RISK FACTORS FOR LOW PREGNANCY RATE IN DAIRY CATTLE: A RETROSPECTIVE STUDY IN THE NORTH WEST OF SPAIN

FACTORES DE RIESGO DE LAS BAJAS TASAS DE GESTACIÓN EN VACAS DE PRODUCCIÓN LÁCTEA: ESTUDIO RETROSPECTIVO EN EL NOROESTE DE ESPAÑA

Quintela, L.A., A.I. Peña, M.J. Taboada, G. Alonso, B. Varela-Portas, C. Díaz, M. Barrio, M.E. García, J.J. Becerra and P.G. Herradón

Unit of Reproduction and Obstetrics. Department of Animal Pathology. Faculty of Veterinary Medicine. University of Santiago de Compostela (USC). Lugo. Spain. E-mail: laquiari@lugo.usc.es

ADDITIONAL KEYWORDS

Cow. Reproduction. Fertility.

PALABRAS CLAVE ADICIONALES

Vaca. Reproducción. Fertilidad.

SUMMARY

Risk factors for low pregnancy rate to first artificial insemination (PR/FAI) were studied using 2859 lactations from 203 farms sited in the province of Lugo (Galicia, North West of Spain). Data were obtained from previous records collected by different veterinarians or by the farmers themselves. Potential risk factors considered in the study were: farm size and location, parity, pregnancy length, calving season, calving difficulty, twin calves and potential postpartum diseases (hipocalcaemia, retained placenta, metritis, or ketosis disease). The mean PR/FAI was 49.8 percent. Multiple logistic regression analysis indicated that intervals parturition to first AI shorter than 51 days (OR= 2.47, p<0.01), dystocia (OR= 1.79, p<0.01), autumn calvings (OR= 1.43, p<0.01), cows belonging to farms located in the central area of the province vs those in the coastal area (OR= 1.46, p<0.01) or cows with parity equal to 5 (OR= 1.38, p<0.05) were risk factors for low PR/FAI. Postpartum pathologies such as metritis (OR= 1.75, p<0.01) hypocalcaemia (OR= 1.66, p<0.05) and retained placenta (OR= 1.46, p<0.01) were also associated to a higher risk for low PR/FAI.

RESUMEN

En el presente trabajo se han estudiado los factores de riesgo de las bajas tasas de gestación en primera inseminación artificial, utilizando los datos procedentes de 2859 lactaciones de 203 explotaciones ubicadas en la provincia de Lugo (Galicia, noroeste de España). Los datos fueron obtenidos de los registros previamente recogidos por los diferentes veterinarios o en algunos casos por los ganaderos. Los potenciales factores de riesgo considerados en este estudio fueron: tamaño y situación de la explotación, número de partos, duración de la gestación, intervalo parto primera inseminación, estación de parto, dificultad de parto, parto gemelar y enfermedades posparto (hipocalcemia, retención de placenta, metritis o cetosis). La tasa media de gestación en primera inseminación artificial fue del 49,8 p.100. El análisis de regresión logística múltiple indica que el intervalo entre el parto y la primera inseminación artificial menor de 51 días (OR= 2,47, p<0,01), la distocia (OR= 1,79, p<0,01), los partos de otoño (OR= 1,43, p<0,01), las vacas alojadas en explotaciones localizadas en el área central de la provincia respecto a las localizadas en la zona de la costa (OR= 1,46, p<0,01) o las vacas

con 5 partos (OR= 1,38, p<0,05) tienen un mayor riesgo de no quedar gestantes en la primera inseminación artificial. Las patologías posparto como la metritis (OR= 1,75, p<0,01) hipocalcemia (OR= 1,66, p<0,05) y retención de placenta (OR= 1,46, p<0,01) están también asociadas a un mayor riesgo de bajas tasas de gestación en primera inseminación.

INTRODUCTION

Cows fertility is commonly measured by calculating the percentage of cows that conceive after a single AI service, also known as the pregnancy rate per artificial insemination (PR/FAI). In lactating dairy cows, the PR/FAI has decreased from 66 percent in 1951 (Spalding *et al.*, 1974), to about 50 percent in 1975 (Spalding *et al.*, 1974; Macmillan and Watson, 1975) and to about 40 percent in 1997 (Butler *et al.*, 1995; Pursley *et al.*, 1997a). And this situation has been observed to occur in several countries: Hoekstra *et al.* (1994) reported that the introduction of Holstein Friesian genes had decreased the fertility of the Dutch dairy population; in France, also a decrease in fertility has been observed in the last 20 years (Boichard *et al.*, 1998); and in UK, conception rate at first service is now below 40 percent, thus, the average cow requires more than two AI to get in calf (Royal *et al.*, 2000). There are also reports from USA of a declining fertility in dairy cows (Thompson, 1998; Washburn *et al.*, 2000). In heifers, however, PR/FAI has remained at 70 percent during this same period (Pursley *et al.*, 1997b). Thus, the disparity in PR/FAI between heifers and lactating cows can not be attributed to differences in genetic selection or semen quality, but it is more likely due to physiological changes or to the stress associated with the increased milk production per cow occurred during this time.

The aim of the present study was to evaluate the individual influence of various potential risk factors for low PR/FAI in dairy cows located in the NW of Spain (Province of Lugo). The risk factors considered in the study were: farm location area, farm size, parity, gestation length, calving season, calving difficulty, twin calves, postpartum diseases such as hypocalcaemia, retained placenta, metritis or ketosis disease and days from parturition to first insemination (DPF).

MATERIALS AND METHODS

Animals

A 3-yr retrospective study (from 1999 to 2001) was carried out at 203 dairy farms located in the Province of Lugo (NW of Spain). The farms size ranged between 1 and 68 cows, being a total number of 1144 Holstein Friesian cows, some of which were studied in 2 or 3 consecutive pregnancies. The cows parity ranged between 1 and 16.

All the farms were visited every 4 weeks by designated veterinarians to collect all the herd management data (productive and reproductive records, clinical diseases, treatments, etc.), which were introduced into a general data base. Herd management data from all the farms included in the study were routinely collected by farmers or veterinarians to control the productive

and health status of the herds (i.e. data were not collected on purpose for this study, they would be collected anyway). Within each farm, all calvings occurring during January 1999-June 2001 were used for the study. In all farms, artificial insemination (A.I.) was the only breeding method used.

VARIABLES

Table I shows the selected variables used to predict the PR/FAI. Farm location area was divided in centre and coast, as different management practices may be used by farmers from different zones. The farm size was defined as the number of cows in each farm during the study period, and it was grouped depending on its frequency distribution: small with less than 12 cows, medium with between 12 and 25 cows, and large with more than 25 cows. Parity was classified as 1, 2, 3, 4, 5 and higher than 5. The gestation length was determined by calculating the number of days since the day of A.I to the day of calving, and it was grouped in 3 periods: short when it was shorter than 271 days, medium when it was between 271 and 290 days, and long when it was longer than 290 days. Calving season was classified as spring (April, May, June), summer (July, August, September), autumn (October, November, December) and winter (January, February and March). Calving difficulty was scored as 0 (Normal) when no help was given and 1 (Dystocia) when some obstetrical manipulation or caesarean section was needed for foetal delivering. Hypocalcaemia disease was considered when clinical signs were detected (post-

Table I. *Calving distribution frequencies for the qualitative variables selected to be tested for their predictive value in the PR/FAI in Dairy cattle.* (Distribución de los partos en función de las variables cualitativas seleccionadas por su posible asociación con las tasas de gestación en primera inseminación artificial en vacas de producción láctea).

Variables	Levels	CF	pregnant*
Area	Centre	1347	44.1
	Coast	1521	54.8
Farm size	Small	833	53.8
	Medium	1268	50.5
	Large	758	44.2
Parity	1	520	51.3
	2	677	50.2
	3	525	51.0
	4	351	49.0
	5	279	44.4
	> 5	507	49.7
Gestation length	Short	83	44.6
	Medium	2353	49.4
	Long	423	52.7
Calving season	Spring	831	50.7
	Summer	846	51.3
	Autumn	553	45.0
	Winter	629	50.7
Calving difficulty	Normal	2751	50.2
	Dystocia	108	38.9
Twin calves	No	2759	49.9
	Yes	100	45.0
Hypocalcaemia	No	2776	50.1
	Yes	83	39.8
Retained placenta	No	2671	50.6
	Yes	188	37.8
Metritis	No	2603	51.0
	Yes	256	37.1
Ketosis	No	2778	49.6
	Yes	81	54.3
DPF	Short	613	37.5
	Medium	1713	51.9
	Long	533	57.0

CF= Calving frecuency;*percent of cows pregnant after first AI.

partum cow showing anorexia, postration, hypothermia) and the symptoms responded to treatment with intravenous calcium solutions. Retained placenta was considered to occur when the foetal membranes had not

Table II. *Final logistic regression analysis to estimate adjusted odds-ratio for the PR/FAI in Dairy cattle.* (Análisis de regresión logística en el que se muestran los odds-ratio ajustados para las tasas de gestación en primera inseminación en vacas de producción láctea).

Variables	Levels	odds-ratio (OR)	95 percent confidence interval of the OR
Area**	Center	1.46	1.19-1.77
	Coast	1.00	-
Farm size	Small	0.90	0.69-1.17
	Medium	0.94	0.76-1.16
	Large	1.00	-
Parity	1	1.00	-
	2	1.08	0.85-1.37
	3	1.04	0.81-1.33
	4	1.14	0.86-1.50
	5*	1.38	1.02-1.87
	> 5	1.17	0.90-1.52
Gestation length	Short	1.30	0.79-2.14
	Medium	1.01	0.88-1.36
	Long	1.00	-
Calving season**	Spring	1.07	0.88-1.30
	Summer	1.00	-
	Autumn**	1.43	1.15-1.79
	Winter	1.16	0.94-1.44
Calving difficulty**	Normal	1.00	-
	Dystocia	1.79	1.19-2.69
Twin calves	No	1.00	-
	Yes	1.25	0.82-1.91
Hypocalcaemia*	No	1.00	-
	Yes	1.66	1.05-2.63
Retained placenta*	No	1.00	-
	Yes	1.46	1.06-2.00
Metritis**	No	1.00	-
	Yes	1.75	1.33-2.32
Ketosis	No	1.00	-
	Yes	0.82	0.51-1.29
DPF**	Short**	2.47	1.93-3.16
	Medium*	1.05	1.05-1.58
	Long	1.00	-

*Chi square p value <0.05; **Chi square p value <0.01.

been expelled after 24 post-partum. Postpartum cows with a purulent vaginal discharge and enlarged uterine horns at rectal palpation were diagnosed as having metritis. Ketosis disease was considered when elevated ketone bodies were detected in urine. The number of days from parturition to first AI (DPF) was grouped in 3 intervals: short (less than 51 days), medium (between 51 and 95 days) and long (more than 95 days).

Statistical Analysis

Data were analysed using the SPSS programme (SPSS Inc., Chicago, Illinois, USA). Frequencies were calculated for all the predictive variables. All the selected variables **(table I)** were included as a block in a Multiple Regression Logistic Analysis in order to determine the individual effect of each one on the PR/FAI. Assumption of linearity was found to be valid by using the Hosmer and Lemeshow test.

RESULTS

The mean PR/FAI was 49.8 percent. Multiple Logistic Regression Analysis **(table II)** indicated that the risk for a low PR/FAI was increased in cows with short DPF (OR= 2.47, $p<0.01$), in cows housed in farms located in the central area of Lugo (OR= 1.46; $p<0.01$), in autumn calvings (OR= 1.43, $p<0.01$), when parity was 5 (OR= 1.38, $p<0.05$) and in cows that had suffered metritis (OR=1.75, $p<0.01$), hypocalcaemia (OR= 1.66, $p<0.05$), dystocia (OR= 1.79, $p<0.01$), or retained placenta (OR= 1.46, $p<0.01$).

DISCUSSION

In the farms used for the present study, estrus detection rates were not determined, therefore, fertility was measured as pregnancy rate instead of conception rate.

Farms located in the central area of the province showed a higher risk for low PR/FAI than those located in the coastal area, probably due to different management systems, which might partially account for different fertility.

Boyd and Reed (1961) and Ball (1978) showed a higher frequency of embryo mortality in cows with more than 5 lactations than in cows between the second and the fourth lactations. And Coleman *et al.* (1985) reported that increased lactation number was associated with more reproductive disorders and poorer reproductive performance. In agreement with those authors, results of the present study also showed slight decrease of PR/FAI as parity increased, that was only significant for animals with parity equal to five. Smith and Legates (1962), however, found no association between age and reproductive performance.

Calving season was a significant risk factor for low PR/FAI. The present results showed that autumn calvings predispose to lower pregnancy rates than other calving seasons. It is known that small ovarian follicles are susceptible to heat stress (Badinga *et al.*, 1993; Wolfenson *et al.*, 1995) and that it takes about 40-50 days for small antral follicles to develop into large dominant follicles (Lussier *et al.*, 1987). Delayed effects of heat stress on follicular steroidogenic capacity (Roth e*t al.*, 2001) and follicular

dynamics (Roth *et al.*, 2000), as well as on oocyte quality and embryo development (Roth *et al.*, 1999), could be responsible for the lower fertility of cows found during the autumn.

Dystocia was also a cause of reduced reproductive performance in the cows included in this study. In a survey of the effects of dystocia on fertility in 1889 cows, Laster *et al.* (1973) found that cows which experienced calving difficulties had a delay in resuming estrus and showed 15.9 percent reduction in conception rate compared with cows which had calved normally.

Postpartum pathologies also showed a negative influence on the PR/FAI. Metritis and placenta retention are known to delay the reproductive tract repair process and can reduce the conception rates, especially if they do not receive timely and effective treatment. The detrimental effect of retained placenta and metritis on fertility has been reported by other researchers (Erb *et al.*, 1985; Francos and Mayer, 1988).

Hypocalcaemia was a risk factor for PR/FAI as had been previously reported by Morrow *et al.* (1966) who suggested that delayed uterine involution occurred in cows with milk fever. This may be due to a lack of calcium for efficient uterine contraction, although all hypocalcaemia cases were adequately treated to overcome the clinical signs of disease, and after treatment, serum calcium concentration should be expected to have recovered.

As it was expected, PR/FAI was higher as the DPF was increased. Conception rate and estrous expression improve with each sequential estrous cycle from first ovulation to the third estrous cycle. For maximum fertility cows should be on the third or higher estrous cycle when AI commences (Ott *et al.*, 1986).

In conclusion, intervals parturition to first AI shorter than 51 days (OR= 2.47, $p<0.01$), dystocia (OR= 1.79, $p<0.01$), autumn calvings (OR= 1.43, $p<0.01$), cows belonging to farms located in the central area of the province vs those in the coastal area (OR= 1.46, $p<0.01$) or cows with parity equal to 5 (OR= 1.38, $p<0.05$) were risk factors for low PR/FAI. Postpartum pathologies such as metritis (OR= 1.75, $p<0.01$) hypocalcaemia (OR= 1.66, $p<0.05$) and retained placenta (OR= 1.46, $p<0.01$) were also associated to a higher risk for low PR/FAI.

REFERENCES

Badinga, L., W.W. Thatcher, T. Diaz, M. Drost and D. Wolfenson. 1993. Effect of environmental heat stress on follicular development and steroidogenesis in lactating Holstein cows *Theriogenology*, 39: 797-810.

Ball, P.J.H. 1978. The relationship of age and stage of gestation to the incidence of embryo death in dairy cattle. *Res. Vet. Sci.*, 25: 120-122.

Boichard, D., A. Barbat and M. Briend. 1998. Genetic evaluation for fertility in French dairy cattle. Proc. of an international workshop on Genetic Improvement of Functional Traits in Cattle (GIFT), Fertility and reproduction, Grub,

Germany, Nov., 1997. *Interbull Bulletin,* 18: 99-101.

Boyd, H. and H.C.B. Reed. 1961. Investigations into the incidence and causes of infertility in dairy cattle: I. Fertility variations. *Br. Vet. J.*, 117: 18-35.

Butler, W.R., D.J.R. Cherney and C.C. Elrod. 1995. Milk urea nitrogen (MUN) analysis: Field trial results on conception rates and dietary inputs. Proc Cornell Nutr Conf p. 89.

Coleman, D.A., W.V. Thayne and R.A. Dailey. 1985. Factors affecting reproductive performance of dairy cows. *J. Dairy Sci.*, 68: 1793-1803.

Dematawewa, C.M. and P.J. Berger. 1998. Genetic and phenotypic parameters for 305-day yield, fertility and survival in Holstein. *J. Dairy Sci.*, 81: 2700-2709.

Erb, H.N., R.D. Smith, P.A. Oltenacu, C.L. Guard, R.B. Hillman P.A. Powers, M.C. Smith and M.E. White. 1985. Path model of reproductive disorders and performance, milk fever, mastitis, milk yield, and culling in Holstein cows. *J. Dairy Sci.*, 68: 3337-3349.

Francos, G. and E. Mayer. 1988. Analysis of fertility of cows with extended postpatum anestrus and other reproductive disorders compared to normal cows. *Theriogenology*, 29: 399-412.

Hoekstra, J., A.W. van der Lugt, J.H.J. van der Werf and W. Ouweltjes. 1994. Genetic and phenotypic parameters for milk production and fertility traits in upgraded dairy cattle. *Livest. Prod. Sci.*, 40: 225-232.

Laster, D.B., H.A. Glimp, L.V. Cindiff and K.E. Gregory. 1973. Factors affecting dystocia and the effects of dystocia on subsequent reproduction in beef cattle. *J. Anim. Sci.*, 36: 695.

Lussier, J.G., P. Matton and J.J. Dufour. 1987. Growth rates of follicles in the ovary of the cow. *J. Reprod. Fert.,* 81: 301-307.

Macmillan, K.L. and J.D. Watson. 1975. Fertility differences between groups of sires relative to the stage of oestrus at the time of insemination. *Anim. Prod.*, 21: 243.

Morrow, D.A., S.J. Roberts, E. McEntee and H.G. Gray. 1966. Postpartum ovarian activity and uterine involution in dairy cattle. *J. Am. Vet. Med. Assoc.*, 149: 1596-1609.

Ott, R.S., K.N. Bretzlaff and J.E. Hixon. 1986. Comparison of palpable corpora lutea with serum progesterone concentrations in cows. *J. Am. Vet. Med. Assoc.*, 188: 1417-1420.

Pursley, J.R., M.R. Kosorok and M.C. Wiltbank. 1997a. Reproductive management of lactating dairy cows using synchronization of ovulation. *J. Dairy Sci.*, 80: 301.

Pursley, J.R., M.C. Wiltbank, J.S. Stevenson, J.S. Ottobre, H.A. Garverick and L.L. Anderson. 1997b. Pregnancy rates per artificial insemination for cows and heifers inseminated at a synchronized ovulation or synchronized estrus. *J. Dairy Sci.*, 80: 295.

Roth, Z., A. Arav, A. Bor, Y. Zeron, A. Ocheretny and D. Wolfenson. 1999. Enhanced removal of impaired follicles improves the quality of oocytes collected in the autumn from summer heat-stressed cows. *J. Reprod. Fert.* Abstract Series 23 78 (Abstract).

Roth, Z., R. Meidan, R. Braw-Tal and D. Wolfenson. 2000. Immediate and delayed effects of heat stress on follicular development and its association with plasma FSH and inhibin concentration in cows. *J. Reprod. Fert.,* 120: 83-90.

Roth, Z., R. Meidan, A. Shaham-Albalancy, R. Braw-Tal and D. Wolfenson. 2001. Delayed effect of heat stress on steroid production in medium-sized and preovulatory bovine follicles. *Reproduction*, 121: 745-751.

Royal, M.D., A.O. Darwash, A.P.F. Flint, R. Webb, J.A. Woolliams and G.E. Lamming. 2000. Declining fertility in dairy cattle: changes in traditional and endocrine parameters of fertility. *Anim. Sci.*, 70: 487-501.

Smith, J.W. and J.E. Legates. 1962. Relation of days open and days to dry to lactation milk and fats yields. *J. Dairy Sci.*, 45: 1192-1198.

Spalding, R.W., R.W. Everett and R.H. Foote. 1974. Fertility in New York artificially inseminated Holstein herds in dairy herd improvement. *J. Dairy Sci.*, 58: 718.

Thompson, J.R. 1998. World wide Holstein breeding. Intermediate report workshop EU Concerted action Genetic Improvement of Functional Traits in Cattle; (GIFT). Warsaw, Poland. International Bull Evaluation Service, Bulletin, 19: 29-35.

Washburn, S.P., C.H. Brown, B.T. McDaniel and S.L. White. 2000. Reproductive trends among Southeastern dairy herds. *J. Dairy Sci.*, 83: suppl. 1. 229.

Wolfenson, D., W.W. Thatcher, L. Badinga, J.D. Savio, R. Meidan, B.J. Lew, R. Braw-Tal and A. Berman. 1995. Effect of heat stress on follicular development during the estrus cycle in lactating dairy cattle. *Biol. Reprod.,* 52: 1106-1113.

Recibido: 18-6-03. Aceptado: 19-11-03.

Archivos de zootecnia vol. 53, núm. 201, p. 76.