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FOAL WEANING METHODS OF FINNISH HORSE OWNERS
SOOME HOBUSEOMANIKE VARSSADE VÕÕRUTAMISE
MEETODID

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<p>In horse breeding, artificial weaning is an established practice that raises welfare concerns due to its observed stressfulness on foals. Artificial weaning occurs at critical stages in foal development and proceeds at a much faster rate than naturally. In an immature foal, the effects of a strong neuroendocrine stress response can lead to temporary growth stagnation, impaired immune function, alterations in the intestinal microbiota and the development of stereotypies. In Finland, foal weaning practices have not been surveyed amongst breeders, and this is the aim of this work with focus on assessing the state of foal well-being. Through an online survey that was shared on equestrian-themed social media groups, 165 Finnish horse breeders contributed to the study. A majority of breeders were found to initiate the weaning process after foals have turned eight months (52.1%), implement features of gradual weaning (60.0%) and ensure weaned foals have social contact during the weaning process (82.4%). Amongst breeders, years in practice and total number of raised foals was found to be significantly associated with some of the practiced weaning methods, in most cases displaying that less experienced breeders are more likely to use less stress-inducing foal weaning techniques. The results show that while most breeders seem to recognize the negative connotations of artificial weaning on foal welfare, methods in practice that largely ignore this still prevail in the Finnish horse industry.</p>			
Keywords: Equine welfare, mare-foal bond, weaning stress, survey			

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<p>Hobusekasvatases on kunstlik võõrutamine väljakujunenud tava, mis tekitab heaoluga seotud probleeme, kuna see tekitab varssadele stressi. Erinevalt loomulikust võõrutamisest toimub kunstlik võõrutamine tavaliselt varsa arengu kriitilistes etappides ja palju kiiremini kui loomulik võõrutamine. Ebaküpsel varsal võivad tugeva neuroendokriinse stressireaktsiooni tagajärjed põhjustada ajutist kasvuseisakut, immuunfunktsiooni halvenemist, muutusi soolestiku mikrobiotas ja stereotüüpides. Soomes ei ole varssade võõrutamise tavadid hobusekasvatajate seas uuritud, mistõttu on selle uuringu eesmärk keskenduda varssade heaolu hindamisele. Uuringusse panustas 165 Soome hobusekasvatajat ratsutamisteemalistes sotsiaalmeediagruppides jagatud veebiküsitluse kaudu. Leiti, et enamik kasvatajaid alustab võõrutamist pärast varssade kaheksakuuseks saamist (52.1%), rakendab järkjärgulise võõrutamise elemente (60.0%) ja tagab võõrutatud varssade sotsiaalse kontakti võõrutamise ajal (82.4%). Kasvatajate seas leiti, et praktiseerimise aastate arv ja kasvatatud varssade koguarv olid oluliselt seotud mõnede praktiseeritud võõrutusmeetoditega, mis enamikul juhtudel näitab, et vähem kogenud kasvatajad kasutavad tõenäolisemalt vähem stressi tekitavaid varssade võõrutamise tehnikaid. Tulemused aga näitavad, et kuigi enamik kasvatajaid näib tunnistavat kunstliku võõrutamise negatiivset mõju varssade heaolule, on Soome hobumajanduses endiselt levinud meetodid, mis seda suures osas eiravad.</p>			
Märksõnad: hobuste heaolu, mära-varsa side, võõrutusstress, uuring			

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LIST OF ABBREVIATIONS

ACTH	Adrenocorticotrophic hormone
CRH	Corticotropin-releasing hormone
HPA	Hypothalamic-Pituitary-Adrenal system
SAM	Sympathetic-Adreno-Medullar system

INTRODUCTION

The modern horse, *Equus caballus*, has been selectively bred to fit functions in various equestrian sport disciplines. However, despite its domestication, the species' needs have remained largely unchanged and still reflect its original role as a highly social, grassland herbivore. To date, existing herds of wild and semi-wild horses have provided valuable information on how to care for the species in domestic conditions, particularly regarding equine social behaviour, herd dynamics and time-budget management patterns of different age groups.

In captivity, manipulation of the dam-offspring bond is common, and artificial weaning is an example of such practice. In many cases, artificial separation of the foal and dam occurs in an abrupt manner and at a much earlier stage than that which has been observed in semi-naturalistic conditions (Henry *et al.*, 2020), thereby representing a stressful event for both the foal and the mare. Due to their incomplete development, foals are particularly susceptible to the negative effects of stress on their health and well-being, whereby breeders have been encouraged to limit weaning-related stress through various methods (Apter and Householder, 1996).

Without human intervention, weaning of the foal is a gradual process and is associated with minimal amounts of stress. It is important to understand that in this context, weaning refers to the cessation of nursing but that the social bond between the mare and foal persists. Therefore, to keep things clear further on in this paper, nutritional weaning without social separation of the dam and foal will be termed „mare-mediated weaning“, in accordance with the report of Merkies *et al.* (2016).

Despite scientific evidence, many practices amongst the equine industry persist based on tradition, practicality and economy-driven habits. Historically, early and abrupt artificial weaning established itself in the latter half of 20th century as it was discovered that milk production in mares distinctly declines around the same time (Doreau and Boulot, 1989) as the milk ceases to nutritionally meet all the foal's needs at 3-4 months of age (Burns *et al.*, 1992; Oftedal *et al.*, 1983). Thus far, the majority of existing studies on the topic have focused on finding practical ways to reduce short-term weaning-induced distress in foals, leaving long-term consequences largely unexplored (Waran *et al.*, 2008).

The aim of this thesis was to investigate prevailing foal weaning methods used in Finland by conducting an online survey of Finnish horse owners with experience in foal raising. The situation was approached from a welfare perspective by attempting to assess the implications of the used methods on foal well-being. Although there is evidence that the dam can also experience

high levels of stress due to abrupt artificial weaning (Malinowski *et al.*, 1990; Merkies *et al.*, 2016), this will not be further examined in this work.

1. LITERATURE REVIEW

1.1. Foal developmental stages

The shifts in a growing foal's body and ways of behaving are important to understand for breeders, veterinarians and other professionals who are dealing with foals. According to Crowell-Davis (1986b), three developmental periods can be distinguished: the dependent period, the socialization period and the stabilization period. These periods have been identified to last from birth to approximately 1 month of age, from 2-3 months of age and from four months of age up until the natural weaning age, respectively (Crowell-Davis, 1986b). In addition, Boy and Duncan (1979) have reported that rapid and permanent changes to the mare-foal bond arise during the process of mare-mediated weaning, which serves to acclimatize the foal for nutritional and physical independence from its dam.

Importantly, Crowell-Davis (1986b) specifies that the beginning of a developmental stage is easier to define than its ending. Notably, it should be understood that although developmental stages aim to delineate time periods in a young animal's life when significant anatomical, physiological and behavioural changes take place, some changes will continue throughout most of early life (Crowell-Davis, 1986b). Lastly, the author concludes that individual differences in foal personality have an influence on the progression of the developmental stages, which may cause deviations from the expected norm.

1.1.1. Dependent period

The first four weeks of a foal's life are characterized by their full dependence on their dam for nutrition, protection and emotional comfort (Crowell-Davis, 1986b). Importantly, the mare-foal bond is established during the first few weeks *postpartum* and is thus susceptible to abnormalities during this period. In particular, unnecessary assistance during and after birth should be avoided. Henry *et al.* (2006) concluded that foals which were assisted to feed colostrum later expressed increased avoidance towards approaching efforts and physical restraint.

On the other hand, a well-established human-mare bond can be of observational value to the foal in terms of forming a positive attitude towards people. In particular, Henry *et al.* (2005) found that through daily grooming and hand feeding of the dam during the first five days *postpartum*, the human-foal bond can be positively influenced without risking the mare-foal bond. However, although some evidence suggests that early, gentle handling of the foal may

facilitate easier handling later on (Simpson, 2002; Spier *et al.*, 2004), this effect does not necessarily become permanent (Lansade *et al.*, 2007; Williams *et al.*, 2002).

After colostrum intake, suckling will continue at a high frequency for the following two weeks in order to meet the foal's nutritional requirements. For instance, nursing will occur at an average of 4-5 times per hour during the first week of life (Carson and Wood-Gush, 1983; Crowell-Davis, 1985), and also during the night-time (Zanker *et al.*, 2021). After a peak in frequency, the suckling behaviour will slowly regress until mare-mediated weaning. In addition to its nutritional importance, suckling is believed to provide a general sense of well-being and safety to the foal.

Proximity with the mare experienced through all senses is another factor which contributes to a feeling of safety in the foal. The mare remains the foal's closest neighbour during this developmental period for up to 92% of the time (Crowell-Davis, 1986a), even if other horses, ponies or foals are available to be socialized with. For example, during the first week *postpartum*, the foal and mare will remain within five meters from each other if left undisturbed (Crowell-Davis, 1986a). The maintenance of the close association is by dual efforts during the first few weeks, after which gradual distancing begins to take place (Houpt, 2002).

Alongside the intake of milk, foals begin early to express grazing behaviours. Rudimentary feeding efforts on solids, such as nibbling on grass blades, can be seen in just a one-day old foal (Crowell-Davis *et al.*, 1985; Tyler, 1972). At this age, the behavior is very non-selective and serves an explorative function. Besides containing a variety of leafy greens, the diet can also include range of soil materials and vegetation parts (Bolzan *et al.*, 2020; Crowell-Davis *et al.*, 1985). As the foal grows, the frequency and length of feeding periods will steadily increase, although the behaviour almost exclusively happens at the same time as the mare is grazing (Crowell-Davis *et al.*, 1985). Unlike with mature horses, drinking is a rare activity amongst young foals as their milk intake covers their hydration needs (Crowell-Davis *et al.*, 1985).

Ingesting small amounts of maternal and occasionally other horses' fresh faeces seems to be a normal behaviour of young foals, yet its primary function remains debated. Interesting explanations for it include ensuring the intake of important nutrients (Crowell-Davis, 1986b) and learning the dietary composition of the dam (Marinier and Alexander, 1995). In mature horses, the behaviour is normally infrequent and is possibly related to the share of concentrates in the diet (Willard *et al.*, 1977).

Different forms of locomotory play, such as running, jumping and circling, tend to be spontaneous and swift in young foals. These behaviours will be expressed in the presence of and occasionally towards the dam, and do not generally involve other playmates (Maglieri *et al.*,

2024). In this period, no major differences in play behaviour between fillies and colts has been observed, thus its function is believed to primarily support rapid motor maturation (Byers and Walker, 1995). In addition, solo-exploration of the environment is an important way for the foal to familiarize itself with its surroundings.

Between motor activities and feeding, at least a third of the foal's 24-hour period consists of a mixture of light rest and deeper sleep (Boy and Duncan, 1979; Crowell-Davis, 1994). Unlike adult horses, young foals spend more time in recumbent resting positions rather than upright ones due to their higher need for paradoxical sleep in opposition to slow-wave sleep (Crowell-Davis, 1986b). Furthermore, Zanker *et al.* (2021) recently described the vigilance stages of polysomnographic recordings on foals to be morphologically different from those that have been recorded in adult horses. Based on round-the-clock measurements, the highest average period of wakefulness was observed in the late afternoon and evening, whereas the lowest average period occurred during night hours (Zanker *et al.*, 2021). Interestingly, the early start of stable and yard duties seemed to cause a sudden increase in wakeful behaviours, leading the authors to recommend such tasks to be performed later in the daylight hours.

1.1.2. Socialization period

During its second and third month of life, the foal's social engagement with other available herd members increases, whereas mare-foal proximity is reduced (Crowell-Davis, 1986b). Meanwhile, weaning remains a primarily nutritional act although it accounts to a decreasing extent for the foal's nutritional needs. Other activities, such as resting, slowly begin to resemble similar patterns that are expressed by adult horses.

Due to a rapid increase in social interactions outside of the mare-foal bond, play behaviour becomes an activity shared primarily with other foals. As specified by Crowell-Davis (1986b), different play activities can be roughly grouped into general motor, interactive and object manipulation. General motor consists of amplified displays of the normal gaits interspersed with bucking and is most prevalent in fillies as well as the main play behavior expressed by adult horses (Crowell-Davis, 1986b). Colts instead engage more in repeat physical contact with each other when playing, which safely mimics the combat of adult stallions (Maglieri *et al.*, 2024) – this has also been termed “play fighting” (McDonnell and Poulin, 2002). On the other hand, grabbing-dropping, carrying and throwing of different environmental objects, is expressed by both sexes in fairly similar proportions. This is also the case for mounting, defined by McDonnell

and Poulin (2002) as “play sexual behavior”, presumably due to its importance for learning future courting skills and the boundaries associated with them.

Since the shedding of the foal coat coincides in this age group, self- and mutual grooming behaviours will be frequently expressed. Even though foals mutually groom with their dams, the behaviour is most often directed towards other foals (Crowell-Davis *et al.*, 1986; Tyler, 1972). Interestingly, fillies appear to be receivers of grooming efforts from foals of both sexes, whereas colts rarely groom each other and have alternatively been observed to more often groom fillies (Crowell-Davis *et al.*, 1986). Arguably, these preferences in social interactions between colts and fillies mirror their future adult roles in a harem, where female-female relationships act as a “glue” keeping the social group together and the harem stallion associates with the herd through acts of herding, guarding and mating (Stanley and Schultz, 2012).

While the cumulative time of nursing bouts continue to decrease at a gradual rate, the time budget of grazing behaviour increases (Bolzan *et al.*, 2020). Bolzan *et al.* (2020) found that during 40 to 110 days of age, semi-wild Criollo foals’ dry matter intake grew rapidly from the previously observed habits of “explorative feeding” in foals younger than 40 days of age. Additionally, these foals expressed increased specialization of the same pasturage flora which made up the bulk of their dams’ diets (Bolzan *et al.*, 2020).

1.1.3. Stabilization period

From the fourth month of age up until the natural weaning age of 9-11 months, foals increasingly resemble adult equids in regards to their time budgeting of different behaviours and how they socially and spatially relate with other herd members (Crowell-Davis, 1986a). Nevertheless, seasons and their respective climate conditions seem to influence time budgeting preferences of horses in both wild- and semi-wild conditions (Boy and Duncan, 1979). As nursing frequencies continue to dwindle, foals spend an increasing amount of time learning and practicing social skills with other herd members.

Time-wise, foals will progressively invest more of their consecutive 24-hours grazing and less time nursing and resting (Boy and Duncan, 1979). The refining of the dietary palette to further resemble that of the dam’s also occurs during this period (Bolzan *et al.*, 2020). However, semi-wild colts especially have been discovered to “comfort-suckle” in response to a rise in aggressive interactions from older stallions perceiving their maturation as a threat (Stanley and Schultz, 2012). In contrast, aggressive interactions remain lower towards fillies as their dispersal from the herd is not as acute a matter in naturalistic conditions (Stanley and Schultz, 2012). The relevance

of the observations described above remain largely unstudied in domestic settings, where social groups of horses are often strictly controlled.

The expression and role of play behaviour continues in this period in a similar fashion as that which has been described in the previous developmental stage, with solo play remaining largely absent (Maglieri *et al.*, 2024).

In the previously described pre-weaning period, concluded from field observations by Boy and Duncan (1979), foals further establish time budgets of grazing, resting and other activities to mimic those of adult horses, possibly in response to the mare's increased weaning efforts during this period. This period ends with total nutritional weaning, which often takes place when the foal is around one year old. However, the more specific timing is influenced by prevalent circumstances, such as the mare's pregnancy state, body condition and even hierarchal rank (Heitor and Vicente, 2008). Importantly, in contrast to methods of artificial weaning, a mare-mediated weaning process does not seem to cause any significant stress in either the mare or the weaned foal.

1.2. The normal mare-foal bond

The mother-infant bond between the dam and her foal starts to form immediately after delivery. This begins by the mare expressing interest in foetal fluids and membranes, mostly during the first 10 minutes post-delivery (Houpt, 2002).

Hereafter, Grogan and McDonnell (2005) observed that mares shift their attention onto the foal itself and continue to familiarize with their foal through gestures involving the vomeronasal organ, behaviours such as nuzzling and licking. Furthermore, the mare is believed to learn to recognize her foal by nose-to-nose nuzzling, mutual breath sniffing and through nudging of the foal's perineal region (Grogan and McDonnell, 2005). The foal, in turn, attempts to seek nose-to-nose contact with its dam, responds to vocalizations initiated by her and actively seeks the udder once standing by seeking structures resembling a mare's abdominal curve (Grogan and McDonnell, 2005). According to the same study, these behaviours serve primarily to establish the mare's bond to her foal and are therefore expressed most frequently during the first hours after birth and gradually diminish during a span of few days. Following this, the frequent expression of maternal behaviors is triggered by specific instances, such as during reunion of the dam and foal after separation (Moons *et al.*, 2005).

The previously described imprinting-type bonding allows the mare to attach herself to the foal rapidly, ensuring the foal does not end up abandoned (Houpt, 2002). However, the foal is

presumed to bond itself to the mare by associative learning which takes a longer time, usually 1-2 weeks (Houpt, 2002). This is reflected in the early *postpartum* period by the foal expressing tendencies to follow other moving objects of a similar size as the dam (Tyler, 1972). Interestingly, mares have been observed to frequently terminate nursing bouts during the first week of the foal's life by walking away. It has been speculated, that this encourages the foal to follow its dam (Crowell-Davis, 1985; Tyler, 1972). Once the mutual bond between the mare-foal dyad has been established, the dam will be the most preferred neighbour of the foal throughout its development.

Nursing is an important feature of mammalian offspring rearing, including in the equid family. Interestingly, foals continue nursing up until the dam's next foaling, despite the fact that the milk content ceases to meet all of the foal's nutritional requirements beyond 3-4 months of age (Burns *et al.*, 1992; Oftedal *et al.*, 1983). Likely this is because besides providing irreplaceable nutrition and the transfer of passive immunity early on, the act of suckling also fosters a sense of emotional security (Stanley and Schultz, 2012). Notably, nursing often occurs after the foal has experienced negative emotions, such as fear, suggesting that suckling is also mentally pacifying (Crowell-Davis and Houpt, 1986; Houpt, 1977). Nursing entails physical closeness with the mare which reinforces a sense of safety in the foal.

Mare-mediated weaning usually occurs when the foal is 9-11 months old, and in many cases is a natural consequence of a mare birthing a new foal (Duncan *et al.*, 1984; Henry *et al.*, 2020). However, the social bond that has formed between the dam and her offspring is retained even after suckling is terminated. For instance, it has been observed that 1-2-year-old weanlings still prefer to keep their dam as the closest neighbour in a herd for the majority of the time (Tyler, 1972; Wells and von Goldschmidt-Rothschild, 1979). This is true especially in the case of fillies (Lansade *et al.*, 2022). Similar social preferences have also been observed in beef cattle (Swanson and Stricklin, 1985) and sheep (Hinch *et al.*, 1990; Lawrence, 1990). In a natural setting, sexually mature colts will be pressured into leaving the natal herd by other herd members, particularly by the harem stallion (Stanley and Schultz, 2012).

1.3. Weaning-related stress in foals

Amongst domestic horses, weaning has been confirmed to represent a major source of stress to a foal (Apter and Householder, 1996; Delank *et al.*, 2023; Heleski *et al.*, 2002). In contrast to its natural version - a gradual process which spans over many months and does not break off the social and emotional affiliation between the dam and foal - artificial weaning may comprise a separation of the foal and dam which is abrupt and definitive (Parker *et al.*, 2008). In

addition, the foal is weaned from its dam when the mare-foal bond is still strong, usually at 4-7 months (Apter and Householder, 1996; Parker *et al.*, 2008). Moreover, other considerable changes in the foal's social periphery, housing and management related to the weaning process can lead to an accumulation of stress. Because foals do not have the capability of an adult horse to cope with large amounts of stress, their well-being is at a higher risk of being compromised.

1.3.1. The equine stress response

In mammalian species, the stress response is the combined changes in physiology and behaviour resulting from different bodily systems that respond to a disruption in homeostasis and functions to ensure survival of the individual. At the cellular level, the response can be divided into the Sympathetic-Adreno-Medullar system (SAM) and the Hypothalamic-Pituitary-Adrenal system (HPA) (Chu *et al.*, 2024). These axes are triggered by the presence of one or more stress-inducing stimuli, so called “stressors” – for instance, to a foal this could represent separation from its dam. It is known that the SAM system reacts more rapidly in comparison to the HPA system (Chu *et al.*, 2024).

Both SAM and HPA axes comprise signalling pathways involving the release of substances which cause changes in organ systems vital for perceived fight-or-flight situations. In SAM activation, the adrenomedullary hormones epinephrine and norepinephrine are released and proceed to initiate an extensive sympathomimetic response in the nervous system affecting all organs (Chu *et al.*, 2024). These changes ensure a prioritized flow of oxygen- and glucose-rich blood to large muscles, the lungs and the brain, which are considered central for rapid and demanding physical performance. Simultaneously, blood flow to other, less immediately necessary organs is momentarily reduced. Visually, signs of increased mental activity can be observed, such as heightened vigilance and restlessness (Chu *et al.*, 2024).

On the other hand, the HPA axis involves a slower feedback loop of the hypothalamus, pituitary gland and adrenal cortex, comprising the release of corticotropin-releasing hormone (CRH), adrenocorticotrophic hormone (ACTH) and cortisol, respectively (Chu *et al.*, 2024). Cortisol induces significant metabolic changes in order to increase blood glucose levels – these include counteracting insulin and favouring gluconeogenesis and glycogenolysis (Chu *et al.*, 2024). Furthermore, activity of the immune system and collagen synthesis is repressed (Khoo *et al.*, 2017). For example, in horses, the concurrence of increased glucocorticoid levels and reduced lymphocyte proliferation has been noted (Kurcz *et al.*, 1988; Tarr and Olsen, 1978). Another

adrenocortical hormone, aldosterone, is released alongside cortisol in order to sustain sufficient blood pressure by retaining sodium and consequently limit fluid loss (Chu *et al.*, 2024).

The sympathetic nervous system and HPA axis will remain activated until the perceived stressors have diminished in importance or are withdrawn. Recovery from the acute stress crisis begins through activation of the parasympathetic nervous system (Chu *et al.*, 2024). At the same time, a decrease in alertness and consequent increase in resting behaviours indicate the dissipation of emotional distress (Górecka-Bruzda *et al.*, 2015).

1.3.2. Assessment of weaning-related stress in foals

In animal species, objective assessment of a stress response has been used to determine the degree of welfare (Ewbank, 1985; Fraser *et al.*, 1975). Naturally, this has also been applied by studies which have investigated the stress response of weaned foals.

In weaned foals, cortisol and its metabolites have been utilized to evaluate the presence and degree of stress, since these are essential components of the HPA axis (Apter and Householder, 1996; Chu *et al.*, 2024). Foal basal cortisol levels can be measured from blood samples (Apter and Householder, 1996) and saliva (Erber *et al.*, 2012; Wulf *et al.*, 2018), and its' parallelling metabolites also from feces (Delank *et al.*, 2023; Górecka-Bruzda *et al.*, 2015). Importantly, intensity and even chronicity of a stress response can be suspect when lower-than-expected values of cortisol are found in response to an ACTH challenge (Fraser *et al.*, 1975). Even so, individual variations between measurements of cortisol and its metabolites need to be accounted for as these may be substantial – for instance, this was the case for ten Arabian foals in the study of midterm effects of weaning stress by Delank *et al.* (2023). Furthermore, sex-related differences in cortisol measurements have been confirmed between fillies and colts (Wulf *et al.*, 2018) as well as post-pubertal horses (Schmidt *et al.*, 2010), and these tend to be higher in females than males. Finally, the predictable effects of the circadian rhythm on cortisol levels also need to be accounted for (Górecka-Bruzda *et al.*, 2015).

In addition to biochemical measure, other measurable physiological changes in organ systems can be used to assess the stress response. In foals, common physiological findings that reflect stress include tachycardia and frequent defecation (Wulf *et al.*, 2018), which are consequences of an activated sympathetic nervous system in a stressful situation (Chu *et al.*, 2024).

Behavioural profiles have also been used to confirm and assess acute distress in weaned foals. Among horses, vocalization serves to localize and re-unite with one's social group during

separation (Lemasson *et al.*, 2009). Therefore, whinnying seen in recently weaned foals is believed to be an expression of their experienced separation anxiety. However, the frequency of this behaviour does not correlate with physiological measurements (Górecka-Bruzda *et al.*, 2015; Hoffman *et al.*, 1995; Lansade *et al.*, 2018), and is a poor evaluator of the severity of a stress response.

Furthermore, recently weaned foals have been found to express high motor activity and consequently a sharp increase in travelled distance (Erber *et al.*, 2012; Górecka-Bruzda *et al.*, 2015; Heleski *et al.*, 2002; Henry *et al.*, 2012). The experienced anxiety at weaning may cause a temporary reduction in feeding (Górecka-Bruzda *et al.*, 2015; Hoffman *et al.*, 1995). Moreover, the demanding situation can stimulate suckling attempts directed towards peers, human handlers or inanimate objects (McCall *et al.*, 1985) or an increase in agonistic behaviors, such as aggression (Górecka-Bruzda *et al.*, 2015; Hoffmann *et al.*, 1995). In cases when the experienced stress response has been particularly overwhelming, the adrenal cortisol reserve may become depleted (Apter and Householder, 1996). In one study, this phenomenon was one of the suspected causes of the observed apathy and other passive behaviours observed in weaned semi-feral Koniak foals in comparison to stable-reared weanlings (Górecka-Bruzda *et al.*, 2015). Following the initial expression of acute stress, an increased demand for rest ensues and dominates over other activities (Delank *et al.*, 2023).

However, although there are similarities between the behaviour profiles of weanlings reacting to a weaning-induced stress response, the role of individual differences cannot be underestimated. For example, the strength of attachment between a foal and its' dam is likely to influence the expression of behavioural stress during physical separation of the two (Henry *et al.*, 2005). In conclusion, the reliance on behavioural measurements alone to evaluate a stress response in weaned foals is not robust. Indeed, Górecka-Bruzda *et al.* (2015) did theorize that stress likely represents a complex, subjective experience, which results in inconsistencies in the stress-induced behavioural patterns in foals across studies.

1.3.3. Consequences of weaning related stress in foals

The consequences of weaning stress can be grouped into short-term (acute) and long-term (chronic), with some possibly becoming permanent. Hitherto, studies have largely focused on investigating the effects of acute stress on weanling well-being and health, and ways to alleviate it. Little information exists on possible chronic and permanent ailments resulting from weaning stress, and to what extent these may impact a foal's future health and career.

Among breeders, one of the greatest concerns has been the reduced, stagnated or even decreased growth rate seen in recently weaned foals (Apter and Householder, 1996; Erber *et al.*, 2012). This results from the combined effects of increased locomotion and the simultaneous reduced time spent feeding, or a reduced appetite due negative emotion experienced. Additionally, this is aggravated by possible weaning-related injuries or health complications which increase the foal's energy demand.

As mentioned earlier, cortisol has been found to impair wound healing and decrease the body's cell-mediated activity. In foals weaned in pairs, Malinowski *et al.* (1990) found that weaning reduced mitogen induced lymphocytic proliferation in the presence of increased cortisol serum concentrations. This finding indicates a reduced capacity to fight off bacterial or viral infections, as well as a higher complication rate of possible injuries acquired during the weaning process.

In early life, the intestinal microbiota are susceptible to alterations in response to a range of different challenges, such as the effects of stress. Mach *et al.* (2017) evaluated the effect of different weaning methods on gut microbiota maturation across time in 34 foals, including in response to separation of the mare-foal dyad. It was found that shifts in the microbiome occurred regardless of the weaning protocol used, but that some foals harbouring a specific set of gut microbial colonies objectively adapted better to weaning-induced stress (Mach *et al.*, 2017). Interestingly, studies in other species indicate the existence of a "window of opportunity" during which the presence of sub-optimal microbial compositions may persistently alter elements of the host's immune system (Bauer *et al.*, 1963; Baptista *et al.*, 2014; Mosconi *et al.*, 2013).

Lastly, weaning-related stress experienced by young foals seems to play a part in the development of stereotypies and other abnormal behaviours in susceptible individuals. According to the findings of Waters *et al.* (2002), abnormal oral behaviours such as cribbing and wood chewing, as well as locomotory ones including weaving and box-walking, were initiated by 34.5% of the studied thoroughbreds and warmbloods during their first four years of life. In particular, the development of oral abnormal behaviours peaked post-weaning during the 9th month of life, with studied foals having been weaned from the age of three to eight months (Waters *et al.*, 2002). However, oral abnormal behaviours may be present also in the pre-weaning period, related to mare rank in a herd (Parker *et al.*, 2008) and features of the housing and diet (Waters *et al.*, 2002), which have also been found to influence the emergence of equine stereotypies.

1.4. Artificial foal weaning methods

To date, no clearly delineated weaning protocol has been created (Waran *et al.*, 2008). However, an understanding of artificial weaning methods being divided according to how rapidly the process is executed in relation to the mare-initiated weaning process exists among horse owners and scientists. In general, breeders design and implement different weaning protocols according to personal preferences and beliefs, as well as by practical limitations in their management system and stable environment.

On the other hand, it has also become clear that the observed stress during weaning can result from other aspects aside from the disruption of the mare-foal bond. In the wild, the weaning process is not regularly accompanied by sudden, large-scale changes, as habitats, diet and social networks remain relatively stable or transform at a manageable pace. This is not as obvious in domestic settings, where the above-mentioned variables, and many more, are controlled and can therefore be changed quickly if needed.

1.4.1. Abrupt weaning methods

Abrupt weaning methods have been long favoured due to being cost-effective, efficient and applicable to most forms of domestic horse keeping. As the methods imply, the separation of a mare and foal is immediate and results in the foal experiencing nutritional and physical weaning within a narrow timeframe, if not simultaneously. Additionally, the separation is performed so that no visual, auditory or olfactory contact remains, such as by transporting one of the two to a new location.

Presumably, the establishment of abrupt weaning practices was inspired by the understanding that, starting from its third and fourth month of life, a foal is capable of surviving on nutrition received from a diet of roughage and concentrates alone (Burns *et al.*, 1992; Doreau and Boulot, 1989; Oftedal *et al.*, 1983). Other reasons for preferring abrupt weaning methods refer to practical limitations of common management systems and the desire to increase the foal's relationship with human handlers (Henry *et al.*, 2020; Lansade *et al.*, 2004).

Some efforts have been made to reduce the stress caused by abrupt weaning. For example, one method aims to get the foal and mare used to being apart from each other by regularly separating the two for short periods of time. However, this does not allow for habituation to the process as it instead sensitizes foals to the anticipated separation attempts (Moons *et al.*, 2005).

Moreover, methods of weaning foals in pairs or even groups are exercised due to practical reasons and as an attempt to relieve some of the separation anxiety by offering new individuals to socially attach to. In a study conducted by Hoffman *et al.* (1995) on “pair weaning”, it was concluded that stall weaned-foals express greater levels of stress due to resulting inter-foal aggression, in comparison to singly weaned foals whose main source of stress is social isolation. In conclusion, weaning of multiple foals requires taking into account individual compatibility in order to minimize the expression of antagonistic behaviours during times of stress.

Another weaning system that allows foals to maintain some of their social bonds is “interval weaning”. Here, multiple mare-foal dyads are put together and allowed to form an established herd before dams are removed from the group one at a time. Although each dam is removed from the group in an abrupt manner, other remaining mares as well as their foals provide social alternatives for the foal with a disrupted mare-foal bond. This appears to be better tolerated than removing all mares at once, although both events do still induce a significant stress reaction in weanlings (Holland *et al.*, 1996).

1.4.2. Progressive weaning methods

Progressive weaning methods aim to reduce weaning-related stress experienced by the foal and also the dam. This is achieved by adopting features of the natural weaning process. Progressive weaning methods include gradually introducing cessation of nursing and distancing of the mare and foal to avoid inducing a severe stress response. With time, the nutritional and physical weaning efforts are slowly increased until the mare and foal have grown tolerant to the desired outcome.

To reduce the stress load, nutritional and physical weaning are applied at different times in the weaning process, sometimes termed “two-stage weaning” (McCall *et al.*, 1985; Merckies *et al.*, 2016). Commonly, nutritional weaning is implemented by not allowing foals to nurse, such as with the aid of a mesh-wire fence (McCall *et al.*, 1985) or fabric udder cover (Merckies *et al.*, 2016). Similarly, physical weaning is introduced in a step-wise manner by partially restricting communication between the foal and dam. For example, this may occur by placing the two in different, adjacent pens so that auditory, olfactory and visual contact is maintained (Lansade *et al.*, 2018; McCall *et al.*, 1985).

Nevertheless, although progressive weaning methods are designed with the aim to induce a less impactful stress response in weaned foals, existing studies are few and show differing results. A stress-reducing effect of progressive habituation to physical weaning was confirmed by

Lansade *et al.* (2018), where gradually weaned Welsh Pony foals spent roughly one month in an adjacent pen to their dams before definitive weaning. In this study, the behavioural indicators of stress as well as salivary cortisol measurements were significantly lower in gradually weaned foals compared to those weaned abruptly. These results demonstrate the potential of progressive weaning methods to improve foal welfare.

However, Merkies *et al.* (2016) found that heart rate and fecal cortisol levels did not significantly differ between foals weaned with a two-stage weaning method and those weaned abruptly, although they did observe minor differences in behavioural profiles. Notably, partial separation of gradually weaned foals was performed by placing the mares approximately 300 meters away from their foals, which allowed for some, albeit greatly reduced, visual, auditory and olfactory contact. Additionally, Turner *et al.* (2003) confirmed that there was no difference between cortisol concentrations between abruptly and gradually weaned foals. However, in that case, gradually weaned foals were nutritionally and physically weaned 48 hours apart, which can be considered as a relatively short time to allow for complete habituation. Evidently, great variations in the applied systems of progressive weaning could explain at least some of the inconsistencies between existing studies.

Furthermore, McCall *et al.* (1985) concluded that foals weaned with a two-stage weaning method with additional access to creep feed expressed locomotory patterns which were most similar to those of the control group of non-weaned, creep-fed foals. From the same study, another group of gradually weaned foals without access to creep feed expressed more behavioural indicators of stress (McCall *et al.*, 1985), suggesting that weaning-related stress is increased by the absence of feed. Indeed, many other factors have been found to do this, including housing type (Heleski *et al.*, 2002; Hoffman *et al.*, 1994), the presence of another stressful event such as a blacksmith visit (Delank *et al.*, 2023), the novelty of the weaning environment (Górecka-Bruzda *et al.*, 2015) and level of habituation towards human handlers (Lansade *et al.*, 2004; McGee and Smith, 2004).

1.5. Conclusions

Artificial weaning of the domesticated horse is a common and established practice that presents a challenge to an immature foal. Notably, the artificial weaning process seems to be an inherently stress-inducing process as it does not manage to replicate important aspects of its natural alternative. Without human intervention, mares will wean their foals over a period of months which allows the foal to better acclimatize to the permanent changes. Furthermore, the

weaning itself occurs at a later time in the foal's development, thereby ensuring better abilities to cope with changes in nutrition and social structure. Lastly, mare-mediated weaning is normally not accompanied by other significant and rapid alterations in the foal's diet, group of conspecifics or environment, effectively limiting the stress load.

So far, the greatest motivation to find ways to reduce the experienced stress in weaned foals has been generated by limited evidence indicating that stress influences foal growth, intestinal microbiota composition, immune system function and behavioural development. Accordingly, proactive efforts have been made to make the weaning process less stressful, such as performing it in a more progressive manner, introducing only one major change at a time and ensuring the foal has the company of other non-related foals and adults. However, as the current artificial weaning methods primarily focus on ensuring an effective and convenient separation of the mare-foal dyad at an earlier time and much faster than in non-domestic settings, aspects of foal welfare remain compromised.

2. AIM OF THE STUDY

This work investigates common practices related to foal weaning amongst Finnish horse breeders and attempts to assess breeders' general understanding of weaning method-related stress and their attitude of its implications to foal welfare.

3. MATERIALS AND METHODS

3.1. Data collection & questionnaire design

In order to investigate the practices of Finnish horse breeders, an online survey composed of a total of 40 questions was distributed to two large Finnish equestrian-themed groups on Facebook, *FWB / Finnish Warmblood Horses* (ca 5,500 followers) and *Hevostutkimuksia* (8,971 members).

The purpose of the first two questions was to exclude possible untargeted respondents (qualifying questions). These were followed by questions that investigated different characteristics of respondents' breeding work. The survey's largest part consisted of questions about foal weaning methods. Finally, the end of the survey shortly explored personal opinions about own and law-provisioned foal weaning practices.

The survey was created with Google Forms and included both open questions and single/multiple choice questions, all of which were mandatory to respond to. Survey answers were accepted during one month (21.1.2025-21.2.2025), and all responses were received during the first two weeks.

3.2. Statistical analysis

The collected data were obtained *via* Google Forms and exported to Microsoft Excel for statistical analysis. Any unsuitable data (e.g. respondents without experience in horse breeding and foal weaning) were filtered out and eliminated from the study. The filtered data were then grouped and calculated, summarized and analyzed with pivot tables in Excel. In addition, Chi square tests and Fisher's exact tests were calculated to estimate significant associations between variables of interest.

3.3. Ethics

In the introduction of the survey, respondents were informed that the collected answers would be used for a Master's Thesis work of a final year veterinary medicine student, and that their answers would remain anonymous. The same information was shared also in connection with the posts on the previously mentioned social media groups.

4. RESULTS

4.1. Profiling of respondents

In total, 170 answers were received, from which five were eliminated based on their responses to the qualifying questions. Therefore, the remaining 165 responses qualified for analysis. After closing the questionnaire in the two Facebook groups *FWB / Finnish Warmblood Horses* (ca 5,500 followers) and *Hevostutkimuksia* (ca 8,971 members), response rates were 3.1% and 1.9%, respectively. These values are influenced by the fairly high count of online members in the two Facebook groups. Based on the survey's objective, language and where it was shared online, all respondents are assumed to be Finnish horse owners with personal experience in horse breeding.

Regarding breeding experience measured in years, roughly half (52.8%) answered having a minimum of 12 years (Figure 1). Otherwise, there was a fairly even distribution (10.0-12.0%) of responses into the four categories spanning from one to less than 12 years in breeding experience. Only three people (2.6%) responded having less than one year of experience.

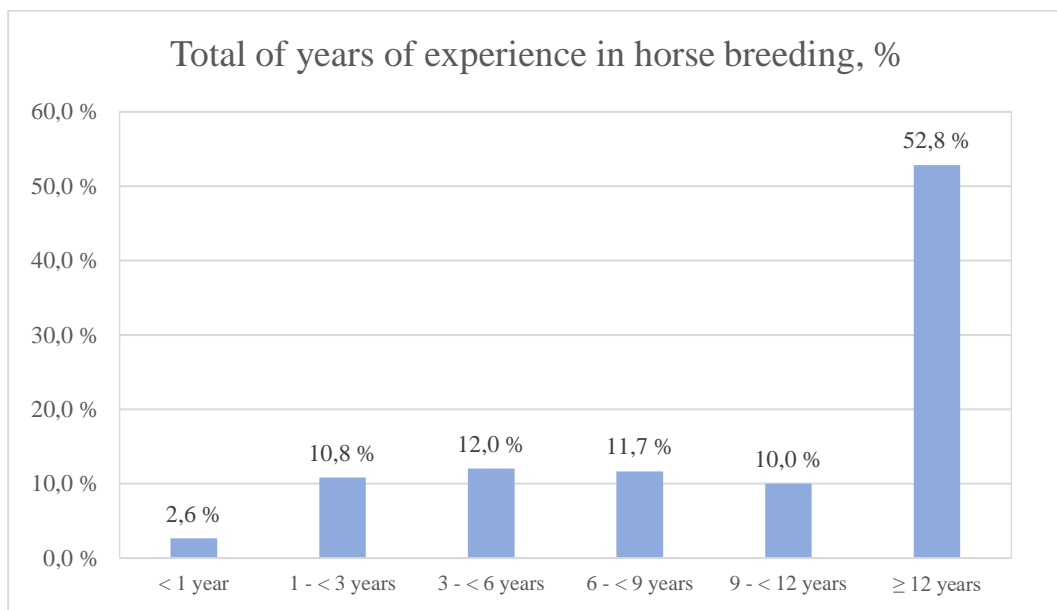


Figure 1. Experience in horse breeding in years.

Furthermore, respondents were asked about the total number of foals that they have raised, which have reached a minimum age of 12 months. Responses seen in Figure 2 showed that the majority have raised a maximum of five foals (51.5%). At most, 20 foals or more, have been reared by 16.4% of respondents.

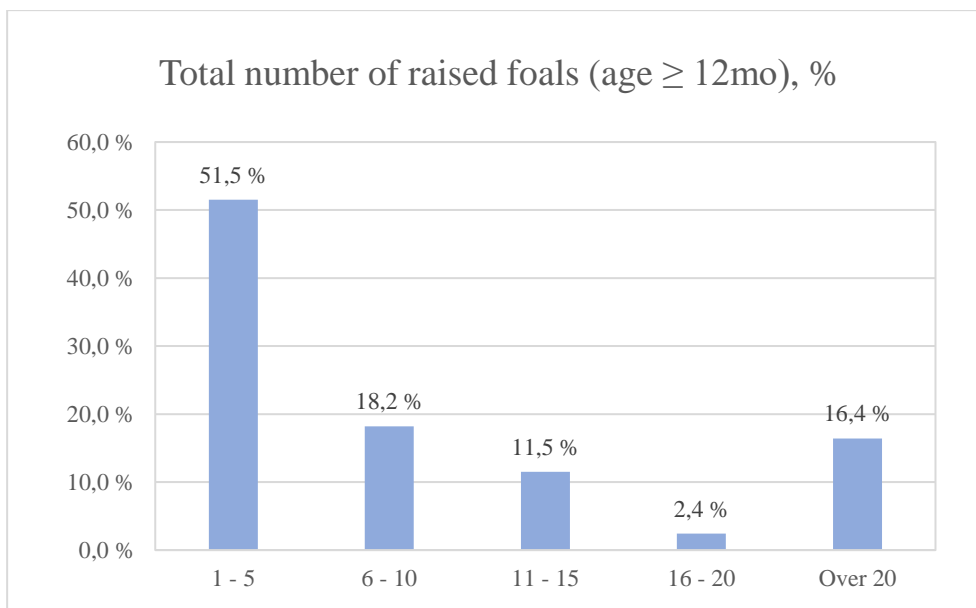


Figure 2. Total number of raised foals (age ≥ 12 months).

In addition to the number of produced foals, respondents were also asked about the number of breeding mares they currently own. An “active breeding mare” was defined as a mare that has birthed a foal in the past 12 months, is pregnant or is planned to be inseminated. Close to a quarter (23.0%) of respondents were found to not own a breeding mare that met the set criteria. For the majority that did, there were usually no more than three mares (67.3%).

As can be observed in Figure 3, close to a third (31.4%) of respondents were found to have an official breeder name that can be linked to their breeding work.

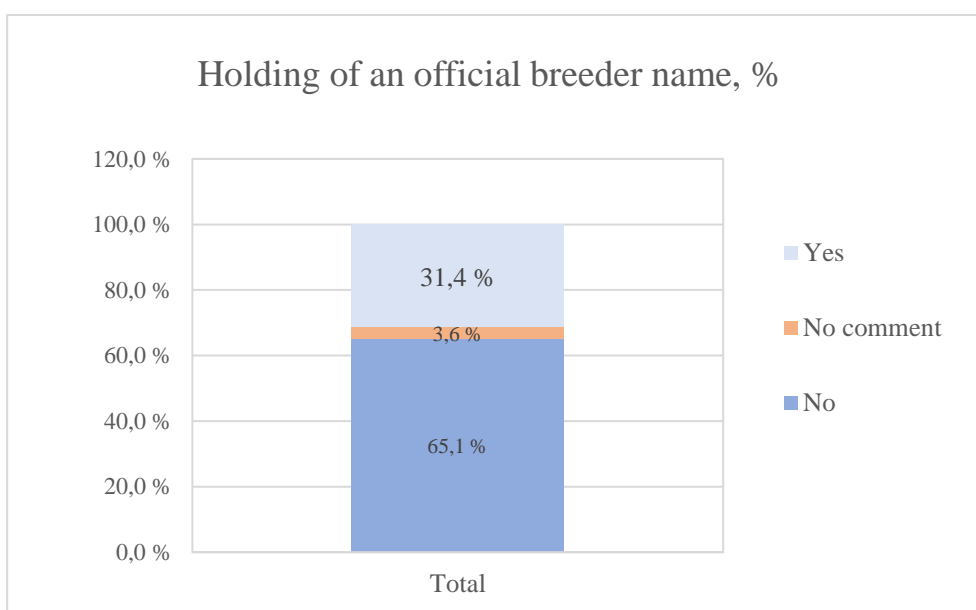


Figure 3. Prevalence of holding an official breeder name.

It was also asked, what kind of stable ownership respondents have for their breeding-related work, such as housing of breeding stock and foals. Out of the available options presented by Figure 4, owning at least one stable was the most common (78.8%). Moreover, renting one or more stalls in a stable (14.5%) was more common than renting an entire stable (6.7%). Here, the total percentage exceeds 100% due to the respondents being able to choose more than one answer option.

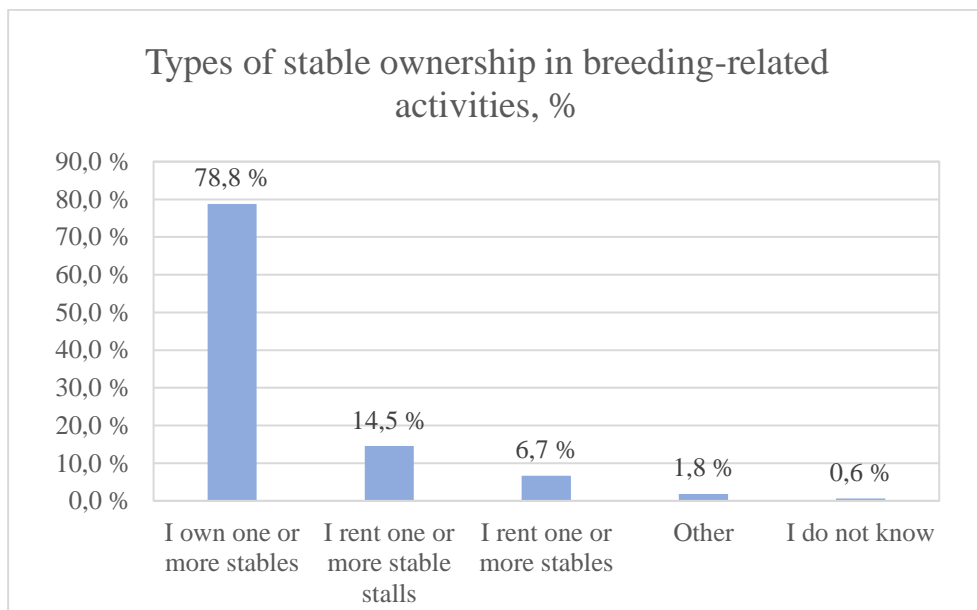


Figure 4. Distribution of different stable ownership types.

Regarding breeds, a majority of respondents own and breed ponies and horses with a Finnish studbook (Table 1). These include the national breeds; Finnish Warmblood, Finnish Riding pony and the Finnhorse, and others such as Warm-blooded trotters, Shetland pony, Icelandic horse, Connemara pony and the Welsh Pony, Cob and Part-bred. To clarify, collected replies exceeded the total number of respondents due to this particular question allowing each respondent to give more than one answer.

Table 1. Prevalence of bred pony and horse breeds

Breeds	Count of replies
Finnish Warmblood	90
Finnhorse	55
Warm-blooded trotters	22
Shetland pony	11
Icelandic horse	10
Connemara pony	8
Finnish Riding pony	5
Welsh Pony/Cob	4
Welsh Part-bred	4
Irish Cob	3
Hanoverian horse	2
Oldenburger	2
Estonian Sport horse	2
Gotland Russ	2
Other	14
Grand Total	234

Investigating the desired equestrian disciplines of bred stock was also of interest. As demonstrated below (Figure 5), roughly half of respondents (51.5%) reported breeding ponies and horses for recreational use, followed by almost equally popular dressage (35.8%) and show jumping (33.9%). So termed “gait competitions” are intended for breeds expressing additional gaits than the basic three, of which the Icelandic horse is a classic representative.

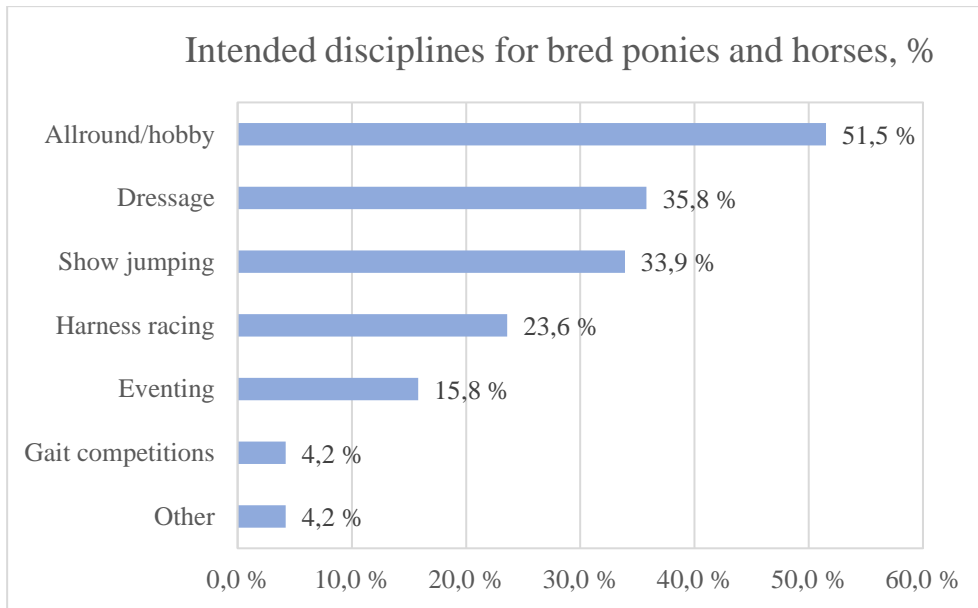


Figure 5. Intended equestrian disciplines for bred ponies and horses.

4.2. Aspects of foal weaning and related methods

When asked about the most common age of weaning, there was a large variability in answers as displayed in Figure 6. Most frequently, foals are weaned when they are between six and eight months old (altogether 40.6%). On the other hand, respondents are least likely to wean their foals during their 5th (7.3%) and 11th (7.3%) months of life. No one was found to wean foals routinely before the age of five months.

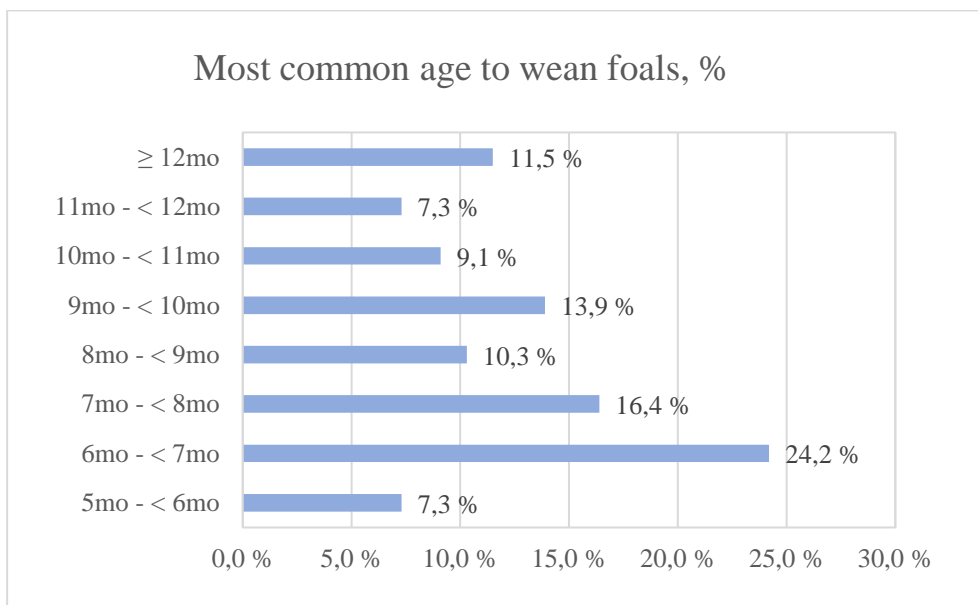


Figure 6. Preferred weaning time according to the foal's age in months.

Moreover, respondents were surveyed about their reasons for weaning foals before the age of six months. In both dams and foals, compromised health (14.5% and 6.7%, respectively) was the most prevalent cause leading to weaning of young foals. Another almost equally important dam-related reason was death (13.3%), followed by behavioural issues (altogether 12.1%). In foals, other reasons were related to assumed early independence (3.6%) and rapid maturation (3.6%), which were believed to cause stress to the dam. Either way, 43.0% of respondents replied not having had to perform weaning of foals in this age range.

Regarding pre-weaning methods, the majority of respondents (80.6%) were found to practice repeat separations of the dam and foal before weaning (Figure 7). In comparison, reducing milk intake of the foal was not found to be as common of a practice, albeit it is still reported to be implemented by 50.9% of respondents.

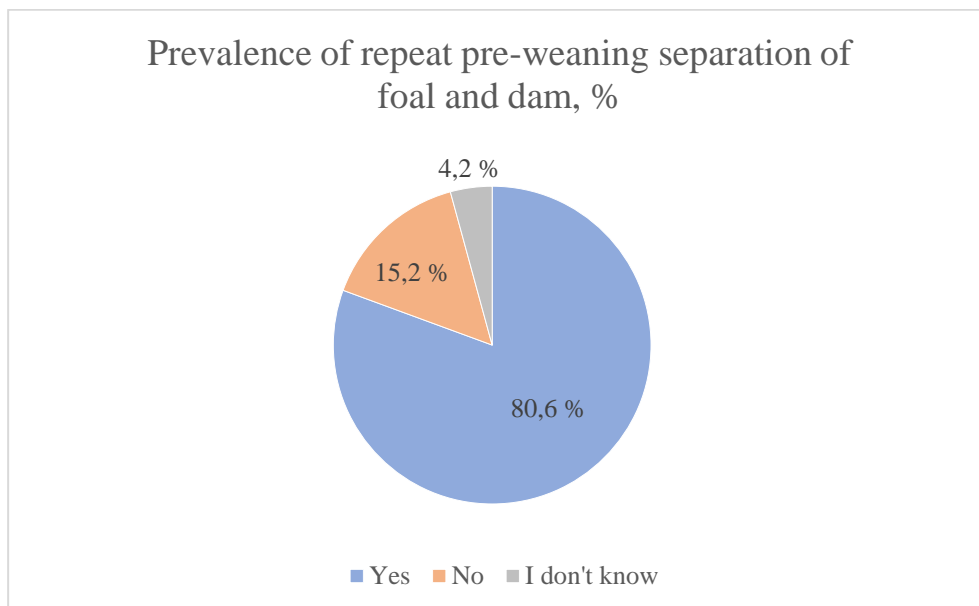


Figure 7. Prevalence of repeat separations of dam and foal in the pre-weaning period.

Furthermore, respondents were asked to estimate the average time they spend on completing a weaning process (Figure 8). According to the majority (41.2%), it lasts for over one month, and for one to four weeks by just under a third of respondents (29.7%). Close to a fifth (altogether 19.4%) described the process being faster, spanning less than one week.

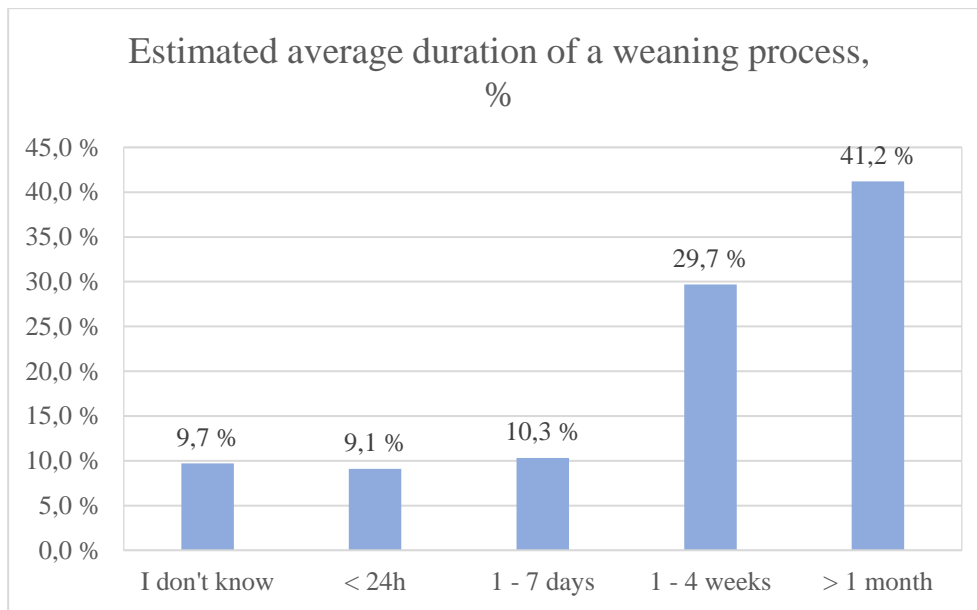


Figure 8. Estimated average duration of a weaning process.

When the preferred weaning methods of respondents were investigated, it was found that the majority of respondents (61.2%) perform a gradual distancing of the dam and foal in a familiar location, in contrast to the sudden relocation of either the foal (10.9%) or dam (9.1%). Additionally, weaned foals are commonly assured company during the weaning process, either within a mixed age herd (44.8%) or one (21.2%) or more (16.4%) weanling peers. Nevertheless, single weaning was preferred by some (9.1%).

Furthermore, assessment of the degree of physical separation was assessed by asking about preservation of dam-foal communication during weaning. As seen in Figure 9, most responded that they allow some visual, auditory or olfactory contact to be maintained during weaning between the dam and foal (60.0%), whereas others prevent all forms of contact between the two (27.9%).

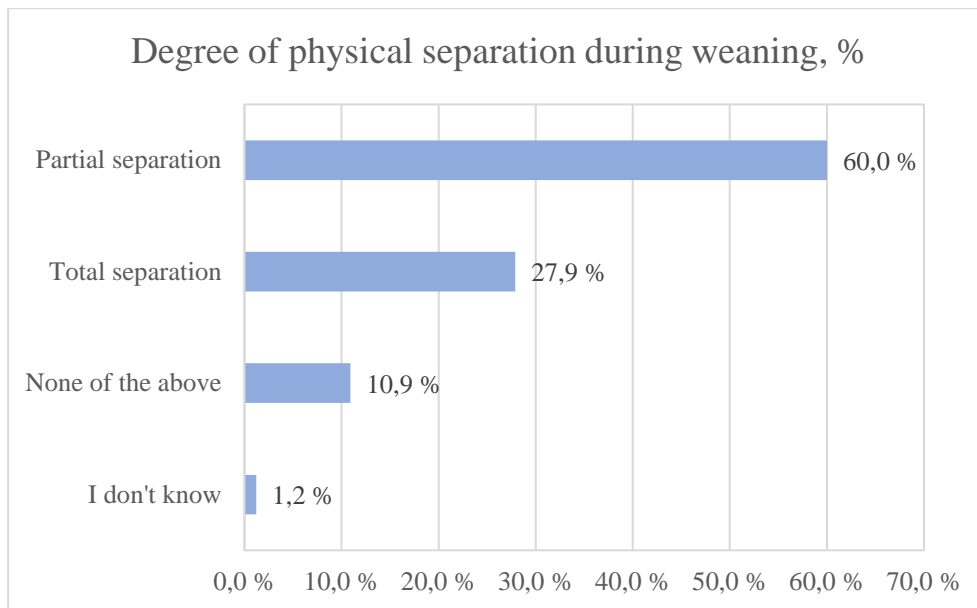


Figure 9. Degree of physical separation between dam and foal during weaning.

Respondents were asked whether they had observed behavioural signs of acute weaning stress in recently weaned foals. Out of the response options, whinnying (44.2%), suckling attempts directed towards peers, humans or inanimate objects (26.7%) and increased activity (26.1%) were noted the most. On the other hand, almost two fifths (37.0%) responded that they had seen none of the listed options.

Finally, the respondents' opinion on a foal minimum weaning age of six months, defined by a recently accepted governmental decree issued under the Finnish Animal Welfare Act (693/2023), were surveyed (Figure 10). Interestingly, almost the same number of respondents found the decision either not sufficient enough (43.0%) or sufficient (40.6%). A fairly small number of respondents felt that the decision is excessive (3.6%).

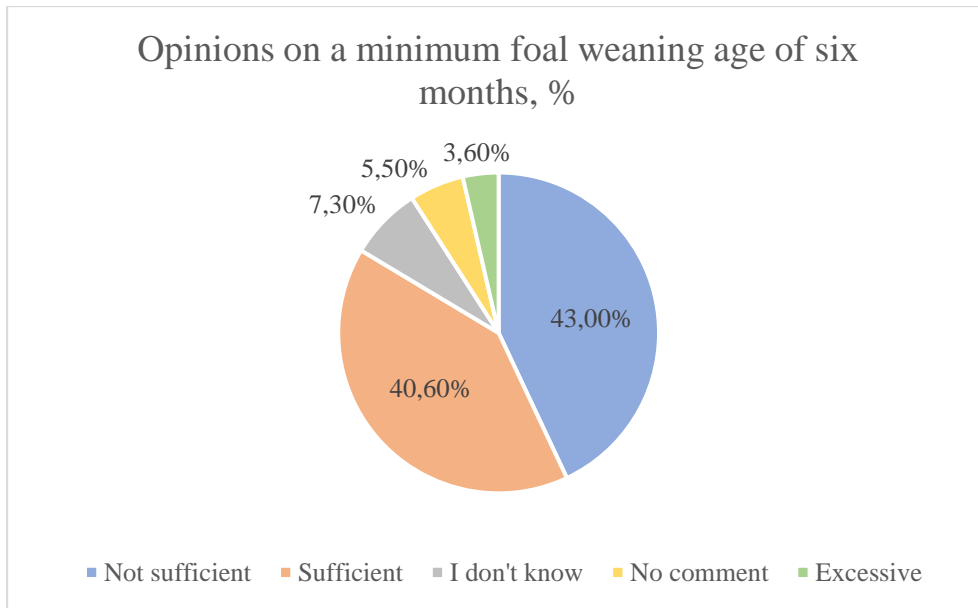


Figure 10. Respondent opinions on a minimum foal weaning age of six months

4.3. Effects of breeder experience on weaning practices

Hereafter, it was decided to investigate whether a breeder’s level of experience has an important effect on practiced foal weaning methods. Since this knowledge can be represented by years of breeding work as well as the total number of foals that one has raised, both variables were used.

Regarding experience measured in years, it was decided to categorized the data into “Less than six years” and “More than six years”. In addition, the most common foal weaning age was grouped into “Five to less than seven months”, “Seven to less than nine months”, “Nine to less than 11 months” and “11 months and more”. Accordingly, a contingency table was created for performing a Chi-squared test. In this instance, the results of a Chi-squared test did not show a significant association between a breeder’s experience in years and their preferred foal weaning age ($\chi^2(1) = 3.3828$, $p = 0.336$). As the p-value exceeds 0.05, stating the lack of a significant association, the null hypothesis was accepted. This means that a breeder’s years of experience does not significantly influence the age at which a foal is decided to be weaned.

Subsequently, a significant association was looked for between the preferred foal weaning age and experience measured as total number of raised foals (minimum age 12 months). The previous grouping for preferred foal weaning age remained, whereas the total number of raised foals was categorized as “Less than six”, “Six to ten”, and “11 or more”. Similarly, a contingency table (Table 2) was made for running an analysis on the data in a Chi-square test. Here, the p-

value was found to be less than .05 ($\chi^2(1) = 14.629$, $p = 0.023$), rejecting the null hypothesis. Conclusively, breeder experience measured as the total number of raised foals significantly influences preferred foal weaning age. More experienced breeders are more likely to wean their foals earlier, before seven months of age, while less experienced breeders tend to prefer weaning their foals later at seven to eleven months of age.

Table 2. Contingency table with observed and expected values for chi square analysis

Number of raised foals	Five months to less than seven months	Seven months to less than nine months	Nine months to less than 11 months	11 months and more	Total
Less than six	22 (26.79)	18 (22.67)	27 (19.58)	18 (15.97)	85
Six to ten	7 (9.45)	11 (8.00)	6 (6.91)	6 (5.64)	30
11 or more	23 (15.76)	15 (13.33)	5 (11.52)	7 (9.39)	50
Total	52	44	38	31	165

Moreover, the association between the weaning process duration and the respondent's level of experience was investigated. The estimated average duration of the weaning process was formed into two distinct groups, "Weaning process lasting less than one week" and "Weaning process lasting one week or more". Respondents reporting "I do not know" when asked about an estimated average on weaning processes that they perform, were not included in the created contingency tables. A total of 16 responses were eliminated from further data analysis.

For a contingency table on experience measured in years and weaning process duration (Table 3), a Chi-squared test was performed. On the other hand, in the cases of the total number of raised foals, a Fisher's exact test had to be chosen due to some expected values being less than 5.00. Due to this, the total number of foals raised was re-grouped into "Less than 11" and "11 and more".

Table 3. Contingency table with observed and expected values for chi square analysis

Years of experience	Weaning process lasting less than one week	Weaning process lasting one week or more	Total
Less than six years	3 (7.30)	31 (26.70)	34
Six years or more	29 (24.70)	86 (90.30)	115
Total	32	117	149

Concerning total years of experience and weaning process duration, a significant association was found between the two variables ($\chi^2(1) = 4.1821$, $p = 0.040$), rejecting the null

hypothesis. Although, this was not the case for experience measured as total number of raised foals and weaning process duration, as that p-value exceeded 0.05 ($p = 0.088$) and therefore the null hypothesis was accepted. This means that experience measured in years affects how long a weaning process lasts, whereas this does not apply if experience is measured as the number of foals one has raised. However, despite years of experience, most breeders' weaning process lasted for at least one week, although less experienced breeders are less likely to carry out a weaning process in less than one week of time.

It was determined if there was a significant association between experience and the practice of repeat pre-weaning separations. The practice of repeat pre-weaning separations was grouped as "Practice of repeat separations pre-weaning" and "No practice of repeat separations pre-weaning", choosing not to include responses stating "I do not know". For total years of experience and total number of raised foals, seven and 15 responses were not included in the created contingency tables, respectively.

Table 4. Contingency table with observed and expected values for chi square analysis

Experience in years	Practice of repeat separations pre-weaning	No practice of repeat separations pre-weaning	Total
Less than six years	35 (30.30)	1 (5.70)	36
Six years or more	98 (102.7)	24 (19.30)	122
Total	133	25	150

Table 5. Contingency table with observed and expected values for chi square analysis

Total number of raised foal (age \geq 12mo)	Practice of repeat separations pre-weaning	No practice of repeat separations pre-weaning	Total
Less than 11	97 (91.75)	12 (17.25)	109
11 and more	36 (41.25)	13 (7.75)	49
Total	133	25	158

For both measures of breeder experience, a chi square analysis was performed based on the data of the contingency tables (Table 4 and Table 5). A significant association was discovered between the practice of repeat pre-weaning separations and a breeder's experience measured in years ($\chi^2(1) = 5.9568$, $p = 0.014$) and also the total number of raised foals ($\chi^2(1) = 6.1144$, $p = 0.013$). In both instances, the null hypothesis was rejected due to the respective p-values being less than 0.05. The results indicate that breeders perform repeat physical separations before weaning regardless of their years of experience or the number of foals they have raised. However,

breeders that have raised fewer foals and that have fewer years of experience are much more likely to do this.

The same tests were also done for limiting suckling pre-weaning, but there was neither a significant association for experience measured in years ($\chi^2(1) = 0.1249$, $p = 0.723$) or by the number of foals one has raised ($\chi^2(1) = 0.8855$, $p = 0.642$). No association was confirmed due to the p-value being more than 0.05 in both instances, leading to acceptance of the null hypothesis. As a result, it can be concluded that breeder experience does not have a notable influence on the pre-weaning practice of reducing foal milk intake before physical separation.

5. DISCUSSION

Breeders that responded to this survey correspond with those of previously discovered features of Finnish horse breeding (Louhelainen and Thuneberg, 2010). According to our findings, the majority of breeders are experienced horse owners that operate small-scale breeding of national breeds and other breeds with a Finnish studbook. Most breeders own one or two breeding mares; however, the practice of mare leasing is not accounted for as it was not further investigated in this thesis. Although the tradition of horse breeding extends far into the country's history, it has not reached the size of larger stud farms in many Central European countries, such as Germany (Louhelainen and Thuneberg, 2010). While a smaller production volume dampens profitability, it may allow for better individual considerations and tailoring of weaning protocols.

On average, approximately 3850 foals are born in Finland annually to serve various purposes (Suomen Hippos ry, 2022). In this thesis, it was found that many breed ponies and horses for all-purpose use in hobby activities, whereas popular sport disciplines include dressage, show jumping and harness racing. Naturally, prevailing equestrian sport disciplines drive which breeds are bred; in particular, Finland represents one of the leading European countries in harness racing, thus favouring the breeding of the Finnhorse, Warm-blooded trotter and Shetland pony.

With the gathered responses, important aspects of foal weaning performed by Finnish horse breeders were uncovered. It was discovered, that out of the individual options, weaning of foals during their 6th (24.2%) and 7th (16.4%) months of life were the most commonly chosen by breeders. Importantly, foals are not weaned before five months of age, although a minority was found to wean their foals routinely at between five and six months of age. In addition, weaning of foals before six months of age is usually due to medical reasons or death of the dam. However, in agreement with Henry *et al.* (2020), artificial weaning is inherently a substandard practice as it entails preterm rupture of the dam-foal bond and creates social stress in both parties. At the least, initiation of weaning before the age of seven months should not be routinely practiced as this rarely is a result of natural weaning (Tyler, 1972; Duncan *et al.*, 1984). Indeed, our study found that 52.1% of respondents wean their foals after the age of eight months, allowing the foal more time to mature before confronting the challenges imposed by artificial weaning.

Furthermore, most breeders seem to recognize the negative connotations of abrupt weaning on foal well-being. For instance, 60.0% of breeders perform what could be considered "gradual weaning", meaning that weaning is rather a process than a point in time, during which period some contact between the dam and foal is preserved. If performed correctly, this method may effectively limit weaning-related stress (Lansade *et al.*, 2018). Nevertheless, total physical

separation in the form of sudden relocation of either the foal or dam is fairly common (27.9%). To a foal, relocation to a novel environment significantly increases the stress load due to transportation and concurrent changes in social periphery, diet and environment.

Additionally, foals are generally weaned either in pairs or in groups (82.4%), which may also include adult individuals. The latter is of particular benefit as one study suggests their presence may alleviate social stress and aggressive interactions in recently weaned foals (Henry *et al.*, 2012). Single weaning might be opted for if there is a lack of suitable social company at the time of weaning. Indeed, Hoffman *et al.* (1995) found that stall-weaned foals were more stressed when weaned in pairs rather than singly, owing to inter-foal aggression. Therefore, particular focus should be placed on ensuring adequate social compatibility between foals that are to be weaned together, and to utilize the presence of a balanced, unrelated adult during weaning when this is possible.

Of the two pre-weaning practices, repeat physical separations is more common (80.6%) than limiting milk intake (50.9%). In fact, a clear majority of breeders use the former to facilitate habituation of the foal to being physically separated from its dam. However, according to Moons *et al.* (2005), this method does not improve the foal's tolerance towards isolation, but rather sensitizes it to future separation attempts. On the other hand, limiting suckling in the pre-weaning period resembles the previously discussed two-stage weaning, where the stress load of the weaning experience is diluted by implementing nutritional and physical weaning at separate occasions. Even though it seems that cessation of nursing is not as stress-inducing as being socially isolated (Merkies *et al.*, 2016; Henry *et al.*, 2020), sufficient time for adaptation to the nutritional changes brought about by weaning can be assumed to benefit the foal with an immature digestive system.

Most importantly, the level of a breeder's experience was found to significantly impact foal weaning customs. When experience is measured as the total number of raised foals, foals are more likely to be weaned earlier by more experienced breeders. Interestingly, more years of experience were not found to influence foal weaning age. This seeming contradiction could be explained by the fact that breeders that have raised a higher number of foals might practice horse breeding at a greater scale, creating a system that places more pressure on producing trainable foals at an expected rate. In addition, such circumstances may require more systematized management practices, whereby the individual needs of foals are difficult to take into account. Either way, weaning of a foal that is still developing and closely bonded to its dam should not be seen as advantageous if one aims to raise individuals with the best prerequisites to become physically and mentally sound (Apter and Householder, 1996).

Concerning weaning duration, regardless of years of experience, the majority of breeders (70.9%) tend to wean their foals over a minimum period of one week, some even exceeding one month. Nonetheless, breeders with more years of experience had a higher probability to complete the weaning process at a faster rate. One explanation for this might be that their knowledge of foal weaning methods originates from older sources or experiences, meaning that there is a higher risk that the information is outdated. Nowadays, as a result of increased and widespread knowledge, professional and non-professional horse breeders have begun to question weaning methods that have been shown to increase weaning-related stress in foals.

On the other hand, less experienced breeders were found to be more likely to implement repeat pre-weaning separations as a means to get the foal habituated to being away from its dam. This was the case for both measurements of experience, meaning that breeders with overall less experience in breeding-related activities and foal raising are more likely to use this method. As for limiting suckling pre-weaning, this practice was not significantly affected by breeder experience measured by either variable.

As discussed previously, details of how repeat pre-weaning separations are carried out are unknown, meaning that there might exist clear differences in the stressfulness of the procedure between those that implement it. For instance, keeping the foal in the stable hallway while its dam is waiting in an adjacent stall is a very different approach compared to leaving the foal alone in a stall while the dam is being ridden in a nearby riding arena. Needless to say, the necessity of it as a preparative tool for future separation of the foal and dam is debatable, as it has the potential to sensitize the foal to stress (Moons *et al.*, 2005).

Interestingly, signs of acute weaning stress in foals had been observed by most breeders, yet many denied having seen any at all (37.0%). This could suggest that some of the breeders' endeavours at gradual weaning are successful, inducing neither frustration nor distress in weaned foals. On the other hand, other explanations to this finding are lack of knowledge in recognizing signs of stress in foals and foal-related reasons that affect individual stress expression and tolerance.

In Finland, a recently accepted draft of a governmental decree on equine welfare has brought some improvements in horse keeping, also concerning the well-being of foals and yearlings. These regulations are issued under the current national Animal Welfare Act (693/2023). The defined requirements are to be complied with when housing horses and other equids, excluding those living in zoos, circuses and laboratory facilities. Regarding foals, routine weaning before the age of six months will be prohibited, and breeders are recommended to adopt gradual weaning methods. Furthermore, foals and yearlings that are kept on paddocks and

pastures must be accompanied by at least one other horse. However, the stated requirements can be waived due to health reasons, risk of injury or if there is a lack of suitable social company. In any respect, many of the improvements are necessary to guarantee equids a life where species-specific needs are being met, thus surpassing the current state of equine welfare in many other countries.

In this study, allowance of mare-mediated weaning was not investigated, leaving an important part of the data undiscovered. In contrast to artificial weaning, natural weaning is a slow process which is completed by efforts of the foal and dam alike, representing a principally stress-free weaning method (Henry *et al.*, 2020). This method addresses many of the negative consequences of artificial weaning methods by allowing the process to run its natural course with minimal human intervention. Therefore, from a welfare perspective, it is the best available option to domestic foals. The prevalence of this practice could be investigated by future studies to shed light on alternative methods to artificial foal weaning. Moreover, despite some evidence of the negative effects of stress on foal well-being, we remain unaware of the possible long-term effects that stress may impose on foals when it is experienced during their critical developmental periods. Clearly, research efforts need to be directed towards further investigating this subject area.

CONCLUSIONS

Concerns about the necessity for prevailing artificial foal weaning methods are raised by professionals and non-professionals alike. Our findings seem to indicate that many Finnish breeders are aware of the stress that this practice causes on foals, and are attempting to reduce it through various methods. These include completing the physical distancing of the dam and foal over an extended period of time without abrupt separation, and providing social companionship during the weaning process. Nonetheless, there is room for improvement as foals are still being weaned at an age defined by critical development times and when there is a strong bond to its dam. Some methods might be practiced due to outdated knowledge or without the awareness of their possible problems or even proven harmful effect. On a global level, it has become more relevant than ever to consider the importance of the mare-foal bond not only from a nutritional perspective, but also an emotional one. Since the horse industry has maintained artificial weaning practices for a long time, it has the responsibility for recognizing its implications on foal welfare. While large stud farms are unknown in Finland, the situation of artificial foal weaning needs to be further investigated in leading countries in the horse industry.

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APPENDICES


Appendix 1. Questions analyzed from the questionnaire

- Have you raised one or more foals?
- Do you wean the foal from its dam?
- Do you have an official breeder name?
- Select below, which stable ownership option best describes your current situation
- How many years in total have you been breeding ponies/horses?
- What is/are your main goal(s) in your work as an equine breeder?
- What breed of ponies/horses do you breed and raise?
- For what disciplines do you breed ponies/horses?
- How many foals have you raised in total that have reached a minimum age of 12 months?
- How many breeding mares do you currently own? (criteria: foaled within the last 12 months, pregnant or planned to be inseminated)
- What is the most common weaning age of your foals?
- If you have weaned a foal aged six months or younger, what was/were the reason(s) for this?
- Do you acclimate the foal and dam to the upcoming physical weaning by separating them for short periods of time before the actual weaning?
- Do you acclimate the foal and dam to the upcoming nutritional weaning by restricting the suckling time of the foal before the actual weaning?
- On average, how long does the entire weaning process last, from initiation to completion?
- Select below, which weaning method you mainly use: foal relocation while the dam remains, dam relocation while the foal remains, progressive separation of both without relocation, none of the above, I do not know
- Select below, which weaning method you mainly use: single, paired, group of weanlings, mixed-age group including adults, none of the above, I do not know
- Select below, which weaning method you mainly use: some contact is preserved between the foal and dam during physical weaning, no contact is preserved between the foal and dam during physical weaning, none of the above, I do not know
- The government decree on the welfare of horses, approved this year, states that from the beginning of 2030, it is prohibited to wean a foal before the age of six months. Do you feel that the decision is: sufficient, not sufficient, excessive, no comment

Appendix 2. Non-exclusive licence for depositing the final thesis and opening it for the public and the supervisor's (supervisors') confirmation for allowing the thesis for defence

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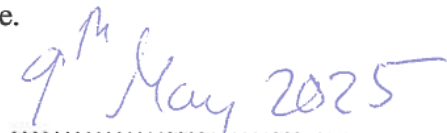
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