Incidence, possible risk factors and therapies for pseudopregnancy on Dutch dairy goat farms: a cross-sectional study

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Abstract

Pseudopregnancy is a frequently diagnosed reproductive disorder in (dairy) goats. This cross-sectional study evaluates the incidence, possible risk factors and therapies for pseudopregnancy on Dutch dairy goat farms. Two questionnaires, one for farmers and one for veterinarians, were designed and included questions about general farm demographics, breeding management, hormonal oestrous induction, treatment, measures for reduction and stress moments in dairy goats in the period June 1, 2016–May 31, 2017. In total, 43 farmers (21.5 per cent response rate) and 27 veterinarians (22.5 per cent response rate) completed the questionnaire. The annual incidence of pseudopregnancy varied between 1 and 54 per cent per farm, with a mean annual incidence of 17 per cent (95 per cent CI 0.14 to 0.21). In this study, we found a significant association between incidence of pseudopregnancy and a higher percentage of goats with an extended lactation ($p<0.0001$) and between incidence of pseudopregnancy and the number of ultrasound examinations per year ($p<0.0001$). The recommended therapy in literature consists of two administrations of prostaglandins. This was only correctly applied by 10 per cent of the farms. On 52 per cent of the farms, an overdose was used comparing to the recommended dose in literature.

Introduction

Pseudopregnancy or hydrometra is considered an important reproductive disorder in dairy goats.[1 2] Pseudopregnancy is a pathological condition of the genital tract in which aseptic fluid accumulates in the uterine lumen in the presence of a persistent corpus luteum, resulting in anoestrus. The amount of intrauterine fluid can vary from less than 100 ml to more than 8 litres, which may lead to abdominal expansion.[3] Pseudopregnancy occurs both during and outside the breeding season,[4] and its aetiology is still insufficiently clear. Pseudopregnancy in goats can be easily and reliably diagnosed by ultrasound examination by an experienced person. However, at the early stage of the developmental process of pseudopregnancy, the distinction between pseudopregnancy and early pregnancy might be difficult to determine and might need an ultrasonic re-evaluation at a later stage[3 5] As a therapy, administration of natural prostaglandin F2α or a synthetic analogue is described to induce regression of the corpus luteum and subsequently discharging of the fluid from the uterus: the so-called cloudburst.[1] In order to reduce the probability of reoccurrence of pseudopregancy, a second injection with prostaglandins should be administered 10–14 days after the first treatment. Pseudopregnancy is reported by Dutch dairy goat farmers as a cause of decreased milk yield, although no studies are published that well found this theory. Another reason for the control of pseudopregnancy is that early detection of pseudopregnancy might provide the opportunity to rebreed valuable breeding goats.

The Dutch dairy goat industry has made several changes in the last decades. Since the introduction of the dairy goat industry in the 1980s, as a consequence of the introduction of the milk quota system in the dairy cattle

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industry in 1984,[6] dairy goats are kept on a larger scale.[7] In the Netherlands, the majority of the professional dairy goat farms are located in the southeastern and eastern part of the country, and the Saanen goat is the most common breed.[8] In 2016, 358 professional dairy goat farms were present in the Netherlands with an average number of 1.226 goats per farm (median: 1032).[9] The number of dairy goats has increased from 98.080 in 2000 to 438.908 goats in 2016.[6 9] Nowadays, the main reason for a farmer to lamb a goat is either to start up milk production or to boost milk production in low productive animals. Duration of normal lactation in goats is approximately 12 months. As an intentional management decision, in an increasing number of goats, lactation is extended (production of milk >12 months without kidding). Another, but probably less important, reason for extended lactation in Dutch dairy goat farming is reproductive failure. The aims of this study were to collect actual information on the incidence, potential risk factors and applied treatment strategies of pseudopregnancy in the current dairy goat industry in the Netherlands.

Materials and methods

General information and questionnaires

The study was conducted between April and August 2017. Two questionnaires, one for dairy goat farmers and one for veterinarians who supervised dairy goat farms, were conducted to investigate the annual incidence, risk factors and applied therapies for pseudopregnancy on Dutch dairy goat farms. The questionnaires were digitalised using the program Survalyzer.[10] The farmers' questionnaire included questions on general farm demographics (ie, goat numbers, age and milk yield), breeding management (ie, ultrasound examination, hormonal oestrous induction, buck, artificial insemination and and way of mating), treatment (ie, methods), measures for reduction (ie, excluded for breeding, farm measures and reassessment) and stress moments in dairy goats (ie, stable renovations, mucking out, blood sampling, feed changes, claw trimming and vaccination) in the year prior to the date on which the questionnaire was filled in. The veterinary practitioners' questionnaire included questions on general health on dairy goat farms, management and hormone use in case of pseudopregnancy. Thereafter, farmers and veterinary practitioners were contacted by email and invited to participate by filling in the online questionnaires using the weblink that was included in the mail. In total, 216 dairy goat farmers and 120 veterinarians that were related to goat farms were invited to fill in the questionnaire.

Analysis of data

Estimations of farmers regarding incidence, risk factors, therapies and preventive measures were descriptively presented using Stata V.15. The information derived from the veterinary survey was solely presented using descriptive statistics due to small observational numbers. The incidence rate was calculated as the total number of goats with pseudopregnancy divided by the total number of goats per farm (all goats ≤1 year and all goats >1 year). The variation in incidence within and outside the breeding season was corrected for the number of months to estimate the average monthly incidence. The association between incidence and general demographics, breeding management, treatment, measures for reducing pseudopregnancy and number of stress moments in dairy goats were evaluated on herd level using a linear logistic regression model with a Gaussian link function in Stata V.15. The variables were prescreened using univariable analysis techniques. The variables that were potentially associated with the pseudopregnancy incidence (p value <0.3) were selected for inclusion in the multivariable model. The final multivariable model was selected using a stepwise backward selection and elimination method in which, at each round, the variable with the highest overall p value was excluded from the model until all variables had a p value <0.1. The final model was checked for normality by monitoring the skewness and kurtosis of the residuals.

Results

Farmers questionnaire

In total, 43 out of 216 goat farmers who received the email with the invitation to participate completed the questionnaire (response rate: 21.5 per cent). Most respondents were located in the south, the middle or the east of the Netherlands, which corresponded to the areas with the largest dairy goat farm density. At May 31, 2017, the mean number of goats per participating farm was 1.466 (range: 117–10.900) of which on average 522 (range: 0–1800) goats had an extended lactation. The goats produced on average 1165 (SD: 170) litres of milk per goat per year. These numbers and location of dairy goat farms are representative for the Dutch dairy goat industry.[8] Of the 43 participating farms, 39 used a management program (EGAM, ELDA ICT & Services).

Participating farmers indicated that the annual within-herd incidence of pseudopregnacy varied between 1 and 54 per cent (figure 1), with a mean annual incidence of 17 per cent (95 per cent CI 0.14 to 0.21). In 77 per cent of the cases, pseudopregnancy occurred in goats older than one year with an extended lactation, 21 per cent involved goats older than one year without extended lactation and 2 per cent of the goats were younger than one year. Sixty per cent of the participating farmers (n=26) were able to indicate the pseudopregnancy incidence per month over the period June 1, 2016–May 31, 2017. During the year, 64 per cent of the pseudopregnancy cases occurred during the breeding season, from August to February, being 4, 2, 11, 14, 16, 11 and 13 per cent per month, respectively.

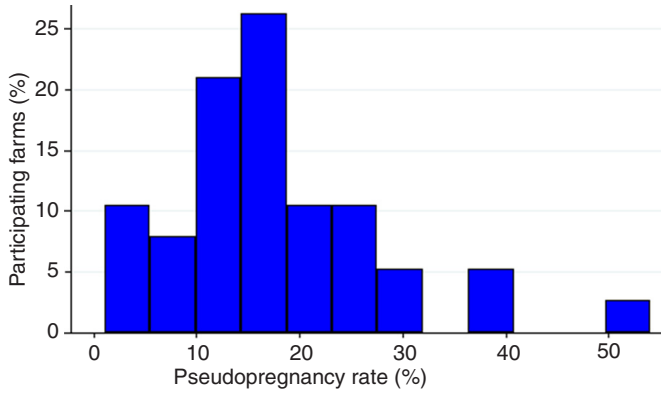

Figure 1 Annual incidence of pseudopregnancy on Dutch dairy goat farms.

The remaining, 36 per cent of the cases, were diagnosed beyond the breeding season from March to August, being 11, 7, 8, 2 and 1 per cent per month, respectively. The breeding season proved to be significantly associated with pseudopregnancy incidence. In 65 per cent of the farms (n=17) whose pseudopregnancy cases were known per month, oestrous was induced by administering vaginal sponges with progesterone analogues in combination with an injection with pregnant mare serum gonadotrophin to synchronise oestrous (July 2016– November 2016). Results did not show a significant increase in pseudopregnancy incidence in the two-month period after this treatment.

On 42 (97 per cent) of the farms (95 per cent CI 0.92 to 1.03), goats with pseudopregnancy were treated with a single intramuscular or subcutaneous injection containing prostaglandin F2α, using varying amounts (mg) per treatment (table 1). On 21 of these farms (50 per cent (95 per cent CI 0.30 to 0.70)), more than in literature recommended dosage per treatment was used[4 11 12]. On the remaining 3 per cent (95 per cent CI 0.003 to 0.21) of the participating farms, treatment was repeated after 2 (n=1) or 10 days (n=3), respectively. The effectiveness of treatment was not followed up on 73 per cent (n=27) of the farms. Follow up of treatment, either by a second ultrasonic examination, or by monitoring the presence of a wet tail or reduction of the abdominal extent, was performed on 22 (n=8), 3 (n=1) and 3 (n=1) per cent of the farms, respectively.

At 97 per cent of the farms (n=37), goats that had been diagnosed pseudopregnant and their off-spring were not excluded from breeding. Thirty-three per cent of the farms applied a variety of management strategies to prevent pseudopregnancy.

Veterinary questionnaire

In total, 27 of 120 veterinary practices completed the questionnaire (response rate: 22.5 per cent). The participating veterinarians supervised in total 118 dairy goat farms, on average four farms (range: 1–18). For diagnosing pseudopregnancy, ultrasound examination was carried out by four veterinarians at six farms.

The veterinarians indicated that pseudopregnancy occurred on all farms (n=118) from June 1, 2016 to May 31, 2017. However, exact pseudopregnancy rates were unknown for veterinarians.

Twenty-six veterinarians advised to treat pseudopregnancy with a single intramuscular or subcutaneous injection with synthetic analogues of prostaglandin F2α using varying amounts of milligrams per treatment (table 1). These veterinarians differed in their opinion with regard to treatment strategy. Forty-four per cent of the veterinarians (n=12) did not advice to repeat the treatment with prostaglandin, 36 per cent (n=9, 95 per cent CI 18 to 57) advised to repeat the treatment only if there was an additional reason (ie, no result after treatment and recurrence of pseudopregnancy) and 16 per cent (95 per cent CI 51 to 88) standardly advised to repeat the treatment 10–14 days after the first intervention. Follow-up after treatment was advised by 78 per cent (n=18) of the veterinarians and included ultrasound examinations (16 times), monitoring of abdominal extent (five times) and monitoring of production or noticing a wet tail (once). Excluding goats that had been pseudopregnant and their off-spring from breeding was advised by 15 per cent (95 per cent CI 4 to 35) of the veterinarians. Others (85 per cent) advised to monitor the goats properly. Seven veterinarians (27 per cent, 95 per cent CI 12 to 48) advised measures that could possibly reduce the number of pseudopregnancies, such as adequate

Table 1 Treatment of pseudopregnancy in Dutch dairy goats: various applied synthetic analogues of prostaglandin F2α and treatment dosages on participating farms (n=41) and advice of dose by veterinarians (n=27) (June 1, 2016–May 31, 2017)

		Farm				Veterinarian			Literature*
Brand name	Active ingredient	Distribution of use at farms	Dose (mg)			Advised dose (mg)			Advised dose (mg)
Dinolytic	Dinoprost	37% (n=15)	1.00	–	10.00	3.75	–	15.00	5†
Enzaprost	Dinoprost	15% (n=6)	5.00	–	50.00	5.00	–	10.00	5†
Estrumate	Cloprostenol	39% (n=16)	0.13	–	0.50	0.06	–	0.38	0.25‡
Planate	Cloprostenol	2% (n=1)	0.18						0.25‡
Genestranvet	Cloprostenol	2% (n=1)	0.08			0.08	–	0.15	0.25‡
Prosolvin	Luprostiol	5% (n=2)	5.63	–	7.50	15			5–7§

Four farms used two brands. Five farms have not shared information about the applied treatment.
*Best standards in literature.
†Hesselink[4] (n=39 goats).
‡Reddy and others[12] (n=20).
§Batista and others[11] (n=12).

Table 2 Potential risk factors for development of pseudopregnancy in Dutch dairy goats: results of univariable analysis of associations with higher incidence of pseudopregnancy per farm

Category	Variables	Expressed in	No. (farms)	P value
General demographics	Goat numbers			
	Total		43	0.27
	Bucks	% of total	43	0.86
	Goats with extended lactation	% of total	43	0.0007
	Age			
	≤1 year	% of total	43	0.41
	>1 year	% of total	43	0.41
	>4 year	% of total	43	0.12
	Annual replacement	% of total	43	0.31
	Milk yield	kg/goat/year	43	<0.0001
Breeding management	Number of ultrasound examinations	Months/year	40	0.0008
	Hormonal oestrous induction	Months/year	43	0.36
	Buck		43	
	Housing right next to dairy goats	Months/year	43	0.83
	Housing in the same building as dairy goats	Months/year	43	0.64
	Natural mating in group (B)	Months/year	43	0.47
	Natural mating guided (G)	Months/year	43	0.12
	Artificial insemination (AI)	Months/year	43	0.51
	Way of mating	Either natural mating/guided mating/ artificial insemination or a combination of mating methods	43	0.25
Treatment	Methods			
	Types of used hormones	Dinolytic (D)/Estrumate (E)/Planate/ Enzaprost/ Genestranvet/Prosolvin (P)/P+E/E+D	37	0.63
	Repetition of treatment	Yes/no	37	0.17
	Dose per injection	<¼, ¼ – ½, >½– 1, >1	32	0.38
Measures for reduction	Excluded for breeding	Yes/no/occasionally/unknown	38	0.6
	Farm measures	Yes/no	43	0.6
	Reassessment	Yes/no	37	0.95
Stress moments in dairy goats	Total (1+2+3+4+5+6)	Stress moments/year	42	0.06
	1. Stable renovations	Months/year	42	0.82
	2. Mucking out	Months/year	41	0.36
	3. Blood sampling	Months/year	41	0.49
	4. Feed changes	Months/year	41	0.05
	5. Claw trimming	Months/year	41	0.54
	6. Total vaccinations (Q+Clos)	Months/year	41	0.58
	Q-fever	Months/year	41	0.74
	Clostridium	Months/year	41	0.66

treatment of metritis, sufficient energy supply in the lamb feed and separation in housing between goats and bucks.

Univariable analysis

Table 2 presents the variables that were included for univariable analysis. In total, nine variables were potentially associated (p value <0.3) with incidence of pseudopregnancy and included: total number of goats per farm, percentage of goats with extended lactation, percentage of goats >4 years of age, milk yield, application of ultrasound, guidance of natural mating, repetition of treatment, total number of stress moments in dairy goats and feed ration changes. The variable number of changes in the diet was included in the number of stress moments and was therefore excluded from the multivariable analysis. The number of goats over four years of age was correlated with the number of goats with extended lactation (r=0.79), and it was decided to exclude the number of goats >4 years from the multivariable analysis (least associated variable).

Multivariable analysis

Seven variables were included in the multivariable analysis. The final model contains two variables (table 3). The incidence of pseudopregnancy on the participating farms was significantly associated with the percentage of goats with extended lactation (95 per cent CI 0.2 per cent to 0.6 per cent) and with applied ultrasound examination (95 per cent CI 0.01 per cent to

Table 3 Risk factors associated with a higher pseudopregnancy rate on Dutch dairy goat farms: results of a multivariable analysis

Variables	Expressed in	Coefficient	95% CI	No. (farms)	P value
Goats with extended lactation	% of total	0.389	0.21 to 0.57	43	<0.0001
Ultrasound examination	Months/year	0.024	0.01 to 0.04	40	<0.0001

0.04 per cent). This means that farms with 80 per cent goats with extended lactation and six applied ultrasound examinations per year do have a 23.2 per cent higher observed incidence of pseudopregnancy than farms with 20 per cent goats with extended lactation and six applied ultrasound examinations.

Discussion

In the last decades, the Dutch dairy goat industry has changed rapidly, as well as the number of farms as the number of goats per farm increased. Consequently, housing, feeding and overall management on these farms have changed considerably. After the large Q fever outbreak in the Netherlands from 2007 to 2010, and enhanced by a recent study that indicated an association between increased numbers of human patients with respiratory disorders and living in close proximity of dairy goat farms, the dairy goat industry is subject of public debate. Therefore, responsible and sustainable dairy goat farming is very important. In this cross-sectional study, we collected information on the incidence of pseudopregnancy and potential risk factors and therapies for pseudopregnancy in the current dairy goat industry in the Netherlands. The mean incidence of pseudopregnancy was 17 per cent, and extended lactation and a higher number of ultrasound examinations were found to be significantly associated with pseudopregnancy. Treatment of pseudopregnancy was carried out in most cases with a single injection of prostaglandin F2α using varying amounts of mg per treatment. Follow-up of treatment was carried out rarely. Goats with pseudopregnancy and previous off-spring were, despite heredity, not excluded from breeding.

Most of the farmers (79 per cent) indicated that the annual incidence of pseudopregnancy on their farm was higher than acceptable to their own standards, possibly indicating dissatisfaction and demonstrating the importance of the issue to be reviewed again. Hesselink[2] reported a mean incidence of pseudopregnancy of 9 per cent (range 3.0–21 per cent) based on observations from three farms in the Netherlands between 1988 and 1990. In that same period, the observed incidence in a French study was 2–3 per cent in >55 per cent of the studied herds (n=139), and more than 5 per cent in 11 per cent of the herds.[13] An annual incidence of 3 per cent was diagnosed on six farms (1998–1999) in Canary Island goats by Batista and others.[11] The mean annual incidence in the present study was found to be higher than reported previously in literature. This could be due to changes in the dairy goat industry in the last decades, for example, an increasing number of goats per farm or an increasing number of goats with an extended lactation. Besides, it cannot be excluded that farmers who experienced more problems with pseudopregnancy at their farm were possibly more motivated to complete the questionnaire which may have influenced the results of this study.

A number of risk factors such as age, breeding season, hormonal oestrous induction and incomplete pseudopregnancy treatment have been re-examined in this study. Mialot and others[13] and Hesselink[2] described a significantly higher incidence in older goats than in yearlings, and this was found in this study as well. Hesselink[2] described previously that pseudopregnancy is more common in the breeding season. This also corresponds to the descriptive findings of this study, although this could not be substantiated in the final multivariable results. Possibly, not all farmers apply a similar amount of ultrasound examinations and therefore might miss pseudopregnancy cases. It has also been described that exogenous induction of ovulation increased the pseudopregnancy rate,[2] but this is not repeatedly shown and not demonstrated in this study.[11 14] High percentages of goats with extended lactation were associated with an increase in the incidence of pseudopregnancy. Additionally, increase in incidence of pseudopregnancy was found to be associated with the number of ultrasound examinations per year. These findings have, to our knowledge, not been described in literature before. Goats with an extended lactation are on average older than goats without an extended lactation, and this could be the explanation for the higher incidence of pseudopregnancy in goats with an extended lactation. However, the age of individual pseudopregnant goats was not correlated to their lactation stage in this study. A higher number of ultrasound examinations per year were also associated with a higher incidence of pseudopregnancy, most likely due to the fact that ultrasound examination is more often applied in farms with a history of higher pseudopregnancy rates. Another theory might be that application of ultrasound energy on pregnant goats could result in a biological alteration of tissues, increasing the probability that pseudopregnancy occurs. Several studies investigated the possible effects of ultrasound energy and especially thermal effects due to the passage of the waveform, with acoustic energy being transformed into heat, and effects of alternating pressure were described.[15–17] Nevertheless, although some risks were described for development of the fetus in early pregnancy, we were not able to find literature that described an association between ultrasound investigation and pseudopregnancy. Given the fact that duration of the ultrasound examination per goat is much less than in humans, we believe that it is unlikely that ultrasound examination in goats would result in an increased heat of tissues.

Although the total number of stress moments and annual milk yield per goat were univariably associated, both were removed from the final multivariable model due to the multivariably insignificant association with pseudopregnancy, possibly because of the relatively low number of observational units.

Pseudopregnancy was mostly treated with cloprostenol or dinoprost (73 per cent), using a large variation in doses per treatment applied. At 62 per cent of the farms where cloprostenol or dinoprost was used, an overdose was applied compared with the advised doses for treatment. Additionally, at 89 per cent of the farms, treatment was administered only once and was not repeated. Hesselink[4] described the first prescribed treatment method and concluded that an intramuscular injection of 5 mg dinoprost is effective and should be administered twice for an optimal treatment. The first injection causes a cloudburst as it induces luteolysis and discharges fluid from the uterus.[1] A second administration is necessary approximately 12 days after the cloudburst to remove the remaining fluid from the uterine lumen,[4 18] therewith reducing possible recurrence after the first oestrous treatment or the next year.[1 4 14 19] Reddy and others[12] repeated this strategy successfully with 0.25 mg of cloprostenol. Other studies used very small numbers of observational units to investigate the optimal method for treatment (≤12 goats per study).[11 18 20 21] The applied treatment dose of prostaglandins could be either based on veterinarian advice or assumed to be the correct dose by the farmers' experience. In order to reduce the use of hormonal therapies in food producing animals, the lowest effective dose should be recommended. Farmers can visually perceive the effect of a single administration of prostaglandins, namely the cloudburst. Witnessing this effect may indicate farmers that the applied therapy was successful and sufficient. This could be a reason to withhold a second treatment, which is unfavourable.

Most farmers (73 per cent) did not follow up whether treatment of pseudopregnancy was effective. Although the exact reason is unknown, it is mentioned that tracing or separating treated goats from the rest of the herd is labour intensive. As a consequence of lack of registration, recurrence rates are often unknown.

Nearly all farms (97 per cent) remained to use goats and their off-spring for breeding after a previous pseudopregnancy. Hesselink and Elving[22] found indications for genetic influences on the occurrence of pseudopregnancy, thus it would be advisable to exclude pseudopregnant goats and their off-spring from the breeding program. Nevertheless, this measure was not applied by many farmers (97 per cent) in this study, possibly because farmers lack pedigree knowledge of the goats in their herd or do not keep recordings of pseudopregnant animals. Currently, economic value of Dutch dairy goats is high and may also play a crucial role during decision making. The fact that nearly all farms still use goats for breeding after previous pseudopregnancy is consistent with the increased incidence of pseudopregnancy.

Veterinarians seemed not to be extensively involved else than prescribing prostaglandins in order to reduce incidences of pseudopregnancy. Therefore, we recommend that Dutch veterinarians should expand their role in guidance and protocolling reproduction activities on dairy goat farms by improving their role in ultrasound examination, registration of disorders, prescribing proper treatment and follow-up of treatment.

The aetiology of the development of pseudopregnancy has still to be unraveled. Additionally, economic effects of pseudopregnancy should be investigated and quantified. To be able to calculate all economic consequences of pseudopregnancy, it is essential to conduct a cohort study on multiple farms to evaluate the effect and possible relationship of pseudopregnancy on milk yield. Part of this information could be collected by analysing data from dairy goat farms in a longitudinal study at farms that properly register information such as cases of pseudopregnancy, milk production, treatments, recurrences and genetics.

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