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Environmental Factors Affecting Gestation Duration and Time of Foaling of Pure Bred Arabian Mares in Algeria

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ABSTRACT

The aim of this study was to determine the influence of some environmental factors on pregnancy length and time of foaling in purebred Arabian mares raised at the national Haras of Chawchawa in Tiaret Algeria. 1262 breeding records from 1985 to 2010 were analyzed and every hour of birth was noted from 2003 to 2010. The mean gestation length, for all years was 332.85±19.81 days. Effect of foal sex, breeding month, breeding age and breeding year was significant ($p<0.005$). The gestation lasted a little bit longer 333.71±8.39 days in mares having had colts, than with the mares having had fillies 332.19±8.68 days. We also noted a significant effect of mares and years on the hour of birth ($p<0.005$). It was noted that 76.19% of foalings occurred between 7 to 19 h. The lowest gestation duration was found 319.75±3.30 days in December and 329.08±7.33 days in January. It was noted that gestation duration increase in other months of birth. Ratios of estrus, pregnancy, sterility, parturition and abortion were 82.51, 62.32, 37.68, 59.77 and 2.55% for Arabian mares, respectively. The results of this study were similar to those described for Arabian mares and other mares' breeds reported in literature.

Key words: Arabian mares, reproductions, performances, pregnancy length, time of birth

INTRODUCTION

Length of gestation in the mare is highly variable and the variability in physical signs of imminent parturition makes predicting foaling particularly difficult. Arabian purebred mares were raised in Algeria since 1886. Those mares usually deliver in open field, without veterinary assistance. Gestation length in the mare has been previously reported by many authors as being 339 (Whitwell and Jeffcott, 1975; Rossdale and Ricketts, 1980) and 344 (Morel *et al.*, 2002) days in Thoroughbred mares and in Arabian mares as being 332.84±0.81 and 336±0.5 days (Demirci, 1988) heritability of gestation length for Arabian mares was reported between 0.16 and 0.36 (Taveira and Mota, 2007). Generally, gestation lengths of 320–360 days are considered acceptable (Panchal *et al.*, 1995). This large variability of time in which viable foals can be born, indicates that gestation length in the mare may be highly susceptible to both genetic and environmental factors. It was reported that gestation duration was longer when mares gave birth to colt rather than fillies (Perez *et al.*, 2003; Sevinga *et al.*, 2004) and most of mares (81.2%) foaled at night (Sevinga *et al.*, 2004). According to published studies, the main environmental factors

influencing gestation period in a certain breed are related to age of mother, number of foalings, nutrition, sex of the foal, year and month of conception, season of conception and photoperiodic influence (Howell and Rollins, 1951; Pozo-Lora, 1954; Flade and Frederich, 1963; Hevia *et al.,* 1994; Panchal *et al.,* 1995; Morel *et al.,* 2002). It was reported that age of mares significantlyinfluenced length of gestation (Demirci, 1988; Valera *et al.,* 2006). Younger fillies at first mating showed longer duration of pregnancy an negatively correlated with mar's age (Cacic *et al.*,2002). Although, Demirci (1988) reported that there was a negative correlation with between the age of mares and gestation length and young mares have longer gestation duration than old mares, Valera *et al.* (2006) reported that gestation duration decrease as the mare gets older, with the shortest gestations periods when the mare is 10-12 years old.

The variation in physical signs of imminent parturition makes the prediction of parturition in the mare particularly difficult. The management of high-value stock demands the precise prediction of parturition. Even though in the equine the gestational length is insufficient to determine foetal readiness for birth (Lofstedt, 1992) since, to a certain extent, the mare can regulate the size of the foal (Allen *et al.,* 2002) the knowledge of the gestation length and the possibility of predicting the date of birth can be important to a successful management of the pregnant mare. The inability to accurately predict the timing of parturition is incurred in extra labour and veterinary costs, as well as higher risks to both mare and foal (Morel *et al.,* 2002). Furthermore, to coordinate deliveries in a given period of time, mares can be grouped according to their predicted gestation lengths. On the other hand, this enables the culling of mares with very long gestation periods that result in very large foals, which can, under some conditions, cause dystocic labours, as well as of mares with very short gestation periods that produce very light-weight foals.

According to published studies, the main environmental factors influencing gestation period in a certain breed are related to age of mother, number of foalings, nutrition, sex of the foal, year and month of conception, season of conception and photoperiodic influence (Howell and Rollins, 1951; Pozo-Lora, 1954; Flade and Frederich, 1963; Hevia *et al.,* 1994; Panchal *et al.,* 1995; Morel *et al.,* 2002).

This study was conducted to investigate the environmental factors affecting pregnancy duration and foaling time of pure bred Arabian mares raised in Algeria.

MATERIALS AND METHODS

The research was carried out from 2006 to 2010. Breeding records of 1262 Arabian mares raised at the national Haras of Chawchawa in Tiaret Algeria, between 1985 and 2010 were collected. Time of foalings was only noted from 2003 to 2010. And from fertility records of 2155 mares, ratios of estrus, pregnancy, sterility, parturition and abortion were calculated. All mares were kept under similar conditions of management and sired by sixty-six Arabian stallions. Mating was by natural mount. Until 1998, gestation lengths were calculated as the time from mating to parturition. This was assumed to be equivalent to ovulation to parturition. From this year on, in all gestations, the moment of ovulation was determined using ultrasound scanning. The advent of ultrasonic scanning began in this stud farm and so, from 2002 onwards, the accurate timing of ovulation and hence, the precise calculation of gestation length, could be made. Gestation lasting with alive birth between 310 and 355 days was to be considered normal and was used for calculation.

With this information, we have studied the descriptive statistics of the gestation length variable for the global population, as well as for each breed. To analyse the possible influence of the different environmental factors on gestation length of the mares, we carried out an ANOVA

factorial model using STATISTICA 5.0 PL, which included as factors the age of the mother, the month and year of conception and the sex of the foal, as well as different interactions between these factors.

RESULTS AND DISCUSSION

Data of gestation length of mares that foaled from 1985 to 2010, evaluated by breeding age, breeding month, breeding year and foal sex are given in Table 1. The average gestation length was estimated as 332.95±8.57 days for Arabian mares, which are in the limits, reported in literature (Demirci, 1988). The lowest gestation duration was found 327.22±8.11 days in 2004. The highest gestation duration was found 338.48±7.28 days in 1999. Many studies have confirmed wide variations in gestation length for different breeds of horses (Salerno and Montemurro, 1965;

Table 1: Gestation length of arabian mares raised in algeria, evaluated by breeding age, breeding month, breeding year and foal sex

Factors	n	Mean	±SD	Factors	n	Mean	±SD
Breeding (year)				**Breeding year**			
3	3	337.33	4.62	1985	50	331.64	7.37
4	40	328.18	7.04	1986	62	333.03	8.26
5	72	330.10	9.43	1987	61	331.18	7.15
6	87	331.26	7.43	1988	55	330.27	7.62
7	80	331.16	8.48	1989	60	335.77	7.84
8	72	334.01	7.72	1990	56	333.36	8.67
9	83	333.41	7.78	1991	46	334.83	8.31
10	78	331.23	8.68	1992	57	331.72	8.54
11	70	332.51	6.75	1993	61	333.97	7.47
12	76	332.20	7.93	1994	48	337.00	8.73
13	87	334.46	7.26	1995	31	330.26	10.14
14	74	332.72	8.06	1996	47	337.13	7.99
15	76	332.26	9.35	1997	52	337.08	8.26
16	62	331.61	8.21	1998	31	332.81	7.88
17	59	333.88	7.95	1999	31	338.48	7.28
18	61	334.21	8.50	2000	43	333.98	7.67
19	53	332.98	7.77	2001	20	333.35	10.15
20	50	333.34	7.44	2002	47	331.87	8.35
21	35	332.23	8.92	2003	58	334.03	8.16
22	24	333.38	8.47	2004	50	327.22	8.11
23	13	334.85	8.01	2005	57	335.14	7.87
24	7	328.86	10.85	2006	50	332.40	8.79
Breeding months				2007	45	332.18	9.25
December	4	319.75	3.30	2008	42	331.88	8.44
January	187	329.08	7.33	2009	49	330.82	8.45
February	454	333.11	8.47	2010	53	326.55	7.65
March	349	334.53	8.09	Over all mean	1262	332.95	8.57
April	201	333.10	9.32				
May	66	334.98	8.81				
June	1	317.00	0.00				
Sex of foal							
Colt	627	333.71	8.39				
Filly	635	332.19	8.68				
Over all mean	1262	332.95	8.57				

Perez *et al.,* 2003). An equine gestation length between 320 and 360 days can be considered normal (Laing and Leech, 1975; Rossdale *et al.,* 1984; Rossdale, 1993). Gestations shorter than 300 days are not viable because vital foetal organs are not fully developed, even though 'full-term' gestations have been described lasting from 294 to 386 days (Rossdale, 1976).

Comparing our results with results obtained in other genetically related breeds, we find that, in the Lusitano breed, the gestation periods are longer than ours, according to Mario and Vidal (1986). In the Lippizaner horse, the mean gestation period is 5 days longer than ours, according to Ilancic (1958). In our study we obtained a gestation period of 332.95 days, shorter than that of 336.4 days found by Howell and Rollins (1951) and of 337.4 days found by Mauch (1937).

There is no doubt that the country or geographic area where breeds are kept can influence the differences observed within these breeds. We cannot compare gestation periods in a cold, rainy climate with few hours of sunlight (such as Holland or Germany), with a dry, hot climate with a much higher number of sunlight hours, such as Spain.

Gestation length of mare gave birth to colt was 333.71±8.39 days longer duration than duration of mares gave birth to fillies 332.19±8.68 days. Effect of foal sex was significant ($p<0.005$). The effect of sex of the foal on equine gestation length was studied (Gerger, 1960; Matassino, 1962; Pjanovic, 1965; Akkayan and Demirtel, 1974; Hintz *et al.,* 1979a; Hevia *et al.,* 1994; Panchal *et al.,* 1995; Morel *et al.,* 2002) and found statistically significant differences, with colt gestations being from 1.7 to 7 days longer.

Though it is generally accepted that the male offspring of many species have longer gestations than the females, the reason is unclear. It is agreed that the male body development is greater than the female's and therefore, as birth only occurs when the foetal development is complete, the colts' gestation period would be longer, even though Wilsher and Allen (2002) have shown that colts have a better developed placenta and might, therefore, be expected to develop more quickly. The longer gestation period of colts has been justified as being due to androgen action (Zegher *et al.,* 1999), to different endocrine functions of male and female foetuses interacting differently with the endocrine control of parturition (Jainudeen and Hafez, 1993) and to sex chromosome-linked effects (Pergament *et al.,* 1994).

Similar investigation was carried out by Valera *et al.* (2006) with two horse breeds, out of which one was Arab purebred horse. At the mares of the age between 10 and 12, the study found out that the gestation of the mares having colts in comparison to the ones having fillies lasts longer for 1.41 day (341.05-339.64 days).

Effect breeding year on gestation duration was found spastically significant ($p<0.005$). It could be said that differences of management (attention and feeding) among years affected gestation duration.

As reported Perez *et al.* (2003) and Cilek (2008), longer gestation duration in some years may be influenced by deficient feeding and very cold years leading to a later end of gestation as a mechanism for adjusting to adverse climatic and nutrition conditions. Thus, dry years and high average temperatures have a negative effect on the gestation length.

Sevinga *et al.* (2004) reported that pregnancies were shorter when conception occurred in July, coinciding with maximum photoperiod oscillations. In this study the effect of month of birth was significant ($p<0.005$) the lowest gestation duration was found 319.75±3.30 days in December and 329.08±7.33 days in January, gestation duration increased in other months, 333.11±8.47 days in February, 334.53±8.09 days in March, 333.10±9.32 days in April and 334.98±8.81 days in May. Perez *et al.* (2003) found that foalings of mares bred later in the breeding season were significantly

shorter than those of mares bred in the transitional period or during the breeding season (334, 341 and 340 days, respectively). We found differences that are similar to these. Variation was greater when mares were bred out of season, as reported by Platt (1984) and Perez *et al.* (2003). These differences can be influenced by factors, such as feeding conditions or temperature. It has been suggested that nature attempts to bring the timing of parturition back to the ideal, i.e. early Spring and that this may be achieved by shorter or longer gestations in late born and early born foals, respectively (Evans and Torbeck, 1998). Hence, favourable weather conditions affect the nutritional value of grasslands and, as a result, the mare can have a larger nutritional intake and the foal takes less time to reach the proper weight for birth (Morel *et al.,* 2002).

However, it is believed that the main cause of this variation is photoperiod, through its effect on the maternal brain. The precise mechanisms involved remain unclear, even though Sharp (1988) suggested that melatonin might be involved. The works of Hodge *et al.* (1982) demonstrated that pregnant mares subjected to 16 h of light per day from December 1st onwards, anticipated the date of birth. This suggestion echoes the findings of Langlois (1973) who reports that the hormonal environment in pregnant mares may be altered by variations in circadian rhythm. Also, it has been suggested that variation in light may be a cause of considerable variation in equine gestation length, due to the modification of the foetal maturation rate as labour approaches (Perez *et al.,* 2003). The results obtained here suggest that the mare may be able to bring parturition forward when more dayhight hours are detected, which could be interpreted as the end of the breeding season. This natural adaptation mechanism allows the newborn foal access to the best nutritive and environmental resources. In our work, when the photoperiod was maximum (May-June), the gestation length was minimum in May. An association between increasing day length, increasing environmental temperature and decreasing gestation length was previously reported (Astudillo *et al.,*1960).

In our study it was noted that 76.19% of foalings occurred between 7 to 19 h which approach 81.2% of mares foaled at night reported by Sevinga *et al.* (2004). 86% of foalings occurred between 19.00 to 07.00 h and the maximal incidence was between 22.00 and 23.00 h (Rossdale and Short, 1967). We also noted a significant effect of mares and years on the hour of birth ($p<0.005$).

It is interesting that a similar, though much less pronounced, circadian rhythm in the time of birth is well recognized in women (Malek *et al.*, 1962; Kaiser and Halberg, 1962) and pigs (Deakin and Fraser, 1935). It is also seen in mice, where the rhythm can be reversed by reversing the periods of light and darkness (Merton, 1937; Svorad and Sachova, 1959) and in the Chinese hamster (Yerganian, 1958). However, in cows there seems to be little variation in the frequency of parturition throughout the 24 h (Richter, 1933) and in sheep and golden hamsters births are commonest during the daylight hours (Lindahl, 1964). The process of parturition must have been subjected to a particularly heavy selection pressure. Thus any circadian rhythm is likely to have been of some adaptive significance. Whilst births at night offer the greatest chance of concealment from predators, this may be largely offset by the fact that night is the time of greatest predator activity. It would be interesting to know what factors led the horse to develop such an efficient mechanism for concentrating births into the hours of darkness (Rossdale and Short, 1967).

The age of breeding had a significant effect on gestation duration, the lowest gestation duration was found 328.18±7.04 days in the age of 4 years and 328.86±10.85 days in the age of 24 years, the highest gestation duration was found 334.46±7.26 days 334.21±8.50 days and 334.85±8.01 days respectively in the age of 13, 18 and 23 years. In our study, we observed longer gestation periods in both younger and older mares. Similar results were obtained in most studies

(Akkayan and Demirtel, 1974; Bos and Van Der Mey, 1980; Demirci, 1988). This was postulated to be due to a decrease in uterine/placental nutritional efficiency (Pashan and Allen, 1979) and/or the metabolic-hormonal drive to grow (Gluckman and Hanson, 2004), as a consequence of age and the multiparous state, slowing intrauterine growth and prolonging gestation. However, our findings were in contradiction with 332.4±0.67 days, the lowest duration found in the age of 10 years and the highest was found 335.9±0.058 days in the youngest age (4 years) reported by Cilek (2009). Most of cited authors, on the basis of their investigations, quote that the age of a mare (mother) has a certain influence on the gestation duration at various horse breeds, that is, the duration of the first gestation shortens progressively to a certain age and then it becomes longer. Valera *et al.* (2006) informed that gestation length decrease as the mare gets older, with the shortest gestations periods when the mare is 10-12 years old and from this point on, it slowly increased. Therefore, Cilek (2009), Morel *et al.* (2002), Hintz *et al.* (1979b, 1992), Hevia *et al.* (1994) and Filho *et al.* (1997) conclude that the duration of gestation depends on the age of a mare, the season in which mating and foaling occur, sex of a colt, conditions of breeding and quality of nourishment.

Each specific species has a genetically determined development rate and birth occurs in response to a signal, given when the foetus attains an appropriate size and/or maturity (Jenkin and Young, 2004). Such a signal could be transuded by the mother (e.g., uterine volume), the foetus (e.g., nutrient restriction) or placenta (e.g., increased foetal for nutrients). In most domestic species, the role of the foetus is clear (Lye, 1996) since it is essential that the foetus is born at a time when it is capable of surviving in the extra-uterine environment, it is, therefore, appropriate that the foetus plays a major role in determining the timing of parturition. In the horse, there is no strong evidence in support of a major role of the foetus in initiating parturition (Liggins and Thorbum, 1994) even though Allen *et al.* (2002) showed significant effects of both maternal and foetal genome on the duration of gestation. They showed the interacting influences of maternal size and foetal genotype on placental and foetal development in the mare, by comparing conventional within-breed experimental foalings established by embryo transfer. The timely birth of a developmentally mature foetus, appropriate for the species, requires that some mechanism synchronizes foetal development and maturation with the maternal mechanisms that affect the birth. In some species, particularly ruminants, the synchronizing factor has clearly been shown to be glucocorticoid, secreted by the foetal adrenal cortex. In the horse, the foetal cortisol profile increases only in the last 48 h before delivery and maternally administered glucocorticoid does not induce labour, as it does in other domestic animals (Jenkin and Young, 2004).

According to breeding year, oestrus, pregnancy, sterihty, parturition and abortion are presented in Table 2. Ratios of pregnancy and parturition were lower before 2002 year, the highest ratio were noted in 2003 (80.82%). It can be said that reproductive performances of Arabian horses are higher in last years because of a better reproductive management and introduction of ultrasonography for the survey of reproduction in the Chawchawa centre.

On the basis of mares at mating estrus, from fertility records of 2155 mares, ratios of estrus, pregnancy, sterility, parturition and abortion were 82.51, 62.32, 37.68, 59.77 and 2.55% for Arabian mares respectively. Ratios of parturitions and pregnancy for Arabian mares were, respectively 59.77 and 62.32%, which is at over limit of literature (Schulman *et al.,* 2003). In this study, ratios of abortion were 2.55%, which is lower than reported in other studies (Hemberg *et al.,* 2004; Cilek, 2009). Abortion can be caused by luteal insufficiencies, embryonic defects, endometritis, twining, equine viral rhinopneumonitis etc. (Cilek, 2009). Yang and Cho (2007) reported high early embryonic death rat of 12.2% within 45 days after ovulation.

Table 2: Ratios of oestrus, pregnancy, sterility, parturition and abortion of Arabian mares according to breeding years

		In estrus		Sterility		Abortion		Pregnancy		Parturition	
Years	Mares at mating n	n	%	n	%	n	%	n	%	n	%
1985	89	64	71.91	38	42.70	1	1.12	51	57.30	50	56.18
1986	83	64	77.11	20	24.10	1	1.20	63	75.90	62	74.70
1987	88	77	87.50	24	27.27	3	3.41	64	72.73	61	69.32
1988	91	79	86.81	30	32.97	0	0.00	61	67.03	61	67.03
1989	96	77	80.21	33	34.38	2	2.08	63	65.63	61	63.54
1990	95	81	85.26	37	38.95	2	2.11	58	61.05	56	58.95
1991	92	83	90.22	41	44.57	4	4.35	51	55.43	47	51.09
1992	98	84	85.71	38	38.78	2	2.04	60	61.22	58	59.18
1993	96	91	94.79	34	35.42	1	1.04	62	64.58	61	63.54
1994	96	85	88.54	44	45.83	1	1.04	52	54.17	51	53.13
1995	80	67	83.75	45	56.25	3	3.75	35	43.75	32	40.00
1996	102	76	74.51	51	50.00	1	0.98	51	50.00	50	49.02
1997	96	86	89.58	41	42.71	3	3.13	55	57.29	52	54.17
1998	94	64	68.09	59	62.77	2	2.13	35	37.23	33	35.11
1999	84	69	82.14	53	63.10	0	0.00	31	36.90	31	36.90
2000	78	72	92.31	33	42.31	1	1.28	45	57.69	44	56.41
2001	72	62	86.11	48	66.67	3	4.17	24	33.33	21	29.17
2002	67	58	86.57	15	22.39	2	2.99	52	77.61	50	74.63
2003	73	52	71.23	10	13.70	4	5.48	63	86.30	59	80.82
2004	69	58	84.06	18	26.09	1	1.45	51	73.91	50	72.46
2005	72	52	72.22	15	20.83	0	0.00	57	79.17	57	79.17
2006	64	43	67.19	9	14.06	4	6.25	55	85.94	51	79.69
2007	65	58	89.23	15	23.08	5	7.69	50	76.92	45	69.23
2008	66	53	80.30	20	30.30	4	6.06	46	69.70	42	63.64
2009	69	58	84.06	14	20.29	5	7.25	55	79.71	50	72.46
2010	80	65	81.25	27	33.75	0	0.00	53	66.25	53	66.25
Total	2155	1778	82.51	812	37.68	55	2.55	1343	62.32	1288	59.77

Mating early in season result in higher pregnancy rates than late season (Katila, 2003; Langlois and Blouin, 2004) at the end of season only repeat breeders are left, which may provide an explanation for this difference (Katila, 2003) early mating gives the mare more opportunities to conceive and is therefore recommended (Langlois and Blouin, 2004) it is well known that the lengthing of the day induce cyclicity in mares, but also nutritional status and environmental temperature.

CONCLUSION

Present results pointed towards the significant influence of different environmental factors, such as year and month of conception, age of the mare and sex of foal. These results are also consistent with results found in other equine breeds, thus confirming the strong multifactorial influence of this variable. It can be said that Arabian horse breeding in this farm was done successfully. However profitable horse breeding, in this farm depends on mare's having alive foal in the every year. To avoid the loss of a full breeding year and have much chance for gestation, mares should be mated in earlier month in breeding season. The use of ultrasonography for the control of ovulation and gestation should be done for better management of reproduction and better results of fertility.

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