o Anders namelijk:……..

25. Vindt er verandering plaats in de groepssamenstelling op de percelen waarop (ook) gespeende veulens staan?

Periode na het spenen tot een jaar

- o Nee, het is een constante groep:
  Er komen <u>geen</u> nieuwe dieren bij en er gaan <u>geen</u> dieren uit de groep
- o Ja, het is een wisselende groep:
  Er worden <u>wel</u> dieren uit de groep gehaald en/of er komen nieuwe dieren bij
- o Anders namelijk……

26. Krijgen de gespeende veulens nog andere vormen van beweging, buiten de weidegang om?

Periode na het spenen tot een jaar

- o Ja
- o Nee → ga door naar vraag 29

27. Op welke manieren krijgen de gespeende veulens beweging gedurende hun eerste levensjaar, buiten de eventuele weidegang om?

Periode na het spenen tot een jaar

Bewegingsvorm	**Gemiddeld aantal uren per week**
Longeren	
Stapmolen	
Paddock alleen	
Paddock met andere paarden	
Stappen aan de hand	
Anders (graag hieronder toelichten)	

28. Toelichting op vraag 26:

Anders namelijk:……..

III Voeding 2012

Drachtige merrie

29. Voert u de (drachtige) merries dagelijks brok in de laatste drie maanden van de dracht?

- Ja
- Nee **(ga naar vraag 31)**

30. Wat voor brok krijgen de (drachtige) merries dagelijks in de laatste drie maanden van de dracht?

Noem naam fabrikant en type voer, bijv: Havens sportbrok of Subli merriebrok, enz...

.....

31. Hoeveel brok krijgen de (drachtige) merries dagelijks in de laatste drie maanden van de dracht?

Per merrie in totaal per dag.....Kg

32. Krijgen de (drachtige) merries dagelijks losse producten, zoals gerst, maïs, muesli enz, in de laatste drie maanden van de dracht?

Bijv. naast de brok een schep muesli of geen brok maar alleen losse producten.

- Ja
- Nee **(ga naar vraag 33)**

33. Wat voor losse producten krijgen de (drachtige) merrie dagelijks in de laatste drie maanden van de dracht?

Meerdere antwoorden mogelijk

- Muesli
- Maïs
- Gerst
- Zemelen
- Lijnzaad
- Slobber
- Haver
- Bietenpulp
- Wortelen
- Luzerne
- Anders, namelijk:.....

34. Krijgen de (drachtige) merries extra supplementen, zoals vitamines/mineralenpoeders, in de laatste drie maanden van de dracht?

- Ja
- Nee **(ga naar vraag 35)**

35. Welke supplement(en) krijgen de (drachtige) merries in de laatste drie maanden van de dracht? Hoeveelheid in grammen per supplement per dag.
Noem fabrikant en type supplement en hoeveelheid, bijv. Boehringer Ingelheim - Equitop Forte - 100 gram per dag

.....gram per dag

.....gram per dag

.....gram per dag

36. Krijgen de (drachtige) merries ruwvoer in de laatste drie maanden van de dracht?
Het gras van eventuele weidegang niet meegerekend

- Nee
- Ja, hooi
- Ja, voordroog kuil
- Ja, kuil

37. U heeft zojuist de voeding van de merrie in de laatste drie maanden van de dracht omschreven. Is dit voedingsschema aan het begin van de dracht anders?
Denk aan de hoeveelheid/soort brok, losse producten, supplementen en/of ruwvoer..

- Nee, het voedingsschema blijft de gehele dracht gelijk

- Ja, namelijk .....

  .....

Voeding merrie met zogend veulen

38. Verandert er iets aan de voeding van de merries als het veulen eenmaal geboren is?
Denk aan de hoeveelheid/soort brok, losse producten, supplementen en/of ruwvoer..

- Nee, de voeding blijft precies zoals zojuist beschreven. **(ga naar vraag 38)**
- Ja, er verandert iets aan de voeding van de merrie

39. Wat verandert er aan de voeding van de merries als het veulen eenmaal geboren is?
Denk aan de hoeveelheid/soort brok, losse producten, supplementen en/of ruwvoer..

.....

.....

Voeding veulen tot het spenen (zoogperiode)

40. Krijgen de veulens tijdens de zoogperiode al hun eigen brok?
Dat wil zeggen: in een speciaal veulenbakje waar de merrie niet bij kan.

- o Ja, de veulens krijgen hun eigen brok.
- o Nee **(ga naar vraag 41)**

41. Wat voor eigen brok krijgen de veulens tijdens de zoogperiode?
Noem naam fabrikant en type brok, bijv. Havens Opti Grow

.....

42. Hoeveel eigen brok krijgen de veulens tijdens de zoogperiode?

Per veulen in totaal per dag.....Kg

43. Krijgen de veulens tijdens de zoogperiode al hun eigen portie losse producten?
Dat wil zeggen: in een speciaal veulenbakje waar de merrie niet bij kan

- o Nee **(ga naar vraag 43)**
- o Ja

44. Wat voor eigen portie losse producten krijgen de veulens dagelijks tijdens de zoogperiode?
Meerdere antwoorden mogelijk

- o Muesli
- o Maïs
- o Gerst
- o Zemelen
- o Lijnzaad
- o Slobber
- o Haver
- o Bietenpulp
- o Wortelen
- o Luzerne
- o Anders, namelijk:.....

45. Krijgen de veulens tijdens de zoogperiode hun eigen supplementen, zoals vitamines/mineralenpoeders?
Dat wil zeggen: in een speciaal veulenbakje waar de merrie niet bij kan

- o Nee **(Ga verder naar vraag 45)**
- o Ja

46. **Welke supplementen krijgen de veulens tijdens de zoogperiode? Hoeveelheid in grammen per supplement per dag**
Noem naam fabrikant en type supplement, bijv. Subli – Magnesium Mix

.....gram per dag

.....gram per dag

.....gram per dag

47. **Vanaf welke leeftijd (in weken) worden de veulens bijgevoerd tijdens de zoogperiode?**
Indiende veulens tijdens de zoogperiode niet bijgevoerd worden, sla deze vraag dan over.

Soort voeding/supplementen	**Leeftijd in weken**
Brok:	
Producten zoals maïs, gerst, enz:	
Supplementen met vitamines/mineralen:	

Voeding veulen na het spenen tot 1 jaar

48. **Krijgen de gespeende veulens dagelijks brok?**
    - Ja
    - Nee **(ga naar 49)**

49. **Wat voor brok krijgen de gespeende veulens dagelijks?**
Noem fabrikant en type voer, bijv: Arie Blok Veulenopfok, Van Gorp Veulenkorrels Start enz...
.....

50. **Hoeveel brok krijgen de gespeende veulens dagelijks?**
Per veulen in totaal per dag.....Kg

51. **Krijgen de gespeende veulens dagelijks losse producten, zoals gerst, maïs, muesli enz?**
    - Ja
    - Nee **(ga naar vraag 51)**

52. Wat voor losse producten krijgen de gespeende veulens dagelijks?
Meerdere antwoorden mogelijk

- Muesli
- Maïs
- Gerst
- Zemelen
- Lijnzaad
- Slobber
- Haver
- Bietenpulp
- Wortelen
- Luzerne
- Anders, namelijk:.....

53. Krijgen de gespeende veulens dagelijks extra supplementen, zoals vitamines/mineralenpoeders?

- Ja
- Nee **(ga naar vraag 53)**

54. Welke supplement(en) krijgen de gespeende veulens dagelijks? Hoeveelheid in grammen per supplement per dag.
Noem fabrikant en type supplement en hoeveelheid, bijv. Boehringer Ingelheim - Equitop Forte - 100 gram per dag

.....gram per dag

.....gram per dag

.....gram per dag

55. Krijgen de gespeende veulens dagelijks ruwvoer?
Het gras van eventuele weidegang <u>niet</u> meegerekend

- Nee
- Ja, hooi
- Ja, voordroog kuil
- Ja, kuil

IV Management factoren 2012

In het volgende (en laatste) deel van de enquête zijn de vragen niet verdeeld in verschillende categorieën, maar staat er in de vraag vermeld over welke periode het gaat.

56. Zijn de veulens gedurende het einde van de zoogperiode al bewust tijdelijk gescheiden van de merries?

- o Nee.
- o Ja, incidenteel
- o Ja, wekelijks (1x per week)
- o Ja, meerdere keren per week
- o Ja, dagelijks

57. Op welke leeftijd werden de veulens gespeend in 2012?

Speenleeftijd	**Aantal veulens gespeend op deze leeftijd in 2012**
4 – 5 maanden	
6 – 7 maanden	
8 – 9 maanden	
10 – 11 maanden	
Anders, namelijk:	

58. Hoe is het spenen uitgevoerd?

- o Gescheiden met veel contact, ze kunnen elkaar zien en horen
- o Gescheiden met weinig contact, ze kunnen elkaar nog horen (niet zien)
- o Gescheiden zonder contact, ze kunnen elkaar niet zien en horen
- o Anders, namelijk:……..

59. Wanneer krijgen de veulens voor het eerst een halster om?

- o Niet gedurende het eerste levensjaar (Ga door naar vraag 60)
- o Direct na geboorte
- o Na een week
- o Na een maand
- o Anders, namelijk: na……. aantal maanden

60. Staan de veulens tijdens het eerste jaar wel eens vastgebonden (met halster bevestigd)? Zo ja, vanaf welke leeftijd (in maanden)?

- o Nee
- o Ja, vanaf…….maanden leeftijd

61. Als de zogende veulens een dagdeel in de wei staan en een dagdeel op stal, hoe worden ze dan van de box naar de wei (en weer terug) gebracht?

Periode geboorte tot spenen

- o Niet van toepassing: veulens staan dag en nacht in de wei
- o Veulen loopt los en merrie loopt los
- o Veulen loopt los en merrie loopt aan het halster
- o Veulen loopt aan het halster en merrie loopt los
- o Veulen loopt aan het halster en merrie loopt aan het halster

62. **Hoe worden de gespeende veulens van de box naar de wei (en weer terug) gebracht?** *Periode spenen tot een jaar*
    - Niet van toepassing: veulens staan dag en nacht in de wei
    - Veulen loopt los
    - Veulen loopt aan halster

63. **Hoe was de wei voor de veulens in 2012 te typeren?**
    Aangezien de wei kan veranderen binnen het seizoen kunt u de seizoenen indelen in percentages. Bijvoorbeeld in de lente was de wei ongeveer 60% van de tijd hard en droog en 40% van de tijd modderig en nat.

	Lente Maart April Mei	**Zomer** Juni Juli Augustus	**Herfst** September Oktober November	**Winter** December Januari Februari
De veulens stonden niet buiten				
Hard en Droog				
Modderig en Nat				

64. **Worden zogende veulens vervoerd met een trailer of vrachtwagen?**
    Periode geboorte tot het spenen
    - Nee
    - Ja, incidenteel
    - Ja, wekelijks (1x per week)
    - Ja, meerdere keren per week

65. **Worden gespeende veulens vervoerd met een trailer of vrachtwagen?**
    Periode spenen tot een jaar
    - Nee
    - Ja, incidenteel
    - Ja, wekelijks (1x per week)
    - Ja, meerdere keren per week

66. **Worden de veulens alleen of samen vervoerd met een trailer of vrachtwagen?**
    - Niet van toepassing: Veulens worden niet vervoerd gedurende het eerste levensjaar
    - Altijd alleen
    - Als zogend veulen met merrie en als afgespeend veulen alleen
    - Als zogend veulen met merrie en als afgespeend veulen samen met ander paard

67. Worden de zogende veulens geleerd voetjes te geven?
Periode geboorte tot het spenen
- o Nee
- o Ja, incidenteel als de hoefsmid/dierenarts komt
- o Ja, regelmatig (om het aan te leren)
- o Anders, namelijk:……

68. Worden de veulens gedurende het eerste levensjaar bekapt?
- o Nee (Sla 68 over)
- o Soms, alleen wanneer dit nodig blijkt te zijn (Sla 68 over)
- o Ja, 1x gedurende het eerste levensjaar
- o Ja, 2x gedurende het eerste levensjaar
- o Ja, meer dan 2x gedurende het eerste levensjaar
- o Anders, namelijk:……

69. Op welke leeftijd is gemiddeld de eerste bekapping van een veulen?

……..maanden oud

70. Worden de veulens ontwormd tijdens de zoogperiode?
Periode geboorte tot het spenen
- o Nee
- o Ja, eerste ontworming tussen 10-14 dagen
- o Ja, Eerste ontworming na 6-8 weken
- o Eerste ontworming later dan 8 weken

71. Worden de gespeende veulens ontwormd?
Periode van spenen tot een jaar
- o Nee
- o Ja, op indicatie van mestonderzoek
- o Ja, elke 6 - 8 weken
- o Minder dan elke 6 - 8 weken
- o Andere frequentie, namelijk…….

72. Naar welke lichaamsconditie streeft u bij uw gespeende veulens/jaarlingen?
- o Geen streefconditie
- o Schraal, ribben zijn enigszins zichtbaar
- o Matig, ribben zijn niet zichtbaar, wel voelbaar
- o Ruim, ribben zijn niet goed voelbaar
- o Zwaar, veulen heeft veel vetreserves

73. Heeft u zelf een vermoeden welke factoren (los van de afstamming) een rol kunnen spelen bij de ontwikkeling van osteochondrose? (ook factoren die niet voorbij zijn gekomen in deze enquête)

……

……

……

74. Heeft u nog vragen/opmerkingen na het invullen van deze enquête?

……

……

……

Hartelijk dank voor uw medewerking aan het onderzoek!

Over de presentatie van de resultaten van dit onderzoek krijgt u t.z.t bericht van ons.

Gelieve deze enquête in bijgevoegde retourenveloppe terug te sturen.
Frankeren is niet nodig.

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Appendix 4. Overview results OC examination

	Database 1 General practice		Database 2 Invited Farms		Database 3 Participating Farms	
Number of horses	828		925		626	
OC positive	**%**	**N**	**%**	**N**	**%**	**N**
OC positive horses	20,7	171	27,5	254	26,7	167
*OC positive males**	50,6	86	62,2	158	60,5	101
*OC positive females**	49,4	84	37,8	96	39,5	66
Percentage OC in all males	21,5	86	28,5	158	28,4	101
Percentage OC in all females	19,6	84	25,8	96	24,4	66
Horses free of OC	79,3	657	72,5	671	73,3	459

* percentage of the OC positive horses

Which joint?	**% OC-horses**	**% total**	**N**	**% OC horses**	**% total**	**N**	**% OC horses**	**% total**	**N**
Metacarpophalangeal joint (front fetlock)	17,54	3,6231	30	20,08	5,514	51	20,95	5,591	35
Femoropatellar joint (stifle)	24,56	5,0725	42	22,04	6,054	56	20,30	5,431	34
Tarsocrural joint (hock)	54,39	11,239	93	51,18	14,054	130	51,49	13,738	86
Metatarsophalangeal joint (hind fetlock)	20,46	4,227	35	25,98	7,135	66	22,75	6,070	38
Horses with more than one joint affected	15,8		27	16,1		41	13,2		22

Only European Warmblood Horses

European Warmblood horses	798		925		626	
	%	N	%	N	%	N
OC positive horses	20,68	165	27,5	254	26,7	167

Farms

Number of farms	350		66		45	
*OC positive farms**	31,7	111	90	60	93,33	42

*Farms with more than one OC positive horse

Score OC per examinators*

Veterinarian 1	20,9	278	25,81	492	25,38	327
Veterinarian 2	19,1	418	22,22	198	20	150
Veterinarian 3	25	132	37,32	209	40	125
Veterinarian 4	-	-	7,69	13	8,33	12
Veterinarian 5	-	-	30,77	13	25	12

* Percentage of OC positive horses of the total horses examinated per veterinarian.

Breeds OC positive

	OC %	**N**	**OC %**	**N**	**OC %**	**N**
Royal Dutch sport horse	19,4	684	28,2	786	27	526

Studbook zangersheide	45,5	33	16,3	43	15,2	33
Belgium warmblood horse	18,2	11	20	15	20	15
Holsteiner Horse	14,3	7	18,2	11	18,2	11
Rheinlander	20	10	35,7	14	35,7	14
Hanoverian	0	8	0	9	0	1
Oldenburger	28,6	21	47,6	21	50	10
Dutch riding horse	0	8	0	5	0	2
Luxemborger	-	-	100	1	100	1
Westfalen	33,33	3	33,3	6	33,3	6
French warmblood (SBS, SFA)	33,33	3	0	1	0	1
German rinding horse	-	-	0	1	-	-
Trakhener horse	38,5	13	33,3	6	-	-
Frisian horse	37,5	8	-	-	-	-
Other	7,14	14	-	-	-	-

Appendix 5. Results questionnaires, pregnant mares, foals before weaning and foals after weaning

Mare concretes	OC-high farms	OC-low farms	P-value
Yes	22	17	
No	1	2	
			0,439

Mare Average amount of concretes	OC-high farms	OC-low farms	P-value
Kilo's	3,125	3,531	0,358

Mare Extra products	OC-high farms	OC-low farms	P-value
Yes	10	7	
No	13	12	
			0,663

Mare supplement	OC-high farms	OC-low farms	P-value
Yes	4	4	
No	19	15	
			0,764

Mare roughage	OC-high farms	OC-low farms	P-value
Haylage	4	7	
Semi-dry haylage	19	11	
			0,123

Changes in diet at the start vs. end pregnancy	OC-high farms	OC-low farms	P-value
No changes	13	5	
Different concretes at the start	3	4	
Less concretes at the start	5	8	
No concretes at the start	1	2	
			0,210

Changes in diet after partus	OC-high farms	OC-low farms	P-value
No changes	8	10	
Different concretes	2	0	
More concretes and/or roughage	10	9	

No more concretes (in the field)	1	0	
			0,30

Foal own concretes	OC-high farms	OC-low farms	P-value
Yes	9	10	
No	13	9	
			0,453

Average amount of foals own concretes	OC-high farms	OC-low farms	P-value
Kilo's	0,9222	1,333	
			0,209

Average age of foal own concretes	OC-high farms	OC-low farms	P-value
Weeks	5,17	4	
			0,519

Foal extra products	OC-high farms	OC-low farms	P-value
No extra products	22	18	
Slobber with Luzerne	1	0	
Muesli with carrots	0	1	
			0,157

Foal supplements	OC-high farms	OC-low farms	P-value
Yes	1	1	
No	22	18	
			0,890

Weaned foals concretes	OC-high farms	OC-low farms	P-value
Yes	23	19	
No	0	1	
			0,278

Average amount of concretes weaned foals	OC-high farms	OC-low farms	P-value
Kilo's	1,767	2,294	
			0,036

Weaned foals extra products	OC-high farms	OC-low farms	P-value
Yes	4	2	

No	18	18	
			0,449

Weaned foals roughage	OC-high farms	OC-low farms	P-value
Haylage	4	5	
Semi-dry haylage	19	15	
			0,541

Weaned foals supplements	OC-high farms	OC-low farms	P-value
Yes	4	5	
No	19	15	
			0,541