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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Swimming Behavior Characteristics in Horses and Their Impact On Pregnancy Rates

Atlarda Yüzme Davranışı Özellikleri ve Gebelik Oranları Üzerindeki Etkileri

Yavuzkan PAKSOY[1*], Nazan KOLUMAN[2], Serap GÖNCÜ[3]

Abstract

In this study, the swimming behaviors of 20 Thoroughbred mares living in a private horse farm in Ulukışla district of Niğde and the effect of swimming on pregnancy rate were investigated. 20 English breed horses between the ages of 4-18 and without any health problems that would prevent them from getting pregnant were included in the study. The horses included in the study had no previous swimming experience. A veterinarian specialized in equine medicine collected the data by examining the observations and camera recordings. The behaviors of the horses around and inside the pool were observed. The pregnancy rate was determined by dividing the number of pregnant horses for each group by the total number of horses. The necessary graphs and tables were created with Microsoft Excel and SPSS statistical package programs to explain and analyze the statistical descriptive characteristics of the camera recordings and observation results. In the presented study, the analysis of pregnancy rates in the swimming group and the control group was performed using the Chi-square method with the SPSS statistical program. 19 of the 20 horses (95%) that were made to swim in the pool and 7 of the 12 horses (58.33%) that were made to swim in the pool became pregnant. The results revealed a range of behaviours including initial reactions to the pool, swimming techniques and post-swim activities. In particular, horses displayed a mixture of curiosity, attention and exploration when first introduced to the water, with the majority taking a measured and cautious approach during pool entry. Swimming behaviours were characterised by alertness, directional tendencies and vocalisations reflecting natural instincts and adaptability. Post-swim activities such as tail wagging, shaking and nose touching provided information on physical adaptation, moving away from the water and potential social or self-comforting behaviours. These findings contribute to the understanding of the behaviour of horses in aquatic environments and highlight the importance of welfare considerations in water-based activities for horses. Furthermore, addressing their natural behaviours and needs improves reproductive performance by an average of 37%. Further research may explore the specific triggers behind the observed behaviours, improve our understanding of equine behaviour in aquatic environments and encourage optimal care practices.

Keywords: Behavior, Horse, Pregnancy rate, Performance, Swimming patterns

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Öz

Bu çalışmada, Niğde'nin Ulukışla ilçesindeki özel bir at çiftliğinde yaşayan 20 Safkan kısrağın yüzme davranışları ve yüzmenin gebelik oranı üzerine etkisi incelenmiştir. Yaşları 4-18 aralığında olan ve gebe kalmaları için herhangi bir sağlık problemi bulunmayan 20 baş İngiliz ırkı at çalışmaya dahil edilmiştir. Çalışmaya dahil edilen atların daha önce yüzme deneyimi olmamıştır. At hekimliği konusunda uzman veteriner hekim gözlem ve kamera kayıtlarını inceleyerek verileri toplamıştır. Atların havuzun çevresinde ve içerisinde sergiledikleri davranışları gözlemlenmiştir. Gebelik oranı, her grup için gebe at sayısının toplam at sayısına bölünmesiyle belirlendi. Kamera kayıtlarının ve gözlem sonuçlarının istatistiksel tanımlayıcı özelliklerini açıklamak ve analiz etmek için gerekli grafik ve tablolar Microsoft Excel ve SPSS istatistik paket programları ile oluşturulmuştur. Sunulan çalışmada, yüzme grubu ve kontrol grubundaki gebelik oranlarının analizi SPSS istatistik programı ile Ki-kare yöntemi kullanılarak yapılmıştır. Havuzda yüzdürülen 20 atın 19'u (%95), kontrol grubunu oluşturan 12 atın 7'si (%58.33) gebe kalmıştır. Sonuçlar, havuza ilk tepkiler, yüzme teknikleri ve yüzme sonrası aktiviteler de dahil olmak üzere bir dizi davranışı ortaya koymuştur. Özellikle, atlar suyla ilk kez karşılaştıklarında merak, dikkat ve keşfin bir karışımını göstermiş, çoğunluğu havuza giriş sırasında ölçülü ve temkinli bir yaklaşım sergilemiştir. Yüzme davranışları, doğal içgüdüleri ve uyum kabiliyetini yansıtan uyanıklık, yön eğilimleri ve vokallerle karakterize edildi. Kuyruk sallama, silkinme ve buruna dokunma gibi yüzme sonrası aktiviteler fiziksel uyum, sudan uzaklaşma ve potansiyel sosyal veya kendini rahatlatma davranışları hakkında bilgi sağlamıştır. Bu bulgular, atların su ortamlarındaki davranışlarının anlaşılmasına katkıda bulunmakta ve atlar için su temelli faaliyetlerde refah hususlarının önemini vurgulamaktadır. Ayrıca, doğal davranışlarını ve ihtiyaçlarını ele alarak üreme performansını ortalama %37 oranında artırmaktadır. Daha fazla araştırma, gözlemlenen davranışların ardındaki belirli tetikleyicileri keşfedebilir, su ortamlarındaki at davranışlarına ilişkin anlayışımızı geliştirebilir ve en uygun bakım uygulamalarını teşvik edebilir.

Anahtar Kelimeler: Davranış, At, Gebelik oranı, Performans, Yüzme modelleri

1. Introduction

To achieve sufficient perfomances from horses in horse breeding, it is crucial to establish optimal environmental conditions (Gücüyener Hacan and Akçapınar, 2013). Adequate care and nutrition for horses are possible through understanding their behaviors. Behavior encompasses the responses of organisms to stimuli from their environments (Akçapınar and Özbeyaz, 1999; Gill et al., 2005), guided by their senses (Gill et al., 2005). Horses utilize senses such as touch, sight, hearing, smell, and taste to interact with their surroundings. Horses exhibit both normal and abnormal behaviors. Examples of normal behaviors in horses include feeding, mimicking, swimming, exploring, establishing dominance, mothering and forming friendships (Gücüyener Hacan and Akçapınar, 2013). Abnormal behaviors in horses include kicking, biting, wind sucking, wood chewing and spinning (Gücüyener Hacan and Akçapınar, 2013).

Horses were domesticated around 5000 BCE (Kelly et al., 2021). While horses were historically bred for agriculture, transportation, military purposes and food, they are now bred for sporting purposes due to advancements in industry and technology (Danışan et al, 2014). For horses to perform well in sporting competitions, their physiological, anatomical and psychological health must be optimal. In addition to conventional exercise and treatment methods, alternative methods are gaining popularity. Swimming horses in pools or in the sea is a prime example. Swimming strengthens muscles, develops cardiovascular and respiratory systems, activates reproductive activities, reduces stress and aids in mental rehabilitation (Taşdemir, 2023).

Swimming is a sport that actively engages the arms, legs and core muscles, requiring the use of many muscles in the body. Swimming reduces pressure on joints, prevents injuries during training, balances heart rate, increases fat burning, promotes muscle mass development and maintains a healthy metabolism (Jackson et al., 2022). Endorphin release during swimming reduces pain and stress (Jackson et al., 2022). While swimming, horses traditionally relied on natural bodies of water, today, the number of horse pools and underwater treadmills in specialized farms or rehabilitation centers is increasing. Pool depth, width, length and water temperature are scientifically adjusted. Scientific recommendations also guide the selection of auxiliary materials.

When incorporating swimming training into horse training and rehabilitation programs, several factors must be considered. Horses should be adequately prepared for the program, accustomed to the equipment and water and gradually exposed to increasing depths. Both horses and trainers should be prepared for various scenarios. Age, gender, breed, performance status, health, swimming experience and breeding and rehabilitation goals should be considered when designing appropriate training programs (Tranquille et al., 2017).

Horses are born with an instinctive swimming behavior, believed to be inherited from their ancestors due to the need to navigate deep waters to escape danger or reach different grazing areas in the wild (Robinson, 2021). The strong muscles, long legs and flexible spines of horses contribute to their swimming abilities. A horse that may be hesitant to walk in water can often swim confidently once it ventures into deeper areas. While swimming, horses keep their heads above water, allowing them to maintain the proper position and have a clear field of vision. They make movements similar to paddling, akin to the trotting behavior they exhibit on land (Robinson, 2021). Their front legs propel them forward in the water, while the hind legs provide balance and control. The hind legs move more than the front legs during swimming, providing stability and propulsion. Horses are not as fast in water as they are on land. While a galloping horse can reach speeds of 40-70 km/h, a swimming horse can reach speeds of 4-10 km/h. Horses cannot hold their breath underwater for extended periods. They can swim with a rider, but many horses are not fond of this situation. When riding a horse in water, the rider should sit on the horse's back slowly, avoid sudden movements, and allow the horse freedom of movement (Dewsbury, 2023). Horses can comfortably stay on the water's surface due to their large lungs. Horses propel themselves forward in water by moving their front legs, while their hind legs are used for balance and control. The hind legs move more than the front legs during swimming, providing stability and propulsion. Horses are not as fast in water as they are on land, so they move more slowly while swimming. It is crucial for horses to have large lungs to stay comfortably on the water's surface.

Several important considerations should be taken into account when introducing horses to swimming. These include acclimating the horse to water, ensuring the water's temperature and cleanliness, gradually increasing the depth, monitoring the horse's behavior and rinsing them clean after exiting the water.

Considerations for introducing horses to swimming

Several considerations must be taken into account when introducing horses to swimming:

• Horses should be accustomed to water by washing their feet.

• They can be introduced to water by walking them around small puddles.

• The swimming pool, sea, water treadmill, or river should be explored, allowing the horse to become familiar with it using its sensory organs.

• Horses should not be forced to enter the water; small encouragements can be given.

• The depth should gradually increase once the horse is in the water.

• Inexperienced horses should be guided by one or two trainers using a long rope, holding them from one or both sides, and directing them from the pool edge.

• The behavior of horses inside and outside the water should be well understood before and after entering the water to prevent any abnormal behavior or modify the training program.

• The water should be at an appropriate temperature, clean, free from harmful elements and the horse should be rinsed with clean water after exiting.

• Horses should be given rest periods of 5-10 minutes between swimming sessions (Dewsbury, 2023; Smith et al., 2012).

It is believed that horses are born with the instinctive ability to swim due to the need to navigate deep waters to escape danger or reach different grazing areas in the wild. Their swimming abilities are supported by their strong muscle structure, long legs, and flexible spines. A horse that may be hesitant to walk in water can often swim confidently once it ventures into deeper areas. During swimming, horses keep their heads above water, allowing them to maintain the proper position and have a clear field of vision.

Swimming in horses has been frequently recommended in recent years in terms of muscle development, heart health and welfare issues. Many horses can swim in shallow water. There is no need to specially teach these animals to swim, it is an instinct that is inherent in nature. However, the first swimming experience is important and should not be forced. Due to limited literature on this topic, the aim is to contribute to colleagues and breeders in this field. Therefore, the aim of this study was to investigate the swimming behaviour and experience of horses in detail.

2. Materials and Methods

2.1. Ethical Approval

In this study, routine breeding in stud farms practices have not been deviated from. Data obtained in these study within the scope of these applications for Experimental and Other Scientific Purposes Concerning the Welfare and Protection of Animals Used Regulation (Official No. 28141 dated 13.12.2011, Gazette) article 2, second paragraph: “This Regulation, non-experimental agricultural and clinical veterinarian In accordance with the provision does not cover applications’, the scope since it is outside the Ministry (T.R. Adana Governorship Provincial Directorate of Agriculture and Forestry, Number: E-74530962-325.99-13486280.) is not subject to permission.

This study utilized a total of 20 Thoroughbred mares (4-18 years old) from a private horse farm located in Ulukışla, Niğde, Turkey. Ulukışla, where the study was conducted, has a continental climate and is located at an altitude of 1427 m. The district is located between 34°30"16' East longitude and 36°58"5' North latitude.

The average annual temperature of the district is 9.8 °C. The lowest average temperature was found in January with -2.1 and the highest in July with 21.9 °C. The district experiences four seasons distinctly, with spring and autumn seasons showing a transitional feature. The climate is a Mediterranean-Central Anatolian transition climate. Summers are cool and dry, winters are cold and snowy. Precipitation intensity shifts to spring and winter seasons. Average annual rainfall: 513 mm.

Figure 1. Ulukışla location

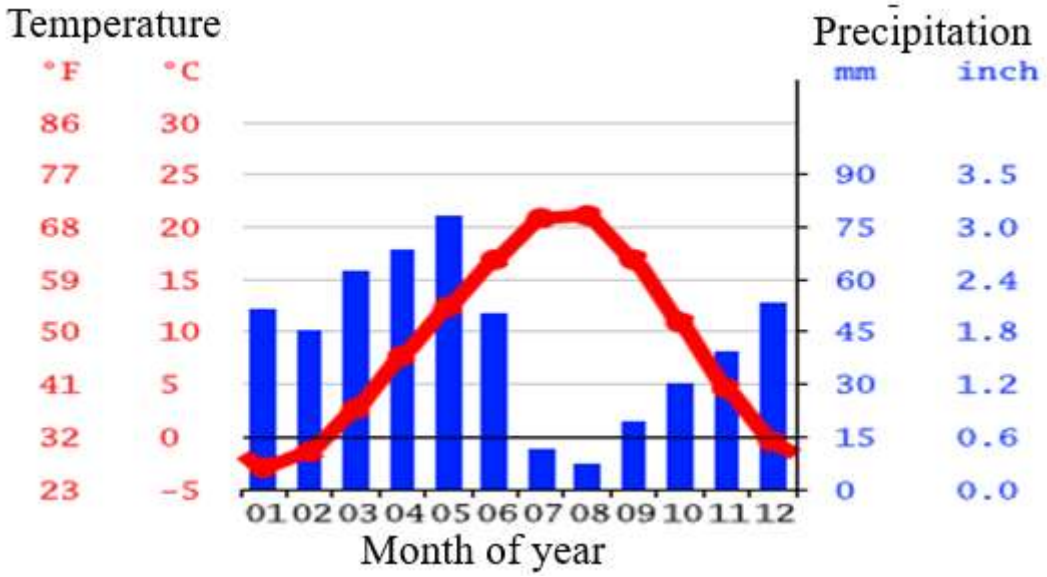

Figure 2. Ulukışla climate

The study was conducted in a privately owned Horse Farm in Ulukışla. The horses were floated in February, the average air temperature was 2°C and the average humidity was 72%. The horses that were swam and included in the control group were mated in March-April-May and the average air temperature was 11°C and the average humidity was 57%. In the trial, a pool was designed for a business to float horses. This pool is 40 m long, 3 m wide and 2.5 m deep. The sole is covered with a non-slip material. There is a 25% inclined ramp at the entrance and exit of the pool so that 1 m horses can enter and exit easily (*Figure 3-5*). The water temperature of the pool was maintained at 25°C room temperature and the pool was cleaned daily throughout the duration of the trial.

Animal material of the study, were selected from among 60 Thoroughbred mares on the farm based on their age and being previously healthy animals that had never swum before. Throughout the trial period, the horses were left unshod. The horses were allowed to roam freely around the pool for two hours the day before without any research conducted to familiarize them with the pool.

The control group of the study consisted of 12 Thoroughbred healthy mares between the ages of 5-18, kept on the same farm. A similar care and feeding program was applied to the mares included in the control group, and they were mated without swimming.

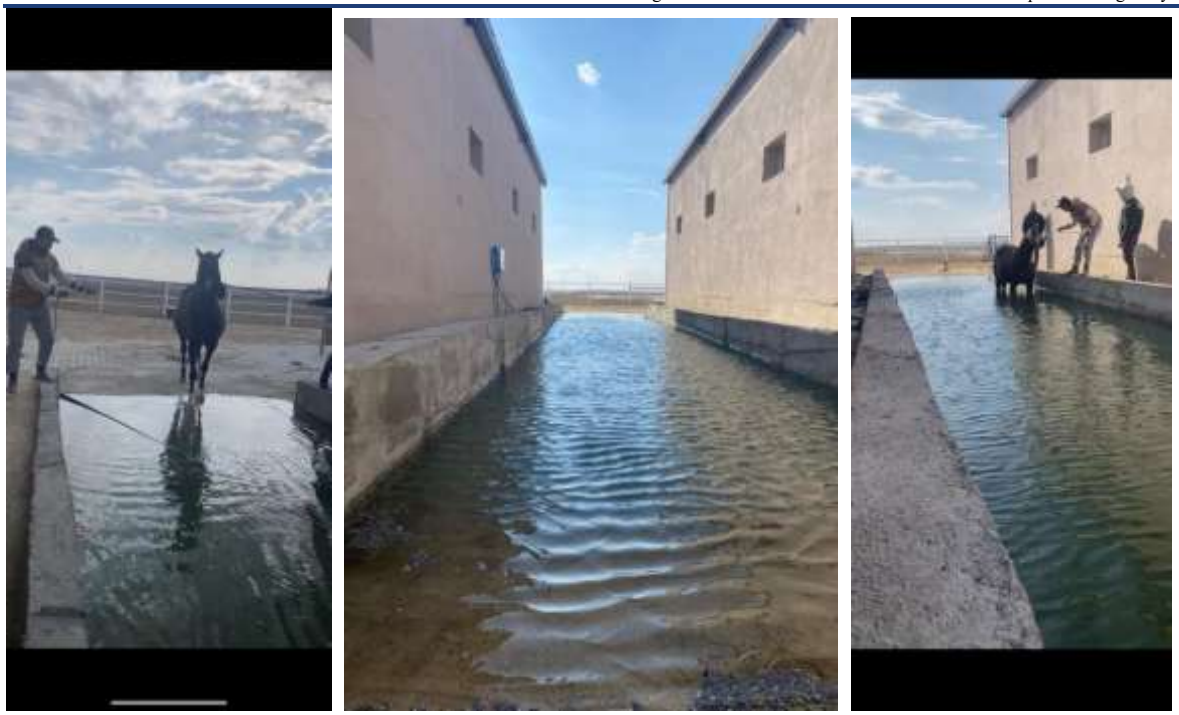

Figure 3-4-5. Pool where horses are swum

Within the scope of the research, the behavior of 20 horses regarding entering and staying in the pool and all their pool experiences were recorded with a camera. Research data was obtained by researchers by examining camera recordings and continuous observation method. During the research, observations were made by the subject expert and the data was recorded on camera and then the data was extracted by watching these records. The leg movements of the horses in the pool were also examined with the help of a wide-angle camera covering the entire pool. The data were measured with a stopwatch and the times were recorded.

Each horse was swum from one end of the pool to the other 5 repetitions a day during the trial period. After exiting the pool, they were kept on concrete for the first 5 min and then on soil for another 5 min. They were then washed with clean water, dried and taken back to their shelter.

The focus was on the behavioral characteristics of horses, such as the number of days it takes to enter the pool, smelling and drinking the pool water, the way they enter the pool, and the feet they prefer for entering and exiting the pool. All horses entered the pool at varying durations between 0-15 min through these trials.

When entering the pool, the horses were gently encouraged by caretakers on both sides to enter the pool on their own for 5 min. Horses that did not enter were encouraged to do so with carrots and green grass for 5 min. However, horses that still did not want to enter the pool had their eyes covered and were gently guided into the pool, and their eyes were uncovered after all four legs entered the water. An adaptation period of 7 days was implemented, followed by observations within the next 5 days.

During the trial period, horses are individually housed, having access to clean water through automatic troughs in the stables and water containers in the paddock whenever they desire. They are fed three meals a day, totaling 5 kg of oats, 3 kg of barley, 3 carrots, 3 apples and 8 kg of hay daily. Each horse is fed in the same manner. It is known that care, feeding and season affect the productivity ability of animals. Therefore, all animals included in the study were housed under similar environmental conditions (Karadağ and Soysal, 2018). No food or drink was given to the horses 1 h before and 1 h after swimming.

In this study, data on 26 characteristics of 20 horses of similar breed and characteristics, different ages (4-18 years old), kept under the same conditions and raised in a private horse care enterprise, were evaluated. The horses' approach to the pool, their behavior when entering and exiting and their behavior while in the pool constituted the basic data of the study. Behavioral frequency and percentage rates were used as descriptive statistics. To see the effect of cooling in the enterprise on the pregnancy rate in horses, horses in the same enterprise and not subject to any treatment were evaluated as a control group. The pregnancy rate was determined by dividing the number of

pregnant horses by the total number of horses for each group. The graphs and tables necessary to describe and analyze the statistical descriptive features of camera recordings and observation results were created with Microsoft Excel and SPSS statistical package programs (Gül and Oflaz, 2021). In the study presented, the analysis of pregnancy rates in swimming group and control group was conducted using the Chi-square method with the SPSS statistical program. Statistical significance was set at $p \leq 0.05$.

3. Results and Discussion

In this study, the swimming experience behaviors of 20 sample horses of the same breed and conditions, which were cared for in a private enterprise, were observed. According to the data, 70% of the horses are 4-7; 30% are 8-18 years old. This distribution shows that the majority of horses (70%) are in the young and middle-aged group.

The behavior of animals is a mixture of instincts and behaviors based on intellectual intelligence. Living beings learn, remember, know and apply. Many horses can swim and there is no need to specially teach these animals to swim, it is an instinct that is inherent in nature. The first experience is effective in improving the animals' later behaviors, abilities and reflexes. Despite it being their first time swimming in the deep part of the water, all horses were able to swim without any hesitation.

When horses first encounter the pool step back, neigh, hit the water with front foot, smelling water and rearing behavior has been observed (*Figure 6*)

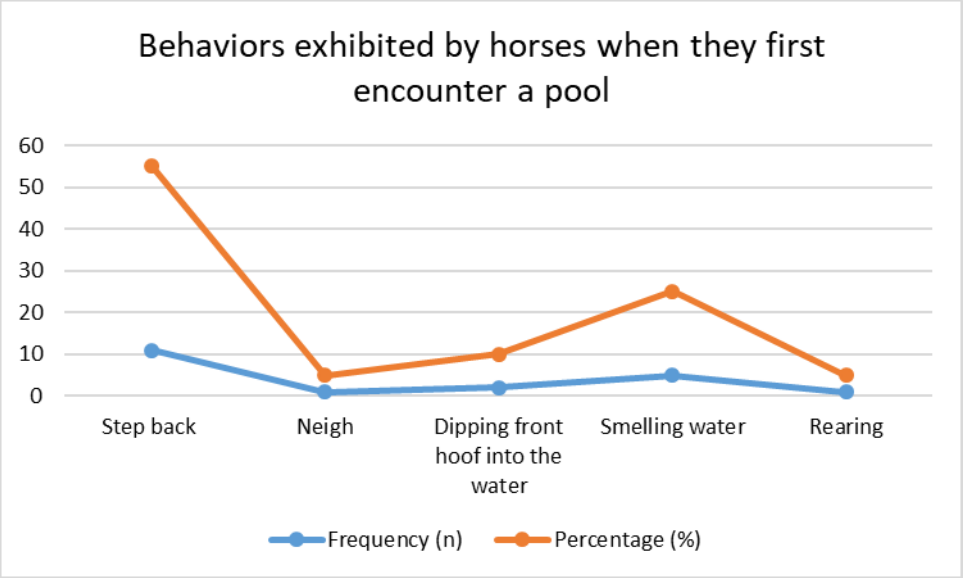

Figure 6. Behaviors exhibited by horses when they first encounter a pool

According to the figure, the behaviors exhibited by horses when they first encounter a pool are as follows. Step back behavior is observed at the highest frequency (55%). This behavior is the initial reaction of horses when approaching water. The step back behavior appears to be the most common response as horses' approach water. This reaction may stem from a natural caution toward water or indicate a bit of apprehension during their initial contact with water. Neigh behavior is observed in only 5% of the total behaviors. This seems to be a rare response during horses' initial contact with water. This suggests that horses generally remain silent or exhibit less vocal reactions when encountering water. Dipping front hoof into the water (10%) and smelling water (25%) behaviors indicate horses' interest and curiosity about water. These behaviors play an important role in horses' exploration and familiarization with water. "Rearing" behavior is less common compared to other behaviors (5%). This may suggest that horses can show a more anxious or cautious response to water. Overall, the behaviors exhibited by horses when they first encounter a pool reflect various emotional responses such as curiosity, anxiety and exploration. Horse owners and caretakers can better understand how horses behave in such environments by observing their reactions to water and taking necessary precautions.

In *Table 1*, an array of behavioral patterns observed during the initial entry of horses into the pool is presented. The predominant mode of entry, evident in a substantial majority (85%) of cases, involves walking into the pool.

This behavior signifies a measured and cautious approach, indicating that horses exhibit a level of comfort and familiarity with the aquatic environment. Conversely, a smaller fraction (15%) of horses opted for a more energetic response by running into the pool, suggestive of a heightened sense of eagerness or confidence. This interplay between caution and boldness underscores the diverse behavioral repertoire exhibited by horses in novel aquatic contexts.

Table 1. Horses' behavior upon entering the pool

Behaviour	Description	Frequency (n)	Percentage (%)
Manner of entering the pool	Running Walking	3 17	15 85
First foot entering the pool	Right Left	20 0	100 0
First foot leaving the pool	Right Left	20 0	100 0
Time taken to accept entering the pool (days)	1 2	17 3	85 15
Behavior of drinking pool water	Yes No	4 16	20 80
Behavior of smelling pool water	Yes No	20 0	100 0

The consistent preference for using both right and left foot during both the entry into and exit from the pool, observed in all instances (100%), may indicate either a naturally ingrained tendency or a learned behavior among horses. This inconsequential attitude in limb selection could be influenced by factors such as limb dominance or the cumulative experiences horses have had with water-related activities, contributing to a predictable pattern of behavior.

Furthermore, the rapid acclimatization of the majority of horses (85%) to pool entry within a single day suggests a remarkable capacity for environmental adaptation. However, it is noteworthy that a minority (15%) required an extended period of two days to fully accept this behavior, highlighting the inherent variability in adaptation rates across individual horses.

The behavior of drinking pool water, exhibited by a minority (20%) of horses, may reflect either a natural curiosity or a physiological need for hydration. Conversely, the majority (80%) abstaining from this behavior could be attributed to factors such as perception of water quality or access to alternative water sources. The ubiquitous behavior of smelling pool water (100%) serves as a common exploratory strategy employed by horses to gather crucial information about water properties, temperature and potential hazards, contributing significantly to their overall assessment and navigation of the pool environment.

Collectively, these behavioral observations underscore the diverse range of responses displayed by horses upon encountering a pool, encompassing elements of cautiousness, adaptability, exploratory tendencies and individual variability. A nuanced understanding of these behavioral nuances is pivotal in designing and maintaining optimal aquatic environments for horses, thereby ensuring their welfare and well-being in aquatic settings.

The behavioral aspects of the horses in the pool is given in *Table 2*. The absence of head submersion (0%) among the observed horses indicates a behavioral tendency of keeping the head above water during swimming. This behavior aligns with the natural instinct of horses to maintain a clear airway and visibility of their surroundings while in the water. It suggests that the horses in this study did not engage in diving or fully submerging behaviors typical of some aquatic species. The prevalence of "Pricked" ears (85%) while swimming signifies an alert and focused state among the horses. Pricked ears are associated with heightened attention and

awareness, indicating that the horses were actively monitoring their environment and responding to stimuli while in the pool. Conversely, the presence of "Normal" ear positions (15%) may indicate moments of relaxation or less intense engagement with the swimming activity. The consistent use of back legs for propulsion by all horses (100%) during swimming is in line with biomechanical expectations.

Table 2. The behaviors of horses in the pool

Behaviour	Description	Frequency (n)	Percentage (%)
Does it submerge its head while swimming?	Yes	0	0
	No	20	100
Position of the ears while swimming	Pricked	17	85
	Normal	3	15
Moving legs while swimming	Front	0	0
	Back	20	100
Directional inclination	Middle of pool	17	85
	Left side	1	5
	Right side	2	10
Neighing in the pool	Yes	20	100
	No	0	0

Horses primarily rely on their powerful hind limbs for forward movement in water, leveraging the strength and coordination of these muscles to navigate effectively. The majority of horses (85%) displaying a "Middle of pool" directional inclination suggests a tendency to swim towards the central area of the pool. This behavior could indicate a preference for open water or a neutral swimming trajectory without distinct directional biases. The smaller percentages of horses favoring the "Left side" (5%) or "Right side" (10%) of the pool may reflect individual variations or environmental factors influencing their swimming paths. The universal occurrence of neighing behavior (100%) while in the pool indicates a vocalization pattern associated with various emotions and communication among horses. Neighing could signify excitement, social interaction with other horses, or responses to the pool environment such as unfamiliar stimuli or changes in water conditions.

Swimming is a sport renowned for its holistic engagement of various muscle groups, including the arms, legs and core muscles, fostering overall muscular development and cardiovascular health (Jackson et al., 2022). The activity's low-impact nature reduces strain on joints, mitigating the risk of injuries during training and promoting joint longevity. Moreover, swimming is known to regulate heart rate, boost fat metabolism, stimulate muscle growth and sustain a healthy metabolic rate (Jackson et al., 2022). The release of endorphins during swimming contributes to pain relief and stress reduction, enhancing the overall well-being of swimmers (Jackson et al., 2022).

In parallel, the behavioral aspects of horses in swimming environments unveil intriguing parallels and distinctions. *Table 3* delineates these observations, notably the absence of head submersion (0%), aligning with horses' innate instinct to maintain clear airways and visibility while in water, thus deviating from fully submerging behaviors seen in some aquatic species. The prevalence of "Pricked" ears (85%) underscores horses' heightened alertness and environmental monitoring during swimming, akin to humans' focused engagement in the sport. Conversely, "Normal" ear positions (15%) among horses may denote relaxation or reduced attention during specific swimming phases, akin to human swimmers experiencing varied levels of intensity in their workouts.

Overall, these detailed behavioral observations provide valuable insights into how horses adapt and behave in aquatic environments. The maintenance of an alert and focused state, coupled with strategic limb usage and directional tendencies, reflects the natural swimming behaviors of horses and their ability to navigate and interact within pool settings.

Analysis of the behaviors observed in *Table 3* regarding horses' post-swimming activities are as follows; All horses (100%) exited the pool by walking, which is indicative of a deliberate and composed approach after the

swimming session. Walking as the exclusive exit behavior suggests that horses may have developed a routine and comfortable method for leaving the water. The first tail swinging times of horses post-exit the pool varied. Notably, 10% of horses immediately swung their tails upon exiting the pool, possibly indicating an immediate response to the water. However, the majority (90%) had first tail swinging times ranging from 0.5 to 1.5 minutes. This tail swinging period could signify a post-swimming relaxation process, where horses adjust physically and mentally to their environment. Horses exhibited diverse first shake-off durations after leaving the pool. The highest proportion (45%) had first shaken-off durations between 0.80 to 1.5 minutes, indicating a relatively quick adjustment phase. However, 35% of horses had shaken-off later between 2.00 to 3.00 minutes, suggesting a more prolonged recovery or water clearance process. Additionally, 15% of horses had started shaking off between 3.00 to 4.50 minutes for shaking off, reflecting further individual variations in post-swimming physical recovery.

Table 3. Horses' behavior upon exiting the pool

Behaviour	Description	Frequency (n)	Percentage (%)
Exiting the pool manner	Walking	20	100
	Running	0	0
Tail swinging duration (mins.)	0	2	10
	0.5-1.5	18	90
Shake-off duration (mins.)	0.80-1.5	9	45
	2.00-3.00	7	35
	3.00-4.50	3	15
First behavior observed after exiting the pool	Head shaking	13	65
	Shaking off	2	10
	Tail swinging	5	25

Upon exiting the pool, horses displayed a range of initial behaviors. The most prevalent behavior was head shaking (65%), which could be associated with clearing water from ears or expressing relief post-swimming. Tail swinging was observed in 25% of horses, potentially aiding in water removal from the body. Additionally, 10% of horses engaged in a general shake-off motion, contributing to the drying process and physical comfort.

These observations provide valuable insights into horses' post-swimming behaviors and their physiological and psychological responses upon exiting the pool. Tail swinging and shake-off durations suggest a period of physical adjustment and water clearance, while head shaking and neighing behaviors may reflect emotional states or communication signals among the horses. The consistency in walking exits and the prevalence of specific post-exit behaviors highlight the importance of considering horses' comfort and well-being during and after swimming activities, contributing to a comprehensive understanding of equine behavior in aquatic settings.

Scientific interpretation of the data provided regarding behaviors observed in horses after exiting a pool were given in *Table 4*.

Table 4. Behaviors observed in horses after exiting the pool

Behaviour	Description	Frequency (n)	Percentage (%)
Rolling on the ground	Yes	12	60
	No	8	40
Time spent nose touching upon exiting the pool (mins)	0	2	10
	0.5-1.5	18	90

The observed behavior of horses rolling on the ground post-pool exit is a common phenomenon in equine behavior studies. Rolling behavior in horses is associated with various factors, including thermoregulation, alleviation of discomfort or irritation, social communication and muscular relaxation. In this study, 60% of the observed horses engaged in rolling behavior, indicating a significant prevalence of this post-pool activity among the studied population.

Rolling on the ground is often linked to thermoregulation, where horses use rolling as a means to redistribute their wet coat and regulate body temperature. Additionally, rolling can serve as a way for horses to alleviate any potential discomfort or irritation caused by pool water, harnesses, or other equipment used during aquatic activities. This behavior may also have social implications, as rolling can leave scent marks on the ground, contributing to olfactory communication among herd members.

The data also includes observations of horses spending time snorting upon exiting the pool. While this behavior was less prevalent, with 2 horses (10% of the observed behaviors) engaging in snorting at 2 minutes, it still represents a notable aspect of post-pool behavior.

Snorting behavior in horses can indicate various states, such as relief and nose cleaning. It can also be a self-comforting behavior which horses may remove the harmful subtances in their respiratory systems.

Overall, the combination of rolling on the ground and snorting behaviors observed in this study reflects the diverse range of post-pool activities exhibited by horses. Further research could delve into the specific triggers and motivations behind these behaviors, contributing to a deeper understanding of equine behavior in aquatic environments and enhancing welfare considerations for horses engaged in water-based activities.

Pregnancy status of the treatment and control groups horses is given in *Table 5* and *6*. While 7 (58.33%) of 12 horses in the non-floated control group became pregnant, 19 (95%) of 20 horses that were floated became pregnant. This shows that swimming behavior has a greater effect on pregnancy rate than expected. In horse breeding, the birth season of the foal (January-June) is as important as obtaining a foal per year. For this, the horse must become pregnant on time and with the least number of vaccinations. In this way, breeding stallions are used more effectively and breeding costs are reduced. In addition, the risk of problems such as uterine inflammation due to repeated overmating is reduced. Heat stress is also an important factor in pregnancy rate (Kang et al., 2023).

Table 5. Reproduction performances of Horses

Pregnancy	Total number horse	Pregnant horse number	Ratio (%)
Control group	12	7	58.33
Pool group	20	19	95.00
X^2			.018

Table 6. Swimming * Pregnancy Crosstabulation

			.00	1.00	Total
Swim	1.00	Count	5	7	12
		Expected count	2.3	9.8	12.0
	2.00	Count	1	19	20
		Expected count	3.8	16.3	20.0
Total		Count	6	26	32
		Expected count	6.0	26.0	32.0

As a result of the chi-square analysis (*Table 7*), it was understood that pool application increased the pregnancy rate of horses at a very significant level (p=0.018).

Factors that create stress in horses, lack of socialization and inadequate training have a negative effect on pregnancy rates (Malschitzky et al., 2015). In line with this view, it has been observed that horses that are made to swim are psychologically relaxed and increase their muscle mass by swimming. It has been stated that increasing horse welfare and improving environmental conditions will have positive effects on birth rate and pregnancy rate (Paksoy and Güngör, 2024). In our study, the welfare levels of horses that were regularly swam were increased, necessary environmental arrangements were made and as a result, it was observed that the pregnancy rate increased.

Table 7. Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
earson Chi-quare	6.619[a]	1	.010		
ontinuity orrection[b]	4.431	1	.035		
kelihood atio	6.644	1	.010		
Fisher's Exact est				.018	.018
near-by-near ssociation	6.412	1	.011		
of Valid ases	32				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.25.
b. Computed only for a 2x2 table

Heat stress is an important welfare issue, there is not a clear definition of heat stress in horses, and there is little data available regarding this condition. In relation to welfare in horses, heat stress can be defined as the inability of the horse to maintain body temperature within a prescribed temperature range (Caulfield et al., 2014).

Hot and humid climatic conditions may exacerbate heat accumulation in the body by restricting heat dissipation (Brownlow et al., 2016; Brownlow and Smith, 2021). It has been documented that body temperature can significantly increase as ambient temperature increases (Aujard and Vasseur, 2001; Minka and Ayo, 2016; Soroko et al., 2017). Humidity will also influence body temperature. As aforementioned, water has high conductivity, so it helps heat dissipation when it is used as a conductive heat transfer but during, and immediately after exercise, the body temperature of horses is significantly higher when humidity is higher, under the same ambient temperature (Kohn et al., 1999). Although horses are non-panting animals and they can only breathe through the nostrils, an increase in respiratory rate during periods of heat load has been reported (Kohn and Hinchcliff, 1995) that indicate it has a primary role in thermoregulation that can contribute to brain cooling (Lekeux et al., 2014; Robertshaw, 2006). Effective and practical intervention methods include using a fan to supply airflow or pouring cool water on the skin can be applied to minimize the prolonged heat stress (Brownlow, 2018; Jeffcott et al., 2009; Marlin et al., 1998; Takahashi et al., 2020; Williamson et al., 1995).

Acute heat stress can affect reproductive functions in both the stallion and the mare. When the body temperature of a stallion is elevated, the scrotal temperature can also be elevated, which may result in poor spermatogenesis or mutations in gamete DNA, as well as decreasing testosterone levels for a few weeks after heat shock exposure (Hansen, 2009; Love and Kenney, 1999; Setchell, 2006). It has also been reported that semen concentration, number of spermatozoa and motile sperm per ejaculation in bulls were lower during summer than in winter and spring (Bernabucci et al., 2010). However, mild heat stress may not result in diminished breeding ability due to the thermoregulation function of the scrotum where there is heat exchange between highly coiled arteries and veins around the testis (Amann, 2011; Gordon et al., 2014). In a study of mammalian females, acute heat stress decreased maternal blood flow to the placenta (Alexander et al., 1987) and reduced follicular volume (Wolfenson et al., 1997), which can cause poorer reproductive results.

If environmental heat stress is prolonged by seasonal or geographical location, various physical factors can change, such as normal body temperature range, fat deposition, coat thickness, or hair density, as an adaptation to mitigate the effects of long-term heat stress conditions (Bernabucci et al., 2010; Collier et al., 2019). Furthermore, the sensitivity and population of the receptors for homeostatic signals can be changed, such as by decreasing catecholamines and glucocorticoids (Bernabucci et al., 2010; Collier et al., 2019). When heat stress is prolonged, following changes have been reported such as damage to oocyte quality (Al-Katanani et al., 2002), suppression of

gonadotropin-releasing hormone (Satué et al., 2021), reduced numbers of gonadotropin receptors (Hansen, 2009; Shimizu et al., 2005) and medium-sized follicles (Roth et al., 2000), impaired embryonic development (Bernabucci et al., 2010; Ealy et al., 1993) and abnormal foetal development (Mortensen et al., 2009; Smith et al., 2012; Yu et al., 2022). In various studies, the heat stress is also recognized as a teratogen (Barrier et al., 2009; Graham and Marshall, 2005; Ouellet et al., 2021). Adaptation to heat stress changes the sensitivity of the onset of sweating, as well as the number of active sweat glands and its volume (McCutcheon and Geor, 2000; Sawka et al., 2001; Sneddon et al., 2008). It was reported that repeated exercise initiates the onset of sweating at lower body temperature (McCutcheon and Geor, 2000) and the sweat gland volume in Thoroughbreds was significantly increased during the summer season when compared to the winter season (Sneddon et al., 2008). Adaptation to the prolonged heat stress can be fixed in gene expressions such as changes in morphological traits, behaviour, metabolism, and productivity over generations to decrease metabolic heat production and increase heat dissipation efficiency (Bernabucci et al., 2010; Geor et al., 1996); (Sejian et al., 2018).

4. Conclusions

In conclusion, this detailed behavioral analysis sheds light on the complex interaction of horses' natural instincts, their adaptability and their responses to new stimuli in their aquatic environment. Swimming behavior in horses is particularly beneficial for post-operative recovery, inadequate muscle mass, endurance in competitions and problems experienced due to psychological disorders. This study showed that swimming behavior in horses provided a 37% positive effect on pregnancy rate and provided significant material and spiritual gains in terms of breeding.

It was determined that swimming behavior is innate in horses and that they are born with this behavior in their repertoire. It was observed that horses generally exhibited a mixture of curiosity, attention and exploration such as stepping back, sniffing the water and dipping their hooves when they first encountered a pool. This study shows horse owners, horse caretakers and colleagues that aquatic environments increase horse welfare and positively affect their reproductive performance.

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Ethical Statement

In this study, routine breeding in stud farms practices have not been deviated from. Data obtained in these study within the scope of these applications for Experimental and Other Scientific Purposes Concerning the Welfare and Protection of Animals Used Regulation (Official No. 28141 dated 13.12.2011, Gazette) article 2, second paragraph: “This Regulation, non-experimental agricultural and clinical veterinarian In accordance with the provision does not cover applications’, the scope since it is outside the Ministry (T.R. Adana Governorship Provincial Directorate of Agriculture and Forestry, Number: E-74530962-325.99-13486280) is not subject to permission.

Conflicts of Interest

The authors declared that there is no conflict of interest.

Authorship Contribution Statement

Conceptualization, N.K.; writing-original draft preparation, N.K. and Y.P.; writing-review and editing, N.K.; Y.P. and S.G. All authors reviewed and approved the final version of the manuscript.

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