The Thai Journal of Veterinary Medicine

Volume 46
Issue 1 *March, 2016*

Article 2

3-1-2016

Prevalence of Subclinical Laminitis and Its Effects on Reproductive Performance in Lactating Cows in Thailand

Suvaluk Seesupa

Kwankate Kanistanon

Rittichai Pilachai

Suneerat Aiumlamai

Original Article

Prevalence of Subclinical Laminitis and Its Effects on Reproductive Performance in Lactating Cows in Thailand

Suvaluk Seesupa[1] Kwankate Kanistanon[2] Rittichai Pilachai[3] Suneerat Aiumlamai[1*]

Abstract

The objectives of this study were to investigate the prevalence of subclinical laminitis and to evaluate its effects on reproductive performances in dairy cows in Thailand. Ninety-eight lactating cows from 22 smallholder dairy farms and 138 lactating cows from one large scale dairy farm were assessed for subclinical laminitis by evaluating lesions after hoof trimming. Hemorrhagic lesions of the sole and white line area were evaluated. Any appearance of sole hemorrhage or white line hemorrhage scoring ≥2 on one or more claws was defined as a case of subclinical laminitis. Reproductive data were recorded and analyzed using subclinical laminitis as the main effect with other covariates. The prevalence of subclinical laminitis in the lactating cows raised on smallholder dairy farms and on a large scale dairy farm was 38.8% and 42.0%, respectively. The calving to conception interval (CCI) of laminitis cows was significantly increased ($p<0.05$) on the smallholder dairy farms (time ratio; TR = 1.32) and on the large scale dairy farm (TR = 1.21). The estimated median times of CCI between non-laminitis and laminitis cows on the smallholder dairy farms and on the large scale dairy farm were 119.8 and 158.6 days, and 134.1 and 163.6 days, respectively. These results showed that subclinical laminitis was highly prevalent in dairy cows in Thailand, and subclinical laminitis had negative effects on reproductive performance by increasing the time span of CCI.

Keywords: dairy cows, prevalence, reproductive performance, subclinical laminitis

[1]*Department of Surgery and Theriogenology, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand*
[2]*Department of Physiology, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand*
[3]*Program in Veterinary Technology, Faculty of Technology, Udon Thani Rajabhat University, Udon Thani 41000, Thailand*
***Correspondence**: suneerat@kku.ac.th*

Introduction

Laminitis is one type of hoof problems and appears frequently in dairy cattle. It is considered to be an important cause of lameness. Approximately 90% of lameness cases in dairy cattle are caused by the occurrence of hoof lesions (Vermunt, 2004). The inflammation of laminae tissue and subsequent deterioration of the dermal layer inside the foot result in various types of laminitis such as acute, sub-acute, subclinical and chronic forms. Furthermore, laminitis is associated with the occurrence of other hoof lesions such as sole ulcer, white line separation, and heel erosion (Lischer and Ossent, 2002). These lesions are regarded as important predisposing factors for lameness and hence a serious problem for animal welfare, reducing both milk production (Warnick et al., 2001; Green et al., 2002) and fertility (Alawneh et al., 2011).

Many factors are implicated in causing laminitis in dairy cows, among which nutrition is regarded as the main factor (Vermunt and Greenough, 1994). In particular, excessive amounts of concentrate or non-structural carbohydrate and inadequate fiber intake are common causes of subacute ruminal acidosis (SARA) (Plaizier et al., 2008), which predisposes to the development of laminitis (Nocek, 1997). In Thailand, dairy cows are mostly fed on high amounts of concentrate, rich in rapidly degradable carbohydrate and inadequate roughages (Wanapat, 2003; Aiumlamai, 2009), all of which are involved in causing SARA. It has been reported that the prevalence of SARA during pre- and postpartum period of dairy cows ranges from 30-40% (Inchaisri et al., 2005; Jarassaeng et al., 2006). Therefore, dairy cows in Thailand are possibly at risk of laminitis.

Many studies have reported the association between hoof health and reproduction. Sood and Nanda (2006) found that lame cows showed suppression of playful behavior during the estrous period. Lameness in cows is related to poor reproductive performance such as increasing calving to first service interval (CFS), calving to conception interval (CCI), and treatment of anestrus (Sprecher et al., 1997; Hernandez et al., 2001; Hultgren et al., 2004). In addition, lameness affects ovarian activity (Garbarino et al., 2004), with a high incidence of ovarian cysts in dairy cows during the early postpartum period (Melendez et al., 2003).

Despite the fact that lameness has been clearly shown to have negative effects on reproductive performance, studies of laminitis and reproduction in dairy cows have not previously been reported. Therefore, the objectives of the present study were to investigate the prevalence of subclinical laminitis and to evaluate its effect on reproductive performance in dairy cows in Thailand. Due to the fact that most dairy producers in Thailand are smallholder dairy farms (approximately >95%) (DLD, 2014), in order to make proper interpretation, the study was designed in two parts, the first study was performed at smallholder dairy farms and the second study was performed at a large scale dairy farm.

Materials and Methods

First study

***Farms and animals*:** A cross-sectional study was carried out at smallholder dairy farms located in Saraburi and Khon Kaen Provinces, Thailand, between May 2008 and January 2009. Twenty-two farms were selected by strata sampling from a list of farms which were willing to participate in our study. The list of farms was provided by local veterinarians based on history of lameness to increase variation of subclinical laminitis prevalence and to reduce selection bias. Primiparous and multiparous lactating cows were randomized according to the criteria as follows: cross-bred Holstein-Friesian (HF) >80%; healthy cows; stage of lactation (day in milk) between 50 to 200 days, a typical period for manifestation of subclinical laminitis lesion (Leach et al., 1997) and a functional period for reproduction of cows; and complete records of reproductive data. Sample size was calculated by prevalence survey estimation (Dohoo et al., 2010), assuming expected prevalence of 50%, an allowable error of 10% and a significance level of 0.05. Accordingly, about 20% of the lactating cows at each farm were selected by random sampling. A total of 98 cows were randomly selected in this study.

***Evaluation of subclinical laminitis*:** Hooves were trimmed using the technique described by Toussaint (1985), and the horn of the sole was pared using a 115 mm diameter hoof abrasive grinding disk (Original IP Philipsen®, IP Philipsen GmbH, Weingarten, Germany) with a rotating machine (BOSCH® 850C, Robert Bosch GmbH, Stuttgart, Germany). Subclinical laminitis lesions were scored after trimming based on visual examination by the same person throughout the study. The lesion was assessed by the presence of hemorrhage on the sole and the white line using the four-point scale for laminitis scoring system described by Sogstad et al. (2005). In brief, score 0 was defined as no lesion, score 1 as slight hemorrhagic discoloration, score 2 as profound hemorrhage covering >20% of the sole surface or white line area, and score 3 as profound hemorrhage covering >50% of the sole surface or white line area. The highest score found on any claw was considered to represent the degree of subclinical laminitis lesion of the cow. A cow with a subclinical laminitis score of 0 or 1 was classified as a non-laminitis cow, whereas a cow with a subclinical laminitis score of 2 or 3 was classified as a laminitis cow.

***Data collection*:** Demographic information regarding the cows was obtained from individual cow records including breed, age, parity, and days in milk (DIM). Body condition scores (BCS) of the cows were scored using a 1-5 scale according to Ferguson et al. (1994). Milk production data were collected by interview during time of hoof trimming and conception. Information regarding feeding management and hoof care was observed during farm visits and claw trimming. Reproductive data were retrospectively collected from trimming date to last calving and then prospectively to the next calving. These data included estrous dates, calving dates, insemination dates and number of insemination. Pregnancy was diagnosed when non-return to estrus in 56 days after the last insemination was found (Radotis and Blood, 1985). Parameters of reproductive performances were calculated according to Brand and Varner (1997) as calving to first estrous interval (CFE), calving to first service interval (CFS), calving to conception interval (CCI), number of service per conception (NS/C) and conception rate at first service (CRFS). CFE was not calculated in the case of smallholder dairy farms because farmers did not record these data. Reproductive outcomes including CFE, CFS, and CCI were measured as time-event data, NS/C was measured as count data, and CRFS was measured as binomial data.

Second study

Animals: The second study was performed at a large scale dairy farm located in Nakhonratchasima Province, Thailand, between November 2009 and July 2010. The inclusion criteria for lactating cows were similar to the first study. In total, 138 out of 347 lactating cows in the farm were randomly selected. The sample size was determined by calculation sample for comparing means (Dohoo et al., 2010), using the standard deviation of CCI in the first study (60.7) with an effect size of approximately 20%.

Evaluation of subclinical laminitis**:** Locomotion of the selected cows at the large scale dairy farm was evaluated using a five-point scale for lameness (Sprecher et al., 1997) before hoof trimming. Hoof trimming technique, lesion evaluation, scoring of subclinical laminitis lesions and laminitis classification were performed as described in the first study.

Data collection**:** Individual and reproductive data of the cows as described in the first study were collected from the farm's recording system. Milk production data of the selected cows were recorded once every two weeks by automatic measurement of pipe-line milking system. Pregnancy was evaluated by a veterinarian using palpation per rectum at 60 days after insemination. Parameters of reproductive performances were calculated as described in the first study.

Statistical analyses: The prevalence of subclinical laminitis was calculated as the total number of cows with subclinical laminitis divided by all the cows enrolled in each study. After validation of data in the first study, data from ten cows were excluded due to loss of reproductive records during follow-ups. In the second study, 13% of the data were excluded due to data set sharing the same identification number (ID) or sharing the same data between ID, and missing or nonsensical dates of reproductive events. Eventually, data regarding 88 cows in the first study and 120 cows in the second study remained for analysis. Basic individual data including age, parity, DIM, BCS and milk production (at hoof trimming) were tested for normality. Differences in these variables between non-laminitis and laminitis cows were analyzed by the Wilcoxon rank-sum test for variables that failed to meet the assumption of normal distribution and by the Student's t-test for variables that met the assumption of normal distribution. The effects of individual data regarding DIM, BCS, milk production and number of cows per farm on subclinical laminitis were tested by logistic regression.

Survival analysis was used for the time-event data (CFE, CFS, and CCI). Censor time for those variables accounted from the starting point (day 1 after calving) to the end of follow-up, which was defined by two situations (1) the day of reproductive events occurred, such as the first estrous date, the first insemination date, and the conception date and (2) the maximum observation time after calving was reached for CFE and CFS (100 and 140 days). These cut-off points corresponded to the 90th percentile of number of days from calving to these events in the complete data, and the final day of data acquisition was used for CCI. Censored cases were defined as cows that did not present a reproductive event within the observation time but were still present at the end of follow-up or as cows culled during the observation time regarding that the last date of a reproductive event was known. An accelerated failure time (AFT) model was used to evaluate time-independent covariates which had an effect on outcome variables by estimating the time ratio (TR). The distribution for the parametric model specified in the procedure was Weibull, as used in previous studies using parametric models with reproductive data of dairy cows (Harman et al., 1996; Schnier et al., 2004). Covariates in the analysis were subclinical laminitis (no or yes), parity (1st, 2nd, 3rd, or ≥ 4th), season of calving (winter, summer, or rainy season) and mean of milk production (kg) prior to pregnancy or censoring. Subclinical laminitis was assigned as the main effect. Initially, all covariates were tested by a univariable model, covariates with *p*-value of Wald χ^2 statistic < 0.25 and covariates that aimed to control for significant effects on the reproduction of dairy cows were placed into the final model. Postestimation of dependent variables (estimated median times) of the non-laminitis and laminitis groups was predicted to represent the reproductive performance of cows.

Poisson regression was used to model the count data (NS/C), and logistic regression was used to model the binomial data (CRFS). The covariates were composed of as described in the AFT model and assigned to the farms as random effect (first study) in the analysis. Collinearity was checked by initial testing of simple association among independent variables including Spearman's correlation for categorized data and Pearson's correlation for categorized vs. continuous data. The fit of models, if significant, was checked by Pearson and deviance goodness-of-fit test. Data analysis was performed using the statistical program Stata 10.1 (Stata Corporation, College Station, TX).

Results

First study

The percentages of cows with subclinical laminitis scores of 0, 1, 2 and 3 were 23.5, 37.8, 28.6 and 10.2%, respectively. The prevalence of subclinical laminitis (score 2 or 3) in lactating cows raised on smallholder farms was 38.8%.

The mean for lactating cows per farm was 25.6±11.0, and all cows were cross-bred Holstein-Friesian (HF) >86.4%. No significant differences were found in age, parity, DIM and BCS between the non-laminitis and laminitis cows. The average age (years), parity, DIM (days), and BCS of the non-laminitis and laminitis cows were 4.8±2.1, 2.5±1.5, 136.8±64.8, 2.8±0.4 and 5.1±2.0, 2.9±1.6, 127.8±70.9, 2.8±0.4, respectively. No significant difference was found in the milk production, and the average milk production (kg/d) of the non-laminitis and laminitis cows was 19.9±6.2 and 18.7±4.9 kg/d, respectively. The effects of DIM, BCS, milk production and number of cows per farm on subclinical laminitis were not observed. Regarding feeding practice, 50% of the farms used separate feeding of concentrate and roughage while the others used combined feeding of concentrate and roughage. Regarding the frequency of concentrate feeding, 77.3% of the farms fed twice per day while the others fed more than twice per day. Regarding stall surface, 77.3% of the farms were solid concrete floors with partial soil while the others were soil floors. No farms used chemicals (copper sulphate, formaldehyde) for footbaths and routine hoof trimming.

The overall means (±SD) for CFS, CCI, NS/C and percentage of CRFS were 83.9±26.2, 120.7±59.6, 2.1±1.5 and 41.9%, respectively. Descriptive statistics for these parameters for the non-laminitis and laminitis cows are shown in Table 1. No significant effects of subclinical laminitis were found in the model of CFS, NS/C and CRFS. For survival model, the censored cases for CFS and CCI were 12.5 and 23.8%, respectively. For the final model of CCI, significant effect was found only in the subclinical laminitis covariate (Table 2); it increased the CCI of laminitis cows (TR = 1.32). The estimated median times of CCI between the non-laminitis and laminitis cows were 119.8 and 158.6 days, respectively.

Table 1 Descriptive statistics for CFE, CFS, CCI, NS/C and CRFS between non-laminitis and laminitis cows in the first and second studies

Group	CFE	CFS	CCI	NS/C	CRFS
	Median	Median	Median	Mean±SD	%
First study					
Non-laminitis	-	83	115	2.1±1.2	44.4
Laminitis	-	86	130.5	2.3±1.7	40.0
Second study					
Non-laminitis	46.5	57.5	116	2.7±2.1	31.8
Laminitis	47.5	64.5	159	3.0±2.1	27.8

Non-laminitis = subclinical laminitis score 0 or 1
Laminitis = subclinical laminitis score 2 or 3
CFE = Calving to first estrous interval (day), CFS = Calving to first service interval (day), CCI = Calving to conception interval (day), NS/C = Number of service per conception, CRFS = Conception rate at first service (%)

Second study

The percentages of cows with subclinical laminitis lesion scores of 0, 1, 2 and 3 were 29.7, 28.3, 21.0, 24.6 and 17.4%, respectively. The prevalence of subclinical laminitis (score 2 or 3) was estimated to be 42.0%. One hundred and thirty three cows with a locomotion score of 1 or 2 were detected, and the cows with locomotion score >2 were as follows: score 3 (n = 4) and 4 (n = 1), all of which were detected in the laminitis group.

All animals were cross-bred HF >82.5%. No significant differences were found in age, parity, DIM and BCS between the non-laminitis and laminitis cows. The average of these parameters of the non-laminitis and laminitis cows were 4. 8±2.2, 3.1±1.8, 86.5±39.7, 3.3±0.3 and 5 . 5±2.0, 3.5±1.7, 101.1±42.9, 3.3±0.4, respectively. No significant difference was found in the milk production, and the average milk production of the non-laminitis and laminitis cows was 19.8±4.1 and 20.1±3.6 kg/d, respectively. Subclinical laminitis was not significantly associated with DIM, BCS, and milk production. The feeding practice was separate feeding of concentrate and roughage, and the average amount of concentrate was 10 kg/cow/day. The cows were kept in open stalls with concrete floors. The use of formaldehyde in a footbath and hoof trimming was occasionally implemented when the incidence of lameness increased on the farm.

The reproductive performances of all animals (mean±SD), CFE, CFS, CCI, NS/C and percentage of CRFS, were 54.3±34.6, 71.2±31.8, 135.8±60.5, 2.8±1.9 and 30.0%, respectively. Descriptive statistics for these parameters for the non-laminitis and laminitis cows are shown in Table 1. The effects of subclinical laminitis on CFE, CFS, NS/C and CRFS were not significant in the second study. The censored cases for CFE, CFS and CCI were 10.0, 10.8 and 20.0%, respectively. Subclinical laminitis significantly increased the CCI (TR = 1.21) of laminitis cows (Table 2). The estimated median times of CCI between the non-laminitis and laminitis cows were 134.1 and 163.6 days, respectively.

Discussion

This study revealed that the prevalence of subclinical laminitis was similar in the smallholder dairy farms and the large scale dairy farm (38.8% and 42%). The prevalence of subclinical laminitis in this study is comparable with previous studies in Thailand and other countries, with the range of 20-45% (Smilie et al., 1996; Manske et al., 2002; Kujala et al., 2004; Sogstad et al., 2005; Pilachai et al., 2013). The current study defined subclinical laminitis by the occurrence of sole and white line hemorrhage according to the previous study by Sogstad et al. (2005). Actually, hoof lesion as sole hemorrhage in Thailand was previously reported to be 6.5% of 216 lame cows (Wongsanit et al., 2002) and 11.5% of cows in 66 smallholder dairy farms in the western region of Thailand (Srisomrun et al., 2010). However, these studies did not define the sole hemorrhagic lesion as a case of subclinical laminitis. Our study emphasizes subclinical laminitis prevalence in Thailand and addresses its relation to impaired reproductive performance.

Table 2 Univariable analysis of subclinical laminitis and covariates on CCI in the first and second studies

Covariates	TR	95% confidence interval	*p*-value
First study			
Subclinical laminitis			0.022
No	1	Ref.	
Yes	1.32	[1.03, 1.69]	
Parity			0.725
1st lactation	1	Ref.	
2nd lactation	0.99	[0.70, 1.40]	
3rd lactation	1.16	[0.81, 1.65]	
≥4th lactation	1.14	[0.79, 1.65]	
Calving season			0.887
Winter	1	Ref.	
Rainy	0.92	[0.63, 1.33]	
Summer	1.01	[0.77, 1.33]	
Milk production*	1.01	[0.79, 1.28]	0.933
Second study			
Subclinical laminitis			0.039
No	1		
Yes	1.21	[1.01, 1.47]	
Parity			0.417
1st lactation	1	Ref.	
2nd lactation	1.20	[0.88, 1.65]	
3rd lactation	0.94	[0.69, 1.27]	
≥4th lactation	0.98	[0.77, 1.26]	
Calving season			0.127
Winter	1	Ref.	
Rainy	1.01	[0.81, 1.24]	
Summer	1.43	[0.95, 2.17]	
Milk production*	1.25	[0.94, 1.65]	0.112

CCI = Calving to conception interval
Time ratio (TR) greater than 1 suggests a longer time to event of reproductive parameter.
Subclinical laminitis (no) = subclinical laminitis score 0 or 1
Subclinical laminitis (yes) = subclinical laminitis score 2 or 3
*Change per 10 kg, Ref. = reference category

Laminitis in dairy cows has been accepted to be a result of multiple factors such as feeding, housing, flooring and exercise regime. Separate feeding of concentrate and roughage was explained to be a cause of laminitis (Pilachai et al., 2013). Furthermore, there was speculation that a high energy diet fed at a high amount per day increased the risk of SARA resulting in laminitis (Nordlund et al., 2004). Alternatively, the loading on the sole due to body weight and longer standing on hard flooring may increase the occurrence of laminitis (Bergsten, 2003). Separate feeding of concentrate and roughage and standing on concrete flooring were observed in both studies; both seem to be the causes related to laminitis in this study. However, factors for the occurrence of laminitis were not analyzed in the current study.

Subclinical laminitis is one form of laminitis in cattle seen in the sole and as white line hemorrhage (Nocek, 1997) without obvious clinical signs of lameness (Thoefner et al., 2004). According to the locomotion test of cows (original data: 138 cows) in the second study, almost all of the cows with subclinical laminitis (54 out of 58 cows) did not show signs of lameness (locomotion score ≤2); only a few cows (4 out of 58 cows) showed signs of moderate lameness (locomotion scores 3, 4). In the first study, the evaluation of locomotion was not performed on the smallholder dairy farms due to the lack of appropriate areas for the test. However, through observation of short-distance walking of cows before hoof trimming, this study did not find any cows with obvious lameness.

In the first study, for data analyses, factors related to farm management were not tested in the model. The difference in management on each farm may mask the effect on the reproduction of cows. To avoid such uncertainties, the second study was performed on a large farm where all the cows received the same management. The analyses revealed that the results were comparable between the first and the second studies. In both studies, the effects of subclinical laminitis were not significant in the models of CFS, NS/C and CRFS. This is explained by the fact that predominantly several factors may affect the reproduction of dairy cows (Brand and Guard, 1997). However, subclinical laminitis obviously showed a significant effect on the CCI of lactating cows in this study. The results indicated that the estimated median time of CCI in the laminitis cows was higher than that in the non-laminitis cows (158.6 vs 119.8 days; first study and 163.6 vs 134.1 days; second study). Although the NS/C between the laminitis and non-laminitis cows was not significantly different, the laminitis cows had a tendency of higher NS/C than the non-laminitis cows (2.3±1.7 vs 2.1±1.2; first study and 3.0±2.1 vs 2.7±2.1; second study). These results imply that subclinical laminitis results in an increasing number of insemination and consequently extends the interval from calving to conception of dairy cows in the current study. No previous study has reported the negative effects of laminitis on reproduction; Sogstad et al. (2006) only reported that laminitis cows required more reproductive hormonal treatments (hazard ratio; HR = 2.30). However, the effects of subclinical laminitis on reproductive performance in the current study are comparable with previous studies which reported an association between lameness or hoof lesions and reproductive performance. Several studies reported hoof lesions and lameness being associated with increasing CFS CCI and calving interval (Sprecher et al., 1997; Hernandez et al., 2001; Machado et al., 2010; Alawneh et al., 2011), decreasing CRFS (odds ratio; OR = 0.59), and increasing treatment anestrus (OR = 1.61) (Hultgren et al., 2004). In Thailand, Arunvipas et al. (2011) reported that lame cows showed higher CFS, NS/C, calving interval and lower pregnancy rate (OR = 3.5) than normal cows.

The mechanisms of hoof lesion affecting reproduction were discussed by Melendez et al. (2003). The first mechanism is that pain and stress result in a high plasma level of cortisol, which is related to the inhibition of reproductive hormones. Subclinical laminitis is suggested to cause low-grade pain in dairy cattle, which complicates the application of the protocol for detection (Thoefner et al., 2004). In this study, it was speculated that the laminitis cows suffered low-grade pain, which might affect reproduction via the pain mechanism described above. Moreover, hoof pain in dairy cows can suppress expression of estrous behavior (Sood and Nanda, 2006), and consequently influence the reproductive performance. The second mechanism is that laminitis is caused by SARA's relation to releasing endotoxins, which contribute to the disturbance of reproductive physiology. In the current study, subclinical laminitis seemed to be the result of feeding and SARA. Therefore, the second mechanism detailed above may also explain the effect of subclinical laminitis on reproductive performance in the present study.

In Thailand, the reproductive performances of cows on smallholder dairy farms, such as CFS, CCI, NS/C and CRFS, from previous studies (Aiumlamai, 2003; DLD, 2009; Inchaisri et al., 2013) are comparable with our results in the first study. It is possible that laminitis cows might be included in the previous studies and affected reproductive performances. Alternatively, other factors related to laminitis such as rumen acidosis also affected the reproductive performances (Inchaisri et al., 2013). Control of laminitis is one strategy for the improvement of reproductive performance on Thai dairy farms. The prevention of laminitis should be performed by ruminal acidosis monitoring and proper feeding management. The monitoring of ruminal acidosis can be performed using several methods, e.g. chemical measurement of dietary fiber and non-fiber carbohydrates, determination of ruminal fluid pH, and evaluation of feces consistency (feces scores) (Nordlund et al., 2004). Feeding management should mainly focused on feeding to avoid ruminal acidosis or SARA, e.g. enhancing physically effective neutral detergent fiber (peNDF) in the diet, supplementing inorganic buffers such as sodium bicarbonate, maintaining particle size of the diet, increasing frequency of feeding concentrate, and combining feeding of concentrate and roughage (Nocek, 1997; Greenough, 2007). In addition, providing stall comfort, softer flooring, and routine hoof trimming and footbath can support the prevention of laminitis on farms (Bergsten, 2003).

In this study, we could not assess the differences in management on the smallholder dairy farms regarding their influence on the reproductive performance of the population. Therefore, further studies should examine several factors of farm management. Based on the hypothesis of laminitis and ruminal acidosis related endotoxins, an experiment related laminitis by the challenge ruminal acidosis could conduct in experimental animals and measure the inflammatory response to endotoxins. It would be worthwhile conducting an investigation into the mechanism by which laminitis impairs reproduction in dairy cows.

In conclusion, this study revealed the high prevalence of subclinical laminitis in lactating dairy cows in Thailand, which affected the reproductive performance by increasing CCI. Factors such as heat stress, negative energy balance, diseases and management are recognized as impacting the reproduction of dairy cows; however, this study presented subclinical laminitis as another factor. Therefore, the prevention of laminitis on dairy farms is important in farm management to improve the fertility of dairy cows in Thailand.

Acknowledgements

This work was supported by the Higher Education Research Promotion and National Research University Project of Thailand, Office of the Higher Education Commission, through the Food and Functional Food Research Cluster of Khon Kaen University. The authors would like to thank the Faculty of Veterinary Medicine at Khon Kaen University, Thailand, for supporting this work and also thank the farmers, dairy extensions, veterinarians, and hoof trimmers for participating in the study.

References

Aiumlamai S 2003. Research on reproductive efficiency in Thai dairy cattle. In: Proceedings of KKU Dairy Conference, Feeding, Health, Fertility and Milk Quality, Khon Kaen, Thailand, 91–112.

Aiumlamai S 2009. Dairy management health and production in Thailand. Int Dairy Top. 8: 11–13.

Alawneh JI, Laven RA and Stevenson MA 2011. The effect of lameness on the fertility of dairy cattle in a seasonally breeding pasture-based system. J Dairy Sci. 94(11): 5487–5493.

Arunvipas P, Theingthum W, Panneum S, Srisomrun S and Rukkwamsuk T 2011. Lameness affects reproductive performance in dairycows raised in smallholder farms in thailand. In: Proceedings of the 16th International Symposium and 8th Conference on Lameness in Ruminants, Rotorua, New Zealand, 116.

Bergsten C 2003. Causes, risk factors, and prevention of laminitis and related claw lesions. Acta Vet Scand. 44 (Suppl 1): 157–166.

Brand A and Guard CL 1997. Principles of herd health and production management programs. In: Herd health and production management in dairy practice. Wageningen: Wageningen Pers 3–67.

Brand A and Varner M 1997. Monitoring reproductive performance: objective, rereproductive indices and materials and methods. In: Herd health and production management in dairy practice. Wageningen: Wageningen Pers 283–343.

Department of Livestock Development (DLD), Ministry of Agriculture and Cooperatives 2009. "Statistic report the artificial insemination in dairy cows of Thailand." [online]. Available: http://www.dld.go.th/biotech/Data/Rut/Statistics/2552/DATA2552.htm. Accessed Sep 10, 2010.

Department of Livestock Development (DLD), Ministry of Agriculture and Cooperatives 2014. "Statistic report the registration dairy farm in Thailand." [online]. Available: http://certify.dld.go.th/th/index.php/en/component/content/article/282-2014-03-06-19-06-39. Accessed Aug 2, 2014.

Dohoo I, Martin W and Stryhn H 2010. Sampling, Modelling survival data. Veterinary Epidemiologic Research 2nd ed. Prince Edward Island: Charlottetown PEI Canada 865 pp.

Ferguson JD, Galligan DT and Thomsen N 1994. Principal descriptors of body condition score in Holstein cows. J Dairy Sci. 77: 2695-2703.

Garbarino EJ, Hernandez JA, Shearer JK, Risco CA and Thatcher WW 2004. Effect of lameness on ovarian activity in postpartum Holstein cows. J Dairy Sci. 87(12): 4123–4131.

Green LE, Hedges VJ, Schukken YH, Blowey RW and Packington AJ 2002. The impact of clinical lameness on the milk yield of dairy cows. J Dairy Sci. 85(9): 2250–2256.

Greenough PR 2007. Nutritional risk factors. Bovine laminitis and lameness. New York: Elsevier 311 pp.

Harman JL, Casella G and Gröhn YT 1996. The application of event-time regression techniques to the study of dairy cow interval-to-conception. Prev Vet Med. 26(3-4): 263–274.

Hernandez J, Shearer JK and Webb DW 2001. Effect of lameness on the calving-to-conception interval in dairy cows. J Am Vet Med Assoc. 218(10): 1611–1614.

Hultgren J, Manske T and Bergsten C 2004. Associations of sole ulcer at claw trimming with reproductive performance, udder health, milk yield, and culling in Swedish dairy cattle. Prev Vet Med. 62(4): 233–251.

Inchaisri C, Ajariyakhajorn K, Chunpongsang S, Suriyasataporn W, Pinyopummintr T, Smolenaars A and Noordhuizen JP 2005. Risk factors of subclinical ketosis and subacute ruminal acidosis under differnt feeding management during post calving of Thai dairy cattle in smallholder farms. In: Proceedings of AHAT/BSAS Internationnal Conference: AUNP symposium, Khon Kaen, Thailand, 70–79.

Inchaisri C, Chanpongsang S, Noordhuizen J and Hogeveen H 2013. The association of ruminal pH and some metabolic parameters with conception rate at first artificial insemination in Thai dairy cows. Trop Anim Health Prod. 45: 1183-1190.

Jarassaeng C, Aiumlamai S and Wachirapakorn C 2006. Subacute ruminal acidosis and subclinical mastitis in dairy cows. In: Proceeding of Dairy Conference, Khon Kaen, Thailand, 89–93.

Kujala M, Schnier C, Niemi J and Soveri T 2004. Occurrence of hoof diseases in dairy cattle in Finland. In: Proceedings of the 13th International Symposium and 5th Conference on Lameness in Ruminants, Maribor, Slovenija,

Leach KA, Logue DN, Kempson SA, Offer JE, Ternent HE and Randall JM 1997. Claw lesions in dairy cattle: development of sole and white line haemorrhages during the first lactation. Vet J. 154: 215-225.

Lischer CJ and Ossent P 2002. Pathogenesis of sole lesions attributed to laminitis in cattle. In: Proceedings of the 12th International Symposium on Lameness in Ruminants, Orlando, USA, 82–89.

Machado VS, Caixeta LS, McArt JAA and Bicalho RC 2010. The effect of claw horn disruption lesions and body condition score at dry-off on survivability, reproductive performance, and milk production in the subsequent lactation. J Dairy Sci. 93(9): 4071–4078.

Manske T, Hultgren J and Bergsten C 2002. Prevalence and interrelationships of hoof lesions and lameness in Swedish dairy cows. Prev Vet Med. 54(3): 247–263.

Melendez P, Bartolome J, Archbald LF and Donovan A 2003. The association between lameness, ovarian cysts and fertility in lactating dairy cows. Theriogenology. 59(3-4): 927–937.

Nocek JE 1997. Bovine acidosis: Implications on laminitis. J Dairy Sci. 80(5): 1005–1028.

Nordlund KV, Cook NB and Oetzel GR 2004. Investigation strategies for laminitis problem herds. J Dairy Sci. 87 (E. Suppl.): 27–35.

Pilachai R, Schonewille JT, Thamrongyoswittayakul C, Aiumlamai S, Wachirapakorn C, Everts H and Hendriks WH 2013. Diet factors and subclinical laminitis score in lactating cows of smallholder dairy farms in Thailand. Livest Sci. 155(2-3): 197–204.

Plaizier JC, Krause DO, Gozho GN and McBride BW 2008. Subacute ruminal acidosis in dairy cows: the physiological causes, incidence and consequences. Vet J. 176(1): 21–31.

Radotis O and Blood D 1985. A textbook of health and production management of agricultural animals. Philadelphia: W.B. Saunders 456 pp.

Schnier C, Hielm S and Saloniemi HS 2004. Comparison of the breeding performance of cows in cold and warm loose-housing systems in Finland. Prev Vet Med. 62(2): 135–151.

Smilie RH, Hoblet KH, Weiss WP, Eastridge ML, Rings DM and Schnitkey GL 1996. Prevalence of lesions associated with subclinical laminitis in first-lactation cows from herds with high milk production. J Am Vet Med Assoc. 208(9): 1445–1451.

Sogstad ÅM, Fjeldaas T, Østerås O and Forshell KP 2005. Prevalence of claw lesions in Norwegian dairy cattle housed in tie stalls and free stalls. Prev Vet Med. 70(3-4): 191–209.

Sogstad ÅM, Østerås O and Fjeldaas T 2006. Bovine claw and limb disorders related to reproductive performance and production diseases. J Dairy Sci. 89(7): 2519–2528.

Sood P and Nanda AS 2006. Effect of lameness on estrous behavior in crossbred cows. Theriogenology. 66(5): 1375–1380.

Sprecher DJ, Hostetler DE and Kaneene JB 1997. A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. Theriogenology. 47(6): 1179–1187.

Srisomrun S, Kananub K, Panneum S, Jenacharoen K and Arunvipas P 2010. Prevalence of lameness and hoof lesions in dairy cows in western Thailand. In: Proceedings of the 48th Kasetsart University Annual Conference, Bangkok, Thailand, 84–88.

Thoefner MB, Pollitt CC, Van Eps AW, Milinovich GJ, Trott DJ, Wattle O and Andersen PH 2004. Acute bovine laminitis: a new induction model using alimentary oligofructose overload. J Dairy Sci. 87(9): 2932–2940.

Toussaint R 1985. Cattle foot care and claw trimming. Sheffield: Framing Press 126 pp.

Vermunt JJ and Greenough PR 1994. Predisposing factors of laminitis in cattle. Br Vet J. 150(2): 151–164.

Vermunt JJ 2004. Herd lameness - a review, major causal factors, and guidelines for prevention and control. In: Proceedings of the 13th International Symposium and 5th Conference on Lameness in Ruminants, Maribor, Slovenija.

Wanapat M 2003. Manipulation of cassava cultivation and utilization to improve protein to energy biomass for livestock feeding in the ropics. Asian-Aust J Anim Sci. 16(3): 463–472.

Warnick LD, Janssen D, Guard CL and Grohn YT 2001. The effect of lameness on milk production in dairy cows. J Dairy Sci. 84(9): 1988–1997.

Wonngsanit J, Pinnyopuminin T and Suriyasataporn W 2002. The correlation of hoof lesions and the severity of lameness in small dairy herds In: Proceedings of the 40th Kasetsart University Annual Conference, Bangkok, Thailand, 398–405.

บทคัดย่อ

ความชุกของภาวะกีบอักเสบแบบไม่แสดงอาการและผลกระทบต่อความสมบูรณ์พันธุ์ของโคนมในประเทศไทย

สุวลักษณ์ ศรีสุภา[1] ขวัญเกศ กนิษฐานนท์[2] ฤทธิชัย พิลาไชย[3] สุณีรัตน์ เอี่ยมละมัย[1]*

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อสำรวจความชุกของภาวะกีบอักเสบแบบไม่แสดงอาการ และประเมินผลกระทบของภาวะกีบอักเสบแบบไม่แสดงอาการต่อความสมบูรณ์พันธุ์ของโคนมในประเทศไทย ทำการสุ่มโคนมจำนวน 98 ตัวจากฟาร์มโคนมรายย่อย 22 ฟาร์ม และ 138 ตัวจากฟาร์มโคนมขนาดใหญ่ 1 ฟาร์ม และประเมินภาวะกีบอักเสบแบบไม่แสดงอาการภายหลังจากปาดแต่งกีบ โดยประเมินรอยโรคการตกเลือดที่พื้นกีบและรอยต่อระหว่างพื้นกีบกับผนังกีบ โคนมที่มีภาวะกีบอักเสบแบบไม่แสดงอาการคือโคนมที่มีคะแนนรอยโรคการตกเลือดที่พื้นกีบหรือรอยต่อระหว่างพื้นกีบกับผนังกีบมากกว่าหรือเท่ากับ 2 คะแนน ทำการบันทึกข้อมูลทางการสืบพันธุ์และวิเคราะห์ผลกระทบต่อความสมบูรณ์พันธุ์โดยกำหนดให้ภาวะกีบอักเสบแบบไม่แสดงอาการเป็นปัจจัยหลักร่วมกับปัจจัยอื่นๆ การศึกษาพบว่าความชุกของภาวะกีบอักเสบแบบไม่แสดงอาการในโคนมของฟาร์มรายย่อยและโคนมของฟาร์มขนาดใหญ่เท่ากับร้อยละ 38.8 และ 42.0 ตามลำดับ ระยะห่างวันคลอดลูกถึงวันผสมติดของโคที่มีภาวะกีบอักเสบเพิ่มขึ้นอย่างมีนัยสำคัญ (p<0.05) ทั้งในฟาร์มโคนมรายย่อย (time ratio; TR = 1.32) และฟาร์มโคนมขนาดใหญ่ (TR = 1.21) ค่าประเมินระยะห่างวันคลอดลูกถึงวันผสมติดระหว่างโคนมที่ไม่มีภาวะกีบอักเสบและมีภาวะกีบอักเสบในฟาร์มโคนมรายย่อยมีค่า 119.8 และ 158.6 วัน และในฟาร์มโคนมขนาดใหญ่มีค่า 134.1 และ 163.6 วัน ตามลำดับ ผลการศึกษาแสดงให้เห็นว่าภาวะกีบอักเสบแบบไม่แสดงอาการของโคนมในประเทศไทยมีความชุกที่สูง และภาวะกีบอักเสบแบบไม่แสดงอาการมีผลกระทบทางลบต่อความสมบูรณ์พันธุ์ โดยมีการเพิ่มขึ้นของระยะห่างวันคลอดลูกถึงวันผสมติด

คำสำคัญ: โคนม ความชุก ความสมบูรณ์พันธุ์ กีบอักเสบแบบไม่แสดงอาการ

[1]ภาควิชาศัลยศาสตร์และวิทยาการสืบพันธุ์ คณะสัตวแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น ประเทศไทย 40002

[2]ภาควิชาสรีรวิทยา คณะสัตวแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น ประเทศไทย 40002

[3]สาขาวิชาเทคนิคการสัตวแพทย์ คณะเทคโนโลยี มหาวิทยาลัยราชภัฏอุดรธานี จังหวัดอุดรธานี ประเทศไทย 41000

***ผู้รับผิดชอบบทความ** E-mail: suneerat@kku.ac.th*