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Canine parturition: The normal whelping process

Kutya ellés: A normál kölyöklési folyamat

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Abstract

This thesis investigates normal parturition in female dogs through a literature review and preliminary analysis of data from the ongoing “The Weight of Whelping” questionnaire by the Virginia-Maryland College of Veterinary Medicine. It examines hormonal influences, physiological and behavioural changes, the three stages of labour and dystocia, including its differentiation, to define what constitutes normal versus abnormal parturition and to provide a timeline for the parturition process. Results from 16 whelps of nine Standard Poodle bitches revealed significant variability in parturition timelines, underscoring the importance of monitoring multiple parameters rather than relying on a single indicator. While the small sample size and incomplete survey data present limitations, the results align with existing literature, reinforcing current knowledge and providing preliminary guidelines for effective whelping management. The discussion explores the correlation between survey findings and literature, noting consistencies in behavioural and physiological patterns while acknowledging limitations in data scope. In conclusion, this research highlights the complexity and individuality of whelping, emphasising the need for comprehensive monitoring and data collection to improve outcomes and support future studies in canine parturition.

Absztrakt

Szakkolgozatomban a fiziológiás ellés lefolyását vizsgáltam szuka kutyában. A vonatkozó irodalom elemzése mellett, bekapcsolódtam a Virginia-Maryland Állatorvostudományi Egyetem által indított kutatásba, mely során az általuk készített, az ellés lefolyását vizsgálni hivatott tulajdonosi kérdőívekből beérkezett adatok egy részének előzetes vizsgálatát volt alkalmam elvégezni. A kérdőív alapján vizsgálatam az ellés három fázisában jellemző élettani és viselkedési változásokat, valamint a nehézellés, beleértve annak elkülöníthetőségét, annak érdekében, hogy pontosabban meg tudjuk határozni, hogy mi számít élettani, illetve már kóros ellési lefolyásnak. A kilenc óriás uszkár fajtájú szuka, tizenhat ellésének megfigyelése során gyűjtött adatok alapján jelentős különbségek mutatkoztak az ellések lefolyásában. Bár az előzetes eredmények, tehát a kis mintaszám, illetve a helyenként hiányos adatsor egyelőre csak korlátozott fokú értékelést tettek lehetővé, az eredmények összhangban voltak az elérhető szakirodalmi adatokkal, megerősítve a jelenlegi ismereteket, valamint előzetes iránymutatást adnak a hatékony gondozás, ellési segítségnyújtás tervezéséhez. A megbeszélés fejezetben részletesen elemeztem a felmérés

előzetes eredményei, valamint az irodalmi adatok között összefüggést, kiemelve a viselkedés, illetve az élettani változások leírása terén jellemző következetességet, elismerve az eredmények alapján levonható következtetések korlátait. Összességében elmondható, hogy ez a kutatás rávilágít az ellés lefolyásának roppant összetett voltára, az egyedi eltérések lehetőségére, hangsúlyozva az átfogó megfigyelés és nyomon követés, valamint az adatgyűjtés jelentőségét a problémamentes ellés lefolyás hátterében, valamint a jövőbeni kutatások támogatása érdekében

Table of Contents

2.1 The hormonal background of pregnancy and parturition in dogs	5
2.1.1 Foetal Cortisol	5
2.1.2 Prostaglandins.....	6
2.1.3 Progesterone	6
2.1.4 Oestrogen	8
2.1.5 Relaxin	9
2.1.6 Oxytocin.....	10
2.1.7 Prolactin	11
2.1.8 Overview of the Interplay of Hormones	12
2.2 Signs of impending parturition in dogs	13
2.2.1 Behavioural Changes.....	13
2.2.2 Physical Changes	14
2.3 The Stages of parturition and their normal course.....	16
2.3.1 Stage One	16
2.3.2 Stage Two.....	18
2.3.3 Stage Three.....	20
2.4 The Concept and Types of Dystocia	21
2.4 Differences indication dystocia	25
3. Objectives	26
4. Materials and methods	27
5. Results.....	28
5.1 Stage One.....	29
5.2 Stage Two	30
5.3 Full parturition	37
6. Discussion	38
7. Summary	43
8. References	44
9. Acknowledgment	46

1. Introduction

Parturition, the action or process of giving birth to offspring, also known as labour and delivery. The word parturition comes from the latin word “parturire” meaning “to be ready to bear young” and is related to the word “partus” which means to prepare [1].

In this thesis I aim to explore the normal parturition process of the female dog, including the physiological, hormonal and behavioural aspects that characterise a typical birth.

The understanding of normal parturition is very important for not only veterinarians but owners and breeders as well [2]. A lack of understanding of the process may cause unnecessary intervention and stress on the bitch and may also lead to missed signs and signals of complications and dystocia. Dystocia can be defined as difficulty during labour, arising from prolonged labour or complications of labour. It occurs when the foetus cannot be expelled through the birth canal, either due to a physical obstruction or a functional abnormality [3].

Parturition is divided into 3 stages [3], that I will discuss in more detail in the literature review section, each stage is characterised by distinct physiological and behavioural changes.

- 1- Stage 1: Preparation
- 2- Stage 2: Delivery of the puppy
- 3- Stage 3: Expulsion of the placenta

Through this comprehensive examination of normal parturition in female dogs, this thesis aims to enhance the understanding of this vital reproductive process, ultimately contributing to improved health and welfare for dogs and better support for those who care for them.

2.1 The hormonal background of pregnancy and parturition in dogs

The hormonal regulation during pregnancy and parturition in dogs is a complex and finely tuned process [4] involving several key hormones that interact to ensure the successful development of the foetus and the eventual delivery of healthy puppies. Understanding these hormonal dynamics is essential for recognising normal patterns and identifying potential complications and risks during pregnancy and labour.

2.1.1 Foetal Cortisol

Foetal cortisol plays a critical role in canine parturition and foetal development. As the foetus matures, rising cortisol levels trigger the onset of labour by signalling the mother's body that

the foetus is ready for birth. This hormone is also essential for the maturation of foetal organs, particularly the lungs, by stimulating surfactant production. In canine puppies, surfactant protein can be detected in the lung tissue as early as 55 days of gestation. However, true alveoli, the small air sacs in the lungs, are not formed until after birth [8].

Additionally, foetal cortisol regulates maternal hormones like oestrogen and prostaglandins, which facilitate labour. Its increase ensures that birth timing aligns with the foetus's developmental readiness, while also preparing the foetus for the stress of transitioning to life outside the womb.

2.1.2 Prostaglandins

Prostaglandins, particularly prostaglandin F2a (PGF2a) and prostaglandin E2 (PGE2), play a crucial role in the hormonal and physical changes that lead to labour in dogs. These compounds are involved in multiple processes, including luteolysis, uterine contractions, and cervical ripening, which are essential for successful delivery [2,4,26]. The corpus luteum, responsible for producing progesterone needed to maintain pregnancy, begins to break down as PGF2a levels rise sharply near parturition usually within 36 hours [4]. This increase is driven by the upregulation of enzymes like cyclooxygenase-2 (COX-2) in the uteroplacental unit, leading to a rapid decline in progesterone levels [4]. This progesterone drop signals the body to prepare for labour and makes the uterus more responsive to contractile signals [2,4,26]. Prostaglandins are central to initiating labour, with PGF2a promoting uterine contractions and PGE2 aiding in cervical softening and ripening [2,26]. PGF2a stimulates the myometrium, or uterine muscle, to contract rhythmically, which is essential for the expulsion of foetuses and placentas [2,4,26]. Additionally, it increases the uterus's sensitivity to oxytocin, amplifying contractions for efficient delivery [26]. PGE2 plays a key role in preparing the cervix by remodelling connective tissue, softening, and dilating it to allow puppies to pass through the birth canal. This process is further supported by relaxin, which is also influenced by prostaglandins [2,4,26].

Prostaglandins are essential for orchestrating the transition from pregnancy to delivery. They regulate the breakdown of the corpus luteum, trigger uterine contractions, and prepare the cervix for birth. These coordinated actions ensure a smooth delivery process and provide a basis for clinical applications in managing canine reproduction [2,4,26].

2.1.3 Progesterone

Progesterone is the primary hormone throughout a dog's pregnancy also known as the maintenance hormone of pregnancy. Progesterone is produced by the corpora lutea in the

ovaries and is crucial for maintaining the uterine lining and provides a supportive environment for the developing embryos. High progesterone levels during pregnancy prevent uterine contractions and aid placental function. As parturition nears, progesterone levels gradually decrease, with a sharp decline occurring 24 - 36 hours before stage 2 of labour [5]. This drop is closely associated with a decrease in body temperature [25], signalling the onset of labour [4,5].

Progesterone is measured in either ng/ml or nmol/L as seen in Figure 2 and an understanding of each unit of measurement paired with an understanding of the blood analysis machine in use is important for interpreting the result as each machine may be calibrated different and have different ways of interpreting the results. Serum samples are taken from the bitch to analyse the levels of progesterone as demonstrated below in Figure 1. These samples are commonly referred to as reverse progesterone as we are looking to observe a sharp drop in serum progesterone concentrations rather than a jump or peak in progesterone that is associated with ovulation. This drop in progesterone is abrupt and happens 24 - 36 hours before parturition as mentioned above [5, 12].

In the final days leading to parturition in bitches, progesterone levels decline sharply [5,12,27], providing a reliable indicator for determining the onset of parturition. Approximately 48 to 60 hours before the first signs of total cervical dilation (TCD), progesterone levels are still relatively high, typically ranging from 1.5 to 6 ng/ml. As labour approaches, these levels begin to drop, falling to between 1.4 and 5 ng/mL about 36 to 48 hours prior. The decline becomes more pronounced within the 24 to 36 hours leading up to TCD, with levels ranging from 0.8 to 3.9 ng/ml. At this stage, levels below 1.1 ng/ml are strongly associated with labour occurring within the next 36 hours. By 12 to 24 hours before TCD, progesterone levels are further reduced, typically between 0.4 and 3.5 ng/ml as seen below in Figure 1, and levels below 0.7 ng/ml are predictive of labour within 24 hours. In the final 12 hours, progesterone is at its lowest, measuring between 0.1 and 1.8 ng/ml in most cases. At the time of TCD, levels usually range from 0.0 to 2 ng/ml, signifying the imminent onset of labour [27].

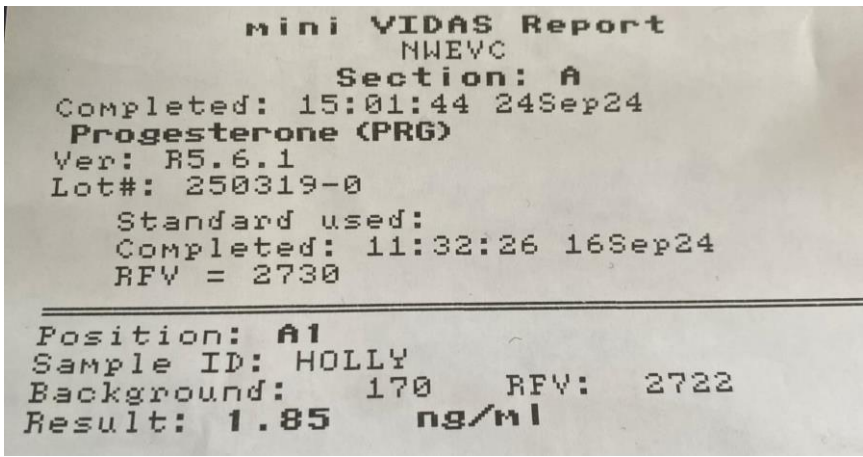


Figure 1: This image displays the results of a reverse progesterone test taken to determine the timing for an elective caesarean section. The results show a marked drop to 1.85 ng/ml from the previous day's level of 13.1 ng/ml, indicating a significant decrease in progesterone levels. This drop is a key indicator, often signalling that parturition is imminent and that the timing is appropriate for an elective caesarean [5,12]. When progesterone plasma concentrations are less than 3.18 nmol/L which converts to 1.3ng/ml that parturition will occur within 24 hours [4].

Source: My own photo.

PROGESTERONE INTERPRETATION FOR WHELPING PLANNIFICATION		
>15	> 47.70	whelping >48H
7 - 14	22.26 - 44.51	PS 24H
< 7	< 22.26	whelping < 24H Possibility of Caesarian

Figure 2: mini Vidas chart for interpreting the drop in progesterone. The figure on the left in the black text represent ng/ml whereas the red text represents nmol/L.

Source: [Canine Progesterone - Glenbio Canine Progesterone](#)

2.1.4 Oestrogen

Oestrogen plays a vital role in preparing the bitches body for labour and delivery as well as lactation. It works in conjunction with progesterone during the early stages of pregnancy to support uterine growth and vascularisation [6]. As parturition nears, oestrogen levels rise, promoting uterine contractility, increasing mammary development and increasing the sensitivity of the uterus to oxytocin, a hormone that triggers contractions. In bitches, oestrogen secretion during pregnancy primarily originates from the ovaries and is influenced

by prolactin stimulation. Serum oestrogen concentrations progressively rise between days 45 and 60 of gestation, peaking at 20 - 30pg/ml shortly before whelping [6].

2.1.5 Relaxin

Relaxin is another important hormone during canine pregnancy. Produced primarily by the cytotrophoblast in the placenta [4], relaxin helps to remodel the connective tissue by softening and relaxing the cervix and pelvic ligaments [2], facilitating the passage of puppies through the birth canal during delivery. Measuring relaxin levels can also be used as a diagnostic tool to confirm pregnancy in dogs as it is the main marker of pregnancy and can be used as a pregnancy diagnosis from day 26-29 of gestation as suggested by FastTest, see figure 3 and figure 4, the manufacturer of the inhouse relaxin test commonly used in practices. Relaxin levels begin to rise 25-30 days after the peak of luteinizing hormone and reach their highest concentrations around the 35th day of pregnancy. These elevated levels of relaxin remain stable throughout the remainder of the pregnancy [4].



Figure 3: In house FASTest, taken from VetLab Supplies, “Fast test for the qualitative detection of the pregnancy hormone relaxin in plasma or serum of the dog and cat”. [22]

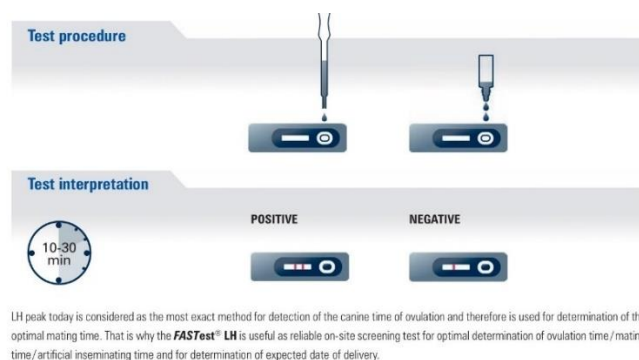


Figure 4: Test procedure and results interpretation for FASTest Relaxin. [22]

2.1.6 Oxytocin

Oxytocin is often referred to as the labour hormone due to its role in stimulating uterine contractions during parturition [4]. During parturition, oxytocin production involves a combination of endocrine and paracrine mechanisms. The maternal hypothalamus produces oxytocin, which is transported to the neurohypophysis and released into the bloodstream in pulses. Sensory nerves in the cervix and vagina detect pressure during parturition, and their signals are sent to the hypothalamus, triggering the release of oxytocin from the posterior pituitary gland. This increases the strength of uterine contractions, which further stimulates the sensory nerves, creating a positive feedback loop known as the Ferguson reflex, as shown in Figure 6 below. Hormones like oestrogen and relaxin, along with the uterine contractions, help the cervix gradually dilate during this process [2,12].

This hormone also plays a key role in helping the mother bond with her puppies after birth and supports milk let-down during nursing [7,8]. Oxytocin release in the mother can be triggered by several key stimuli, each playing a vital role in supporting maternal behaviours, bonding, and the physiological processes essential to caring for newborn puppies. One of the primary triggers for oxytocin release is nursing or suckling [7]. When puppies nurse, it stimulates a surge of oxytocin, which helps milk let down [5], ensuring that the puppies receive adequate nutrition and colostrum. Nursing also strengthens the bond between the mother and her litter, reinforcing the mother's care instincts through this regular release of oxytocin. Physical contact [7], such as licking and grooming, also plays a crucial role. Mothers naturally lick and groom their puppies, which promotes oxytocin release and enhances the maternal bond. This behaviour has multiple purposes, it keeps the puppies clean, stimulates them to defecate and urinate, and provides a comfort contact that strengthens the bond between mother and pups. Puppy vocalizations, such as crying or whimpering, are another powerful stimulus for oxytocin release. The sounds made by puppies not only alert the mother to their needs but also trigger oxytocin in her system, promoting nurturing behaviours and keeping her interested in the puppy's wellbeing. Finally, the simple presence of the puppies, including visual and olfactory cues, further enhances oxytocin release. When the mother sees or smells her puppies, these sensory inputs reinforce maternal behaviours, keeping her attentive and bonded to the litter as shown in Figure 5 below. Together, these stimuli create a continuous feedback loop of oxytocin release [9].



Figure 5: Vikki, 6-year-old Hungarian Vizsla showing a strong maternal bond with her day old puppies.

Source: My own photo.

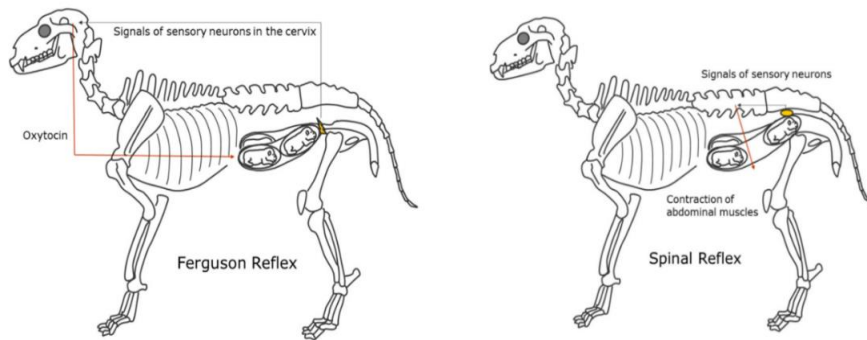


Figure 6: Ferguson Reflex: Sensory neurons in the cervix and the vagina detect pressure and submit signals to the hypothalamus. The release of oxytocin from the posterior pituitary into the blood induce uterine contractions [2].

Source: Arlt, S.P., 2020. The bitch around parturition. Theriogenology.

2.1.7 Prolactin

Prolactin is crucial for the onset and maintenance of lactation in dogs. Secreted by the anterior pituitary gland, prolactin levels increase toward the end of pregnancy, peak after parturition and remain high during lactation [2,4,5]. It is thought that prolactin levels are not involved in the initiation of parturition but rather parturition causes the peak in prolactin [5]. During pregnancy, high progesterone levels usually inhibit prolactin secretion to prevent milk production before birth. However, as parturition approaches, progesterone levels decrease, which removes the inhibitory effect on prolactin, leading to a significant increase

in prolactin levels. This rise in prolactin helps prepare the mammary glands for milk production and supports the transition to lactation after birth [4].

2.1.8 Overview of the Interplay of Hormones

The transition from pregnancy to parturition in dogs involves a complex interplay of hormones, with each playing a vital role in the timing and progression of labour, although the precise timing is still not fully understood in the dog [4]. The process begins with stress-related glucocorticoid secretion by the foetal adrenal cortex, which boosts oestrogen synthesis in the placenta through the induction of placental aromatising enzymes. This rise in oestrogen, coupled with cortisol, contributes to prostaglandin F2a (PGF2a) synthesis in the endometrium. Oestrogen also increases the number of oxytocin receptors in the uterus, allowing oxytocin, released from the pituitary gland, to stimulate the release of PGF2a directly from the uterus [6,7]. Thus, oestrogen both directly promotes PGF2a synthesis and indirectly enhances its release via an oxytocin-dependent mechanism.

PGF2a plays a pivotal role by inducing luteolysis, causing a sharp decline in progesterone levels over the 2-3 days leading up to labour, as seen in figure 7 below indicated by the orange line [4,10]. This drop removes the inhibitory block on uterine contractions [2,4,26]. High levels of progesterone during pregnancy are critical for maintaining uterine relaxation and preventing premature contractions. With the decline in progesterone, the oestrogen to progesterone ratio increases, facilitating oxytocin release from the posterior pituitary. This process is reinforced by Ferguson's reflex, promoting strong and regular uterine contractions [2,4,26]. Concurrently, prostaglandins enhance myometrial contractions and soften the cervix, facilitating dilation and the delivery of puppies.

Prolactin also rises during the prepartum period, preparing the mammary glands for lactation and ensuring the puppies have immediate access to colostrum after birth [2,4]. Together, these hormonal dynamics underscore the importance of monitoring multiple parameters during parturition, enabling veterinarians and breeders to identify complications early and optimize birthing management [4,10].

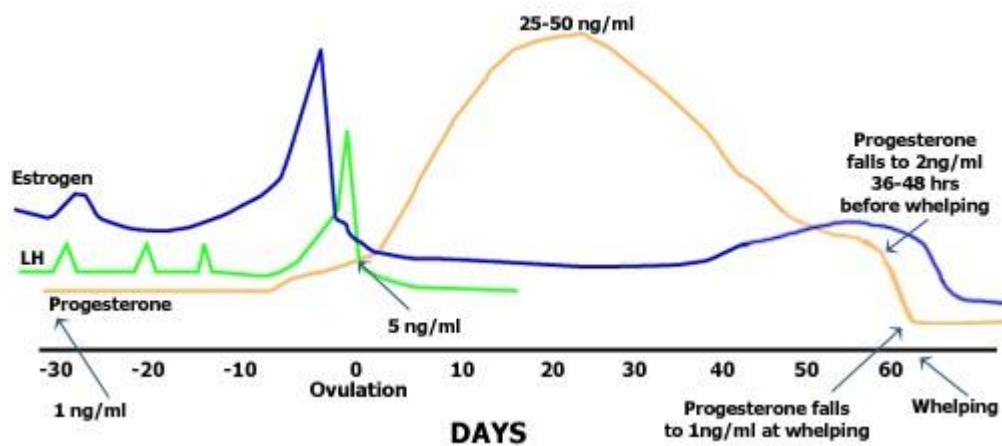


Figure 7: This figure illustrates the complex interplay of hormones throughout the reproductive cycle, from the pre oestrus stage, through ovulation, and finally to whelping. It effectively demonstrates the role of key hormones. This visual guide has been an essential tool for me in helping educate owners, as it clearly outlines how progesterone levels rise at ovulation, drop at whelping and the impact of these changes on the reproductive process, making it easier for them to understand the hormones that influence their dog's pregnancy and delivery.

Source: caninep4.com

2.2 Signs of impending parturition in dogs

Recognising the signs of impending parturition in dogs is essential for ensuring a safe and successful delivery. Misinterpreting these signs can lead to poor decisions regarding diagnostics, treatment, or guidance [2]. As whelping nears, several indicators help predict labour, such as changes in body temperature, restlessness, or a drop in appetite [2]. Maternal behaviours also play a crucial role, with preparation for whelping marking the start of interactions that ensure the birth, survival, and healthy development of the pups into social, well-adjusted dogs. This comprehensive approach underlines the importance of monitoring both physiological and behavioural cues [9].

2.2.1 Behavioural Changes

As a dog approaches parturition, several behavioural changes are commonly observed. One of the earliest signs is nesting behaviour, where the dog instinctively seeks a quiet, comfortable place and begins arranging or biting at bedding or blankets to create a safe and warm environment for her puppies [2, 5, 11,12]. This behaviour mirrors that of their wild ancestors, as domesticated dogs should show similar instincts during the prelabour period as those seen in wild canids, including behaviours like digging and nesting [9]. Another typical behavioural change is restlessness and anxiety, where the dog may pace, pant excessively, and appear unsettled, with owners reporting signs of prelabour anxiety, drowsiness, or even

aggression in about 50% of cases [9]. These changes are also accompanied by a decreased appetite, which typically occurs 12 to 24 hours before labour, due to hormonal shifts like the quick decline in plasma progesterone concentrations [9].

Dogs also show varied emotional responses as labour approaches. Some become unusually affectionate, seeking more attention from their owners, while others prefer to isolate themselves. It is important to be mindful of these different behaviours and not force affection if the dog seeks solitude. This range of responses can vary from pregnancy to pregnancy, as evidenced by personal experiences with different litters. For example, my own Vizsla was seeking seclusion during her first pregnancy but choose to stay closer to myself during a subsequent litter and chose my bedroom as her whelping area, she instantly presented stressed in her whelping area. Bitches may seek isolation and privacy or become clingy and search for human interaction and company as they prepare for labour [9].

2.2.2 Physical Changes

The following information is from my own experience working in a canine reproduction clinic as a Veterinary Nurse for several years and is supported by the included references.

1. **Drop in Body Temperature:** A significant drop in body temperature by 1 degree is a reliable indicator of impending labour. According to the Minivet guide [24], a dog's normal temperature typically ranges from 37.5 to 39.1°C. Pregnant females usually have a temperature at the lower end of this range. Between 49-72 hours before Stage 2 of labour, the bitches approximate temperature is 37.7 +/- 0.1°C. This slightly decreases to an average of 37.6 +/- 0.2°C in the 24-48 hours prior to Stage 2. In the final 24 hours leading up to Stage 2, the temperature further drops to an average of 37.3 +/- 0.3°C [25]. Although the drop in temperature is reliable it is not always present in some females as studies have shown. The idea that a body temperature drop is a good indicator of impending parturition in dogs is supported by multiple sources. This decreases, often about 1.0°C, typically occurs approximately 24 hours before whelping. It is thought to result from hormonal changes, including a sudden drop in progesterone levels as progesterone is thermogenic [2,5,12,20,25] The bitch's body temperature will return to normal at the time of parturition, so it is important to monitor this temperature frequently in order to establish a baseline and help us note the drop in temperature [12][20].
2. **Changes in the Mammary Glands:** The female's mammary glands will become enlarged and firm as they prepare for milk production, this is due to the proliferation

of the glands and the changes to the ducts system [13]. As parturition approaches, progesterone levels decrease, which allows prolactin to stimulate the mammary glands to initiate milk production, a process known as lactogenesis [23]. The alveoli, the milk-producing structures within the mammary glands, become enlarged and begin to secrete colostrum, a nutrient-rich fluid that provides essential antibodies to the puppies in the early days after birth. Meanwhile, oxytocin triggers the contraction of smooth muscle cells surrounding the alveoli, facilitating milk ejection during nursing [7,8,13]. Some dogs may start to produce colostrum a few days before giving birth, some dogs have a delayed production of milk, and some first-time mothers have been known to produce milk up to 14 days before giving birth but can also be delayed 2 – 3 days post parturition [13,23]. Noticeable mammary development typically begins around Day 45, while visible milk secretion usually starts at or after parturition. However, cases of delayed mammary growth or early milk production can sometimes occur as mentioned above [14].

3. **Contractions:** As stage two approaches, one of the most notable signs in dogs is visible abdominal contractions and looking at the flank [5]. These contractions are a result of uterine activity as the muscles of the uterus begin to contract rhythmically in preparation for expelling the puppies. Initially, these contractions may be mild and irregular, but as labour progresses, they become more intense and frequent [15]. These contractions help move the puppies into the birth canal. The contractions can be seen as distinct waves across the abdomen, especially in the final stages of labour when the dog's uterine muscles are fully engaged in the process of delivering the pups. In eutocic dogs, uterine contractions occur frequently and regularly, lasting between two and five minutes, with a contractile tone of 30 to 40%. During the expulsive phase, these contractions are paired with abdominal pressure spikes reaching 80 to 99% [15]. The onset of visible contractions often marks the beginning of the second stage of labour, known as the expulsive stage, which is characterised by the active pushing of the puppies through the birth canal. In many cases, the contractions are accompanied by a visible strain or pushing by the mother, as well as other physical signs such as panting and restlessness [5]. These abdominal contractions are critical in facilitating the normal passage of the puppies and should continue regularly until all the puppies are born. Prolonged periods of contractions without delivery, however, may indicate dystocia, a condition that requires veterinary attention [2].

4. Vulvar changes are another key indicator that parturition is imminent. As the cervix begins to dilate in preparation for delivery, the vulva becomes noticeably swollen due to the increased blood flow and hormonal changes associated with labour [20]. This swelling helps to accommodate the passage of the puppies through the birth canal. Additionally, a discharge may be observed from the vulva as the body prepares for delivery. This discharge is typically clear or slightly bloody and is a normal part of the labour process, signalling that the cervix is opening. The mucus plug, which has sealed the cervix throughout pregnancy, is expelled during this time, contributing to the discharge [2]. The presence of this discharge, often accompanied by softening and further dilation of the vulva, is a sign that the body is preparing for the final stage of labour, where the puppies are delivered. Any abnormal discharge, such as a green or foul-smelling fluid should raise concern, as it may indicate a complication such as placental detachment or infection, warranting immediate veterinary care [9].

These physiological changes are essential components of normal canine parturition, ensuring the safe delivery of puppies. Close monitoring of these signs can help detect any deviations from the norm and guide necessary interventions.

2.3 The Stages of parturition and their normal course

Parturition, or the process of giving birth, in dogs is typically divided into three distinct stages, early labour, active labour, and the expulsion of the placenta [2,12]. Each of these stages involves specific physiological and behavioural changes that are crucial for ensuring the health and safety of both the mother and her puppies.

2.3.1 Stage One

Also referred to as the preparation phase [12] or early labour, typically lasts between 6 to 12 hours, though it can extend up to 36 hours, especially in first-time mothers or nervous dogs [2]. Other articles say 6 to 12 hours but up to 24 in primiparous bitches, [16] so overall it is noted 6 to 12 hours is ideal and considered normal but case dependant other bitches in stage one may last 24 to 36 hours, and this can still be classed as normal.

During this stage, the dog will show a range of behavioural changes. Restlessness is common, she may shiver, pace, dig, or begin to nest in preparation for delivery [5]. These behaviours are instinctive, helping the mother create a safe and comfortable environment for her puppies, others say it is a means of increasing body temperature after the sudden drop in

temperature prior to parturition [9]. We also notice and increase in both the respiration and heart rate of the female in stage one [16]. Some dogs may seek isolation to avoid disturbances, while others may become more affectionate and clingier to their owners. However, it is important to note that in some cases, these behavioural signs may be subtle or entirely absent.

Alongside behavioural changes, there are significant physical changes. One of the earliest signs of labour is a drop in body temperature as mentioned above [2,9,25] and shown below in Figure 8 and Figure 9. Another important change is cervical dilation. Though not externally visible, the cervix begins to dilate during early labour in preparation for the delivery of the puppies. The onset of the first stage of labour is characterised by the initiation of uterine contractions following the removal of the progesterone block, facilitating cervical dilation [2]. In addition, a mucous discharge may be observed as the cervix opens and prepares for the next stage of labour [5].

Throughout this first stage, the dog experiences mild uterine contractions that help to gradually move the puppies down the uterine horns toward the cervix. Though these contractions are not yet strong enough to expel the puppies, they play a crucial role in preparing the birth canal and ensuring the mother's body is ready for the delivery process. Over time and toward the later period of stage one, the contractions increase in intensity, gradually forcing the first puppy down the birth canal towards the dilating cervix [2].

This first stage is essential in priming the body for the more intense phases of labour, laying the groundwork for a successful delivery. The combination of behavioural and physical signs provides vital cues for owners and veterinarians to monitor the progress of parturition and to intervene if any abnormalities arise. Understanding these early changes is key to supporting the dog through a healthy delivery process.



Figure 8: Vikki's body temperature reading at 10.34am, her first puppy was delivered at 3.56am the following morning, 17 hours after the recorded drop in temperature.

Source: My own photo.



Figure 9: Voodoo's body temperature reading at 4.04pm, her first puppy was delivered at 9.43am the following morning, 18 hours after the recorded drop in temperature.

Source: My own photo

2.3.2 Stage Two

Also known as active labour, involves the delivery of puppies and is often the most intense and visibly dynamic phase of birth. Stage one progresses into Stage two, which starts with the rupture of the foetal membranes and finishes with the birth of the final foetus [12]. Stage two usually starts 6 - 36 hours after the onset of stage one, as discussed in the previous section, "stage one". A timeline of 6 - 36 hours may be worrying for some owners, which is very understandable as whelping can be a stressful time on the bitch, the owner and the

veterinarian who is advising the owner. So, it must be noted that each bitch is different, and we must handle each whelp individually, the duration of this stage can vary depending on the number of puppies and individual circumstances, but typically lasts 3 - 12 hours [17] but can last up to 18 hours [12]. The duration may be longer in cases where a large litter is expected. During this phase, strong contractions become evident, and these abdominal contractions are visible and palpable as they become more intense and frequent, aiding the dog in pushing the puppies out. Usually, the water bag is seen at the vulva soon after the pushing or straining begins [5] as seen in Figure 10.

The delivery of the first puppy generally takes the longest, often occurring within four hours after the onset of strong contractions [2]. After the arrival of the first puppy, the remaining puppies are typically delivered at intervals of less than 2 hours [12], although these timings can vary as we will see later in the thesis when I analyse results of a whelping survey. If more than two hours pass between the birth of puppies, or if the mother is experiencing 30 minutes of unproductive straining [12], it may indicate complications such as dystocia, which warrants veterinary intervention [5]. Although a viable puppy may still be born after a longer duration of straining, this could also signal a possible obstruction, a critical sign that should not be ignored [2].

Puppies are typically born in one of two normal presentations: head-first (anterior) or hind-feet-first (posterior), both of which are physiologically normal for dogs [5]. Approximately 60% of puppies are delivered in the anterior presentation, while the remaining 40% are born in the posterior presentation [16,26]. These positions ensure the puppy's long axis remains parallel to that of the mother. During the process, the amniotic sac typically ruptures as the puppy passes through the birth canal. In some cases, however, the mother may need to break the sac manually to prevent asphyxiation [9], especially if the puppy is still enclosed after delivery [5,26] as we can also see in Figure 9 and Figure 10. Once the puppy is born, the mother instinctively begins licking and cleaning it to stimulate breathing and clear the membranes from its body [9]. This licking also plays a vital role in triggering the newborn's respiratory system [9] and this oronasal contact is important for mother and puppy bonding process.

Care must be taken during this phase, particularly when the mother bites and tears the umbilical cord [9]. Excessive pulling or chewing on the cord during this process can result in complications, such as an umbilical hernia or, in rare cases, a rupture through the abdominal wall [26]. In these situations, the mother may inadvertently continue licking and could potentially damage the internal organs of the puppy [5] or worse ingest the puppy or

its abdominal contents [9]. This natural behaviour is part of a critical instinct, but when not properly monitored and supervised, it can result in unintended harm. Therefore, while the mother plays an essential role in nurturing the newborns, careful observation from humans can help ensure the puppies remain safe during and after birth.

Understanding the normal course of events in stage two is crucial for identifying any deviations that might signal complications, such as dystocia, and for ensuring that both the mother and her puppies remain healthy throughout the birthing process.



Figure 10: The Delivery of Voodoo's first puppy, on the left we see the water bag presenting at the vulva as described by Allen [5] and on the right we see the puppy still enclosed in the sac.

Source: My own photo

2.3.3 Stage Three

Also known as the expulsion of the placenta or afterbirth, typically follows the delivery of each puppy, though it can sometimes occur simultaneously with the puppy's birth therefore it is hard to distinguish exactly stage 2 vs stage 3 [5, 12]. This stage is critical for ensuring the complete delivery process is successful and that no complications arise.

After each puppy is born, the placenta or allantochorion should be expelled [5]. This may occur immediately following the birth of the puppy or during the next uterine contraction. The mother may also take short resting periods between the deliveries, particularly after birthing several puppies. From personal experience with whelping, many females take a noticeable break after delivering the first 3-4 puppies. Upon consulting with a reproduction veterinarian, it was explained that the initial puppies are positioned closer to the cervix, whereas those higher up in the uterine horn must travel further down the birth canal, causing

these intervals between deliveries. From literature this is supported as it is noted breaks of 2 – 3 hours can occur without causing distress of the foetus and still result in live puppies [12].

It is essential during this stage to be vigilant in counting the placentas. Retained placentas can lead to serious health issues such as infection, inflammation of the uterus known as metritis, or more severe complications [2]. If the number of placentas expelled does not match the number of puppies born, veterinary intervention may be necessary to avoid complications. Once all the puppies and placentas have been delivered, the mother will continue her post birth care by licking and cleaning the puppies to stimulate breathing and encouraging them to nurse [12]. She will also rest, gathering her strength to care for her new litter in the following days.

2.4 The Concept and Types of Dystocia

Dystocia, commonly referred to as difficult or abnormal labour, is characterised by a failure in the normal birthing process, leading to complications during parturition. This condition can arise due to a variety of maternal or foetal factors. Early identification and management are essential in preventing severe outcomes for both the bitch and her litter. Dystocia can be classified into two main categories: maternal dystocia and foetal dystocia, each presenting unique challenges and requiring specific treatment approaches [12,18].

Maternal dystocia results from issues associated with the bitch herself. One of the most common causes is uterine inertia, which is the inability of the uterus to contract effectively during labour, preventing the expulsion of the puppies [11,12,21]. Uterine inertia is further divided into two types: primary and secondary. Primary uterine inertia occurs when the uterus fails to initiate contractions at the onset of labour [5]. Several factors may contribute to this condition. Hormonal imbalance is one such factor, where insufficient production of oxytocin, the hormone responsible for stimulating uterine contractions, can prevent labour from progressing normally [18]. Another cause is genetic predisposition, as some breeds, such as Bulldogs, are more prone to experiencing uterine inertia [18]. Additionally, small litter size can affect the onset of labour, as the uterus may not be sufficiently distended to trigger contractions when only one or two puppies are present [12,21]. On the other hand, very large litters can overstretch the uterus, reducing its ability to contract efficiently [11,19]. Nutritional deficiencies, particularly in calcium, can also impair the uterus's muscle function, further complicating the labour process [11,12,19]. Obesity in the dam is another significant factor, as overweight dogs are more prone to weaker uterine contractions, increasing the risk of uterine inertia [5,11]. Age is also a predisposing factor, as elderly

bitches are also more prone to dystocia, in studies bitches over the age of 4 showed evidence that as the age increased so did the risk of dystocia [18].

Secondary uterine inertia develops after labour has started but the uterus becomes exhausted and stops contracting [5]. Prolonged labour can lead to uterine fatigue, especially if it continues for an extended period without successful delivery. In some cases, obstruction in the birth canal, caused by a large or improperly positioned puppy, can lead to uterine fatigue, as the contractions become ineffective in overcoming the blockage. Uterine torsion, where the uterus twists, or uterine rupture can also cause a complete cessation of contractions, leading to serious complications [5,11,12]. Dehydration or electrolyte imbalance in the dam may further exacerbate uterine exhaustion, making it difficult for the birthing process to progress.

Other maternal causes of dystocia include pelvic abnormalities. A narrow pelvic canal, whether due to genetic factors or previous injury, can obstruct the passage of the puppies. In some cases, pelvic fractures or congenital deformities further restrict the space available for the puppies to pass through, making natural delivery difficult [11,12,21]. Additionally, obesity or weakness in the dam may contribute to dystocia, as excessive fat or poor muscle tone can reduce the effectiveness of uterine contractions [5]. Overweight dogs may struggle with the exertion required for a successful delivery, and older dogs or those with poor muscle condition may experience reduced contraction strength, increasing the likelihood of dystocia [11].

Foetal dystocia, on the other hand, is caused by issues related to the puppies themselves. One common cause is malpresentation, where the puppies are positioned incorrectly within the uterus. Transverse presentation, where the puppy is lying sideways, is particularly problematic, as this position makes it difficult for the puppy to pass through the birth canal without assistance. Another cause of foetal dystocia is foetal oversize, where the puppies are too large to pass through the birth canal as seen in Figure 11. This is especially common in cases where there is a single large foetus in a small litter, as the puppy may grow larger than normal due to having more space and resources available within the uterus [11,12].

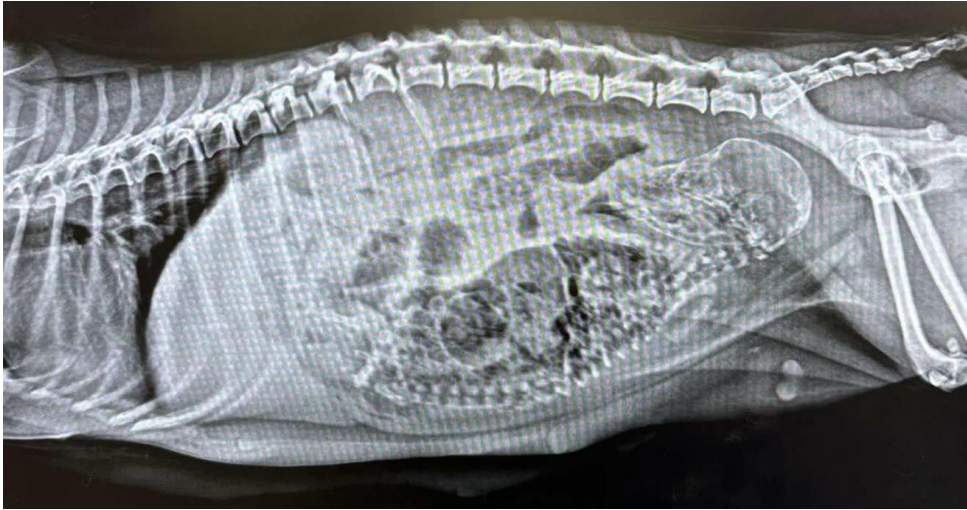


Figure 11: This X-ray shows a pregnant Miniature Yorkshire Terrier who presented at the clinic after passing two puppies at home approximately 12 hours earlier. The third, remaining pup could not be delivered naturally due to two complications visible on the X-ray. First, the size of the pup relative to the mother's narrow pelvic canal posed a significant complication, particularly given the small stature of this 2.2 kg Yorkshire Terrier. Second, there is a malpresentation of the pup. Although positioned anteriorly, the pup's spinal axis is incorrectly oriented. Ideally, the pup's spine should align dorsally, allowing the head to enter the pelvic canal nose-first. In this case, however, the rounded dome of the skull is attempting to enter the canal, leading to an unsuccessful delivery. Unfortunately, ultrasound confirmed that the pup was deceased. A caesarean section was performed to remove the pup and relieve the mother from further labour complications. This case highlights the challenges of size related dystocia and malpresentation, particularly in small breeds, where such issues often necessitate surgical intervention to ensure the health and safety of the mother.

Source: My own photo

Foetal malformations can also contribute to dystocia. Puppies with congenital defects, or foetal monsters as seen in Figure 12 and Figure 13, may have structural abnormalities that prevent their passage through the birth canal. These malformations can vary in severity, but they often complicate the birthing process, necessitating medical or surgical intervention to ensure the safety of both the dam and the litter [11,12].



Figure 12: Conjoined twins which caused a Uterine obstruction which needed human intervention to help deliver the pup(s). In this case I could easily palpate the pup through the abdomen wall but on an internal examination I could not feel the pup. By stimulating the Ferguson's reflex by applying digital pressure to the walls of the vagina the bitch's contractions became stronger, the pup gradually came down the uterus and I was able to hook my index finger around the caudal aspect of the pups head and slide my middle finger under its mandible. With my grip in place the pup was slowly and carefully delivered.

Source: My own photo



Figure 13: On the left we see a normal puppy vs on the right we see an anasarca puppy that caused a uterine obstruction and required a caesarean section. These puppies are also referred to as water puppies or walrus puppies.

Source: My own photo

2.4 Differences indication dystocia

Dystocia, or difficult labour, can be recognised by several key signs that deviate from the normal course of parturition. One of the first indications of dystocia is a gestation period exceeding 65 days from ovulation, which is beyond the typical range for a normal pregnancy. Additionally, extended periods of over 4 hours [12] between the rupture of the foetal membrane and the delivery of the pup can signal a problem [12,18,19].

In cases where the dam is discharging a green or black foul-smelling substance before the arrival of the first puppy, it is a strong indicator of complications such as placental separation or foetal distress [5,12,18] as during normal labour discharge should be clear and non-pungent [5,11,12], this information is illustrated in Figure 14. This type of discharge should be taken seriously, as it often signals a serious complication that requires immediate veterinary intervention [5,11,12]. Recognising these abnormal signs is essential for ensuring timely intervention, as failure to act promptly can increase the risks for both the mother and her puppies. Dystocia significantly heightens the risk of mortality in both, and the chances of stillbirth are higher in such cases [19]. Mortality rates for neonates can be high, reaching upwards of 20% when dystocia is involved [12]. Ensuring the health and safety of the dam and her litter requires careful monitoring, particularly around the expected delivery time. It is also crucial to have accurate information regarding the dates of ovulation and mating to determine the exact length of gestation, as this can help anticipate when the labour should occur and identify any delays that might indicate dystocia [12].

Appearance of Vaginal Discharge	Differentials/Rule-outs
Blood/hemorrhagic	Normal whelping, placental separation, uterine/vaginal trauma, uterine torsion, subinvolution of placental sites or coagulopathy
Green-brown	Lochia or uteroverdin; placental separation and impending stage 2 labor
Clear/serous	Allantoic/amniotic fluid; impending parturition
Purulent/sanguinopurulent	Metritis, vaginitis (rare); single-horn pyometra

Figure 14: A guide to distinguish the appearance of the vaginal discharge and what it may mean [21].

Dystocia is not extremely common in most breeds, with an average occurrence of about 5% [11]. However, certain breeds, particularly brachycephalic breeds like Bulldogs, Boston terriers and Pugs, are much more prone to this condition, with rates that can reach up to 100% [12]. These breeds often require veterinary intervention, including caesarean sections,

to safely deliver their puppies due to the disproportion between the size of the puppies' heads and the mother's pelvic canal, which can obstruct natural birth.

One major sign of dystocia is prolonged labour. Stage one of labour, which involves mild contractions and the gradual dilation of the cervix, typically lasts no more than 12 hours. If it exceeds this time frame without progressing to stage two, where active labour and delivery occur, it may indicate dystocia [12]. Similarly, during stage two, the active delivery of puppies, a significant sign of dystocia is if more than 2 to 3 hours pass without the birth of a puppy, or if the entire stage lasts more than 18 hours. These delays suggest that labour is not progressing as it should, and veterinary assistance is needed [11].

Another clear indication of dystocia is weak or absent uterine contractions. In normal labour, the uterus contracts regularly to help expel the puppies. However, if contractions are too weak, infrequent, or absent altogether, it can signal uterine inertia, where the uterus fails to contract effectively. This condition often requires medical intervention to stimulate contractions or perform a caesarean section to prevent complications [5,18].

Signs of distress in the mother are another critical indicator of dystocia. If the bitch exhibits signs of severe pain, exhaustion, lethargy, or distress, such as continuous heavy panting, whining, vomiting or symptoms of shock [2], it is an urgent sign that veterinary attention is needed. These symptoms suggest that the labour process is not progressing normally, and the health of both the mother and the puppies may be at risk, these are the signs we used to warn people of dystocia when I was working in a Canine Reproduction Clinic as a Veterinary Nurse.

Lastly, a failure to deliver, such as when a puppy becomes visibly stuck in the birth canal without any progress despite strong contractions, is a definitive sign of dystocia. This situation requires urgent intervention to prevent harm to the puppy and the mother. If a puppy is trapped in the birth canal for too long, both its life and the bitch's health can be compromised [5].

3. Objectives

The primary objective of this thesis is to determine whether it is possible to define normal and abnormal parturition in dogs based on existing literature and observed data. This study combines comprehensive literature review and analysis of data from the ongoing "The Weight of Whelping" questionnaire with a to compare findings with established knowledge. By joining a research group that examines breeders' experiences of labour from several

perspectives, I was given the opportunity to conduct a detailed analysis of data from several whelping questionnaires, thus comparing the observed data collected on the course of labour with those known from the literature.

Through this approach, it explores the physiological, behavioural, and observable signs associated with each stage of labour, aiming to create a detailed framework that distinguishes typical whelping processes from potential complications. The thesis also addresses the importance of defining time limits for each stage of labour to provide guidance on what constitutes normal progress and when delays or abnormalities should raise concern. In addition to timelines, the research identifies specific indicators of complications, such as prolonged labour, abnormal discharge, or signs of maternal distress, equipping owners with the information to make timely, informed decisions and seek medical intervention when needed.

4. Materials and methods

The research method for my thesis was a comprehensive literature review focused on gathering, analysing, and synthesising information related to parturition in dogs. This approach was chosen to expand on my existing knowledge and develop a deeper understanding that will enable me to provide accurate and effective guidance and advise to breeders and clients as I transition into my role as a Veterinarian at a Canine Reproduction Clinic post-graduation.

I sourced numerous scientific articles and journals from platforms such as Google Scholar, PubMed, and ScienceDirect, prioritising recently published materials to ensure up to date information. Additionally, I consulted veterinary books and reputable websites to supplement my research and cross reference information from primary sources. I organised these materials by downloading PDF versions of the articles, starring those most relevant for my research, and consistently citing references where necessary.

In addition to the literature review, I included observations from my hands on experience assisting with whelping. During the thesis writing period, I was called upon to assist with several whelping's, including five females who were able to whelp naturally with minor assistance. These experiences allowed me to record first hand observations and photos, adding practical insights to my study.

I also incorporated preliminary findings from an ongoing questionnaire, "The Weight of Whelping": A Survey on Whelping Events in the Broodbitch [28], conducted by the

Department of Small Animal Clinical Sciences at Virginia Maryland College of Veterinary Medicine. This survey is still on going so I could only partially review the results. This questionnaire collects detailed data on key whelping events, such as temperature changes and precise birth times, as well as the influence of body weight, nutrition, and physical activity on labour. While a comprehensive database on whelping timing and milestones is lacking, this study aims to reevaluate existing guidelines to enhance maternal and puppy wellbeing, as well as survival rates, a goal that aligns closely with my thesis objectives.

Originally, I aimed to distribute the survey among Hungarian Vizsla breeders across Europe, but unfortunately, I was unable to gather sufficient responses. However, I was provided data on 16 whelps from 9 different Standard Poodles, which I analysed relevant areas below for this thesis. I will partially analyse the results of these questionnaires in the following section.

To analyse the data, I first converted all times to a 24-hour digital format to avoid confusion during time frame calculations. For Stage 1 of parturition, I calculated the time from the temperature drop to the birth of the first pup. I then examined the presence or absence of the behavioural changes described in this thesis as well as signs of vaginal discharge and mammary development. For each whelp, I calculated the time intervals between the births of successive pups and determined the average time between each birth. Next, I analysed the minimum, maximum, mean, and standard deviation of these intervals. Finally, I determined the total duration of parturition, starting from the temperature drop in Stage 1 to the birth of the last pup, and analysed this total duration in relation to the number of pups in the litter.

5. Results

The results presented in this section were derived from relevant data collected through the ongoing “The Weight of Whelping” survey[28]. For this study, specific survey responses relevant to the objectives of this thesis were selected and analysed to investigate trends and patterns in canine parturition, these results will then be discussed in the following chapter. These data points were systematically examined and interpreted in the context of existing literature to better understand the variations in the whelping process. The analysis aimed to identify both consistent trends and deviations in the collected data.

5.1 Stage One

Stage 1 timeline, from temperature drop to the birth of the 1 st pup.						
Whelp case number	Temp reading	Time of reading	Date of reading	Date of whelp	Time of first pup	No. of hours (to the nearest)
1	37.0	NA	30/06/18	1/07/18	1.00am	NA
2	36.8	12.00pm	9/05/19	10/05/19	9.23am	9hrs
3	36.6	10.00am	24/05/21	25/05/21	11.56am	26hrs
4	37.2	9.45am	9/04/22	9/04/22	16.32pm	7hrs
5	36.9	8.00am	3/11/21	3/11/21	18.10pm	10hrs
6	37.0	16.00pm	1/04/22	2/04/22	17.21pm	25hrs
7	36.8	8.00am	3/09/23	3/09/23	13.15pm	5hrs
8	37.1	6.00am	27/08/15	27/08/15	18.45pm	13hrs
9	37.3	NA	24/04/16	24/04/16	21.30pm	NA
10	37.2	17.00pm	22/12/13	22/12/13	20.35pm	4hrs
11	36.6	23.00pm	8/02/15	9/02/15	14.45pm	15hrs
12	NA	NA	NA	31/08/23	7.45am	NA
13	NA	NA	NA	19/07/10	11.15am	NA
14	NA	NA	NA	2/04/11	04.55	NA
15	36.9	12.00pm	20/10/21	21/10/21	19.00pm	19hrs
16	37.2	23.00pm	25/09/22	27/09/22	2.33am	28hrs

Table 1: This table presents data on temperature drop from the whelping survey [28].

As seen in Table 1 above the results varied significantly, reinforcing the idea that each whelping event is unique. This variability highlights the need for a comprehensive approach to monitoring whelping, considering multiple parameters beyond a single factor, such as temperature. Instead, a combination of behavioural changes, physical observations, and physiological indicators is necessary, as discussed earlier in this thesis. Instead of grouping each whelp by the individual bitch, I analysed each whelp separately, as previously discussed, each whelp can vary significantly. Whelps highlighted in red seen in Table 1 had incomplete data and therefore could not be analysed, while those highlighted in green show instances where the owner recorded necessary details, allowing for calculation of the interval between this temperature drop and the delivery of the first puppy. Although results varied, the majority aligned with findings in this thesis, which indicated that a temperature drop of approximately 1°C typically precedes the onset of parturition by 12-24 hours. Based on the green highlighted whelps, the maximum time was 28 hours, the minimum time was 5 hours and the average time from temperature drop to the delivery of the first puppy was calculated at 14 hours and 36 minutes.

Whelp number	Behavioural changes, nesting, panting etc	Vulvar discharge	Mammary development	Loss of appetite
1	Yes	Yes	Yes	Yes
2	-	-	Yes	-
3	-	-	-	-
4	-	-	Yes	Yes
5	Yes	Yes	Yes	Yes
6	Yes	-	-	-
7	-	-	Yes	Yes
8	Yes	-	Yes	Yes
9	No	No	No	No
10	Yes	-	Yes	Yes
11	-	-	Yes	No
12	Yes	-	Yes	Yes
13	No	No	-	Yes
14	-	Yes	-	Yes
15	Yes	Yes	Yes	Yes
16	Yes	-	Yes	Yes
%	80%	67%	92%	85%

Table 2: This table illustrates the presence of some of the signs of stage one of parturition.

In Table 2, I reviewed each whelp individually for signs indicating the onset of stage one of parturition. I examined a range of behavioural and physical signs, including digging, nesting, panting, restlessness, vulvar discharge, mammary development, and a decrease in appetite. Since the study is ongoing, only partial results are available. Unfortunately, many owners did not answer all questions, and any missing information is marked as “-” in Table 2. These cases were excluded from the calculation of percentages reflecting the occurrence of these signs.

5.2 Stage Two

Tables 3 – 16 below illustrate the intervals between the births of each pup, providing a basis for analysing what might be considered a safe time between each delivery which in turn could be used to help guide and advise owners during whelps.

Whelp 2, 10/05/2019, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups

1	9.23am	M	A	NA
2	10.35am	F	A	1hr 12mins
3	11.00am	M	A	25mins
4	15.00pm	M	A	4hr
5	18.43pm	F	A	3hr 43mins
6	19.03pm	M	A	20mins
Total time: 9 hours 40mins				
Average time per pup: 1 hour 37 mins				

Table 3: Whelp 2. This data shows notable time gaps between the births of pup 3 and pup 4 (4 hours), as well as between pup 4 and pup 5 (3 hours 43 minutes).

Whelp 3, 25/05/2021, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	11.56am	F	A	NA
2	12.46pm	F	A	50mins
3	13.29pm	M	A	43mins
4	14.27pm	M	A	58mins
5	14.40pm	M	A	13mins
6	15.01pm	F	A	21mins
7	15.43pm	M	A	42mins
8	16.10pm	F	A	27mins
Total time: 4 hours 14mins				
Average time per pup: 32 mins				

Table 4: Whelp 3. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 4, 09/04/2022, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	16.32pm	F	A	NA
2	17.05pm	F	A	33mins
3	18.00pm	F	A	55mins
4	19.10pm	F	A	1hr 10mins
5	19.22pm	F	A	12mins
6	20.35pm	M	A	1hr 13mins
7	20.43pm	M	A	8mins
8	23.38pm	F	A	2hr 55mins
9	01.00am	F	A	22mins
10	01.25am	M	A	25mins

Total time: 8 hours 53mins
Average time per pup: 53 mins

Table 5: Whelp 4. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours except pup 8 who was born 2 hours and 55 minutes after pup 7, with no instances of dead pups to report.

Whelp 5, 03/11/2021, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	18.10pm	F	A	NA
2	18.15pm	M	A	5mins
3	18.35pm	F	A	20mins
4	18.55pm	M	A	20mins
5	19.20pm	M	A	25mins
6	19.55pm	F	A	35mins
7	20.45pm	F	A	50mins
8	22.40pm	F	DOA	1hr 55mins
9	23.35pm	F	A	55mins
10	23.45pm	M	A	10mins
11	12.35am	M	DOA	50mins
12	12.45am	F	A	10mins
13	2.10am	M	DOA	1hr 25mins
Total time: 8 hours				
Average time per pup: 37 mins				

Table 6: Whelp 5. This table presents data from the first recorded whelp where stillborn pups, or pups dead on arrival (DOA), were observed. In this case, the live pups were delivered with relatively short intervals between births, whereas the stillborn pups had notably longer intervals, ranging from 50 minutes to 1 hour and 55 minutes.

Whelp 6, 02/04/2022, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	17.21pm	M	A	NA
2	17.40pm	M	A	19mins
3	17.48pm	M	A	8mins
4	18.05pm	M	A	17mins
5	18.48pm	M	A	43mins
6	19.25pm	F	A	37mins
Total time: 2 hours 6 mins				
Average time per pup: 21 mins				

Table 7: Whelp 6. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 8, 27/08/2015, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	18.45pm	F	A	NA
2	19.04pm	F	A	19mins
3	19.33pm	M	A	29mins
4	19.48pm	F	A	15mins
5	20.35pm	M	A	47mins
6	21.30pm	M	A	55mins
7	22.15pm	M	A	45mins
8	22.37pm	M	A	22mins
Total time: 3 hours 52 mins				
Average time per pup: 29 mins				

Table 8: Whelp 8. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 9, 24/04/2016, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	21.30pm	M	A	NA
2	21.40pm	F	A	10mins
3	23.20pm	M	A	1hr 40mins
4	23.50pm	F	A	30mins
5	12.35am	M	A	45mins
6	1.40am	F	A	1hr 5mins
7	2.20am	M	A	40mins
8	3.20am	M	A	1hr
Total time: 5 hours 50 mins				
Average time per pup: 44 mins				

Table 9: Whelp 9. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 10, 22/12/2013, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	20.35pm	F	A	NA
2	20.45pm	F	A	10mins
3	20.57pm	F	A	12mins

4	21.13pm	M	A	16mins
5	21.22pm	F	A	9mins
6	21.53pm	M	A	31mins
7	22.01pm	M	A	8mins
Total time: 1 hour 26 mins				
Average time per pup: 12mins				

Table 10: Whelp 10. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 11, 9/02/2015, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	14.45pm	M	A	NA
2	15.04pm	M	A	19mins
3	15.16pm	M	A	12mins
4	16.33pm	F	A	1hr 17mins
5	17.13pm	F	A	40mins
6	17.23pm	F	A	10mins
7	17.40pm	M	A	17mins
8	18.24pm	F	A	44mins
9	19.13pm	M	A	49mins
Total time: 4 hours 28 mins				
Average time per pup: 30mins				

Table 11: Whelp 11. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 12, 31/08/2023, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	7.45am	M	A	NA
2	8.00am	M	A	15mins
3	8.45am	M	A	45mins
4	8.50am	M	A	5mins
5	13.45pm	NA	DOA	4hrs 55mins
6	13.50pm	F	A	5mins
7	14.00pm	F	A	10mins
8	15.15pm	F	A	15mins
9	23.30pm	F	A	8hrs 15mins
10	23.53pm	M	A	23mins
11	1.30am	F	A	1hr 37mins

Total time: 17 hours 45 mins
Average time per pup: 1 hour 36 mins

Table 12: Whelp 12. Notably, Pup 5 was delivered DOA after a prolonged gap of 4 hours and 55 minutes following Pup 4 whereas pup 9 was born alive after 8 hours and 15 minutes after pup 8.

Whelp 13, 19/07/2010, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	11.15am	M	A	NA
2	11.45am	M	A	30mins
3	13.55pm	F	A	2hrs 10 mins
4	14.21pm	M	A	26mins
5	16.40pm	F	A	2hrs 19mins
6	17.30pm	M	A	50mins
7	18.51pm	M	A	1hr 21mins
8	20.20pm	M	A	1hr 29mins
Total time: 9 hours 5 mins				
Average time per pup: 1 hour 8mins				

Table 13: Whelp 13. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp14, 02/04/2011, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	4.55am	F	A	NA
2	05.07am	M	A	12mins
3	05.32am	F	A	25mins
4	07.06am	M	A	1hr 34mins
5	07.33am	M	A	27mins
6	08.45am	F	A	1hr 12mins
7	09.05am	F	A	20mins
Total time: 4 hours 10 mins				
Average time per pup: 36mins				

Table 14: Whelp 14. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 15. 21/10/2021, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	19.00pm	M	A	NA
2	19.15pm	M	A	15mins

3	19.40pm	M	A	25mins
4	20.05pm	M	A	25mins
5	20.55pm	F	A	50mins
6	22.00pm	M	A	1hr 5mins
7	23.00pm	M	A	1hr
8	23.20pm	F	A	20mins
9	12.20am	F	A	1hr
10	1.11am	F	A	51mins
Total time: 6 hours 11 mins.				
Average time per pup: 37mins				

Table 15: Whelp 15. The results showed that all the time intervals between births fell within the normal parameter of less than 2 hours, with no instances of dead pups to report.

Whelp 16, 27/09/2022, Stage 2.				
Pup	Delivery time	Sex	Alive or DOA	Time between pups
1	2.33am	F	A	NA
2	5.42am	F	A but died 29/09	3hrs 9 mins
3	7.14am	F	A	1hr 32mins
4	8.00am	M	A	46mins
5	10.06am	F	A	2hrs 6mins
6	10.20am	F	A	14mins
7	10.51am	M	A	31mins
8	11.44am	M	A	53mins
9	12.53pm	M	A	1hr 9mins
10	13.21pm	F	A	28mins
11	14.25pm	M	A	1hr 4mins
12	15.05pm	F	A	40mins
13	15.11pm	F	A	6mins
14	17.20pm	F	DOA	2hrs 9mins
Total time: 14 hours 47mins				
Average time per pup: 1 hour 3 mins				

Table 16: Whelp 16. This table presents data from a large litter of 14 pups, where some level of pup mortality can be expected due to the demands of larger litters [18]. As seen in Whelp 5 which involved 13 pups, some mortality was observed. Pup 2 was born alive but passed away two days later, with a time interval of 3 hours and 9 minutes after pup 1. Pup 14 was born DOA 2 hours and 9 minutes after pup 13.

Minimum time/whelp	1 hour 26 mins
Maximum time/whelp	17 hours 45mins

Mean time/whelp	6 hours 36 mins
Standard deviation	4 hours 38 mins

Table 17: Min, max, mean and SD of the Whelps studied for the time period of Stage 2. This data provides insights into the duration variability experienced in the birthing process, specifically during the active labour stage when pups are delivered.

Minimum average time/pup	12mins
Maximum average time/pup	1 hour 37 mins
Mean time/pup/whelp	47 mins
Standard deviation	25 mins

Table 18: An average time between pups was determined per whelp, then we pooled these whelps together to get an overall average time between every pup examined.

Table 18 provides a summary of the average time between pups across multiple whelps, highlighting both the minimum, maximum, mean, and standard deviation for this interval. This data reflects the variability and typical timing intervals observed between the births of each pup within individual whelps. The minimum average time of 12 minutes between pups indicates that in some whelps, deliveries proceeded at a very rapid pace. On the other hand, the maximum average time of 1 hour and 37 minutes shows that in certain cases, there were significantly longer intervals between pup deliveries.

5.3 Full parturition

Time Periods for the full course of Parturition						
Whelp	Stage 1	Stage 2	Stage 3	TOTAL time	No. of Pups	Time/no. of pups
2	9 hr	9 hr 40 mins	-	18 hr 40 mins	6	3 hr 07 mins
3	26 hr	4 hr 14 mins	-	30 hr 14 mins	8	3 hr 47 mins
4	7 hr	8 hr 53 mins	-	15 hr 53 mins	10	1 hr 35 mins
5	10 hr	8 hr	-	18 hr	13	1 hr 23 mins
6	25 hr	2 hr 6 mins	-	27 hr 06 mins	6	4 hr 31 mins
8	13 hr	5 hr 50 mins	-	18 hr 50 mins	8	2 hr 21 mins
10	4hr	1 hr 26 mins	-	5 hr 26 mins	7	0 hr 47 mins
11	15 hr	4 hr 28 mins	-	19 hr 28 mins	9	2 hr 10 mins
15	19 hr	6 hr 11 mins	-	25 hr 11 mins	10	2 hr 31 mins
16	28 hr	14 hr 47 mins	-	42 hr 47 mins	14	3 hr 03 mins

Table 19: Total time periods showing the full course of parturition. Stage 1 (from the temperature drop to the delivery of the 1st pup) and stage 2 (total time between 1st and last pup). The total time is compared to the total number of puppies in the litter.

Table 19 shows us total duration of labour divided into stage 1, stage 2 and total. The total labour duration, combining Stages 1 and 2, ranges from 5 hours 26 minutes to 42 hours 47 minutes. This broad range shows that while some whelps proceed relatively quickly, others require much more time. It must also be noted litter size can affect total duration as the shortest whelp, whelp 10, consisted of a litter of 7 pups whereas the longest whelp, whelp 16, consisted of 14 pups. I will evaluate this further in the following table.

Minimum total time	5 hr 26 mins
Maximum total time	42 hour 47 mins
Mean time	22 hr 9mins
Standard deviation	9 hr 26 mins

Table 20: Min, max, mean and SD of total time of full parturition.

Table 20 shows the minimum, maximum, mean, and standard deviation for the total parturition time across all whelps, the figures were taken from table 19 to conduct this table. This table provides insights into the overall time required for a full labour cycle, from the onset of labour to the birth of the last pup.

6. Discussion

In this discussion, I will review the initial findings from the whelping survey [28]. Since the survey is still ongoing, only a portion of the data has been collected so far. The sample size is relatively small, covering just 16 whelps, and some questions were left unanswered by respondents. Because of these gaps, certain areas of the whelps could not be included in the calculations used for this analysis. Although this limits the scope of the current findings, the available responses still offer valuable insights. Further data collected in the future may help complete the picture and strengthen our understanding of the trends observed here but for now I am evaluating the 16 whelps from 9 different Standard Poodle bitches.

Table 1: This table presents the analysis of the duration of Stage 1, from the temperature drop to the delivery of the first pup. It also includes temperature drop data recorded by the owners. The results indicate a consistent temperature drop of approximately 1°C [2,5,9,12,20,25], followed by the onset of parturition within 12 to 24 hours [2,16,25]. The average duration, as calculated from the survey data, was 14 hours and 36 minutes, which falls within this time frame.

Table 2: Of the bitches in whelp, 80% displayed behavioural changes associated with Stage One of labour. The behaviours questioned in the survey were restlessness, nesting, digging, panting, hiding and clinginess [28], others added in additional behaviours notes such as shivering and resting motionless, all very similar to those described in the literature review [2,5,9,11,12,26]. This high percentage aligns with expectations; however, these signs vary greatly between individuals and cannot reliably predict when labour will begin [2].

Regarding vulvar discharge, 67% of bitches in whelp showed signs of it. This figure is unsurprising, as many females keep themselves clean through vulvar licking prior to labour [5], making discharge easy to overlook and even miss it completely. Additionally, only 6 out of the 16 owners responded to the question about vulvar discharge, which likely influenced the percentage.

Signs of mammary development were observed in 92% of the bitches in whelp, which supports the theory outlined in the literature review [5,23,26]. As progesterone levels decrease before whelping, prolactin levels rise [4], initiating lactogenesis and leading to increased mammary development [23].

Lastly, 85% of the bitches in whelp showed a decrease in appetite. This high percentage is also expected and supports information presented in the literature review [5,9,26], suggesting that appetite decreases in stage one of parturition due to hormonal changes, particularly the drop in progesterone levels and increase in prolactin [26].

Table 3: Whelp 2. Despite extended intervals between the births of pups 3 and 4, as well as pups 4 and 5, both pups were delivered alive and healthy. The interval between pups 4 and 5 lasted 3 hours and 43 minutes, while the delay between pups 3 and 4 was even longer at 4 hours, exceeding the recommended maximum interval of 2 hours between births [12]. These findings suggest that even when birth intervals surpass the recommended time, pups can still be born alive and in good condition. Additionally, from literature, breaks of 2–3 hours between pups have also resulted in the delivery of live and healthy pups [12].

Table 6: Whelp 5. This difference in delivery times during this whelp suggests that prolonged intervals may be associated with adverse outcomes for some pups. Specifically, pup 8 was born dead 1 hour and 55 minutes after pup 7, pup 11 was born dead 50 minutes after pup 10, and pup 13 was born dead 1 hour and 25 minutes after pup 12. Notably, these intervals fall within the recommended time of 15 minutes to 2 hours between births [2, 12]. This comparison indicates that delivery intervals alone are not a definitive predictor of pup viability. These findings highlight the uniqueness of each whelping event and suggest that a universal

definition of a “safe” interval between births based solely on time may not be appropriate. Additionally, it is important to consider external factors, such as environmental stress. In this case, the bitch was whelped in an unfamiliar home as this was marked as a concern in the whelping survey, which may have contributed to delays in delivery for some pups [5]. To ensure a safe delivery process, a comprehensive assessment of multiple factors such as temperature changes, behavioural observations, and physical signs are essential for each individual whelp.

Table 12: Whelp 12. Pup 5 was born 4 hours and 55 minutes after pup 4, this lengthy interval may suggest that extended gaps between deliveries could be associated with increased risk to pup viability. However, this pattern does not hold consistently across the whelp, as shown by Pup 9, who was born alive even after an 8 hour and 15minute interval following Pup 8. These findings underscore the complexity of whelping dynamics and indicate that while prolonged intervals can sometimes correlate with adverse outcomes, they do not always predict them. This variability reaffirms that each whelping case is unique, and that timing alone cannot reliably determine pup viability. In relation to this whelp the bitch was 2 years of age therefore age was not a risk factor but as this was a larger litter of 11 pups this could be considered a risk factor as litters over 9 pups are categorised as large [18].

A comprehensive assessment involving multiple factors, such as maternal behaviour, physical signs, and environmental conditions remains essential for evaluating whelping progress, determining safe intervals between pup deliveries and advising owners and breeders.

Table 16: Whelp 16. Here we see the largest litter in the study, consisting of 14 pups, like Whelp 5, which had 13 pups some pup mortality was seen. Notably, Pup 2, who passed away at two days old, was delivered after a prolonged interval of 3 hours and 9 minutes following Pup 1. Similarly, Pup 14, who was stillborn, was delivered 2 hours and 9 minutes after Pup 13, suggesting that extended intervals over 2 hours between deliveries may be linked to pup mortality [12]. However, not all prolonged intervals led to negative outcomes; for example, Pup 5 was born healthy after a 2 hour and 6-minute delay following Pup 4. This variability highlights that while extended delivery intervals could pose a risk; they are not absolute indicators of survival outcomes for pups as notes previously some breaks between pups of 2-3 hours can still result in live pups [12].

Table 17: Stage 2 evaluation. The mean duration for Stage 2 of parturition was 6 hours and 36 minutes, providing an average reference for Stage 2 across all whelps. This duration

aligns with the literature, which indicates that Stage 2 typically lasts between 3 to 12 hours [17]. However, the standard deviation of 4 hours and 38 minutes highlights considerable variability, indicating that while some whelps experience a relatively quick and uncomplicated Stage 2, others may endure a much longer process. This high variability suggests that factors such as litter size, maternal health, and environmental conditions could significantly influence the length of labour. It is important to note that the small sample size of the survey may have significantly influenced the results, potentially contributing to the higher standard deviation observed.

Table 18: Pooled sample of times between pups in every whelp examined. Such extended times may suggest pauses in labour or the potential for mild labour inefficiencies, which could be linked to factors like maternal fatigue, uterine inertia, oversized pups, narrow pelvis, positioning of pups or any other risk factor of dystocia mentioned in this thesis [11,12.21]. The overall mean time of 47 minutes per pup provides an average reference point for birth intervals within whelps, showing that nearly an hour per pup is typical across the studied cases which is within the range of 15 minutes to 2 hours between pups [2,12]. However, the standard deviation of 25 minutes suggests considerable variability around this average. The spread illustrated by the standard deviation shows that while some whelps experience short, consistent intervals, others have prolonged times between pups. This variation highlights the importance of monitoring labour carefully, as significant deviations from expected intervals may suggest additional attention or intervention. This pooled average helps establish a practical guideline for breeders and veterinary professionals to better anticipate the progression of labour and recognise potential issues.

Table 19: Time periods for full parturition.

The data from the whelps indicate a range of durations for the stages of parturition, with some variability in both normal and extended times. Stage 1 typically lasts between 6 to 12 hours but can extend up to 36 hours in certain cases [2,5,12]. Most whelps in this study fell within this typical range, though Whelps 3, 6, and 16 had extended Stage 1 durations, with Whelp 16 reaching 28 hours, which is still within the maximum expected limit. Stage 2, which generally lasts 3 to 12 hours [17], some literature saying it can last up to 18 hours [12], also showed variability. Whelp 6 had a notably brief Stage 2 of just 2 hours and 6 minutes, while Whelp 16 had an unusually long Stage 2 at 14 hours and 47 minutes, exceeding the typical range. Despite these variations, the total parturition times for all whelps remained within the literature's suggested limit of up to 48 hours from combining recommended times from stage 1 and 2, with the shortest total duration being 5 hours and

26 minutes (Whelp 10) and the longest being 42 hours and 47 minutes (Whelp 16). These findings demonstrate that while some whelps had extended durations, especially in Stage 1 or Stage 2, all remained within the overall expected window for total parturition time, highlighting that extended labour can still fall within normal limits depending on the individual circumstances, such as litter size and maternal factors such as weight and age.

Table 20: The minimum total time of parturition of 5 hours 26 minutes reflects the shortest duration observed, indicating a rapid progression through labour. This suggests that in some cases, labour can proceed smoothly and efficiently with minimal delays. On the other end, the maximum total time of 42 hours 47 minutes shows that labour can also be significantly extended while still in the recommended time interval of up to 48 hours when we combine the recommended times for stage 1 and 2 [2,5,12,17], which may indicate breaks of 2 – 3 hours [12] or slower progression between stages. The mean total time of 22 hours 9 minutes gives an average reference point, showing that labour can generally take a full day from start to finish. However, the standard deviation of 9 hours 26 minutes reveals a big degree of variation around this average. This indicates that while some whelps align closely with the mean, others differ widely.

In conclusion, this discussion highlights a strong correlation between the findings of the literature review and the data gathered from the whelping survey [28]. The survey results align well with the information presented in the literature, confirming many of the trends and observations expected in the whelping process. These consistencies help strengthen the validity of the research, as both sources of information support similar patterns in behavioural and physiological signs of labour.

However, the study faced limitations due to the smaller sample size and the incomplete nature of many questionnaires. Several areas essential to this thesis were left unanswered by owners, which narrowed the scope of the data available for analysis. A larger, more complete pool of survey responses would have provided a more comprehensive view and potentially allowed for deeper insights into each stage of whelping. It is also important to note that the survey data used in this study was exclusively from Standard Poodles. This breed specific focus may limit the findings, as whelping characteristics can vary significantly between breeds. For instance, breeds with smaller litters may experience shorter whelping times, while others, known to be more prone to dystocia, may have longer and more complicated labour processes.

Despite these limitations, the findings gathered from the responses remain valuable. The results not only reinforce the information from existing literature but also emphasise the importance of collecting thorough and detailed data to better understand variations in whelping outcomes. Future studies with a larger and more complete dataset could build on these initial findings and help refine best practices for monitoring and supporting whelping bitches.

7. Summary

The study consisted of a comprehensive literature review combined with first-hand observations and preliminary data analysis from an ongoing questionnaire, “The Weight of Whelping,” conducted by the Virginia Maryland College of Veterinary Medicine. This questionnaire aims to refine current guidelines for maternal and puppy wellbeing, aligning closely with the objectives of this thesis as stated previously.

Scientific articles, veterinary books, and reputable online sources were thoroughly reviewed to identify factors affecting parturition, including physiological and behavioural indicators, the role of hormones, and conditions like dystocia. Complementing the literature review, this research also included data analysis from 16 whelping events recorded from nine Standard Poodle bitches. Observations taken from the survey included behavioural signs, temperature changes, and time intervals between deliveries, contributing valuable insights into the normal variability of whelping parameters and allowed me to look at total parturition times as well as an in depth look at the division of total labour into stages 1 and 2.

Key findings indicate that while certain indicators, like a temperature drop, often precede labour by 12-24 hours, the whelping process itself is highly variable. For example, intervals between puppy births ranged from rapid successions to extended delays, with both short and long intervals sometimes resulting in healthy pups. These findings underscore that while general patterns exist, each whelping event is unique and requires close monitoring of multiple parameters such as maternal behaviour, temperature, and physical signs rather than reliance on any single indicator.

Despite limitations, including a small sample size and incomplete data from the ongoing survey, this research reinforces current understanding and offers preliminary guidelines for safe whelping. Further research with a larger dataset could refine these findings and enhance the quality of care provided to whelping bitches. This study contributes to the development of best practices for veterinary professionals, promoting improved outcomes for both bitches and their litters.

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