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Analysis of Risk Factors for Dystocia in a Turkish Holstein Herd

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Abstract: The aim of this study was to investigate the effects of calf birth weight, sex of calf, dam weight, parity of dam, age at first calving, gestation length, season and year of calving on dystocia in a Turkish Holstein herd. The data were collected from the Holstein herd of the research farm of the Agricultural Faculty of Ege University. A total number of 687 calvings (single births) from January 2005 through May 2010 were investigated in the study. The results of the preliminary analysis showed that dystocia was much more prevalent in primiparous cows (41.9% dystocia) compared with multiparous cows (5.1% for second parity and 4.4% for third and greater parity cows). Therefore, the data set was divided into two parts for analyzing dystocia in primiparous (236 first calvings) and multiparous (451 sec and later calvings) cows separately. Binary logistic regression analysis was used to determine the factors affecting dystocia. Variables which had a p-value of ≤0.15 in univariate logistic regression analysis were included in the multivariate analysis. In this stage, backward stepwise logistic regression analysis was carried out and variables which had a p-value of ≥0.10 were removed from the model. For primiparous cows, variables in the univariate analyses with a p-value ≤0.15 were sex of calf, birth weight class, dam weight class, ratio of calf birth weight to dam weight class, gestation length class and year of calving. Of these 6 variables included in the multivariate logistic regression analysis, birth weight class, gestation length class and year of calving remained in the model ($p<0.05$). The risk of dystocia increased with increasing birth weight in first parity cows. Compared to the reference category (birth weight class of ≤35 kg), the risk of dystocia for calves with birth weight classes of 35.1-40.0, 40.1-45.0 and ≥45.1 kg were 1.96, 4.53 and 5.29 times higher, respectively. Heifers with shorter gestation lengths had a lower risk of dystocia. Heifers with gestation lengths of 271-280 days had a 74% lower risk for dystocia compared to heifers with gestation lengths of ≥281 days. For multiparous cows, factors in the univariate analyses with a p-value of ≤0.15 were sex of calf and year of calving. None of these factors was found to have a significant effect ($p>0.10$) on dystocia in multivariate logistic regression analysis for multiparous cows.

Key words: Dystocia, risk factors, holsteins, primiparous cows, multiparous cows, Turkey

INTRODUCTION

Dystocia is defined as delayed or difficult calving requiring sometimes severe assistance (Lombard *et al*., 2007; Zaborski *et al*., 2009). It has a considerable impact on dairy cattle production. Dystocia can have a traumatic effect on both the cow and the calf (Johanson and Berger, 2003), resulting in loss of milk production, delayed conception, early culling, sometimes death of the calf or cow and increased cost of veterinary treatment especially for uterine infections (Dematawewa and Berger, 1997; Rajala and Grohn, 1998; Mee, 2008). On the other hand, dystocia causes pain or pain and injury. Thus it is also a problem associated with animal welfare.

Dystocia is a complex reproductive problem. Dystocia is affected by several factors such as breed, parity of dam, sex of calf, birth weight of calf, weight of dam at parturition, ratio of calf birth weight to dam weight, pelvic size of dam, gestation length, nutrition, periparturient management and year and season of calving (Laster *et al*., 1973; Thompson *et al*., 1983; Sieber *et al*., 1989; Berger *et al*., 1992; Berger, 1994; Johanson and Berger, 2003; Mee, 2008; Zaborski *et al*., 2009).

The risk of dystocia is much greater in first parity cows compared with later parity cows (Sieber *et al*., 1989; Meyer *et al*., 2001; Johanson and Berger, 2003; Berry *et al*., 2007; Lombard *et al*., 2007). Lombard *et al*. (2007) found that a larger percentage of male calves (40.0%) had mild or severe dystocia compared with female calves (33.0%).

To the knowledge, there is no research published on risk factors for dystocia in dairy cattle in Turkey. The aim of this study was to investigate the effects of calf birth

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weight, sex of calf, dam weight shortly after parturition, parity of dam, age at first calving, gestation length, season and year of calving on dystocia in a Turkish Holstein herd.

MATERIALS AND METHODS

The data were collected from the Holstein herd of the research farm of the Agricultural Faculty of Ege University. A total number of 713 calvings from January 1, 2005 through May 11, 2010 were investigated in this study. The data set included information such as date of calving, dystocia score, birth number (single or twin), sex of calf, birth weight of calf, parity of dam, age of dam at calving, mean weight of dam in the 1st week after parturition, sire of the calf, sire of the dam and gestation length. After a preliminary analysis, 26 twin births were excluded from the data.

Since the results of the preliminary analysis showed that dystocia was much more prevalent in primiparous cows (41.9% dystocia) compared with multiparous cows (5.1% for second parity and 4.4% for third and greater parity cows), the data set was divided into two parts for analyzing dystocia in primiparous and multiparous cows separately. In the final data sets, there were 236 first parity cows (heifers) and 451 second and greater parity cows with parities ranging from 2-9.

Dystocia was scored by the veterinarian of the Faculty farm on a scale of 1-5 with 1 = unobserved but no problem, 2 = no assistance, 3 = easy pull, 4 = difficult (hard pull), 5 = extreme difficulty (hard pull with damage on vulva or vagina or both). In the analyses, dystocia scores were classified into two groups as no dystocia (score 1, 2 or 3) and dystocia (score 4 or 5).

Season of calving was classified into two groups as cold and warm season. Cold season included the months from November through April while warm season included the months from May through October.

Birth weight of the calf was measured during the 1st week after birth. In the farm all cows were weighed by an automatic walk through cow weighing system (Taxatron 5000, Westfalia-Surge) after exit from the milking parlor. The weighing data were transferred and stored on-line on a computer and evaluated through a herd management software. The software calculates the weekly average of the body weights for each cow from daily body weight measurements. In this study, average body weights of cows for the 1st week after parturition were used.

Statistical analyses were carried out using SPSS (2006). For descriptive results the Descriptives, the Crosstabs and the Means procedures were used.

The dependent variable (dystocia) in this study was a dichotomous variable (0 = no dystocia or 1 = dystocia). Binary logistic regression procedure of SPSS (2006) was used to determine the factors affecting dystocia. First, univariate logistic regression analysis was performed for each of the potential effects on dystocia. Then, variables (effects) which had a p-value of ≤0.15 were included in the multivariate analysis. In this stage, backward stepwise: LR (likelihood ratio) logistic regression analysis was carried out and variables which had a p-value of ≥0.10 were removed from the model. The analyses described above were performed separately for primiparous and multiparous cows.

RESULTS AND DISCUSSION

Descriptive statistics of risk factors for dystocia: Mean birth weights of calves are shown in Table 1 by sex of calf within parity. The overall mean of birth weight for female and male Holstein calves were 40.2 and 42.5 kg, respectively. Male calves were heavier than female calves for all parities. Furthermore, birth weights increased as parity increased. Mean birth weights of calves from first, second and third and greater parity cows were 39.8, 41.0 and 43.0 kg, respectively. In Table 2, mean body weights of dams in the 1st week after parturition were given according to parity. Mean body weights of dams were 526.6, 588.7 and 644.6 for first, second and third and greater parities, respectively.

Table 1: Means and standard deviations of birth weights (kg) by sex of calf within parity

	Female			Male			Overall		
Parity	N	Mean	SD	N	Mean	SD	N	Mean	SD
1	88	38.2	4.3	107	41.0	4.3	195	39.8	4.5
2	60	39.2	4.9	76	42.4	5.3	136	41.0	5.4
≥3	124	42.1	4.3	113	44.0	4.6	237	43.0	4.5
Overall	272	40.2	4.8	296	42.5	4.8	568	41.4	4.9

Table 2: Means and standard deviations of dam body weights (kg) after parturition by parity

Parity	N	Mean	SD	Min.	Max.
1	221	526.6	51.2	402	729
2	145	588.7	59.5	475	799
≥3	252	644.6	54.4	500	833
Overall	618	589.3	75.0	402	833

Table 3: Means and standard deviations of ratio of calf birth weight to dam weight (%) by sex of calf within parity

	Female			Male			Overall		
Parity	N	Mean	SD	N	Mean	SD	N	Mean	SD
1	83	7.2	1.02	102	7.9	0.98	185	7.6	1.06
2	57	6.8	0.97	68	7.2	0.80	125	7.0	0.91
≥3	109	6.5	0.77	92	6.8	0.86	201	6.6	0.83
Overall	249	6.8	0.96	262	7.4	1.02	511	7.1	1.03

Table 4: Means and standard deviations of gestation length (day) by sex of calf within parity

	Female			Male			Overall		
Parity	N	Mean	SD	N	Mean	SD	N	Mean	SD
1	107	276.5	4.4	122	278.4	4.9	229	277.5	4.8
2	73	277.7	6.3	85	279.8	6.8	158	278.8	6.6
≥3	153	279.5	4.9	135	279.3	4.5	288	279.4	4.7
Overall	333	278.1	5.2	342	279.1	5.3	675	278.6	5.3

Table 5: Rates of dystocia by year of calving

Year of calving	No dystocia (Score = 1, 2 or 3)	Dystocia (Score = 4 or 5)	Overall
2005			
N	101	18	119
%	84.9	15.1	100
2006			
N	90	30	120
%	75	25.0	100
2007			
N	112	24	136
%	82.4	17.6	100
2008			
N	95	17	112
%	84.8	15.2	100
2009			
N	121	26	147
%	82.3	17.7	100
2010			
N	48	5	53
%	90.6	9.4	100
Overall			
N	567	120	687
%	82.5	17.5	100

Dystocia scores:1 = unobserved but no problem, 2 = no assistance, 3 = easy pull, 4 = difficult (hard pull), 5 = extreme difficulty

Table 6: Rates of dystocia by sex of calf within parity

Parity	Sex of calf	No dystocia (Score = 1, 2 or 3)	Dystocia (Score = 4 or 5)	Overall
1	Female			
	N	75	35	110
	%	68.2	31.8	100
	Male			
	N	62	64	126
	%	49.2	50.8	100
	Overall			
	N	137	99	236
	%	58.1	41.9	100
2	Female			
	N	72	2	74
	%	97.3	2.7	100
	Male			
	N	80	6	86
	%	93	7.0	100
	Overall			
	N	152	8	160
	%	95	5.0	100
≥3	Female			
	N	149	5	154
	%	96.8	3.2	100
	Male			
	N	129	8	137
	%	94.2	5.8	100
	Overall			
	N	278	13	291
	%	95.5	4.5	100
Overall	Female			
	N	296	42	338
	%	87.6	12.4	100
	Male			
	N	271	78	349
	%	77.7	22.3	100

Dystocia scores:1 = unobserved but no problem, 2 = no assistance, 3 = easy pull, 4 = difficult (hard pull), 5 = extreme difficulty

The ratios of calf birth weights to dam weights were also calculated as one of the important risk factors for calving difficulty. The higher the ratio, the higher the risk for dystocia. The ratios by sex of calf within parity are shown in Table 3. As can be expected, mean ratio for male calves was higher than that for female calves in all parities. On the other hand, the ratios decreased with increasing parity.

Table 4 has mean gestation lengths according to sex of calf within parity. Generally, mean gestation length increased as parity increased. Furthermore, gestation length for male calves was longer than that for female calves. Rates of dystocia by year of calving are shown in Table 5. The overall mean of dystocia rate in the herd was 17.5%. The rate of dystocia ranged from 9.4% in 2010 to 25.0% in 2006. Table 6 shows rates of dystocia by sex of calf within parity. First parity cows had by far the highest dystocia rate with 41.9%. Dystocia rates for second parity cows and third and greater parity cows were 5.0 and 4.5%, respectively. The overall dystocia rates for female and male calves were 12.4 and 22.3%, respectively. Within first parity cows, dystocia rates for female and male calves were 31.8 and 50.8%, respectively. The corresponding values were 2.7 and 7.0% for second parity cows and 3.2 and 5.8% for third and greater parity cows, respectively.

Table 7: Means of birth weight, dam weight, ratio of calf birth weight to dam weight, gestation length and age of calving by non-dystocic and dystocic calvings within parity

	Birth weight (kg)		Dam weight (kg)		Calf/Dam ratio (%)		Gestation length (day)		Age of calving (month)	
Parity	No dystocia	Dystocia[2]	No dystocia	Dystocia	No dystocia[1]	Dystocia	No dystocia	Dystocia	No dystocia	Dystocia
1	38.8	41.2	529.5	522.4	7.4	7.9	276.3	279.2	27.4	27.4
	(113)[3]	(82)	(130)	(91)	(107)	(78)	(135)	(94)	(137)	(99)
	40.8	44.7	588.6	589.9	7.0	7.7	279.0	275.4	41.8	40.2
2	(130)	(6)	(138)	(7)	(119)	(6)	(150)	(8)	(152)	(8)
	42.9	44.5	644.1	662.3	6.6	6.8	279.4	280.9	73.7	77.7
≥3	(227)	(10)	(245)	(7)	(196)	(5)	(275)	(13)	(278)	(13)
Overall	-	-	-	-	6.9	7.9	278.5	279.2	-	-
	-	-	-	-	(422)	(89)	(560)	(115)	-	-

[1]Dystocia score = 1, 2 or 3; [2]Dystocia score = 4 or 5; [3]Figures in parenthesis indicate the number of observations

In Table 7, means of birth weight, dam weight, ratio of calf birth weight to dam weight, gestation length and age of calving by non-dystocic and dystocic calvings within parity are given. Mean birth weight of calves with dystocia was higher than that of calves with no dystocia for all parities. Mean weight after parturition in first parity cows with dystocia was lower than that of cows with no dystocia. However, this trend disappeared in later parities. Mean ratio of calf birth weight to dam weight for dystocic cases was higher than the ratio for non-dystocic cases in all parities. Mean gestation length in cows with dystocia was higher than that of cows with no dystocia, except for second parity cows. Mean age of calving was the same in first calving cows with dystocia or no dystocia.

Logistic regression analysis of dystocia for primiparous cows: Table 8 shows the results of univariate logistic regression analysis for primiparous cows in which every potential risk factor for dystocia was analyzed separately.

The dystocia rate of 50.8% for male calves was higher than the rate of 31.8% for female calves. The rate of dystocia increased with increased calf weight. For birth weight classes of ≤35.0, 35.1-40.0, 40.1-45.0 and ≥45.1 kg, the rates of dystocia were 25.9, 34.4, 52.7 and 65.2%, respectively. Rate of dystocia increased with decreased dam weight. For dam weight classes of ≤475, 476-550 and ≥551 kg, the rates of dystocia were 58.3, 39.8 and 34.7%, respectively. The rate of dystocia also increased with the increasing ratio of birth weight to dam weight at parturition. For ratio of birth weight to dam weight classes of ≤7.0, 7.01-8.00, 8.01-9.00 and ≥9.01, the rates of dystocia were 28.0, 37.1, 55.3 and 66.7%, respectively. The rate of dystocia also increased with increased gestation length. By gestation length classes of ≤270, 271-280 and ≥281 days, the rates of dystocia were 25.0, 32.7 and 65.6%, respectively. There was no relationship between age at first calving, season of calving and rate of dystocia ($p>0.15$).

Variables in the univariate analyses with a p-value of ≤0.15 (sex of calf, birth weight class, dam weight class, ratio class, gestation length class and year of calving) were included in the multivariate logistic regression analysis. The results of the multivariate analysis are shown in Table 9. Of the 6 variables, birth weight class, gestation length class and year of calving remained in the model ($p<0.05$). The risk of dystocia increased with increasing birth weight. Compared to the reference category (birth weight class of ≤35 kg), the risk of dystocia for calves with birth weight classes of 35.1-40.0, 40.1- 45.0 and ≥45.1 kg were 1.96, 4.53 and 5.29

Table 8: Dystocia rates by potential effects on dystocia in primiparous cows and P-values from univariate logistic regression analysis

		Dystocia (Score = 4 or 5)		
Variables	N	N	%	p-value
Sex of calf (N = 236)				
Female	110	35	31.8	0.003
Male	126	64	50.8	-
Birth weight (kg) (N = 195)				
≤35.0	27	7	25.9	0.007
35.1-40.0	90	31	34.4	-
40.1-45.0	55	29	52.7	-
≥45.1	23	15	65.2	-
Dam weight (kg) (N = 221)				
≤475	36	21	58.3	0.063
476-550	113	45	39.8	-
≥551	72	25	34.7	-
Ratio of birth weight to dam weight at parturition (N = 185)				
≤7.0	50	14	28.0	0.007
7.01-8.00	70	26	37.1	-
8.01-9.00	47	26	55.3	-
≥9.01	18	12	66.7	-
Age at first calving (month) (N = 236)				
≤23.9	18	7	38.9	0.927
24.0-29.9	171	73	42.7	-
≥30.0	47	19	40.4	-
Gestation length (day) (N = 229)				
≤270	12	3	25.0	0.000
271-280	156	51	32.7	-
≥281	61	40	65.6	-
Year of calving (N = 236)				
2005	32	9	28.1	0.117
2006	49	28	57.1	-
2007	45	19	42.2	-
2008	43	16	37.2	-
2009	52	23	44.2	-
2010	15	4	26.7	-
Season of calving (N = 236)				
Warm	101	43	42.6	0.866
Cold	135	56	41.5	-

Table 9: Multivariate logistic regression analysis for dystocia in primiparous cows

Variables[1]	N	B	SE	Wald	df	P	Exp (B) (Odds ratio)	95% CI for Exp (B) Lower	Upper
Birth weight (kg)	178	-	-	8.623	3	0.035	-	-	-
≤35.0	24	-	-	-	-	-	1.000	-	-
35.1-40.0	82	0.674	0.592	1.293	1	0.255	1.961	0.614	6.261
40.1-45.0	50	1.510	0.634	5.667	1	0.017	4.526	1.306	15.686
≥45.1	22	1.665	0.764	4.752	1	0.029	5.285	1.183	23.609
Gestation length (day)	178	-	-	10.495	2	0.005	-	-	-
≤270	6	-1.209	1.006	1.444	1	0.229	0.299	0.042	2.145
271-280	119	-1.345	0.415	10.489	1	0.001	0.261	0.116	0.588
≥281	53	-	-	-	-	-	1.000	-	-
Year of calving	178	-	-	13.564	5	0.019	-	-	-
2005	12	-	-	-	-	-	1.000	-	-
2006	35	2.756	0.936	8.669	1	0.003	15.731	2.513	98.489
2007	42	1.791	0.908	3.893	1	0.048	5.993	1.012	35.495
2008	35	1.603	0.924	3.010	1	0.083	4.968	0.812	30.392
2009	43	1.310	0.900	2.120	1	0.145	3.706	0.635	21.616
2010	11	0.694	1.095	0.402	1	0.526	2.003	0.234	17.130
Constant	-	-0.610	0.376	2.629	1	0.105	0.543	-	-

[1]Variables entered in step 1 were sex of calf, birth weight class, dam weight class, ratio class, gestation length class, and year of calving. *Nagelkerke R^2 value of the model is 0.264

times higher, respectively. Heifers with shorter gestation lengths had a lower risk of dystocia. Heifers with gestation lengths between 271 and 280 days had a 74% lower risk for dystocia compared to heifers with gestation lengths of ≥281 days.

Logistic regression analysis of dystocia for multiparous cows: The statistical analyses carried out for primiparous cows were also carried out for multiparous cows. Table 10 shows the results of univariate logistic regression analysis for multiparous cows in which potential risk factors for dystocia was analyzed separately. The dystocia rate for male calves with 6.3% was higher than that for female calves with 3.1%. There was no relationship between the rate of dystocia and birth weight class, dam weight class, ratio class, parity of dam, gestation length class and season of calving, for multiparous cows (p>0.15).

Variables in the univariate analyses with a p-value of ≤0.15 (sex of calf and year of calving) were included in the multivariate logistic regression analysis. None of these potential risk factors was found to have a significant effect on dystocia (p>0.10) in multivariate analysis for multiparous cows.

Dystocia rates in primiparous and multiparous cows: The results showed that the rate of dystocia was by far higher in first calvings compared with later calvings in the Holstein herd investigated. Sieber *et al.* (1989) reported 51.7, 20.1, 17.4, 17.1 and 14.1% dystocia in Holsteins from Iowa State University research dairy herd for 1st-5th and greater parities, respectively. In a later study in the same herd, Johanson and Berger (2003) reported that first-parity cows had an incidence of dystocia of 40.4% and later parity cows had an incidence of 13.2%.

Table 10: Dystocia rates by potential effects on dystocia in multiparous cows and p-values from univariate logistic regression analysis

Variables	N	Dystocia (score = 4 or 5) N	%	p-value
Sex of calf (N = 451)				
Female	228	7	3.1	0.113
Male	223	14	6.3	-
Birth weight (kg) (N = 373)				
≤35.0	25	0	0.0	0.932
35.1-40.0	105	4	3.8	-
40.1-45.0	157	7	4.5	-
≥45.1	86	5	5.8	-
Dam weight (kg) (N = 397)				
≤550	51	1	2.0	0.784
551-625	146	5	3.4	-
≥626	200	8	4.0	-
Ratio of birth weight to dam weight at parturition (N = 326)				
≤6.00	57	0	0.0	0.360
6.01-7.00	148	3	2.0	-
7.01-8.00	93	6	6.5	-
≥8.01	28	2	7.1	-
Parity (N = 451)				
2	160	8	5.0	0.797
≥3	291	13	4.5	-
Gestation length (day) (N = 446)				
≤270	17	2	11.8	0.297
271-280	243	9	3.7	-
≥281	186	10	5.4	-
Year of calving (N = 451)				
2005	87	9	10.3	0.149
2006	71	2	2.8	-
2007	91	5	5.5	-
2008	69	1	1.4	-
2009	95	3	3.2	-
2010	38	1	2.6	-
Season of calving (N = 451)				
Warm	221	8	3.6	0.310
Cold	230	13	5.7	-

Lombard *et al.* (2007) evaluated 7380 calving records on 3 Colorado dairy operations with >95% Holsteins and reported that 51.2% of primiparous cows and 29.4% of multiparous cows required assistance during calving.

Meyer *et al.* (2001) found that the incidence of dystocia in the U.S. Holstein population was 28.7 and 10.7% for primiparous and multiparous cows, respectively.

Berry *et al.* (2007) also reported that first calving cows were more likely to have a difficult calving relative to older cows. Moreover, they stated that older parity cows did not significantly differ from each other in risk of dystocia. On the other hand, it should be emphasized that dystocia scoring systems were not the same in the studies mentioned above. Mee (2008) pointed out the fact that there is clearly a need for a uniform international dystocia scoring system to facilitate comparisons.

Factors affecting dystocia in primiparous cows: The effect of calf birth weight on dystocia was found to be significant in multivariate logistic regression analysis for primiparous cows. Risk of dystocia increased with increasing calf weight. This result is consistent with the results of Laster *et al.* (1973), Sieber *et al.* (1989), Johanson and Berger (2003) and Berry *et al.* (2007). Johanson and Berger (2003) found that the odds of dystocia increased by 13% kg^{-1} increase in birth weight. In addition, birth weights of male calves are generally heavier than those of female calves. Thus, the risk of dystocia is higher for male calves. On the other hand, morphological differences between female and male calves increase the risk of dystocia in male calves (Berry *et al.*, 2007). Ratio of calf birth weight to dam weight shortly after parturition was highest in the first parity cows in this study (Table 3). Mee (2008) stated that the main cause of dystocia is Feto-Pelvic Disproportion (FPD) in primiparous cows and the two primary determinants of FPD are calf birth weight and maternal pelvic size.

This study showed that long gestation lengths were associated with higher risk of dystocia in primiparous cows (Table 7-9). Mean birth weights for gestation length classes of ≤270, 271-280 and ≥281 days were 36.8, 38.7 and 42.8 kg, respectively (not given in tables). As shown in our study, as gestation length increases, calf birth weight also increases (Mee, 2008). In addition, gestation lengths are longer for male calves compared with female calves (Table 4). Thus, the higher risk of dystocia in long gestation lengths is associated with increased calf weight or sex of calf or with both.

Factors affecting dystocia in multiparous cows: None of the potential risk factors was found to have a significant effect on dystocia in multivariate logistic regression analysis for multiparous cows. Rate of dystocia was low in multiparous cows and none of the potential effects included in the multivariate logistic regression analysis was a valuable predictor of dystocia in multiparous cows in this study.

CONCLUSION

This study showed that dystocia is an important problem mainly in primiparous cows in Holsteins. Calf birth weight is an important risk factor for dystocia in Holstein heifers. Gestation length which is a factor related with calf birth weight and sex of calf is also a risk factor for dystocia. More attention should be given to periparturient management in primiparous cows.

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