Factors Contributing to Embryonic Mortality in Mares Within the Tiaret Region, Algeria

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Abstract:

Embryonic mortality in mares is of significant importance as it directly impacts reproductive efficiency in equine breeding programs. Elevated embryonic mortality rates result in reduced pregnancy success, extended breeding cycles, and significant economic setbacks for breeders and those involved in the equine industry. In this paper, our aim is to elucidate the diverse factors associated with embryonic mortality in mares at the National Stud of Chaouchaoua, Stud El-Mesk, and mares owned by a private farm in the Tiaret region, west of Algeria. We have validated our experimentation through ultrasound-based pregnancy monitoring, aconducted on a sample of 197 mares representing diverse breeds: 125 *Arabians*, 26 *Barbs,* 21 *Arabian-Barbs*, 18 *Thoroughbreds*, 4 *Anglo-Arabians*, and 3 *saddle* mares. The monitoring was initiated on the 13th day following ovulation within the breeding season. Based on our findings, the embryonic mortality rate within the initial 45 days post-ovulation stood at 14.3%. Among these, 5.5% of embryonic mortalities were identified between D 13 and D 20 following ovulation. The incidence of embryonic mortality was notably elevated in barren mares at 22.8%, mares aged over 16 years at 15%, and those bred at the onset of the season (February) at a staggering 50%. Additionally, mares with twin pregnancies exhibited a heightened embryonic mortality rate, accounting for 75% of cases in contrast to the 11% observed in single-pregnant mares. An alteration in the uterine environment also contributed to diminished fertility, leading to a substantial embryonic mortality rate of 22.4%, attributable to irregular uterine fluids. The significant influence of variables like embryonic vesicle count, reproductive status, and abnormal uterine environment on embryonic development highlights the importance of understanding and acknowledging these factors. This knowledge is essential for reducing losses in equine farming.

Key words: Breeding, Embryonic mortality,Fertility, Mare,Pregnancy.

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Introduction:

In Algeria, the horse occupies a privileged position in the country's history, culture, and traditions. It stands at the origin of the evolution of the primary North African horse breeds. Once an animal of warfare and pageantry, the horse has now transformed into an athlete employed across various cultural and sporting disciplines, including Fantasia and equestrian sports such as show jumping, horse racing, and endurance raids [1], [2].

According to agricultural statistics released by the Algerian Ministry of Agriculture and RuralDevelopment in 2019, the total horse population in Algeria is estimated to be 49,911. Notably, Tiaret stands out with a population of 6,012 horses, reinforcing its status as the central hub for horse production in the country [3].

Reproduction is a fundamental biological process for all living beings, and horses are no different. Among them, the mare is considered a long-day seasonal polyestrous species. This signifies that she experiences regular estrous cycles within her breeding season, extending from spring to autumn [4], [5]. Further factors are linked to her physiology, including the stipulated administrative period set by the authorities, which commences on February 15 and concludes on June 30. These circumstances contribute to making gestation in mares a substantial economic challenge.

In horse reproduction, embryonic mortality pertains to the loss of the embryonic vesicle between fertilization and 40 days post-ovulation [6]According to various researchers, the frequency of embryonic mortality in mares varies from 5% to 25%[7], [8], [9].

Mares'embryonic mortality can be brought on by a variety of factors. According to a number of studies, mares over the age of 18 have a 20–30% embryonic mortality rate [7], [10].The reproductive status (barren/foaling/maiden) of the mare significantly impacts embryonic development[11].Furthermore, other studies suggest that factors such as maiden, foaling, and barren mares are associated with embryonic mortality [12]. An abnormal uterine environment has also been linked to embryonic mortality [7], [13]. On the other hand, [14]have identified endometritis as the primary cause of embryonic mortality in mares. Additionally, twin gestation is the main contributor to non-infectious abortions in mares[15], [16], [17].

Hence, understanding the factors that influence embryonic development in mares becomes significantly crucial. That's why, our current study aims to determine the various factors associated with embryonic mortality in the mares ofTiaret region.

Materials and Methods:

Study area :

Our study was conducted in the Tiaret region, situated in western Algeria, approximately 268 km away from the capital, Algiers. The region features a continental climate, marked by cold

winters and hot, dry summers, with an average temperature of 26.9°C. The peak of heat occurs in July, which is the hottest month of the year, while January stands as the coldest month with an average temperature of 6.2°C. The region has a historical association with horse breeding.

The study focused on mares from three breeding stations in the region: the National Stud Chaouchaou, El-Mesk Stud Farm, and a private farm. The National Stud Chaouchaoua, situated north of Tiaret city, spans 741 hectares and is a significant equestrian production center in Algeria. It houses 225 horses, including breeds like *Arabian, Barb, Arabian-Barb, Anglo-Arabian,* and *Thoroughbred*. This comprises 15 stallions, 48 mares, and the rest are divided among foals aged 6 months, yearlings, and foals over 2 years old.

El-Mesk stud farm, located 4 km from Tiaret city center, spans 52 hectares and is keeping 100 horses of various breeds, such as *Arabian, Barb, Arabian-Barb, Anglo-Arabian, Thoroughbred*, and *Shetland* ponies. Among them are 7 stallions and 16 broodmares, with the remaining horses divided into foals aged 6 months, yearlings, and foals over 2 years old.

Experimental Animal Management:

A total of 197 mares, including *Arabian, Barb, Arabian-Barb, Thoroughbred, Anglo-Arabian*, and *saddle* mares, were selected from the National Stud Chaouchaoua, Stud El-Mesk, and private breeders within the region. These mares were involved in our study throughout the 2022 breeding season. Ranging in age from 3 to 25 years and weighing between 269 to 546 kg, the mares received a specific diet consisting of a combination of hay (primarily oats) and barley, along with a vitamin supplement. The quantity of feed administered was adjusted based on the individual physiological stage of each mare. Additionally, the mares had unrestricted access to water, and straw was utilized for bedding purposes.

Physical activity for these mares occurred within the paddock from 10 a.m. to 4 p.m., with the remaining duration of the day spent in the stable. Regular deworming and vaccination protocols were strictly adhered to for all mares.

The stallions selected for this study from the National Stud Chaouchaoua and Stud El-Mesk were specifically chosen due to their recognized genetic and athletic merits. These stallions were meticulously cataloged in studbooks maintained by the Office National of Development of Equine and Camel Breeding (ONDEEC), encompassing comprehensive details such as pedigree information and other relevant data.

Clinical Examination and Reproductive Monitoring:

The reproductive tract of each mare underwent pre-breeding examination. Evaluation of thegenital tract was conducted through transrectal palpation and ultrasound assessment using a 5MHz linear probe. Daily monitoring of follicular growth and ovulation, occurring 2 days post-mating, was performed. Pregnancy verification occurred on the 13th day following

ovulation,utilizing an ultrasound scanner (Type SONOSCAPE A6 Italian) with a 5 MHz linear probe.Further evaluations were conducted on days 20, 30, and 45 post-ovulation to ascertain thepreservation of pregnancy (embryonic mortality), enabling timely intervention if required before the season's conclusion.

Uterine anomalies preceding and following mating were meticulously documented. Pregnancy rates and embryonic mortality rates were computed considering factors such as mare age, reproductive status, post-partum cycle, mating month, and uterine conditions. The stud farms exclusively employed natural breeding for mating.

Statistical Analysis:

In this study, Minitab 21.4.0.0 software was employed to conduct a comprehensive statistical analysis aimed at assessing the influence of various contributing factors on embryonic mortality in mares. The significance of the P-value was set at $P \leq 0,05$.

Results:

Fertility rate among all studied mares:

Ultrasound examination conducted at 13 days post-ovulation revealed varying fertility rates among different mare breeds. Arabian mares exhibited a fertility rate of 82.4%, *Barb* mares showed a rate of 69.2%, *Thoroughbred* mares displayed a rate of 55.5%, *Arabian-Barb* mares reached 71.4%, and both *Anglo-Arabian* and *Saddlebred* mares demonstrated a 100% fertility rate (Table 1). Additionally, the examination unveiled an embryonic mortality frequency of 14.3% within 45 days after ovulation.

Table 1. Fertility rates of breeding mares by breed

Breeds	Arabian	Barb	Arabian-Barb	Thoroughbred	Anglo-Arabian	Saddlebred	P
Fertility rate (%)	82.4% (103/125)	69.2% (18/26)	71.4% (15/21)	55.5% (10/18)	100% (4/4)	100% (3/3)	0.000

Key: (/) Number of pregnant mares/Number of mares served.

Fig.1 illustrates embryonic mortality at D 45, characterized by irregular contours of the embryonic vesicle, reduced size, absence of heartbeats, and deviation from the typical embryo shape, as opposed to Fig. 2, which presents an ultrasound image of the embryonic vesicle at D 45.

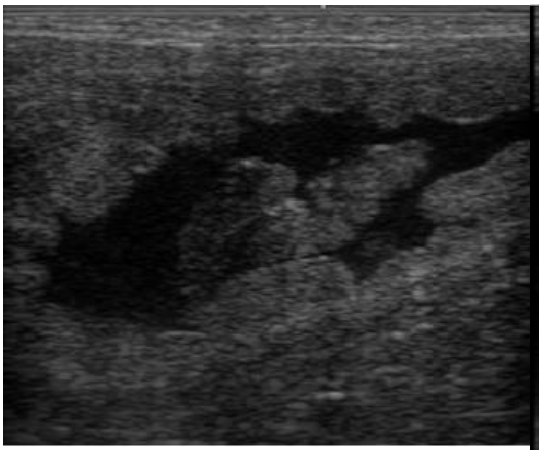

Fig. 1: Ultrasound Image Depicting Embryonic Vesicle at D 45.

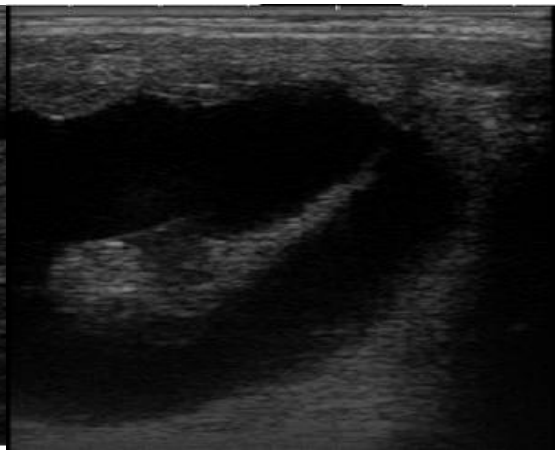

Fig. 2:Ultrasound Image of an Embryonic Loss at D 45.

Our findings demonstrate the profound impact of breed on fertility rate, reaching a high level of significance (P = 0.000). The analysis of mean values revealed a distinct hierarchy in fertility among breeds. Specifically, the *Anglo-Arab* and *Saddle* breeds exhibited the highest fertility, statistically speaking, followed by the *Arabian* mares, *Barb* and *Arabian-Barb* breeds. Conversely, the *Thoroughbred* breed displayed the least fertility.

The impact of reproductive status on the frequency of embryonic mortality:

The findings concerning the mare's reproductive status revealed an embryonic mortality rate of 22.8% for Barren mares (mares mated but not pregnant at the end of the previous season), a rate of 13.5% for foaling mares (mares that gave birth during the previous season), and a rate of 8.1% for Maiden mares (mares that have never been bred) (Table 2).

Table 2. The influence of the mare reproductive status on embryonic mortality

Reproductive status	Barren	Foaling	Maiden	P
Embryonicmortality rate	22.8% (8/35)	13.5% (11/81)	8.1% (3/37)	0.041

Key: (/) Number of mares with embryonic mortality/Number of pregnant mares.

The obtained results reveal a significant influence of the mares'reproductive status on the rate of embryonic mortality (*P = 0.041*). When analyzing the averages, it became apparent that Barren mares exhibited a higher susceptibility to embryonic mortality compared to Maiden mares. However, there were no significant distinctions observed in terms of embryonic mortality between Barren mares and foaling mares, or between foaling mares and Maiden mares.

The impact of age on the incidence of embryonic mortality:

According to Table 3, the incidence of embryonic mortality is more marked in mares aged over 17 years, exhibiting a rate of 15%, as opposed to mares aged between 3 and 10 years, and those aged 11 to 16 years, which demonstrate rates of 11% and 10%, respectively. Based on our research, the age of the mares exhibited no significant impact on the embryonicmortality rate (*P = 0.390*).

Table 3. The influence of mare's age on embryonic mortality

Age	3-10	11-16	17-25	P
Embryonicmortality rate	11.01% (13/118)	10% (5/52)	15% (4/27)	0.390

Key: (/) Number of mares with embryonic mortality/Number of pregnant mares.

The impact of mating month on on the frequency of embryonic mortality:

Table 4 illustrates the relationship between the month of mating and embryonic mortality. The peak of embryonic mortality within the breeding season was observed in February, registering a rate of 50%. This rate gradually declined to 13.3% in March, followed by a further reduction to 11.4% in April. May witnessed a minor increase to 20%, subsequently leading to a decline to 4.3% in June.

Table 4. The relationship between mating month and embryonic mortality

Months	January	February	March	April	May	June	P
Embryonicmortality rate	0% (0/9)	50% (5/10)	13.3% (4/30)	11.4% (4/35)	20% (8/40)	4.3% (1/23)	0.010

Key: (/) Number of mares with embryonic mortality/Number of pregnant mares

The statistical analysis revealed a significant impact of the mares' mating month on the embryonic mortality rate (*P = 0.010*). An examination of the mean values confirmed that February exhibited a statistically significant increase in embryonic mortalities compared to the other months within the breeding season.

The impact of postpartum estrous cycle on the frequencyof embryonic mortality:

Embryonic mortality frequency of 16.2% was revealed during the first postpartum estrous cycle (foaling heat) and 13.04% during the second postpartum cycle. Notably, there were no cases of embryonic mortality observed in the third postpartum estrous cycle (Table 5). It's important to highlight that out of the 78 pregnant mares, 19 were not pregnant at the conclusion of the season.

Table 5. The relationship between the post-partum cycle and embryonic mortality

Post-partum cycle	1st cycle	2nd cycle	3rd cycle	P
Embryonicmortality rate	16.2% (7/43)	13.04% (3/29)	0% (0/6)	0.030

Key: (/) Number of mares with embryonic mortality/Number of pregnant mares.

As shown Table 5, the postpartum estrous cycle of mares exhibited a significant influence on the embryonic mortality rate (*P = 0.030*). A comparison of the mean values highlighted that the third postpartum estrous cycle of mares displayed a decrease in the rate of embryonic mortality compared to the other cycles.

Theimpact of the uterine environnement on the incidence of embryonic mortality:

Based on our findings, uterine fluids resulted into the primary cause of embryonic mortalityattributed to an abnormal uterine environment, exhibiting a rate of 22.4%. Among maressubjected to ultrasound examination, those with the co-occurrence of uterine fluids and cystsdisplayed an embryonic mortality frequency of 13.3%. In contrast, mares solely affected byuterine cysts exhibited a rate of embryonic mortality at 11.4%. Notably, these rates ofembryonic loss were two to three times higher than those observed in mares without uterineanomalies, which stood at 5.17% (Table 6).

Table 6. The influence of uterine abnormalities on embryonic mortality

uterine environment	Uterinefluid	Uterinecysts	Uterinefluid+ Uterinecysts	Absence of anomaly	P
Embryonicmortality rate	22.4% (11/49)	11.4% (4/35)	13.3% (2/15)	5.17% (6/116)	0.012

Key: (/) number of mares with embryonic mortality / total number of pregnant mares.

Our results indicate that uterine anomalies exerted a significant influence on the embryonic mortality rate among our mares *P = 0.012*. The statistical analysis demonstrated a significant distinction between mares with abnormal uterine fluids and those without. However, no significant differences were identified among mares with abnormal uterine fluids, those with uterine cysts, and those presenting both abnormal uterine fluids and uterine cysts. Any accumulation of uterine fluid during diestrus that surpasses a diameter of 2cm could be indicative of a uterine infection (refer to Fig. 3). Uterine cysts, as visualized through ultrasound examination, manifest as spherical and anechoic structures (Fig. 4). While there is a possibility of

mistaking uterine cysts for embryonic vesicles, it's important to note that uterine cysts maintain their size and position within the uterus, aiding in differentiation (see Fig. 5).

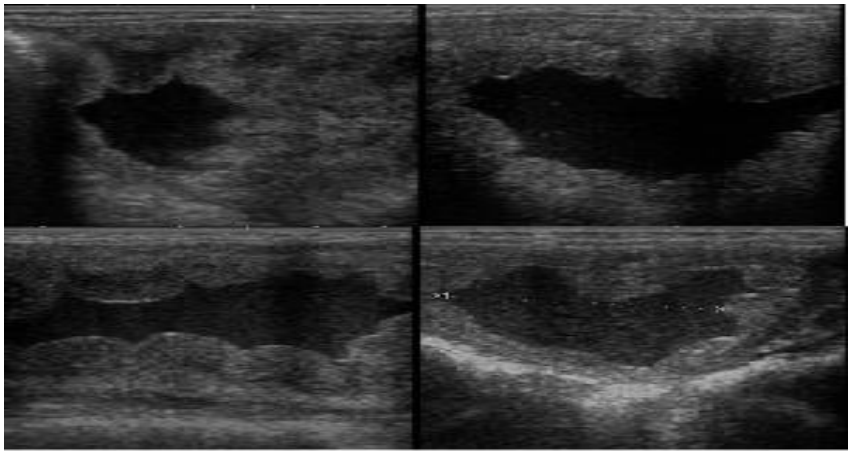

Fig. 3: Ultrasound images of pathological intrauterine fluid accumulation exceeding 2cm in various mares.

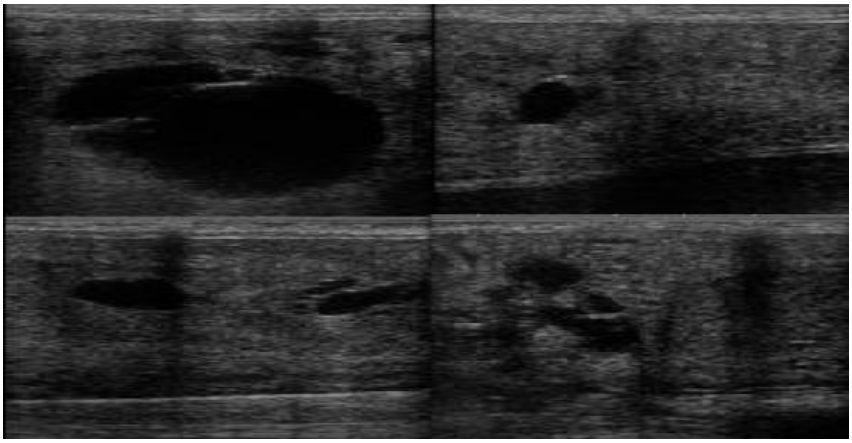

Fig. 4: Ultrasound Images of Varied Uterine Cysts.

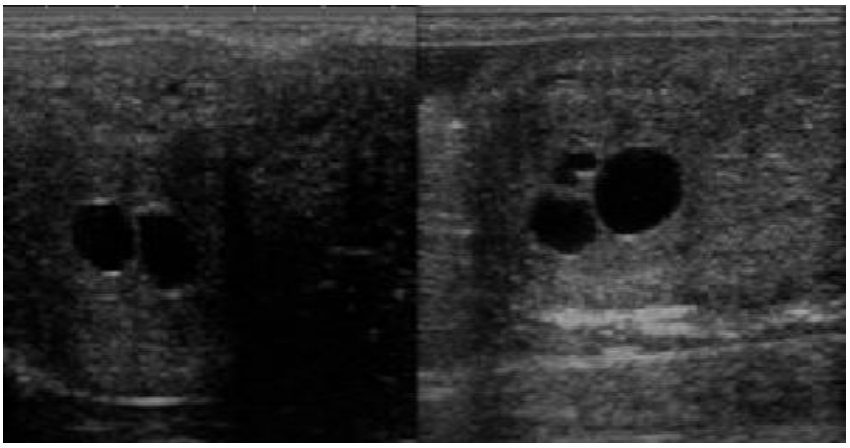

Fig. 5: Ultrasound images of embryonic vesicle combined with a uterine cyst in different mares.

The impact of embryonic vesicle count on the frequency of embryonic mortality:

According to our research, mares carrying twins had an embryonic loss rate of 75%, which was higher than the 11.03% rate seen in mares carrying singleton foals. Additionally, Fig. 6 shows ultrasound pictures of twin pregnancies at various stages.

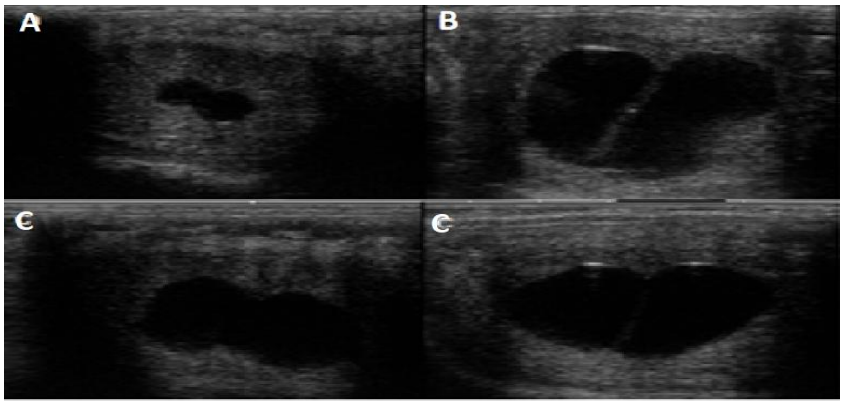

Fig. 6: Ultrasound images of twin pregnancies in various mares at different stages of gestation: (A) Embryonic vesicle at day 13 post-ovulation, (B) Embryonic vesicle at day 15 post-ovulation, (C) Embryonic vesicles at day 16 post-ovulation.

The correlation between the time of embryonic mortality and the number of embryonic vesicles:

Regarding the timing of mortality, the incidence of mortality was remarkably higher during the initial twenty days post-ovulation, with rates of 66.66% for mares with twin pregnancies and 5.5% for those with single pregnancies. This frequency exhibited a decline as gestation progressed, with rates of 33.33% (twins) and 1.3% (singles) during the period from Day 20 to Day 30, and 0% (twins) and 4.13% (singles) from Day 30 to Day 45 (Table 7).

Table 7.The relationship between the time of embryonic mortality and the number of embryonic vesicles

Time of embryonic loss	D13-DJ20	D20-D30	D30-D45
Embryonic mortality rate in case of twins	66.66% (4/6)	33.33% (2/6)	0% (0/0)
Embryonic mortality rate in single pregnancy	5.5% (8/145)	1.3% (2/145)	4.13% (6/145)

Key: (/) Number of mares with embryonic mortality/Number of pregnant mares.

Discussion:

The embryonic mortality rate observed in our study stands at 14.3%, measured within 45 daysafter ovulation. Our findings were closely with the work of [11], who reporteda rate of 15.2% in Ireland, and [18]who documented a range of 2.5% to25% in the Southern Marmara region of Turkey. In contrast, our results diverge from previousliterature, where we find rates such as 12.2% by[19], 7.2% to 8% by[20], 7.1% to 7.5% by[21], 5.5% by[22], 5.8% by[23]6.4% by[24], 9.5% by[25], 7.9% by [26], 11.2% by [27]and 9.1% by[28]. Particularly, our results also differ from the work of [29], who reported a higher rate of 17.2%.

These variations in embryonic mortality rates can be attributed primarily to the quality of the mares bred on the farms, especially concerning breed, reproductive status, and age. Additionally, breeding conditions and nutrition may also contribute to embryonic mortality.

Regarding the reproductive status of mares, our findings align with the research conducted by [19], which showed a higher incidence of embryonic mortality in barren mares at 17.2%, in contrast to foaling and maiden mares, who exhibited rates of 12.3% and 12%, respectively. Likewise, a separate study conducted by [24]revealed an elevated embryonic mortality rate occurring between the 15th and 42nd day post-ovulation among barren mares, with a rate of 8.1%, while foaling and maiden mares had rates of 7.1% and 2.4%, respectively. These consistent results underscore the significant influence of mare reproductive status on embryonic mortality rates.

The elevated rate of embryonic mortality observed in barren mares in our study is primarily attributed to an aberrant uterine environment. Barren mares exhibited abnormal uterine fluids during ultrasound examinations, with diameters exceeding two centimeters during the diestral period.On the other hand, foaling mares demonstrated delayed uterine involution, which followed dystocia and instances of placental retention post-foaling.

In our investigation, the influence of mare age on embryonic mortality diverges from thefindings of various authors who have explored the impact of age on mare fertility, assupported by several field studies:[30] [29]and [31]have observed a decline in fertility commencing around 15 years of age. [32]reported a gradual reduction in mare fertility between the ages of 12 to 13 years.[33]noted a gradual decrease in the insemination index with increasing mare age,although the decline of fertility rate was not significant.[8]observedmorphological and degenerative defects in oocytes of older mares, which were absent inyounger counterparts. They hypothesized that these modifications might decrease ovocyteviability, potentially increasing the risk of embryonic mortality in older mares. Contrary tothese findings, our study revealed a higher embryonic mortality rate in mares aged older than16 years at 15%, compared to mares aged between 3 to 10 years and 11 to 16 years, whichexhibited rates of 11.01% and 10%, respectively. These results align with the work of[23], who identified a heightened embryonic mortality rate between 17-35 days post-ovulation in mares older than 14 years at 8.5%, compared to mares aged 3-8years and 9-13 years with rates of 4% and 6.7%, respectively. In contrast, [34]reported no cases of

embryonic mortality in mares aged between 4 and 10 years. However, henoted a higher incidence of embryonic mortality in mares aged between 10 to 13 years, 14 to17 years, and mares aged over 21 years, with rates of 20%, 26%, and 50%, respectively. It'sworth noting that the higher rate in the last age category was attributed to the smaller samplesize compared to the other age categories. These diverse findings underscore the complexinterplay of mare age and embryonic mortality, suggesting the need for further research toelucidate the underlying mechanisms.

The findings in our study contrast with those reported by multiple authors, and this incompatibility can be linked to the deliberate exclusion of older mares with prior reproductive challenges by the breeding season managers at the two stud farms.

The findings obtained about the timing of mare mating in our study were in ligne with the research conducted by [28], indicating that the month of mating can indeed influence the pregnancy rate and elevate the risk of pregnancy loss. In our investigation, we observed that February exhibited the highest embryonic mortality rate among mares at 50%. This month represents a transitional period between the seasonal anoestrus phase and the breeding season. However, as we progressed into March and April, corresponding to the peak of the breeding season, we observed a decline in embryonic mortality rates to 13.3% and 11.4%, respectively. These results mirror the findings of [19]who also noted a decrease in embryonic loss as the breeding season advanced, with rates diminishing from 19.6% in March to 6.8% in June. Especially, our study recorded a slight increase in embryonic mortality in May, reaching 20%. We attribute this uptick to the climatic changes occurring during this month.

Our research found that there was no noteworthy distinction in the rates of embryonic mortality between the initial postpartum cycle (16.2%) and the subsequent cycle (13.04%).This outcome is consistent with the findings of previous research conducted by[22], [11] [35]all of whom reported no significant disparity in the frequency of embryonic mortality between the first and second postpartum cycles, with percentages of 10.4% versus 8%. On the other hand,[36],observed a higher embryonic mortality rate in mares bred during foaling heats compared to those bred during a second cycle induced by prostaglandin, with rates of 9% versus 4%. Similarly, a study conducted in England by[20]also documented a higher rate of embryonic mortality in mares bred during foaling heats compared to their second heats. These varying results underscore the complexity of factors influencing embryonic mortality in mares and highlight the need for further investigation into this phenomenon.

The embryonic mortality rate in the first and second postpartum cycles may be influenced by delayed uterine involution resulting from obstetrical interventions in mares experiencing dystocia and retained placenta.

The outcomes we have obtained are in harmony with several prior studies in this domain, allof which emphasize endometritis as the primary contributor to mare infertility [37], [38], [39],

[40]. In our investigation,endometritis emerged as the primary uterine ailment responsible for embryonic mortality inmares, with an incidence rate of 22.4%. A study by[41]uncovered a lowerpregnancy rate per cycle in mares exhibiting uterine fluids compared to those without suchfluids. Additionally,[42]reported that 46.66% of infertile mares werediagnosed with endometritis. Further supporting our findings, a retrospective study conductedby[43]on clinical observations in Arabian barren mares in Saudi Arabia, as wellas research by[29], identified endometritis as a significant contributor topregnancy interruption.

In our current study, mares diagnosed with uterine cysts exhibited an embryonic mortality rateof 11.4%. Research by [44],indicates that uterine cysts frequentlycontribute to reduced fertility in mares.[26], observed that uterine cysts canlead to embryonic mortality within the 17-35 day timeframe.[45]and[46], have reported that endometrial cysts hinder the mobility of the embryonic vesicle,potentially leading to its loss. Furthermore, these cysts may impede fetomaternal recognitionand delay the diagnosis of pregnancy[47]. Overall, uterine cysts diminishthe quality of the endometrium, consequently compromising embryonic survival[48].The presence of both fluid and cysts in the uteruses of mares led to embryonic loss in 13.3%of cases, in contrast to 5.17% in mares without uterine anomalies. This underscores thesignificance of maintaining a healthy uterine environment, as it directly impacts the prospectsfor successful fertilization, embryo implantation, and embryonic development.

According to studies of several researchers, twinning is the main non-infectious cause ofembryonic mortality in mares, and our findings are consistent with previous researchconducted by various researchers[49], [16].Typically,twin gestations are not viable, especially when they are unilateral due to placentalinsufficiency, often resulting in the demise of one or both fetuses and rarely reaching full term[50]. It is worth noting that only 1% of twin pregnancies result in the birth of live,healthy foals [31]due to the frequent occurrence of complications such asdystocia, genital tract trauma, retained placenta, and delayed uterine involution [16]. In our present study, the rate of embryonic mortality in twin-pregnant mares wasnotably higher at 75 % compared to single-pregnant mares. These results are consistent withthe findings of[19], who reported a twofold higher embryonic mortality rate intwin-pregnant mares (20.4%) compared to their single-pregnant counterparts (10.5%). Incontrast, a study conducted by [23]found a similar rate of embryonicmortality in both single and twin gestation mares.

In the current study, the highest incidence of embryonic mortality was observed during theperiod between Day 13 and Day 20, affecting 66.66% of twin-gestation mares and 5.5% ofsingle-gestation mares. This early embryonic loss could potentially be attributed to lutealinsufficiency resulting from primary corpus luteum dysfunction [51].Subsequently, a secondary peak in embryonic mortality was noted between Day 30 and Day45 in single-gestation mares, with a rate of 4.13%. This rate was lower than the 13% reportedby [34]for embryonic mortality during the same timeframe post-ovulation.Conversely, among mares with twin pregnancies, the mortality rate between Day 30 and Day45 was 0%. This disparity may be

attributed either to embryonic loss occurring before Day 30or to the manual reduction of twin pregnancies.

These variations in embryonic mortality at different stages of gestation suggest a possibleinfluence of reproductive status and an inadequate uterine environment on embryonicdevelopment.

Conclusion:

In conclusion, this research contributes significantly to the existing knowledge regarding thefactors influencing embryonic mortality in mares, offering the potential to enhance marefertility and the economic aspects of equine breeding in Tiaret region. Key factors influencingembryonic mortality include embryonic vesicle count, reproductive status, and uterineconditions. These factors relate to breeding methods, post-partum cycles, foaling conditions,and possibly mare breeds. Surprisingly, and in contrast to our predictions, age does not have asignificant impact on embryonic mortality due to the exclusion of older mares with breedingissues. Vigilant breeding management involving early clinical and ultrasound evaluations iscrucial for identifying pathologies and reducing embryonic mortality. Finally, the adoption ofadvanced examinations and reproductive techniques is crucial for improving overall equinebreeding success.

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Author's contribution :

These authorsare contributed in the current work.

Conflict of interest :

The authors declares that there is no conflict of interests regarding the publication of this article

References:

[1] ıadi, M., Mezouar, K., & Gaouar, S. Characterization of the Barbe horse breed in Algeria.Genetics and Biodiversity Journal,2018 ;1.

[2] Rahal , K., 2021: Situation of the horse in Algeria. Partners Available at : https://docplayer.fr/196648189-Situation-du-cheval-en-algerie.html

[3] MARDP: Ministry of Agriculture and Rural Development and Fisheries.(2019).Agricultural statistics areas and production.https://madr.gov.dz/wp-content/uploads/2022/04/SERIE-B-

2019.pdf.

[4] Davies, Z., Pilliners, S.,2018 : Reproduction. VolumeI: Equine Science : 1st edn.John Wiley, Sons Ltd, UK.

[5] England, G., 2005: Endocrinology of the Oestrous Cycle and Puberty. In : Fertility and Obstetrics in the Horse : 3rd edn. Blackwell, UK.

[6] Morel, M., 2021: Management of the Pregnant Mare.In :Equine reproductive physiology, breeding and stud management,5 th edn. pp.186-195. CABI, UK.

[7] Barry A., Ball.,2011 : Embryonic Loss. In: Mckinnon, A., Squires, E., Vaala, W., Varner, D, Equine Reproduction.Volume I, 2nd edn.pp.2327-2336.John Wiley& Sons, UK.

[8] Vanderwall, D.K., Newcombe, J.R.,2007 : Early Embryonic Loss. In : Current therapy in equine reproduction.(Samper, J., Pycock, J., Mckinnon, A.) Saunders Elsevier, pp.374.Saunders, USA.

[9] Ashraf, R., Rashid, S., Rasheed, I., Asif, S. Early embryonic death in equines and camelids. Open Veterinary Journal,2022; 12(6): 903–909.

[10] Benhayed, N. 2020: study of the potential impact of climatic conditions on early embryonic death in mares in the context of embryo transfer.PhD thesis, Claude BernardUniversity, Lyon,France.

[11] Lane, E., Bijnen, M., Osborne, M., More, S., Henderson , I., Duffy, P., Crowe, M. Key Factors Affecting Reproductive Success of Thoroughbred Mares and Stallions on a Commercial Stud Farm. Reproduction in Domestic Animals,2016; 51(2): 181-187.

[12] Godderis, L. 2020: Gynecological follow-up of mares for veterinary clients: analysis of reproductive performance.PhDthesis.Paul-Sabatier University,Toulouse, France.

[13] Morel, M., 2005: Management of the Pregnant Mare. In : Breeding Horses, pp.111-131. Blackwell Pub, UK.

[14] ا., and Rigaud, E. 2019: atlas of transrectal ultrasound of the mare's genital tract.PhDthesis, Paul-Sabatier University, Toulouse,France.

[15] Thirouin , M. 2020:Creation of a board game for learning about equine reproduction. Doctoral dissertation.Claude-Bernard University, Lyon,France.

[16] Trundell, D. Equine Reproduction:seasonality,Endometritis,and Twinning in the mare. Equine Science,2020.

[17] Le Guedart, M. 2023: The origins and evolution of twinship in mares.PhDthesis.Claude Bernard University,Lyon,France.

[18] Durmaz, S., Mert Polat, I., Korkmaz, O., Pir Yagci, I., Burak Elifoglu, T., Akal, E., çelebi, M. The effect of lactation and body condition score changes on embryonic death rates in KWPN mares. International Journal of Veterinary and Animal Research (IJVAR),2020; 3(1): 21-24.

[19] Yang, Y.-J., & Cho, G.-J. Factors concerning early embryonic death in Throroughbred mares in South Korea. Journal of Veterinary Medical Science,2007; 69(8): 787-792.

[20] Allen, W., Brown, L., Wright, M.,Wilsher, S. Reproductive efficiency of Flatrace and National Hunt Thoroughbred mares and stallions in England. Equine Veterinary Journal, 2007; 39(5): 438-445.

[21] Nath, L., Andersona, G., Mckinnon, A. Reproductive efficiency of thoroughbred and standardbred horses in noth-east Victoria. Australian Veterinary Journal,2010; 88(5):169-175.

[22] Hanlon, D., stevenson, M., Evans, M., Firth, E. Reproductive performance of Thoroughbred mares in the Waikato region of New Zealand: 1 Descriptive analyses. New Zealand Veterinary Journal,2012; 60(6): 329-334.

[23] Miyakoshi, D., Shikichi, M., Ito, K., Iwata, K., Okai, K., Sato , F., Nambo, Y. Factors influencing the frequency of pregnancy loss among Thoroughbred Mares in Hidaka,Japan. Journal of Equine Veterinary Science,2012; 32(9): 552-557.

[24] Rose, B., Firth, M., Morris, B., Roach, J., Wathes, D., Verheyen, K., De Mestre, A. Descriptive study of current therapeutic practices,clinical reproductive findings and incidence of pregnancy loss in intensively managed thoroughbred mares. Animal Reproduction Science,2018 ; 188 : 74-84.

[25] Wilsher, S. The uterus and early pregnancy failure in the mare. Equine Veterinary Education,2019; 31(4): 214-224.

[26] De Mestre, A., Rose, B., Chang, Y., Wathes, D., Verheyen, K. Multivariable analysis to determine risk factors associated with early pregnancy loss in Thoroughbred Broodmares. Theriogenology,2019; 124:18-23.

[27] en, I., Cuervo-Arango, J. Effect of Timing of postovulatory Insemination Relative to Human chorionic Gonadotropin/Buserelin Treatment with 1 straw of Frozen-Thawed semen on mare fertility. Journal of Equine Veterinary Science,2020; 87: 102900.

[28] ıda, E., Grimard, B., Gourtay, C., Chavatte-palmer, P. Factors affecting post-breeding endometritis,pregnancy rate and embryonic/fetal death in sport mares in two French commercial stud farms:special focus on age,parity and lactating status effects. bioRxiv,2022; 1: 2022.

[29] Casenave, P. 2017: analysis of reproductive performance of mares under veterinary care.PhDthesis, Paul-Sabatier University, Toulouse,France.

[30] kouider, Z. 2015: Treatment of endometritis by intrauterine infusion of a 70% honey solution in mares.PhDthesis.Ibn Khaldoun University,Tiaret, Algeria.

[31] F. 2022: creation of a practical guide to follicular monitoring, insemination and monitoring of the embryonic period in mares.PhDthesis. Claude Bernard University, Lyon,France.

[32] Morel, D.,2008 : Infertility. In : Equine Reproductive Physiology,Breeding,and Stud Managment. 3rd edn. pp. 237-239. CABI, USA.

[33] Derradji, C. 2018: Practical study of the effect of age on fertility in post-partum mares at the Haras National de Tiaret.PhDthesis.Ibn Khaldoun University,Tiaret, Algeria.

[34] Bouakkaz, A. 2008: study of factors for improving fertility and fecundity in the mare in Algeria using R eproduction Biotechnologies "Ultrasoundand Hormonotherapy".PhD thesis, Es-SeniaUniversity,Oran, Algeria.

[35] De Souza, J., Gonçalves, P., Bertolin, K., Ferreira, R., Ribeiro, A., Ribeiro, D., Pimentel, A.Age-Dependent effect of foal heat breeding on pregnancy and embryo mortality rates in Thoroughbred mares. Journal of Equine Veterinary Science,2020; 90: 102982.

[36] ɛrson, M., Blanchard, T. Breeding mares on foal-heat. Equine Veterinary Education,2005; 17(1): 44-52.

[37] Buczkowska, J., Kozdrowsk, R., Nowak, M., Ras, A., Staroniewicz, Z., Siemieniuch, M.Comparison of the biopsy and cytobrush techniques for diagnosis of subclinical endometritis in mares. Reproductive Biology and Endocrinology,2014; 12(1): 1-6.

[38] Campistron, M. 2016: Diagnosis and treatment of bacterial endometritis in mares and study of equine veterinary practices in France in 2015.PhDthesis, Paul-Sabatier University,Toulouse,France.

[39] Nikita, A. 2020: Reasoned use of antibiotics in the treatment of endometritis in mares.PhDthesis. Claude Bernard University, Lyon, France.

[40] ma, K., and Bouchouka, K. 2022: The effect of age and parity on the timing of ovulation in the first post-partum cycle in mares.PhDthesis, Ibn KhaldounUniversity,Tiaret, Algeria.

[41] Barbacini, S. Retrospective study on the incidence of postinsemination uterine fluid in mares inseminated with frozen/thawed semen. Journal of Equine Veterinary Science,2003; 23(11): 493-496.

[42] r, Z., Benallou, B., Hmida, H. Ultrasonographic and cytological diagnosis of endometritis in the mare. Global Veterinaria,2017; 19(4): 586-589.

[43] Ali, A., Alamaary, M., & Al-sobyil, F., 2015: a retrospective study on clinical findings in the barren Arabian mares in Saudi Arabia.In: The 30th meeting of Saudi Biological Society, 9-11 April University of Tabuk,Saudi Arabia.

[44] Carluccio, A., Gloria, A., Mariotti, F., Petrizzi, L., Varasano, V., Robbe, D., Contri, A. Ethanol Sclerotherapy for the treatment of uterine cysts in the mare. Journal of Equine Veterinary Science,2018; 63: 27-29.

[45] Ley, W., 2004: Uterine cysts. In : Broodmare Reproduction for the Equine Practitioner. pp.112. CRC Press.

[46] Radny, B., Prado, T., Klabnik-Bradford, J. Ablation of endometrial cysts using endometrial biopsy forceps.Clinical Theriogenology,2020 ; 12(1): 47-50.

[47] Ponthier, J., Geoffroy de la Rebière, Salciccia, A., Deleuze, S. Endoscopy guided photoablation of endometrial cysts using a 980nm laser with a contact fiber in mares. JoVE (Journal of Visualized Experiments),2020;(161): e61569.

[48] E., Sinnot, A., Roach, J., Verheyen, K., De Mestre, A. Mixed-effects modelling of the risk factors associated with multiple pregnancies in Thoroughbred mares. Animals,2022; 12(14): 1841.

[49] me-Josson, A. Diagnosis and management of twinning in mares. In practice,2014; 31(5): 226-231.

[50] Munroe, G.,2020: Early embryonic death. In :Equine Clinical Medicine,Surgery and Reproduction,2 nd edn. pp.449. CRC Press,USA.