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A two-fold study of equine weaning practices and behaviours displayed following mare removal

by

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Author's Declaration

At no time during the registration for the degree of Research Masters has the author been registered for any other University award without the prior agreement of the Graduate Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

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Abstract

The behavioural effects on the foal and dam during weaning in horses are well documented and it is commonly agreed that both are likely to suffer from stress at this time. Many different weaning methods are employed worldwide, with no indication of the least stress inducing. This study has two aims. First, to document frequency of weaning method, type of breeder, foal age at the time of mare removal and reason for use of weaning method. Second, to compare behaviours following abrupt and gradual weaning methods. The first aim was addressed by a questionnaire distributed globally via social media and equine academic societies' distribution lists. All (100%) of the 440 responses were usable. Data were collated and statistically analysed. Gradual weaning was the most common (40.5%) method, and abrupt method second most common (30.9%). Typically, larger studs which breed more foals per annum, tend to wean earlier and use abrupt methods, smaller studs, breeding few foals per annum, tend to wean later using gradual or 'other' methods of weaning. The second aim was addressed via behavioural observation of two groups of seven foals, one group subjected to gradual weaning and the second to abrupt weaning. Foals displayed increased behaviour frequency post-mare removal versus pre-mare removal. Locomotary behaviours increased following mare removal and eating and lying down behaviours decreased. Foals in the abrupt group displayed significantly more behaviours, post-mare removal than the gradual group. These results indicate that industry practice reflects a wide range of weaning

methods utilised for many reasons. Additionally, foals were more stressed following mare removal and use of gradual methods, may improve welfare.

Key words: Equine, Weaning, Method, Stress, Behaviour, Welfare,

Contents

1.0 Introduction to weaning in horses

Domestication of the equid conflicts with its natural evolutionary progression (Goodwin 1999). Horses are herd animals, they live in harem groups, usually predominantly mares with one dominant stallion, breeding on average, one foal per year and roaming freely across a vast area. It is clear that equids have learned to adapt throughout the process of domestication, however it is also clear that they have not learned to adapt according to all human practices (McGreevy *et al.* 2009). The influence of humans on equine use has raised concerns concerning the implications common practices have with regards to compromising welfare (Broom 1993). Animal welfare concerns are emerging at the forefront of current research, and recognition and assessment of welfare is continually developing frameworks in order to ensure that welfare is not compromised where possible. The Five Freedoms are an internationally recognised guideline habitually used when assessing welfare, not only in equines, but in all animals.

Freedoms	**Provisions**
1. **Freedom from hunger or thirst**	Providing ready access to fresh water and a diet to maintain full health and vigour.
2. **Freedom from discomfort**	Providing an appropriate environment including shelter and a comfortable resting area.
3. **Freedom from pain, injury or disease**	Prevention or rapid diagnosis and treatment.
4. **Freedom to express normal behaviour**	Ensuring conditions and treatment which avoid mental suffering.
5. **Freedom from fear and distress**	Providing sufficient space, proper facilities and company of the animal's own kind.

(Mellor 2016)

These five freedoms provide a solid baseline for developing legal and ethical requirements in order to maintain and prevent welfare concerns. However, whilst they are a resource based indicator, more recently Mellor (2017) has proposed the use of animal based indicators via the Five Domains Model, which allow further assessment of animal welfare. Following the guidelines of the Five Domains, animal management can be tailored via monitoring of animal response following welfare-focused remedial interventions. Welfare may then be assessed according to qualitative grading of welfare when compromised. Whilst the Five Freedoms have been open to interpretation, most guidelines follow these freedoms very closely, however, they have limitations in terms of adaption, recognition of all features of good and poor welfare, management guidelines and enabling retrospective animal welfare assessment. When considering animal husbandry, where possible, animal welfare must not be compromised and it is important to recognise and adhere to these frameworks accordingly. To date, welfare assessment has typically focused on the absence of experiences that induce negative emotion, such as fear or pain (Waran & Randle 2017), however more recently 'quality of life' and 'mental state' have become more accepted notions in the world of science (Green & Mellor 2011, Stewart *et al.* 2010). It is important to recognise that these notions must be evaluated in the context of animal welfare. Animal based indicators such as those described in the Five Domains allow us to recognise and assess positive emotion as opposed to physical health measures alone. Input based measures encapsulated within the Five Freedoms are resources such as feed, water or housing allowing a quick, easy and reliable measure. However, various factors can influence animal welfare and measurements of output parameters such as behaviour or health will help assess animal experience (Waran & Randle 2017)

Weaning is the common term used for the removal of the mother from its young; however, it is more accurately and scientifically described as accustoming an infant to food other than its mother's milk (Latham & Mason 2008). The action of what is commonly described as weaning, is to physically ensure young and their dams are separated, not only by the ceasing of suckling, but also typically removing one from the other so that they can no longer see, hear or touch one another. Arguably, foals are not free from fear and distress at this time (Waran *et al.* 2008, Weary *et al.* 2008) and it is common for foals to injure themselves (Morel Davies 2008) and lose weight (Rogers *et al.* 20014) during this period. Additionally we can debate whether they are expressing normal behaviour or whether behaviours following mare removal are reactive and distress induced. Ethograms are commonly used to assess individual behaviours in equids (Hall & Heleski 2017) so that it is easier to understand agreed and recognise behaviours when assessing stress. Defined as adverse or demanding circumstances, triggering a state of mental or emotional strain or tension, following mare removal, stress is well documented and widely recognised as the most traumatic time in any animal's life emotionally, physically and psychologically (McCall *et al.* 1987, Apter and Householder 1996, Heleski *et al.* 2002, Waran *et al.* 2008, Henry *et al.* 2012, Xiao *et al.* 2015). Further to this, indications of good welfare should ensure that animals have good health, comfort, be well-nourished, safe, be able to express natural behaviour and not suffering from pain or distress (Lord 2017). The period of weaning, is a critically sensitive time and the implications weaning stress has long term is one of major concern. Addressing welfare concerns triggered by apparent stress in the foal at the time of weaning, is a primary motivating factor for further weaning research to understand best practice. Stressors recorded at the time of mare removal, by Merkies *et al.* (2016) are maternal deprivation, social

disruption, nutritional changes, physical environmental changes and management changes, evidenced also in Weary *et al.* (2008) and Nicol (1999). These factors can directly relate to the five freedoms and it is clear that welfare is compromised if we follow these guidelines. Stress at the time of weaning is believed to have implications for both short and long-term welfare of the foal (Morel Davies 2008, Waran *et al.* 2008, Randle 2011), however the full extent is yet to be measured and fully understood. The aims of the research presented in this dissertation are (i) to document current weaning practices used within the industry, (ii) to determine whether weaning (mare removal) increases stress-related behaviours and (iii) to establish whether the stress-related behaviours associated with the gradual method differ from the abrupt method.

Weaning in equines is required for many reasons, in the wild; foals are weaned by their dams in order to prepare for the arrival of their oncoming foal. Domestication typically requires foals to be subjected to human induced, artificial weaning, primarily for young stock management purposes, however this usually results in mare removal at an earlier time in the young foal's life compared to natural weaning, often as early as 4 months (Heleski *et al.* 2002, Waran *et al.* 2008, Randle 2011, Erber *et al*. 2011). A study by Parker *et al.* (2008) found average age for foals domestically weaned to be between 5.2 and 6.8 months. In contrast, other studies have found that natural weaning often occurs at a much later age. While exact time of natural weaning is still under debate, research believes it to be between 7.5-11 months of age (Waran *et al.* 2002, Randle, 2011, Erber *et al.* 2011). However, this may depend on whether the dam has subsequently conceived; findings suggest non-pregnant mares may continue to allow their foals to suckle up to two years of age (Cameron *et al.* 2000,

Dubcová *et al*. 2015). Whilst some believe that 6 months is the optimum age to wean foals (Xiao 2015), others suggest it should be later (McBane 2000), however, it has been frequently reported that common practice is to wean between 4-6 months (Evans *et al.* 1990, Harper and Freeman 1994, Waran *et al.* 2008, Adams *et al.* 2016). Studies advise that pre 6-month weaning has serious impacts on the foal later in their life, suggesting a higher prevalence of stereotypies in those weaned earlier (Waters *et al.* 2002, Heleski *et al.* 2002, Widowski *et al.* 2008), It is certainly clear that weaning has an impact on stereotypic development (Nicol 1999). Similarly McBane (2000) believes that foals should not be weaned until at least eight months of age, as this limits stress and reduces the onset of stereotypical behaviours. The impact of weaning on welfare in other species has been investigated, particularly of livestock species and has yielded conflicting findings. Whilst Evans ***et al's*** (2011) study of early weaning in calves at 4 days old suggest that the impact is less stressful than in later life, more recently Ahola *et al.* (2017) study of early weaning impact in cats, find that those weaned at eight, rather than 12-13 weeks, display a higher frequency of aggressive behaviours than those weaned later. They reported that early separation across all breeds, impacts health and behaviour in animals, based on measurements of memory and cognition impairment, negative social behaviour and increased anxiety. Breaking of the mare-foal bond is believed to be the most stress-inducing factor, and while Evans *et al.* (2011) study provided positive results, it must be noted that this was based on calves weaned at four days old, thus we could argue that the maternal bond is perhaps not as strong as those who have been allowed to remain with their dams for a longer period, this may have implications of its own, but is yet to be documented.

Practice is often based on tradition, opinion and fashion (Randle 2016), traditionally, abrupt weaning method has been the most common used in domesticated horses (Apter & Householder, 1996, Gooding and Merkies 2008). Though breeders are now more often looking to find alternate, less stress inducing methods to remove foals from their dams, preferred options may not be practical in individual owner's circumstances and may be dictated by available resources, such as housing and the presence, or absence of other equids for companionship (Waran *et al.* 2008, Randle 2011). A number of studies investigating the range of differing weaning methods used in horses exist and are defined by the nature of the timing and location in which it is done, (Table 1.1) (McCall *et al.* 1985, Malinowski *et al.* 1990, Heleski *et al.* 2002, Nicol *et al.* 2005, Waran *et al.* 2008, Henry *et al.* 2012), and has been conducted with the primary purpose of understanding equine welfare, however a comparable analysis, of these studies is not easily undertaken due to the differing weaning methodologies used and the measures recorded.

Table 1.1 – Definition of weaning methods

Weaning Method	Definition
Abrupt	Sudden and complete separation of mare and foal out of sight and hearing. Foals are usually left on their own in a stable.
Gradual	Partial removal of the mares (for short periods), before complete removal completed.
Barn	Mares are normally removed suddenly and completely, out of sight and hearing. Foals remain within a group together.
Paddock	Mares are removed from the foals, often to the field next door where foals can see and touch, but cannot suckle (nurse)
Natural	Mare removes foal when ready, normally before the onset of the next foal

Table 1.1 shows common definitions for each method of weaning as found in examination of literature in: McCall *et al.* 1985, Malinowski *et al.* 1990, Heleski *et al.* 2002, Nicol *et al.* 2005, Waran *et al.* 2008, Henry *et al.* 2012.

Welfare concerns have been raised for foals that may have been relocated, placed in isolation, or in alternative social groups (Weary *et al.* 2008, Merkies *et al.* 2017) as

part of the weaning process. Research on piglets remaining in the same environment following weaning has shown positive results, displaying fewer stress related behaviours (Ekkel *et al.* 1995) than those who were relocated immediately following weaning. Similar results have been reported in calves (Lynch *et al.* (2011) and foals (Nicol *et al.* 2005). A recent study conducted by Dubcová *et al.* (2015) investigated foal response and weight measurements following relocation immediately and one week following weaning. Their results suggest that those foals remaining in their normal environment show a greater weight loss than those immediately relocated however cortisol levels, which are commonly used as an indicator of stress (v. Borstel *et al.* 2017), were higher for foals relocated immediately after weaning, compared to those relocated after one week. They advise that foals should be relocated immediately following mare removal in order to reduce acute stress and subsequent weight loss. However, it must be noted that in this study, all variables were not consistent. For example, foals relocated after one week, joined another, stable herd, whereas foals immediately relocated remained on their own with no introduction to or contact with other equids. The use of other adult horses has been shown to have a positive effect on stress experienced by the weanling (Erber *et al.* 2012, Henry *et al.* 2012). Exploration of the social influence on foals during and following weaning is another aspect yet to be thoroughly researched.

The perception of reduced stress in gradual weaning methods has recently led to a higher frequency of use of this method in various forms and has been widely discussed with varying outcomes (McGreevy 2004, Moons *et al.* 2004, Waran 2008). Moons *et al.* (2005) hypothesised that partial removal of the mare (for short periods of time) prior to complete mare removal, would minimise stress experienced by the

foal at the time of actual separation, however, their findings could not conclude on the effect that partial mare removal has on the foal pre-weaning. Others suggest that by adopting a gradual form of mare removal, foals may become more sensitised to weaning stressors and therefore stress actually increase in the foal (e.g. Waran 2008). Some believe that young animals display less stress related behaviours using the gradual method in various forms (e.g. Enriquez *et al.* 2011), while others report no reduction in physiological and behavioural stress-responses displayed (e.g. Latham & Mason 2008). Fence line weaning has shown some benefits in maintaining welfare in both mare and foal, indicators of stress appear less frequent compared to those placed in isolation (McCall *et al.*1985), however further study of fence-line weaning appears to be very limited. A two-stage weaning method employed in beef cattle by Haley *et al.* (2005) show reduced stress related behaviours, and a further study by Haley *et al.* (2009) found similar positive results of fewer stress-related behaviours in horses. However, the findings of this study, showing that a two-phase approach of nutritional followed by physical separation in horses has since been contradicted by Merkies *et al.* (2016), who reported minimal benefit in using a two-phase approach.

The abrupt method is believed to be the most stress inducing form of weaning, resulting in foals becoming more susceptible to physical damage and illness (McCall *et al.* 1985 & Morel Davies 2008). It is possible that foal sex may also impact on the stress recorded following weaning using the abrupt method. A recent study of stress responses in abruptly weaned foals conducted by Wulf *et al.* (2018) found a greater weight loss (units) and cortisol level in females during the first five days post weaning than in males, Analysis of behavioural data indicated that male foals defecated and

vocalised more frequently than females. This study appears to be the first of its kind and shows interesting results, however has a small sample size of 22 foals, 11 males and 11 females and therefore investigation of differences between males and females at weaning warrants further investigation. Other weaning methods include weaning in social pairs or presence of other adult horses unrelated to the foal (Henry *et al.* 2012). Positive results have been seen in foals weaned with other adults horses, displaying reduced stress-related behaviours (Henry *et al.* 2012) and a decrease in the prevalence of unwanted, stereotypic behaviours can be seen in paired weaning (Mellor and Beausoleil 2015). Foals have traditionally been weaned singly without a substitute adult horse or companionship provided in the form of another foal weaned simultaneously. However, while some believe that although the use of companion horses during weaning appears less stressful (egg. Waran *et al.* 2008), others consider that the additional stress of separation from the nanny or companion horse at a later time may remove any benefits from a reduction in stress at the earlier stage, resulting in a second period of potentially unnecessary stress (McGreevy 2004). In contrast, Malinowski *et al.* (1990) and Hoffman et al. (1995) found increased stress behaviours and plasma cortisol levels in paired weaning, indicating that sudden (abrupt) single weaning may be less stressful to the individual than sudden paired weaning. The presence of humans during the weaning process may also elicit negative responses such as transference of attachment (Randle 2011). While it is agreed that single, abrupt weaning appears to result in increased stress related behaviours compared to other methods, there appears to be little research investigating the occurrence of stress related behaviours over time. For instance, is it possible that abruptly weaned foals display more stress related behaviours in the short term but that stress is simply prolonged in gradual methods?

Findings reported in Hoffman *et al.* (1995) suggest that group weaning is more stressful than single weaning, however it must be noted that this study has a small sample size and is contradicted by both Houpt *et al.* (1984) and Waran *et al.* (2008) who independently found group weaning potentially to be least stressful for foals. Like so many other aspects of weaning, such as the potential implications foal sex may have is yet to be fully investigated. Waran *et al.* (2008) also observed that singly weaned foals who had limited or no social contact during with other equids weaning, are less able to socialise with conspecifics later in life. Newberry & Swanson (2008) reported lack of social contact may result in impaired learning and memory function in foals, similarly, early weaned cats also showed learning impairment (Ahola 2017). Reid *et al.* (2017) noted that as a herd animal, equids are driven by the need for social contact and that social isolation induces anxiety, documented in earlier studies by Alexander *et al.* (1988) and Strand *et al*. (2002), the short and long term impact of such anxiety on equines at the time of weaning is yet to be measured.

It is proposed by Newberry & Swanson (2008) that mother-young separation causes emotional distress and this clearly impacts on the welfare of the foal, and moreover it is important to note the strength of the mother-young bond when considering implementation of any weaning process. Morel-Davies (2008) maintains that correct weaning and management of equine foals is vital for the weanling to maintain good health, physical growth, psychological development, social interaction and long-term productivity. Research suggests that stress during weaning may predispose the foal towards abnormal behaviours such as stereotypies which are very likely to persist into later life (Nicol 1999, Latham and Mason 2008). Stereotypies, defined as ‘repetitive, relatively invariant sequences of behaviour with no obvious goal or

function" (Mason 1991), include behaviours such as weaving and cribbing, and can be used as welfare indicators (Broom & Johnson 1993). Foals have been demonstrated to develop a coping mechanism in order to handle stress inducing situations such as a change in husbandry or management, or in particular, changes to natural feeding and/or social contact (Nicol 2000). Other unwanted responses physiological and behavioural may also be seen, such as a pre-disposition to gastric ulcers, depressed growth rate (Nicol *et al.* 2002), susceptibility to physical damage and illness (McCall *et al.* 1985) and heightened fearfulness which may impact trainability and behaviour (Waran *et al.* 2008; Waran & Randle 2017) Weaning in domesticated animals is also associated with distress behaviours, increased cortisol release and altered immune function (Hameister *et al*. 2010, Erber *et al.* 2011). Whilst behavioural and physiological responses have been well documented (McCall *et al.* 1987, Heleski *et al.* 2002, Moons *et al*. 2005, Henry *et al.* 2012), some believe that weaning related stress can be alleviated under favourable weaning conditions (Price *et al*. 2003). This may include identification of best housing, weaning method, and age. However, despite substantial research over the past two decades regarding the weaning of the foal, ideal foal age and mare-foal separation method is yet, over a decade later, to be established. Further evidence is needed to suggest and identify the approach that reliably constitutes best practice.

Stress related behaviours, associated with all weaning methods and their impact on welfare of the foals at this time are of concern. Whilst it may not be eliminated entirely, a real need remains for conclusive evidence into the possibilities of potential stress reduction at this crucial time in a foal's life and the implications long term.

Aim one of this study sets out to characterise and quantify weaning methods worldwide, including why those methods are employed, age of the foal at time of weaning, and whether the respondent is what might be considered a small or large breeder, thus indicating potential professional versus hobby breeders. The second aim sets out to investigate the comparative behaviours displayed by foals subjecting to weaning using two different weaning methods. One group will be weaned using the abrupt method; the second will be weaned using the gradual method. The objective is to identify whether there is a significant difference between the two methods and to determine whether one method may induce less stress-related behaviours than the other and therefore begin to address current welfare concerns.

2.0 Materials and Methods

Ethical approval was sought for the study and approved by the University of Plymouth, see appendix.

2.1 Weaning Methods – Questionnaire

A questionnaire comprising 10 questions was devised including a mixture of 6 closed end questions and 4 open ended questions (Appendix). The questions were designed to identify those who breed from mares annually, how many foals breeders produce per annum, size of the stud, stud location country, typical age of the foal at weaning, method of weaning used, reasons for using chosen method and behaviours observed at the time of weaning. For the purposes of this study, the size of the stud was measured by the number of horses residing on the establishment, and not the number of breeding mares. A small stud was defined as those with 10 horses or less in total, a medium stud was defined as those with between 11 and 30 horses in total, a large stud was defined as those with more than 30 horses in total.

The questionnaire data were anonymous, however the design allowed participants to add any further comments and to indicate if they would be interested in further participation in the study. The target audience was breeders in Britain and worldwide, breeders were defined as those who breed foals annually and bi-annually, people who bred their mares less frequently than two years were not considered breeders for the purposes of this study. The questionnaire was piloted with 10 known breeders, local to the author in Devon, UK. Questions were refined and then distributed via direct email contact, found in an online search of horse breeders, through social media Facebook, the distribution lists of the British

Equestrian Federation (BEF) and the International Society of Equitation Science (ISES) distribution list. The questionnaire data were analysed using Minitab v18 and SASv9.4.

Using the responses from question 8, behaviours noted in foals during weaning by respondents were assigned by the author into (i) extroverted (energised behaviours), (ii) introverted (sedentary behaviours), and (iii) oral (use of mouth and oral area) using the categorisations described by Williams (2013).

1. Extroverted – Walk, Trot, Canter, Stand Alert, Kick/Jump, Aggression, Paw, Shake head, Searching, Play, Confidence, Panic, Restlessness
2. Oral activity – Drink, Vocalise, Bite, Eat,
3. Introverted – Stand head down, Self-groom, Sniff, Swish tail, Calm, Tension, Seeking comfort, Nervousness, Anxiety

2.2 Observations of behavioural responses to two weaning methods.

Research was conducted at Newton Stud in Devon, UK during October and November 2016.

2.2.1 Animals

Subjects were 14 foals, selected due to their availability, (seven fillies and seven colts) and were deemed Sport Horse type breeds (generally a mix of breeds mainly consisting of warmblood and/or thoroughbred types). All foals were between six (184 days) and seven months (215 days) old at the start of the study. Foals were allocated to the two different weaning methods according to the availability of resources. The gradual group required a barn with an adjacent pen for the mares to be moved into so as to separate them from the foals for the purposes of this study.

Prior to mare removal, one colt foal was removed from the gradual weaning group as he was not deemed to be in peak physiological condition and therefore concerns were raised about his welfare at the proposed time of weaning

2.2.2 Materials

Two video cameras (Annke 1080P Hi-Resolution home security camera system, IP66 weatherproof video surveillance camera with night vision with digital recording box) were located in two corners of each barn directed into the barn; a third was directed across the barn. The location of all three cameras ensured all areas within the barn were recorded at all times. Continuous recordings of the foals took place for three days (72 hours), both 48 hours prior to weaning, and 24 hours following weaning. Data were noted during observations taken at one-hour intervals immediately following mare removal. Both the gradual and abrupt weaning groups were housed in large barns. Abrupt groups barn was wooden, 20metres square with three solid sides, the fourth side comprised of bars allowing two-way visual contact into the yard, though there were no other horses housed within the yard at the time. Gradual groups barn was a mixture of solid metal gates and concrete walls on three sides, the fourth side comprised of adjoining large (6x10 feet) gates, 20metre by 60metre in size. This allowed two-way visual contact into the adjacent pen for the mares which extended approx. one third of the length of the foals barn. The remaining length was adjoined by a large area where hay was kept. Both were bedded with straw, had two large hay feeders and one automatic water drinker located approx. five metres from one corner. Both barns had two exit/entry gates. All foals were housed in the same barn for at least two weeks prior to the mare removal procedure commencing.

2.2.3 Procedure

2.2.3.1 Abrupt Procedure

The abrupt weaning group comprised seven foals; three colts and four fillies. Removal of mares commenced at 16:00, recording begun when all mares were removed (16:06), and continued for one hour. All mares were removed at the same time in one group and placed in a field away from the yard and out of ear-shot, whilst foals remained in the barn with their social group.

2.2.3.2 Gradual Procedure

The gradual group comprised seven foals; four colts and three fillies. Mare removal begun at 09:00 on day one, mares were placed in an adjacent pen where foals could see and touch their dams, but were unable to suckle. On day one, mares were removed for one hour before returning to the barn with the foals. Each day at 09:00, mares were removed and the separation increased by one hour each day, meaning that day two separation was a total of two hours, day three a total of three hours until the penultimate day (day six) when separation lasted for six hours. At 08:50 total removal of all mares begun, this was completed by 08:56, recording of behaviours exhibited begun immediately at this time and continued for one hour.

2.2.4 Data Collection

For the purpose of data collection, foals were monitored for one hour following mare removal, all behaviours were noted and recorded using an ethogram (Table 2.2), an acceptable form of measuring and validating behaviours used in prior studies (Fureix *et al.* 2009, Yarnell *et al.* 2015, Hall & Heleski 2017). It provides a clear and comprehensive descriptive list of behaviours which can be observed in equids enabling evaluation of welfare. Data were recorded using continuous focal sampling,

simultaneously collecting data on the foal population for the duration of the study, allowing accurate data collection. All behaviours were recorded as displayed using the afore mentioned ethogram. Individuals were examined separately and observations were varied systematically.

Using the behaviours displayed by the foals following mare removal, behaviours were assigned by the author into (i) extroverted (energised behaviours), (ii) introverted (sedentary behaviours), and (iii) oral (use of mouth and oral area) using the categorised behaviours as noted in Williams (2013).

1. Extroverted – Walk, Trot, Canter, Stand Alert, Kick/Jump, Aggression, Paw, Shake head,
2. Oral activity – Drink, Vocalise, Eat,
3. Introverted – Stand head down, Self-groom, Sniff, Swish tail,

Table 2.2 - Ethogram - Behaviours recorded following weaning in two different weaning methods with descriptors

Behaviour	Definition
Vocalising	Produce sound in the larynx
Standing Alert –Head Up	Stand attentively with head and neck raised, eyes wide open and ears pricked or mobile and above withers
Standing Relaxed – Head Down	Stand inattentively with head and neck lowered, ears below withers
Eating	Ingest food
Walking	Forward movement in four-time gait
Trotting	Forward movement in two-time gait
Cantering	Forward movement in three-time gait
Drinking	Ingest water
Pawing	Striking of the ground with one forelimb
Self-grooming/Scratching	Used own teeth or hooves to relieve skin irritation
Sniffing/Investigating	Extending neck towards object or part of the environment and sniffing
Defecting	Lift tail and defecate
Urinating	Urination
Kicking/Jumping	Raising of one hind-leg or all four feet off the ground at the same time
Head Shaking	Head shaking from side to side continuously
Biting/Aggression	Horse swings head, teeth bared, ears back and stretches the neck in order to bite another animal or turns back end and raises one or both hind legs in order to kick another animal
Swish Tail	Horse swings tail from side to side or up and down

Heleski *et al.* (2002)

Definition of the individual behaviours recorded during one-hour post-mare removal in foals subjected to the abrupt or gradual method.

2.3. Data Extraction

Data are extracted using two methods, (i) questionnaire survey, and (ii) Behavioural Observations using video cameras (noted in 2.2.2).

2.3.1. Questionnaire data extraction

Data are extracted using basic statistics in the first instance, following this, further analysis of mean using interval plot and one-way ANOVA tests are used to compare the mean between groups. Tukey tests conducted in conjunction with ANOVA allow further testing of significance. Correlation coefficient analysis is used to estimate whether there are signs of a linear relationship between behaviour variables, and the strength of any relationship found.

2.3.2. Behavioural Observation data extraction

Following basic statistical analysis, Anderson Darling normality tests are undertaken for all behaviours pre and post-mare removal. The results of these tests allow recognition of either parametric, e.g. T test, or non-parametric analysis, e.g. Mann-Whitney and Chi squared tests, to further investigate data. Correlation coefficient analyses are used to assess whether there is a linear relationship between behaviour variables, and the strength of any relationship found. The use of both Pearson (linear relationships) and Spearman (monotonic relationships) correlation coefficients allow a more robust analysis of data. Following correlation analysis, Principal component analysis is undertaken as a method of variable reduction.

3.0 Results

3.1 Global weaning practices as identified in the questionnaire

A total of 440 usable responses were received from 17 countries across 4 continents, all (100%) were usable.

3.1.1. Type of weaning method used.

The majority of respondents (71.1%) report use of either gradual or abrupt weaning with the remaining respondents using barn, paddock or other forms of weaning (28.9%). (Figure 3.1).

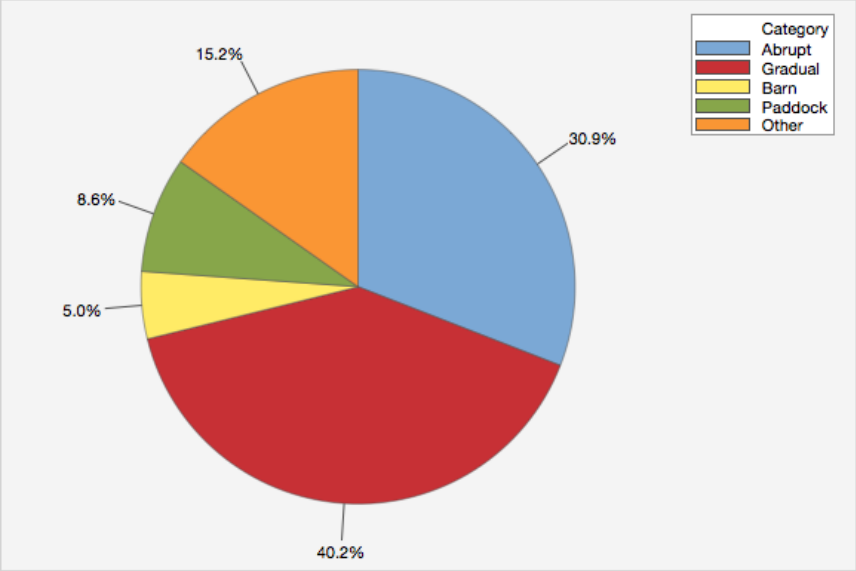

Figure 3.1 – Weaning Method - Percentages of the types of weaning method used as reported by 440 questionnaire respondents. Abrupt (n=136), Barn (n=22), Gradual (n=177), Other (n=67), Paddock (n=38).

3.1.2. Age of foal at the time of weaning.

Majority of weaning occurs between five and seven months (>55%). Six months is the most common age to wean (total 107). Nearly half of breeders remove mares from foals at six months or earlier (49.5%). (Figure 3.2).

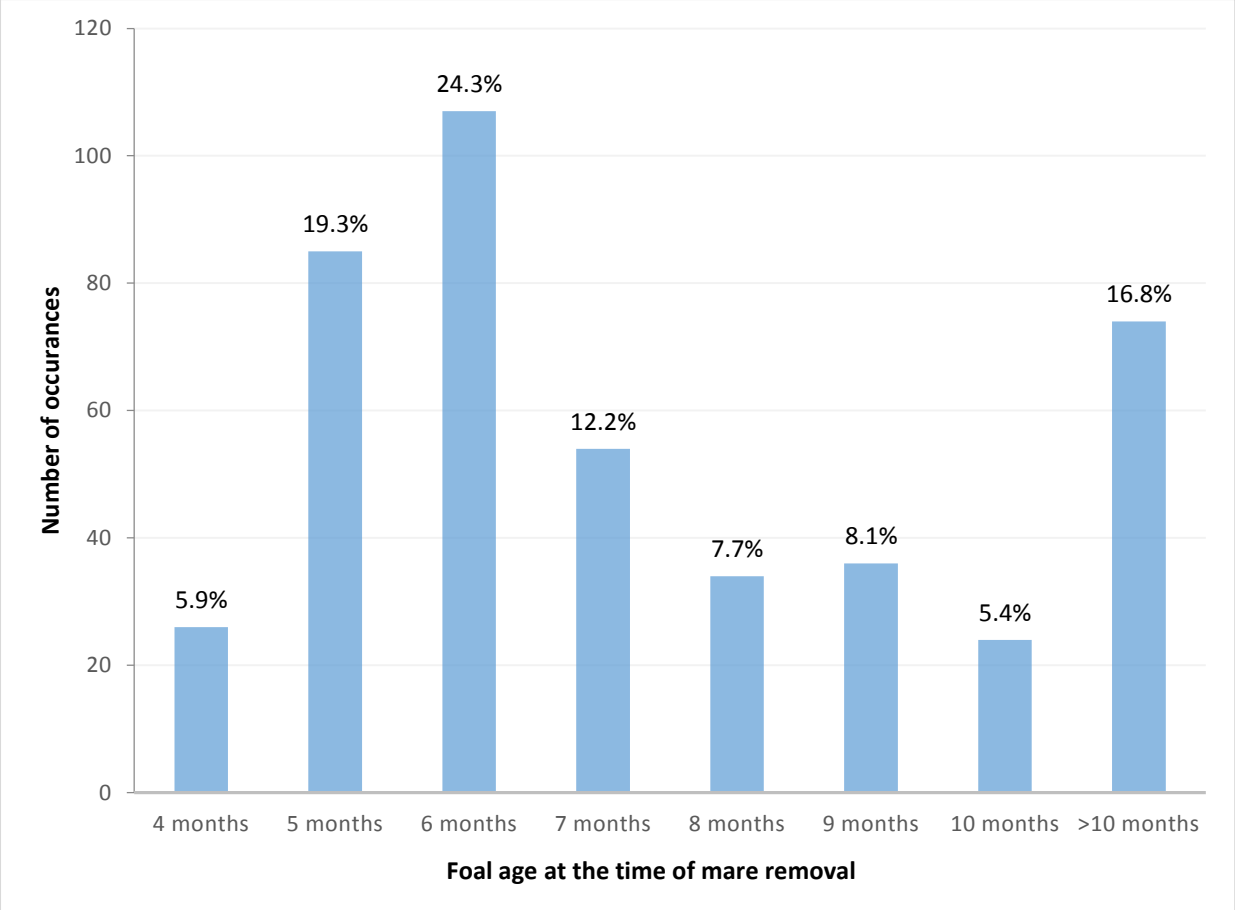

Figure 3.2 – Average age of foals at weaning. 4 months (n=26), 5 months (n=85), 6 months (n=107), 7 months (n=54), 8 months (n=34), 9 months (n=36), 10 months (n=24), >10 months (n=74).

Age of foals categorised by month at the time of weaning, counted per stud and displayed as a percentage.

3.1.3. Size of stud.

Majority of respondents came from small studs keeping 10 or less horses in total (63%). The remaining studs were considered medium or large (37.1%).

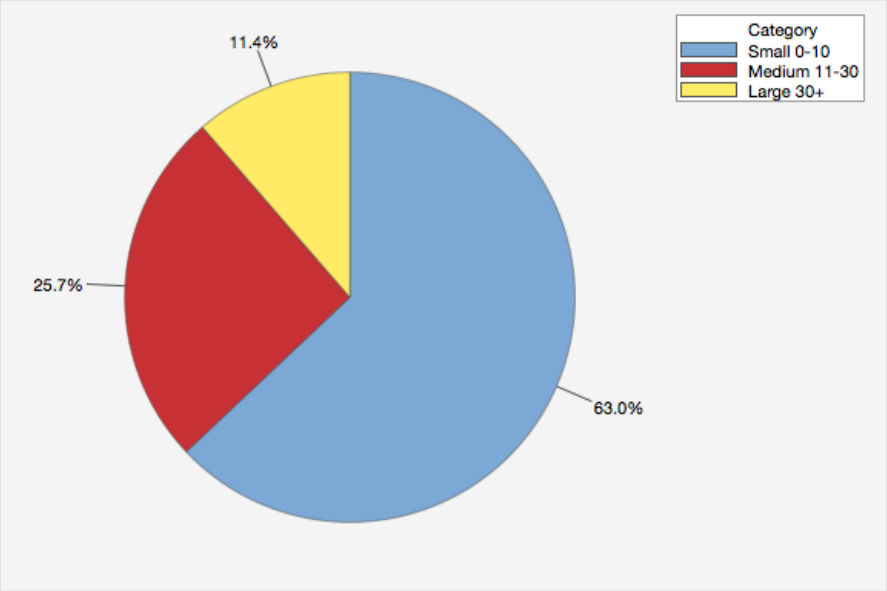

Figure 3.3 – Stud Size as categorised by the number of horses residing in the stud. Small 0-10 (n=277), Medium 11-30 (n=113), Large >30 (n=50).

3.1.4. Number of foals bred per annum.

Most studs (63.6%) breed one or two foals per annum, the remaining studs (36.2%) breed five or more foals per annum (Figure 3.4).

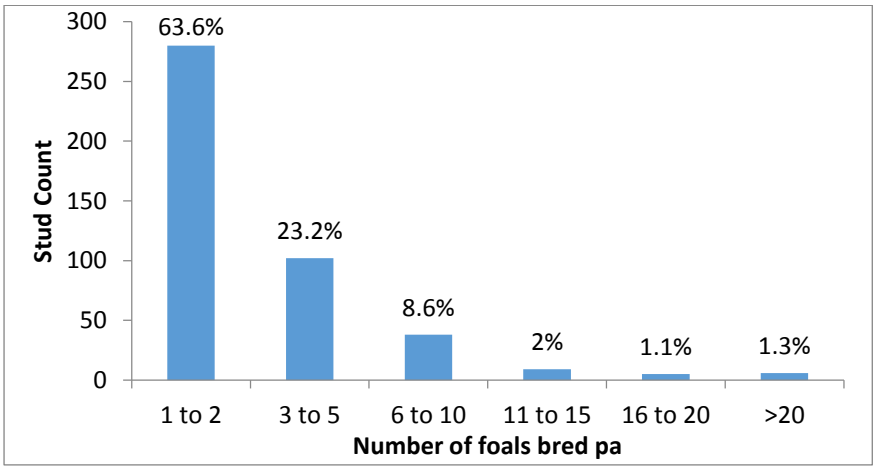

Figure 3.4 – Number of foals bred per annum per respondent. 1 to 2 (n=280), 3 to 5 (n=102), 6 to 10 (n=38), 11 to 15 (n=9), 16 to 20 (n=5), >20 n=6).

Number of foals bred per annum categorised and recorded per stud/respondent and displayed by percentage.

3.1.5. Foal age at weaning ref. weaning method.

Younger foals are more likely to be weaned by the abrupt (mean=5.90, St.Dev 1.43) and barn method (mean 6.0, St.Dev 1.22) and older foals more likely to being weaned using the 'other' (mean=7.06, St.Dev 2.11), gradual (mean=6.96, St.Dev 1.62) and paddock methods (mean 6.64, St.Dev 1.45). ANOVA results show that age at weaning is statistically significantly affected by the method of weaning used ($F_{4,361}$=9.45, p<0.0001). (Figure 3.5).

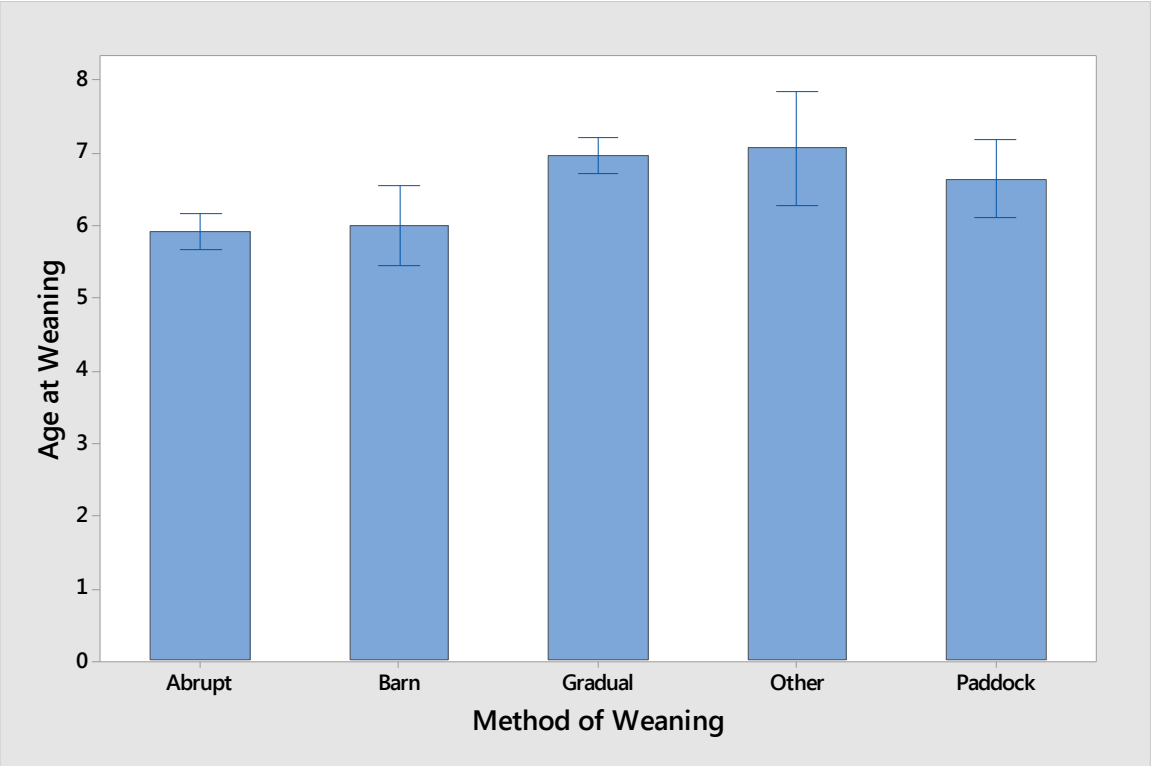

Figure 3.5 – Foal age (mean=6.51±0.08) at the time of mare removal for the five methods of weaning.

Age at time of weaning is recorded in the number of months. Mean age at the time of weaning and method of foal weaning is displayed; individual standard deviations are used to calculate the intervals. Abrupt (n=129, mean=5.9±0.12, St.Dev 1.4), Barn (n=21, mean=6.0±0.26, St.Dev 1.22), Gradual (n=155, mean=6.96±0.13, St.Dev 1.6), Other (n= 30, mean=7.06±0.38, St.Dev 2.11), Paddock (n=31, mean=6.64±0.26, St.Dev 1.45). The category 'other' was removed for age as exact date for weaning was uncertain.

Using the Tukey Method other and gradual methods are significantly different from abrupt method. Other-Abrupt T=3.63, p=0.003, Gradual-Abrupt T=5.62, p=<0,001.

3.1.6. Foal age at weaning ref. the number of foals bred per annum.

ANOVA results show that the age at weaning is significantly affected by the number of foals bred per annum ($F_{5,360}$=3.16, <p=0.001). Studs that breed fewer foals tend to wean at a later age than studs that breed larger numbers (Figure 3.6).

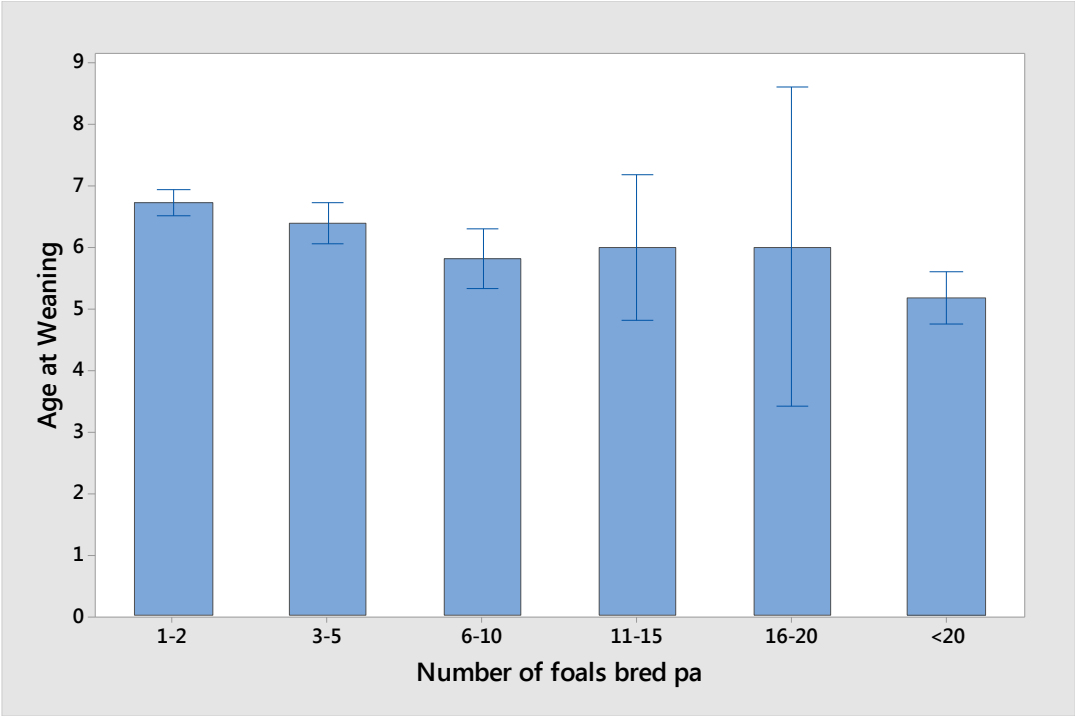

Figure 3.6 – Foal age (mean=6.51±0.08) at the time of removal versus the number of foals bred per annum.

Age at time of weaning is recorded in the number of months. Mean age at the time of weaning and category of the number of foals bred per annum is displayed; individual standard deviations are used to calculate the intervals. 1-2 (n=223, mean=6.73±0.11, St.Dev 1.67). 3-5 (n=92, mean=6.39±0.17, St.Dev 1.64), 6–10 (n=32, mean=5.81±0.23, St.Dev 1.33), 11–15 (n=8, mean=6.0±0.5, St.Dev 1.41), 16–20 (n=4, mean=6.0±0.81), >20 (n=6, mean=5.16±0.16, St.Dev 0.4).The category 'other' was removed for age as it was difficult to calculate exact age at the time of removal.

Using the Tukey method, studs that breed 1-2 foals per annum are statistically different from studs that breed 6-10 foals per annum (T=2.99, p=0.03).

3.1.7. Foal age ref. the size of stud.

Large studs wean earlier (mean=5.81, St.Dev 1.52) than small (mean=6.58, St.Dev 1.66) or Medium studs (mean 6.68, St.Dev 1.58) (Figure 3.7). ANOVA results show that the age at weaning is significantly affected by the size of the stud ($F_{2, 363}$=4.73, p= <0.01).

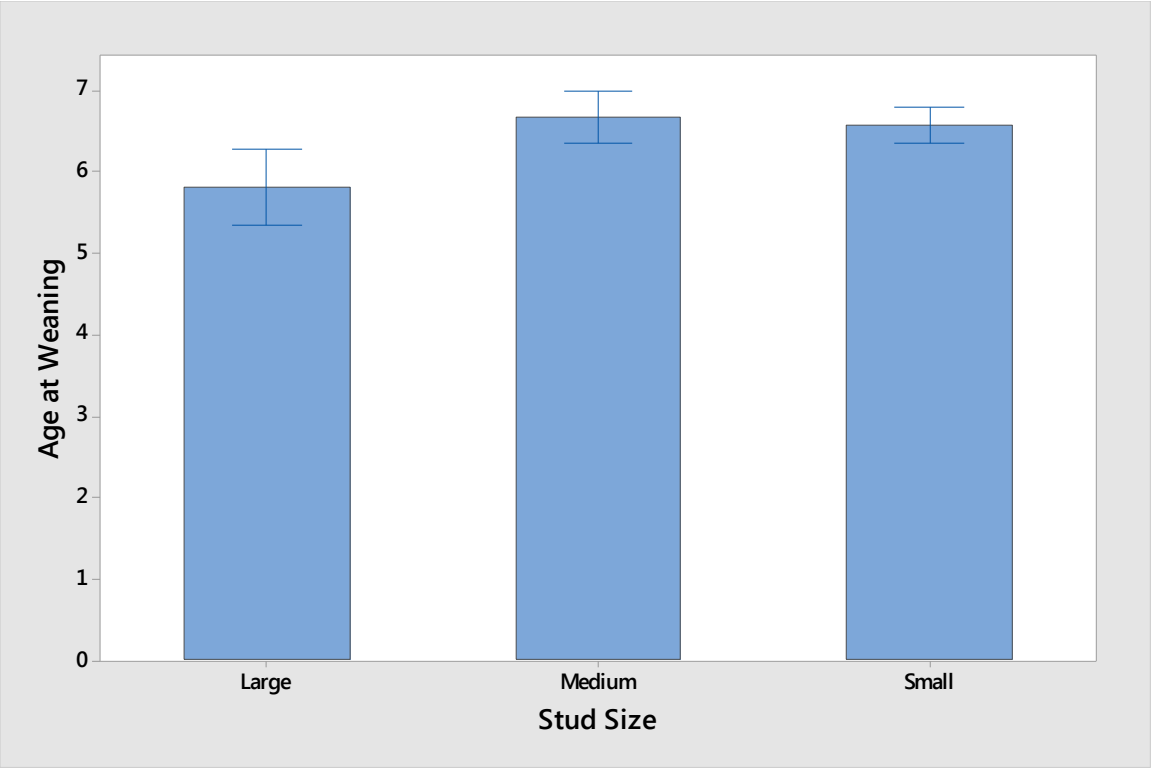

Figure 3.7 Foal age (mean=6.51±0.08) at the time of mare removal by size of stud.
Age at time of weaning is recorded in the number of months. Mean age at the time of weaning and size of stud categorised by the number of horses residing at the stud is displayed; individual standard deviations are used to calculate the intervals. Large=30+ horses (n=44, mean=5.81±0.23, St.Dev 1.52), Medium=10-30 horses (n=98, mean=6.68±0.16, St.Dev 1.59), Small= <10 (n=224, mean=6.58±0.11, St.Dev 1.66).The category 'other' was removed for age as it was difficult to calculate exact age at the time of removal.

Using the Tukey Method, there is a statistically significant difference between small and medium studs cf large studs (Table 3.3).

Table 3.3. Tukey Simultaneous tests for differences of means.

Difference of Levels	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Medium-Large	0.87	0.30	2.93	**0.01**
Small-Large	0.76	0.27	2.84	**0.01**
Small-Medium	-0.10	0.20	-0.52	0.86

3.1.8. Weaning method as used by country.

Figure 3.8 shows heterogeneity in the use of weaning methods internationally. Studs in Sweden strongly prefer the gradual method. Studs in New Zealand prefer the paddock and gradual method. Studs in the UK and Holland frequently use abrupt and gradual methods. It is difficult to interpret the results of some countries due to the low response rate.

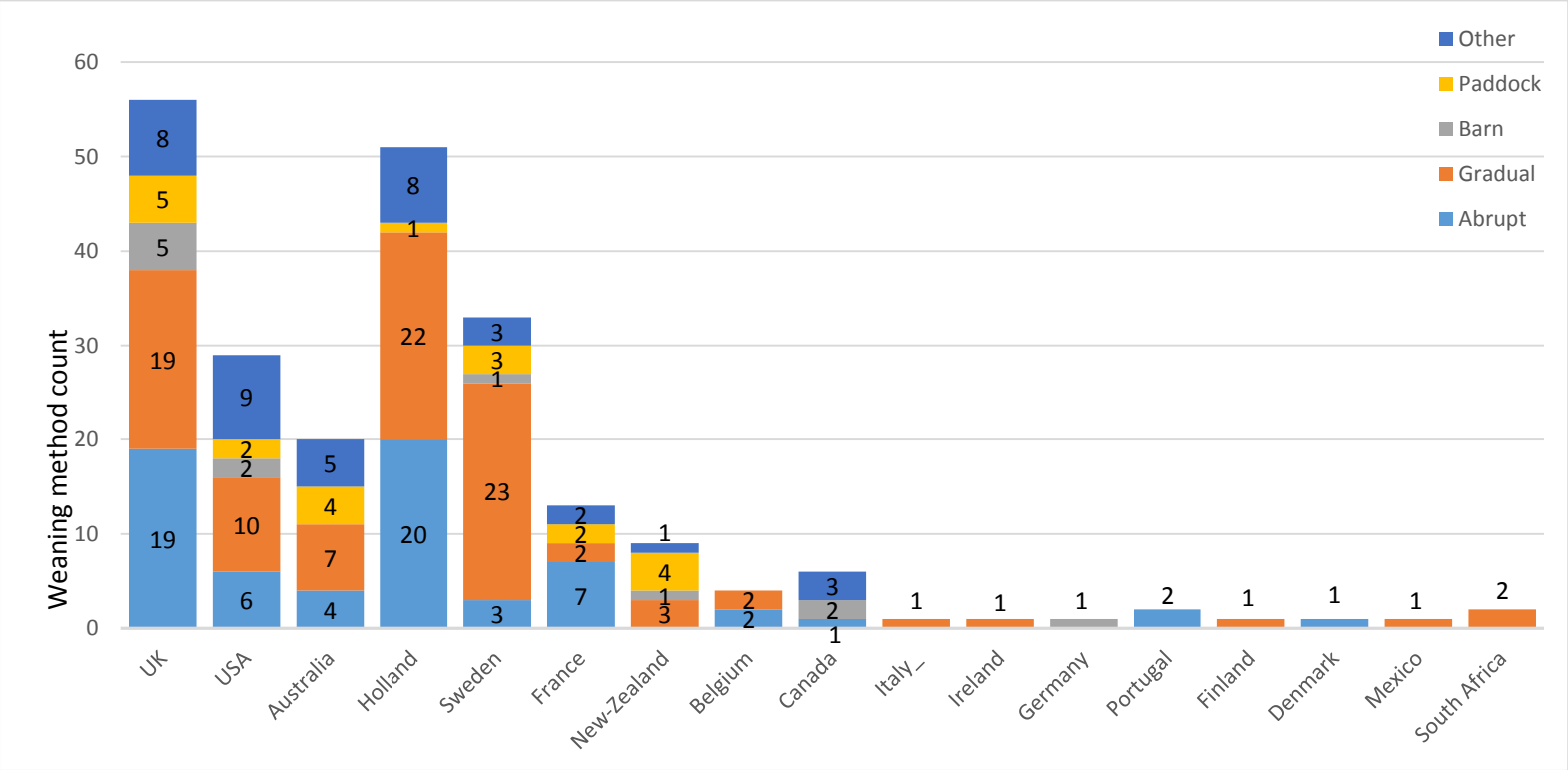

Figure 3.8 – Methods of weaning adopted per Country.

Use of different weaning method is recorded per country. UK (n=56), USA (n=29), Australia (n=20), Holland (n=51), Sweden (n=33), France (n=13), New Zealand (n=9), Belgium (n=4), Canada (n=6), Italy (n=1), Ireland (n=1), Germany n=1), Portugal (n=2), Finland (n=1), Denmark (n=1), Mexico (n=1), South Africa (n=2).

3.1.9. Behaviours noted by questionnaire respondents at the time of weaning.

The responses to the behaviours observed and noted in the questionnaire were correlated to examine interrelationships (Table 3.4). Some extroverted behaviours are significantly positively correlated at the $p<0.05$ level (Stress with Searching, Stress with Play, and Searching with Play. Some introverted behaviours are positively correlated (Nervousness with Upset, Upset with Seek Comfort, Tense and Seek Comfort, Restless and Anxious, Calm and Confidence, Calm and Inquisitive). Significant positive correlations were observed between Restless and Confidence, Calm and Anxious and Calm and Restless). Significant positive correlations between behavioural categories (Stress with Vocalisation, Reduced Feed Intake with Upset, Aggression with Tension, Aggression with Seek Comfort, Anxiety with Pawing, Confidence with Pawing, Inquisitive with Pawing and Restless and Pawing., Calm with Pawing is significantly positively correlated. All other behaviours are not significantly correlated. It is important to note that the data is subjective due to the nature of data collection.

Table 3.4 displays the correlation matrix of behaviours as perceived by respondents to the questionnaire.

	Vocalisation	Stress	No change	Calm	Confused	Searching	Friend Attachment	Panic	Nervous	Reduced feeding	Play	Aggression	Upset	Tense	Seek comfort
Stress	**0.968921**														
	0.0065														
No change	0.441122	0.381223													
	0.4571	0.5266													
Calm	0.439348	0.551148	0.708787												
	0.4592	0.3356	0.1802												
Confused	0.31791	0.4741	0.070009	0.350758											
	0.6021	0.4198	0.9109	0.5627											
Searching	0.898582	**0.950504**	0.591237	0.776537	0.479073										
	0.0382	**0.0131**	0.2937	0.1225	0.4142										
Friend Attachment	0.304721	0.061827	0.363002	-0.333005	-0.456435	-0.02058									
	0.6181	0.9213	0.5482	0.584	0.4397	0.9738									
Panic	0.494646	0.416475	-0.316218	-0.501965	0.279508	0.138631	0.408248								
	0.3969	0.4855	0.6042	0.3888	0.6488	0.8241	0.495								
Nervous	0.553885	0.340753	0.200376	-0.345101	-0.279508	0.170138	0.918559	0.6875							
	0.3327	0.5747	0.7466	0.5695	0.6488	0.7844	0.0276	0.1996							
Reduced feeding	0.519762	0.365301	0.107615	-0.387829	0.16855	0.174795	0.738549	0.866845	0.866845						
	0.3694	0.5454	0.8632	0.5189	0.7864	0.7786	0.154	0.0571	0.0571						
Play	0.861518	**0.935018**	0.446735	0.764015	0.383482	**0.968292**	-0.140028	0.085749	0.085749	0.025854					
	0.0606	**0.0197**	0.4507	0.1326	0.524	**0.0067**	0.8223	0.891	0.891	0.9671					
Aggression	0.822681	0.71069	0.049586	-0.147223	0.081978	0.493461	0.56875	0.843221	0.843221	0.806938	0.465271				
	0.0872	0.1785	0.9369	0.8132	0.8957	0.3982	0.317	0.0727	0.0727	0.0988	0.4297				
Upset	0.453006	0.263208	-0.078770	-0.555636	-0.185058	0.025032	-0.810885	0.848296	**0.951747**	**0.910794**	-0.042580	0.855630			
	0.443	0.6688	0.8998	0.3309	0.7657	0.9681	0.0959	0.0693	**0.0126**	**0.0316**	0.9458	0.0644			
Tense	0.734564	0.605783	-0.043832	-0.282355	0.000000	0.365482	0.612372	0.875000	0.875000	0.829156	0.342997	**0.989868**	**0.910366**		
	0.1575	0.2789	0.9442	0.6453	1	0.5452	0.2722	0.052	0.052	0.0826	0.572	**0.0012**	**0.0318**		
Seek comfort	0.734564	0.605783	-0.043832	-0.282355	0.000000	0.365482	0.612372	0.875000	0.875000	0.829156	0.342997	**0.989868**	**0.910366**	**1.000000**	
	0.1575	0.2789	0.9442	0.6453	1	0.5452	0.2722	0.052	0.052	0.0826	0.572	**0.0012**	**0.0318**	**<0.0001**	
Anxious	0.535002	0.672068	0.617293	**0.922265**	0.677666	0.840820	-0.380011	-0.227296	-0.308473	-0.166436	0.783332	-0.011111	-0.44251	-0.151531	-0.151531
	0.3529	0.214	0.2673	**0.0257**	0.2087	0.0744	0.5281	0.7131	0.6136	0.7891	0.1171	0.9859	0.4555	0.8078	0.8078
Confidence	0.330115	0.401878	0.857655	**0.94138**	0.342327	0.663715	-0.166667	-0.535826	-0.280671	-0.276956	0.577616	-0.231990	-0.515250	-0.357217	-0.357217
	0.5874	0.5024	0.0631	**0.0169**	0.5728	0.2219	0.7888	0.352	0.6474	0.6519	0.307800	0.7073	0.3743	0.5550	0.5550

	Vocalisation	Stress	No change	Calm	Confused	Searching	Friend Attachment	Panic	Nervous	Reduced feeding	Play	Aggression	Upset	Tense	Seek comfort
Inquisitive	0.390034	0.488789	0.792221	**0.972050**	0.433013	0.732158	-0.263523	-0.484123	-0.322749	-0.291937	0.664211	-0.189321	-0.534217	-0.322749	-0.322749
	0.5163	0.4034	0.1101	**0.0056**	0.4664	0.1595	0.6684	0.4086	0.5963	0.6336	0.221400	0.7604	0.3537	0.5963	0.5963
Restless	0.419584	0.571400	0.570231	**0.979231**	0.479353	0.773769	-0.490098	-0.450184	-0.450184	-0.426597	0.779412	-0.163474	-0.610313	-0.300123	-0.300123
	0.4819	0.3143	0.3155	**0.0036**	0.4139	0.1247	0.4020	0.4468	0.4468	0.4738	0.1202	0.7928	0.2743	0.6237	0.6237
Pawing	0.467988	0.605783	0.644960	**0.972556**	0.559017	0.806580	-0.408248	-0.375000	-0.375000	-0.301511	0.771744	-0.109985	-0.537944	-0.25	-0.25
	0.4267	0.2789	0.24	**0.0054**	0.3273	0.0991	0.495	0.534	0.534	0.622	0.1263	0.8602	0.3497	0.685	0.685
Defecating	-0.479836	-0.378614	-0.544772	-0.439219	0.559017	-0.453701	-0.408248	0.250000	-0.375000	0.075378	-0.514496	-0.293294	-0.124141	-0.25	-0.25
	0.4134	0.5297	0.3424	0.459300	0.3273	0.4428	0.495	0.685	0.534	0.9041	0.3751	0.632	0.8423	0.685	0.685
Happy	-0.361358	-0.53006	0.488417	-0.125491	-0.559017	-0.390687	0.612372	-0.3755	0.25	0.075378	-0.514496	-0.293294	0.082761	-0.25	-0.25
	0.5501	0.3582	0.4038	0.8406	0.3273	0.5155	0.2722	0.534	0.685	0.9041	-0.3751	0.632	0.8947	0.685	0.685

	Anxious	Confidence	Inquisitive	Restless	Pawing	Defecating
Confidence	0.877117					
	0.0507					
Inquisitive	**0.936207**	**0.988212**				
	0.0192	**0.0015**				
Restless	**0.950393**	**0.883927**	**0.940966**			
	0.0132	**0.0466**	**0.0171**			
Pawing	**0.98495**	**0.918559**	**0.968246**	**0.986117**		
	0.0022	**0.0276**	**0.0068**	**0.002**		
Defecating	-0.151531	-0.357217	-0.322749	-0.300123	-0.25	
	0.8078	0.555	0.5963	0.6237	0.685	
Happy	-0.313885	0.153093	0	-0.300123	-0.25	-0.25
	0.607	0.8058	1	0.6237	0.685	0.685

Top value in each cell is recorded as correlation coefficient; bottom value is recorded as the P value. Significant values showing correlated behaviours are noted in bold.

3.1.10. Reasons given by respondents for use of weaning method.

The reasons given for use of chosen method are displayed in Figure 3.9. Nearly half of respondents (n=208) report that chosen method was least stressful.

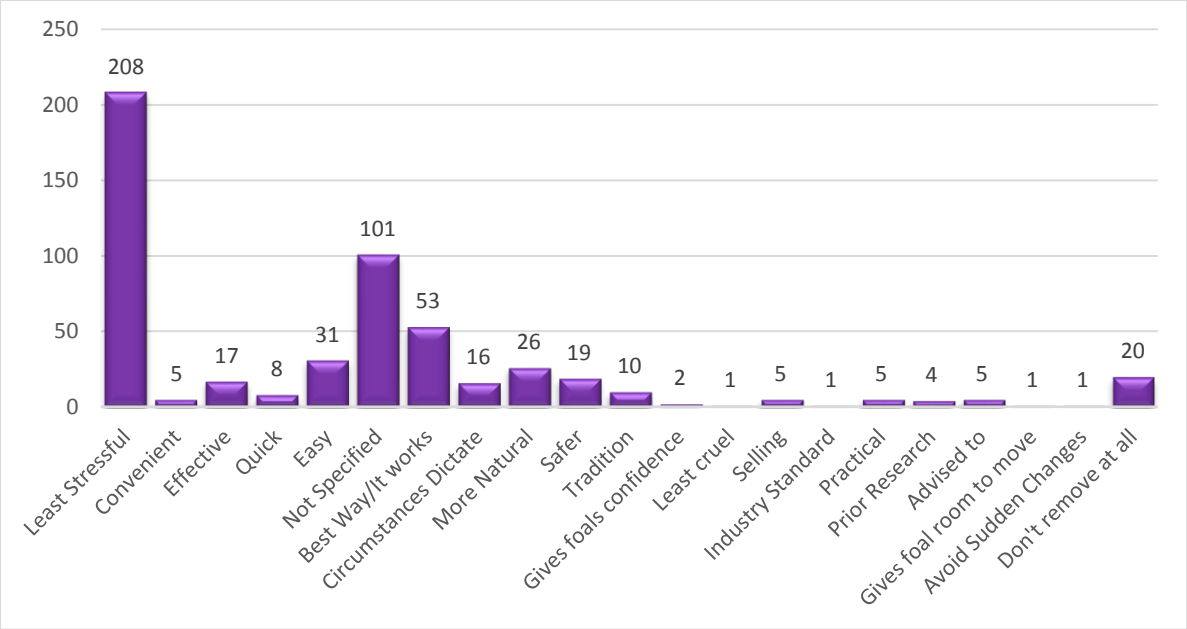

Figure 3.9 – Questionnaire responses for reasons given by respondents for use of chosen weaning method.

Number of occurrences displayed for reasons given by respondents for use of chosen method. Responses from open ended question in questionnaire, reasons are opinion based. 101 respondents did not note the reason for use of method. Twenty respondents did not remove the foal from the mare at all via human intervention.

3.2 – Behavioural Observation Analysis

A total of 7719 behaviours were recorded or 14 foals throughout this behaviour observation, 4705 or the abrupt group and 3014 for the gradual group. Recordings were observed over a total of 27 hours (two hours per foal) for all foals.

3.2.1 Pre-Mare Removal

A total of 819 behavioural observations were recorded for 14 foals prior to mare removal, 309 for the abrupt group and 510 for the gradual group. These recordings were observed over a total of 14 hours, one hour per foal.

Anderson Darling Normality tests results are reported in Table 3.5. Few behaviours are noted with significant values, Suckle (<0.005), Defecate (<0.005), Urinate (<0.05), Shake Head (<0.005) and Lie Down (<0.005) all are significant. These mixed results show that the data are normally distributed for some variables and are not normally distributed for others.

Table 3.5. Anderson Darling pre-mare removal

Variable	A-Sq.	Pr > A_Sq
Eat	0.32169101	>0.250
Walk	0.58734176	0.104
Suckle	1.38914668	**<0.005**
Swish Tail	0.40029056	>0.250
Rest Hind	0.68615212	0.059
Stand Head Up	0.55279534	0.13
Stand Head Lowered	0.69409109	0.055
Defecate	1.63760391	**<0.005**
Urinate	2.63423339	**<0.05**
Scratch	0.52044977	0.157
Shake Head	3.84074665	**<0.005**
Lie Down	2.63423339	**<0.005**

Walk was the most common behaviour displayed, (by 11 of the 14 foals). Swish tail is the second most common behaviour, shown in 4 foals and eat is displayed once as the most common behaviour for foal 1. Note, some foals show more than one

behaviour most commonly. Most other behaviours recorded are not displayed many times, if at all. For the purpose of comparative analysis, it was important to note these behaviours pre-mare removal (Table 3.6).

Table 3.6 - Summary Statistics for variables used in Pre-mare removal analysis.

Panel A - Descriptive Statistics for all Pre-removal behaviours

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	14	0	6.8571	0.7621	2.8516	2	11
Walk	14	0	16.429	1.686	6.309	7	29
Suckle	14	0	2.0714	0.3847	1.4392	1	5
Vocalise	14	0	0	0	0	0	0
Swish Tail	14	0	11.429	2.388	8.933	1	33
Rest Hind	14	0	1.4286	0.4021	1.5046	0	5
Stand - Head Up	14	0	2.8571	0.6009	2.2483	0	6
Stand Head lowered	14	0	6.857	1.586	5.934	0	18
Defecate	14	0	0.5714	0.202	0.7559	0	2
Urinate	14	0	0.6429	0.1329	0.4972	0	1
Sniff	14	0	5.5	1.185	4.433	0	12
Drink	14	0	0.2857	0.1634	0.6112	0	2
Scratch/Self Groom	14	0	2.8571	0.6277	2.3487	0	8
Kick/jump	14	0	0.14286	0.09705	0.36314	0	1
Shake Head	14	0	0.2143	0.1547	0.5789	0	2
Lie Down	14	0	0.3571	0.1329	0.4972	0	1

Panel B - Descriptive Statistics for Abrupt Method Pre-removal behaviours

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	7	0	4.5714	0.6494	1.7182	2	7
Walk	7	0	12.143	1.204	3.185	7	17
Suckle	7	0	2.2857	0.5216	1.3801	1	5
Vocalise	7	0	0	0	0	0	0
Swish Tail	7	0	8.857	2.613	6.914	1	20
Rest Hind	7	0	2.1429	0.6701	1.7728	0	5
Stand - Head Up	7	0	4.2857	0.7781	2.0587	0	6
Stand Head lowered	7	0	3.286	1.085	2.87	0	7
Defecate	7	0	0.1429	0.1429	0.378	0	1
Urinate	7	0	0.8571	0.1429	0.378	0	1
Sniff	7	0	3	1.464	3.873	0	11
Drink	7	0	0	0	0	0	0
Scratch/Self Groom	7	0	1.4286	0.6494	1.7182	0	5
Kick/jump	7	0	0.2857	0.1844	0.488	0	1
Shake Head	7	0	0.4286	0.2974	0.7868	0	2
Lie Down	7	0	0.4286	0.202	0.5345	0	1

Panel C - Descriptive Statistics for Gradual Method Pre-removal behaviours

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	7	0	9.1429	0.5948	1.5736	7	11
Walk	7	0	20.714	2.179	5.765	16	29
Suckle	7	0	1.8571	0.5948	1.5736	1	5
Vocalise	7	0	0	0	0	0	0
Swish Tail	7	0	14	3.958	10.472	2	33
Rest Hind	7	0	0.7143	0.2857	0.7559	0	2
Stand - Head Up	7	0	1.4286	0.5281	1.3973	0	4
Stand Head lowered	7	0	10.429	2.339	6.188	3	18
Defecate	7	0	1	0.3086	0.8165	0	2
Urinate	7	0	0.4286	0.202	0.5345	0	1
Sniff	7	0	8	1.363	3.606	3	12
Drink	7	0	0.5714	0.2974	0.7868	0	2
Scratch/Self Groom	7	0	4.2857	0.7781	2.0587	2	8
Kick/jump	7	0	0	0	0	0	0
Shake Head	7	0	0	0	0	0	0
Lie Down	7	0	0.2857	0.1844	0.488	0	1

Foals in the gradual group display significantly more behaviours than foals in the abrupt group pre-mare removal, abrupt group Mean=44.13±5.47, gradual group Mean 72.85±6.58, Mann-Whitney W=34, p=<0.05.

3.2.1.1. Behaviour analysis – pre-mare removal

Behaviours observed were correlated to examine evidence of interrelationships. Correlations between behaviours displayed in abrupt group, pre-mare removal are shown in Table 3.7 Some introverted behaviours are positively correlated at the p<0.05 level (Stand head lowered and Scratch/Self-groom). Some extroverted behaviours are positively correlated (Walk and Stand head up). There are no correlated oral behaviours. There are significant positive correlations between behavioural categories (Sniff and defecate, shake head and defecate, kick and sniff, sniff and shake head, rest hind and suckle).

Table 3.7 - Correlations - Pre -Mare Removal Abrupt

	Eat	Walk	Suckle	Swish Tail	Rest Hind	Stand - Head Up	Stand Head lowered	Defecate	Urinate	Sniff	Scratch/ Self Groom	Kick/ Jump	Shake Head	Lie Down
Eat	1.00000	-0.49091	-0.37763	0.28830	-0.33339	-0.31487	**-0.76277**	0.10299	-0.41194	-0.31788	**-0.77414**	0.15954	-0.4495	-0.29129
		0.2633	0.4036	0.5307	0.4649	0.4916	**0.0461**	0.8261	0.3585	0.4872	**0.0411**	0.7326	0.9238	0.5262
Walk	-0.474254	1.00000	0.66085	-0.30632	0.43526	0.64826	0.19069	0.61791	-0.10299	0.59837	0.21714	0.15954	0.40452	-0.07282
	0.2823		0.1061	0.5040	0.3290	0.1153	0.6821	0.1392	0.8261	0.1558	0.6400	0.7326	0.3680	0.8767
Suckle	-0.431730	0.520022	1.00000	0.43038	**0.94248**	0.72129	0.29704	0.42779	0.00000	0.50488	0.40196	0.33137	0.02334	0.07562
	0.3334	0.2315		0.3351	**0.0015**	0.0673	0.5177	0.3386	1.0000	0.2478	0.3714	0.4678	0.9604	0.8720
Swish Tail	0.190384	-0.165426	0.389222	1.00000	0.62409	0.00000	-0.18898	-0.20412	-0.20412	0.03706	-0.09356	0.31623	-0.57907	0.00000
	0.6826	0.7230	0.3881		0.1342	1.0000	0.6849	0.6606	0.6606	0.9371	0.8419	0.4896	0.1731	1.0000
Rest Hind	-0.414265	0.527131	**0.934199**	0.600191	1.00000	0.59434	0.33995	0.31473	0.10491	0.55241	0.44239	0.48758	-0.06868	0.00000
	0.3555	0.2241	**0.0021**	0.1542		0.1593	0.4556	0.4918	0.8229	0.1985	0.3203	0.2670	0.8837	1.0000
Stand - Head Up	-0.525017	**0.806191**	0.611741	0.120432	0.626288	1.00000	0.53421	0.52455	-0.10491	0.32382	0.56741	0.16253	0.52655	-0.29673
	0.2263	**0.0285**	0.1443	0.7970	0.1324		0.2168	0.2268	0.8229	0.4786	0.1840	0.7277	0.2477	0.5181
Stand Head lowered	-0.680723	0.213585	0.438773	-0.123571	0.318188	0.576220	1.00000	0.00000	0.54006	0.19612	**0.99015**	0.00000	0.35355	0.00000
	0.0923	0.6456	0.3247	0.7918	0.4868	0.1757		1.0000	0.2108	0.6734	**<0.0001**	1.0000	0.4366	1.0000
Defecate	0.109985	0.672510	0.228218	-0.245984	0.213201	0.367194	-0.043895	1.00000	0.16667	0.63549	0.00000	0.54550	**0.73676**	-0.35355
	0.8144	0.0979	0.6226	0.5949	0.6462	0.4178	0.9256		0.7210	0.1251	1.0000	0.1174	**0.0457**	0.4366
Urinate	-0.366618	-0.118678	0.091287	-0.264205	0.035533	-0.152998	0.504794	0.166667	1.00000	0.21183	0.53474	0.25820	0.25459	0.35355
	0.4186	0.7999	0.8457	0.5670	0.9397	0.7433	0.2479	0.7210		0.6484	0.2162	0.5761	0.5817	0.4366
Sniff	0.025045	0.635069	0.218263	0.018671	0.339836	0.418069	-0.014993	**0.910840**	0.227710	1.00000	0.19418	**0.82041**	0.41603	-0.44936
	0.9575	0.1254	0.6382	0.9683	0.4558	0.3506	0.9745	**0.0043**	0.6234		0.6765	**0.0238**	0.3532	0.3118
Scratch/Self Groom	-0.604839	0.200144	0.783139	0.160324	0.633122	0.525017	**0.849696**	-0.109985	0.366618	-0.125224	1.00000	0.00000	0.28006	0.07562
	0.1502	0.6670	0.0373	0.7313	0.1269	0.2263	**0.0155**	0.8144	0.4186	0.7891		1.0000	0.5430	0.8720
Kick/jump	0.170389	0.291104	0.106066	0.359905	0.330289	0.237023	-0.068002	0.645497	0.258199	**0.881917**	-0.170389	1.00000	0.39441	-0.54772
	0.7149	0.5265	0.8209	0.4278	0.4694	0.6088	0.8848	0.1174	0.5761	**0.0086**	0.7149		0.3813	0.2031
Shake Head	0.035223	0.570111	0.021926	-0.477143	-0.051209	0.426286	0.231952	**0.880705**	0.240192	**0.765718**	-0.352230	0.496139	1.00000	-0.54006
	0.9402	0.1814	0.9628	0.2791	0.8302	0.3402	0.6167	**0.0088**	0.6039	**0.0448**	0.9402	0.2574		0.2108
Lie Down	0.311086	-0.237768	0.258199	-0.161053	0.100504	-0.432742	0.015519	-0.353553	0.353553	-0.483046	0.311086	-0.547723	-0.509525	1.00000
	0.4971	0.6077	0.5761	0.7301	0.8302	0.3322	0.9737	0.4366	0.4366	0.2722	0.4971	0.2031	0.2428	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Behaviours observed were correlated to examine evidence of interrelationships Correlations between behaviours displayed in gradual group, pre-mare removal is shown in Table 3.8. Some introverted behaviours are positively correlated at the $p<0.05$ level (Rest hind and swish tail, sniff and head lowered, lie down and scratch/self-groom). Lie down and stand head-lowered is negatively correlated. There are no correlations between oral behaviours or extroverted behaviours. Significant negative correlations between behavioural categories (Walk and eat, eat and sniff), in contrast there are significant positive correlations across categories (walk and stand-head lowered, suckle and defecate, walk and sniff).

Table 3.8 - Correlations - Pre - Gradual

	Eat	Walk	Suckle	Swish Tail	Rest Hind	Stand - Head Up	Stand Head lowered	Defecate	Urinate	Sniff	Drink	Scratch/ Self Groom	Lie down
Eat	1.00000	**-0.85411**	-0.04668	-0.14161	0.14148	0.25005	-0.67363	0.39606	-0.07562	**-0.75490**	0.03131	0.01923	0.33137
		0.0143	0.9208	0.7620	0.7622	0.5887	0.0971	0.3791	0.8720	**0.0498**	0.9469	0.9674	0.4678
Walk	**-0.839828**	1.00000	-0.09245	0.31788	0.12010	-0.38097	0.74125	-0.58835	0.14979	**0.79615**	0.06202	-0.19048	-0.32817
	0.0181		0.8437	0.4872	0.7976	0.3991	0.0566	0.1647	0.7486	**0.0322**	0.8949	0.6825	0.4724
Suckle	-0.326923	0.068236	1.00000	0.35957	0.33679	-0.43498	0.17817	**0.82496**	0.72008	0.32673	-0.07454	0.20604	-0.39441
	0.4742	0.8844		0.4283	0.4601	0.3294	0.7023	**0.0224**	0.0680	0.4744	0.8738	0.6576	0.3813
Swish Tail	-0.111253	0.044169	0.242734	1.00000	**0.93420**	0.16670	-0.07207	0.23837	0.43693	0.39651	-0.45227	0.01852	0.00000
	0.8123	0.9251	0.6000		**0.0021**	0.7209	0.8780	0.6067	0.3270	0.3785	0.3083	0.9686	1.0000
Rest Hind	0.180144	-0.098339	0.240192	**0.905313**	1.00000	0.17844	-0.23146	0.30619	0.46771	0.28296	-0.51640	0.11896	0.17078
	0.6991	0.8339	0.6039	**0.0050**		0.7019	0.6175	0.5042	0.2899	0.5386	0.2354	0.7995	0.7143
Stand - Head Up	0.346518	-0.499502	-0.346518	0.558117	0.450835	1.00000	**-0.82600**	0.00000	-0.51928	-0.44239	-0.58358	0.31132	0.73137
	0.4464	0.2537	0.4464	0.1929	0.3100		**0.0220**	1.0000	0.2323	0.3203	0.1690	0.4967	0.0618
Stand Head lowered	-0.674915	**0.896376**	0.264097	-0.128607	-0.147621	**-0.795881**	1.00000	-0.37796	0.43301	0.69235	0.41833	-0.47725	-0.79057
	0.0962	**0.0063**	0.5671	0.7835	0.7521	**0.0323**		0.4032	0.3318	0.0847	0.3503	0.2788	0.0343
Defecate	0.259437	-0.566495	**0.778312**	0.175428	0.270031	0.000000	-0.329895	1.00000	0.38188	-0.19803	-0.15811	0.38851	0.00000
	0.5742	0.1849	**0.0393**	0.7067	0.5581	1.0000	0.4699		0.3979	0.6704	0.7349	0.3891	1.0000
Urinate	-0.084921	0.262691	0.679366	0.148873	0.353553	-0.510061	0.539918	0.381881	1.00000	0.60499	-0.24152	-0.22255	-0.54772
	0.8564	0.5693	0.0932	0.7501	0.4366	0.2422	0.2109	0.3979		0.1501	0.6018	0.6018	0.2031
Sniff	**-0.793138**	**0.906019**	0.352506	0.185391	0.122300	-0.463151	**0.836713**	-0.283069	0.518875	1.00000	-0.31311	0.01923	-0.33137
	0.0333	**0.0049**	0.4380	0.6907	0.7939	0.2953	**0.0189**	0.5385	0.2328		0.4941	0.9674	0.4678
Drink	-0.211538	0.262446	-0.192308	-0.445012	-0.520416	-0.563093	0.386365	-0.259437	-0.283069	-0.058751	1.00000	-0.46072	-0.52915
	0.6489	0.5696	0.6795	0.3171	0.2311	0.1881	0.3919	0.5742	0.5385	0.9004		0.2982	0.2220
Scratch/Self Groom	0.036749	-0.314954	0.117596	-0.085039	-0.045899	0.240039	-0.442991	0.297461	-0.281283	-0.089816	-0.323390	1.00000	0.73137
	0.9377	0.4914	0.8017	0.8562	0.9222	0.6041	0.3195	0.5171	0.5411	0.8481	0.4792		0.0618
Lie Down	0.372104	-0.499355	-0.372104	0.228315	0.258199	0.768273	**-0.764942**	0.000000	-0.547723	-0.378932	-0.496139	0.734770	1.00000
	0.4111	0.2539	0.4111	0.6224	0.5761	0.0436	**0.0451**	1.0000	0.2031	0.4019	0.2574	0.0600	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Behaviours observed were correlated to examine evidence of interrelationships. Correlations between behaviours displayed in all foals, (gradual and abrupt) pre-mare removal is shown in Table 3.9. Some extroverted behaviours are positively correlated at the $p<0.05$ level (Kick/jump and Shake head. There are no correlations between oral behaviours or introverted behaviours. Significant positive correlations between behavioural categories (walk and stand head lowered, walk and sniff, suckle and rest-hind, rest-hind and stand head up, sniff and stand head lowered, drink and stand head lowered). Eat is significant and negatively correlated with stand head up.

Table 3.9 - Correlations Pre Mare Removal All

	Eat	Walk	Suckle	Swish Tail	Rest Hind	Stand - Head Up	Stand Head lowered	Defecate	Urinate	Sniff	Drink	Scratch/ Self Groom	Kick/ Jump	Shake Head	Lie down
Eat	1.00000	0.42794	-0.36426	0.23334	-0.47719	-0.63780	0.23397	**0.62890**	-0.46689	0.40741	0.46741	0.40361	-0.30687	-0.37699	-0.37699
		0.1269	0.2004	0.4221	0.0844	0.0141	0.4208	**0.0160**	0.0924	0.1482	0.0919	0.1524	0.2859	0.1839	0.1839
Walk	0.324343	1.00000	-0.04523	0.26136	-0.11547	-0.31279	**0.62557**	0.43279	-0.27920	**0.89151**	0.36096	0.48429	-0.12744	-0.04901	-0.27920
	0.2579		0.8780	0.3668	0.6943	0.2762	**0.0167**	0.1222	0.3337	**0.0001**	0.2048	0.0793	0.6642	0.8670	0.3337
Suckle	-0.334687	0.038728	1.00000	0.28883	**0.68798**	0.32235	0.02636	0.27118	0.49738	0.08608	-0.16323	0.04444	0.29967	0.05626	-0.11937
	0.2421	0.8954		0.3166	**0.0065**	0.2610	0.9287	0.3484	0.0704	0.7698	0.5771	0.8801	0.2979	0.8485	0.6844
Swish Tail	0.256237	0.202588	0.23077	1.00000	0.45250	-0.09031	0.13602	0.16325	-0.01851	0.33928	-0.06903	0.21790	0.05069	-0.49459	-0.12957
	0.3766	0.4873	0.4273		0.1042	0.7588	0.6429	0.5771	0.9499	0.2353	0.8146	0.4542	0.8634	0.0722	0.6589
Rest Hind	-0.522493	-0.223434	**0.624189**	0.351566	1.00000	**0.64569**	-0.29925	-0.09193	0.32485	-0.00345	-0.43392	-0.12920	0.52332	0.06149	0.09555
	0.0553	0.4426	**0.017**	0.2177		**0.0126**	0.2986	0.7546	0.2571	0.9907	0.1211	0.6598	0.0548	0.8346	0.7452
Stand - Head Up	**-0.627316**	-0.423774	0.241115	0.030092	**0.701683**	1.00000	-0.39503	-0.21785	0.07496	-0.32320	**-0.53577**	-0.13914	0.38489	0.51897	0.09369
	0.0163	0.131	0.4063	0.9187	**0.0052**		0.1621	0.4543	0.7990	0.2597	**0.0483**	0.6352	0.1742	0.0572	0.7500
Stand Head lowered	0.248735	**0.858629**	0.136397	0.092669	-0.259718	**-0.532117**	1.00000	0.18029	0.09369	**0.58671**	0.48452	**0.59729**	-0.30791	-0.06944	-0.39351
	0.3912	**<0.0001**	0.642	0.7527	0.3699	**0.0502**		0.5374	0.7500	**0.0274**	0.0791	**0.0241**	0.2842	0.8135	0.1639
Defecate	**0.576051**	0.235031	0.383819	0.234333	-0.164253	-0.310356	0.191094	1.00000	-0.12472	0.50219	0.23773	0.50446	0.0000	0.02433	-0.12472
	0.0311	0.4186	0.1755	0.42	0.5747	0.2802	0.5128		0.6710	0.0673	0.4131	0.0658	1.0000	0.9342	0.6710
Urinate	-0.47274	-0.217183	0.468331	-0.118747	0.323145	0.088465	0.085662	-0.029235	1.00000	-0.03739	-0.36096	-0.24416	0.30429	0.30339	-0.06667
	0.0878	0.4558	0.0912	0.686	0.2598	0.7636	0.7709	0.921		0.8990	0.2048	0.4002	0.2902	0.2917	0.8209
Sniff	0.328573	**0.852592**	0.138642	0.262216	-0.103792	-0.339568	**0.690112**	0.413166	0.017447	1.00000	0.19833	0.43680	0.17921	0.00547	-0.39263
	0.2514	**0.0001**	0.6364	0.3651	0.724	0.2349	**0.0063**	0.142	0.9528		0.4967	0.1184	0.5399	0.9852	0.1649
Drink	0.334134	0.484435	-0.19986	-0.165024	-0.394313	-0.527747	**0.542335**	0.118913	-0.397706	0.25548	1.00000	0.16032	-0.21183	-0.21120	-0.38675
	0.243	0.0792	0.4933	0.5729	0.163	0.0524	**0.0451**	0.6856	0.1591	0.378		0.5840	0.4672	0.4686	0.1719
Scratch/ Self Groom	0.410178	0.362646	0.208052	0.190119	-0.068413	-0.193532	0.346152	0.482771	-0.310507	0.30289	0.137778	1.00000	-0.36004	-0.21612	0.22537
	0.1452	0.2026	0.4754	0.5150	0.8162	0.5074	0.2254	0.0804	0.2799	0.2925	0.6386		0.2061	0.4580	0.4385
Kick/Jump	-0.27591	-0.196661	0-.1261	0.050813	0.442485	0.403786	-0.275396	-0.040032	0.30429	0.238909	-0.19803	-0.334989	1.00000	0.45698	-0.30429
	0.3397	0.5004	0.6674	0.8630	0.1131	0.1522	0.3406	0.8919	0.2902	0.4107	0.4974	0.2417		0.1004	0.2902
Shake Head	-0.306191	-0.090260	0.072537	-0.346346	0.151390	0.498108	-0.169543	0.050220	0.286299	0.194830	-0.186321	-0.258612	**0.574979**	1.00000	-0.30339
	0.2870	0.7589	0.8054	0.2251	0.6054	0.0699	0.5230	0.8646	0.3210	0.5045	0.5236	0.3720	**0.0315**		0.2917
Lie Down	-0.123997	-0.371313	-0.03838	0.014843	0.190949	0.117954	-0.450659	-0.175412	-0.066667	-0.436187	-0.361551	0.310507	-0.304290	-0.286299	1.00000
	0.6728	0.1912	0.8963	0.9598	0.5132	0.6880	0.1058	0.5486	0.8209	0.1189	0.2040	0.2799	0.2902	0.3210	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Given the multiple correlations between behaviours identified, a Principal Components Analysis further reduces the number of correlated variables and then derives three independent composite measures. Using the eigenvalue-one criteria (Kaiser, 1960) and scree test (Cattell, 1966), three components for behaviours pre-mare removal which account for 64% of the total variance (Table 3.10).

Table 3.10 Principal Components Initial Factor Method – All behaviours pre-mare removal.

	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	4.64978067	1.89281790	0.3100	0.3100
2	2.75696277	0.63163141	0.1838	0.4938
3	2.12533136	0.7691112975	0.1417	0.6355

The weightings of the behaviours contributing to the three factors (Table 3.11) show: Factor one - Show foals tend to walk, eat and lower their head, but do not put their heads up. Factor two - Foals suckle, sniff and kick. Factor three - Foals scratch and lie down but do not swish their tails.

Table 3.11 Factor Pattern Table – All behaviours pre-mare removal..

	PC1	**PC2**	**PC3**
Eat	**74%**	-20%	15%
Walk	**78%**	42%	-6%
Suckle	-19%	**65%**	49%
Swish Tail	15%	26%	**-61%**
Vocalise	0	0	0
Rest Hind	-62%	-48%	43%
Head-up	**-79%**	22%	10%
Head-Lowered	**75%**	41%	-11%
Defecate	47%	33%	35%
Urinate	-40%	48%	-8%
Sniff	61%	**68%**	-8%
Drink	66%	-7%	-34%
Scratch	50%	3%	**62%**

	PC1	PC2	PC3
Kick	-44%	**56%**	-29%
Shake head	-38%	48%	-47%
Lie Down	-30%	-50%	**58%**

Printed values are multiplied by 100 and rounded to the nearest integer. The top three values for each factor are shown in bold

Behaviour correlations can be further determined using a correlation coefficient (Table 3.12). Here Factor one records foals that eat, stand head lowered, sniff and drink but do not stand head with their up, interpreted as oral behaviours. Factor two shows foals that stand head up, urinate, kick and shake their heads do not eat or rest their hind legs, interpreted as active behaviours. Factor three shows that foals who suckle and swish their tails also scratch, interpreted as passive behaviours.

Table 3.12 Correlation Coefficients of variables with Principal Components Factor Scores – All behaviours pre-mare removal.

Variable	Factor 1	Factor 2	Factor 3
Eat	0.41724 0.137	**-0.65511** **0.011**	0.12254 0.676
Walk	**0.83894** **0.0002**	-0.16464 0.573	0.21767 0.454
Suckle	0.02061 0.944	0.45061 0.105	**0.70741** **0.004**
Swish Tail	0.03649 0.901	-0.07382 0.802	**0.67647** **0.007**
Rest Hind	-0.38065 0.179	**-0.07382** **0.02**	0.67647 0.053
Head-up	**-0.53866** **0.046**	**0.62358** **0.017**	0.9807 0.738
Head-Lowered	**0.83509** **0.0002**	-0.14025 0.632	0.16795 0.566
Defecate	0.41123 0.144	-0.14637 0.617	0.51206 0.061
Urinate	-0.03107 0.916	**0.62612** **0.016**	0.09721 0.74
Sniff	**0.85712** **<0.0001**	0.13712 0.64	0.29354 0.308
Drink	**0.59832** **0.023**	-0.36268 0.202	-0.25971 0.369

Variable	Factor 1	Factor 2	Factor 3
Scratch	0.18286	-0.46060	**0.61989**
	0.5315	0.0974	**0.018**
Kick	0.05640	**0.76177**	-0.05656
	0.848	**0.001**	0.847
Shake head	0.12911	**0.72036**	-0.24938
	0.66	**0.003**	0.3899
Lie Down	-0.69773	-0.34412	0.26237
	0.0055	0.228	0.3648

Correlation coefficients are the top value; p value is the bottom value. Significant figures noted in bold.

Chi squared analysis shown in Table 3.13 shows distribution for behaviours recorded pre-mare removal. The majority of behaviours recorded for foals pre-mare removal are not significantly different from the assumed even population distribution for the frequencies recorded per behaviour. The exception to this is Kick/Jump (p-value <0.01, Dist. 50%, Freq. 2) and Shake Head (p-value <0.001, Dist. 33%, Freq. 3) which both show a significant difference to the assumed even population for each of the different frequencies.

Table 3.13 - Chi squared analysis pre mare removal

Variable	Chi Sq.	Pr >Chi Sq
Eat	4.1277	0.8454
Walk	3.1429	0.9584
Suckle	4.8571	0.1826
Swish Tail	0.8545	1.000
Rest Hind	3.1429	0.5342
Head Up	0.5895	0.9885
Head lowered	5.4264	0.7112
Defecate	4.1564	0.1252
Urinate	1.1429	0.285
Sniff	3.1429	0.8715
Scratch	1.4804	0.9153
Kick/Jump	**7.1429**	**<0.01**

Variable	Chi Sq	Pr >Chi Sq
Shake Head	**17.5954**	**<0.001**
Lie Down	1.1429	0.285

Foals spent on average more than 30 minutes (50% of their time) eating pre-mare removal (Table 3.14), the gradual group and the abrupt group ate for similar amounts of time. Mann Whitney W=52.00, p=1.000.

Table 3.14. Summary Statistics for foals eating pre-mare removal.

Variable	N	Mean	SE Mean	St.Dev	Minimum	Maximum
Abrupt	7	33.357	6.620	17.514	7.420	49.040
Gradual	7	38.971	3.092	8.180	26.020	48.090

Foals spent very little time moving pre-mare removal. Mann Whitney W=59.00, p=0.443 (Table 3.15).

Table 3.15. Summary Statistics for foals time spent moving pre-mare removal.

Variable	N	Mean	SE Mean	St.Dev	Minimum	Maximum
Abrupt	7	5.4586	0.8404	2.2234	2.4000	8.5200
Gradual	7	4.7071	0.3909	1.0343	3.1300	6.4000

3.2.2 Post Mare Removal

A total of 6,900 behavioural observations were recorded for 13 foals following mare removal, 4,396 for the abrupt group and 2,504 for the gradual group, it must be

noted that gradual group had one fewer foal than abrupt group. These recordings were noted separately for each foal, over a total of 13 hours, one hour per foal.

Anderson Darling Normality tests results are reported in Table 3.16. The majority of post-removal behaviours are highlighted as significant (noted in bold), with few Walk (0.232), Trot (>0.250) and Canter (0.227), showing no significance. This shows the majority of data are not normally distributed.

Table 3.16 - Anderson Darling Normality Test

Post-Mare Removal		
Variable	**A-Sq**	**Pr > A_Sq**
Eat	0.79044562	**0.03**
Walk	0.4539445	0.232
Trot	0.34535616	>0.250
Canter	0.45812524	0.227
Vocalise	1.17328246	**<0.005**
Swish Tail	1.61351395	**<0.005**
Bite/Aggression	2.53702295	**<0.005**
Stand Head Up	0.72628425	**0.045**
Stand Head Lowered	0.71101091	**0.048**
Defecate	0.69918514	**0.051**
Urinate	1.50940103	**<0.005**
Scratch	1.63260145	**<0.005**
Shake Head	0.9540284	**0.011**
Paw Ground	1.00413955	**0.008**

Summary statistics for behaviours recorded are noted in Table 3.17, it is important to note that the data sample is small, which may potentially cause skewness. For example, this is most significantly noted in bite (0min, 158max, St Dev 41.9),

Table 3.17 - Summary Statistics for variables used in Post-mare removal analysis.

Panel A - Descriptive Statistics for all Post-Mare Removal behaviours

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	13	0	10.462	2.129	7.677	1	26
Walk	13	0	130.538	8.918	32.155	89	190
Trot	13	0	35.846	7.433	26.801	1	82
Canter	13	0	8.077	1.238	4.462	1	18
Vocalise	13	0	50.615	7.366	26.56	29	108
Swish Tail	13	0	22.462	7.945	28.646	1	93
Bite/Aggression	13	0	22.15	11.62	41.9	0	158
Stand - Head Up	13	0	101.538	7.779	28.046	74	168
Stand - Head Down	13	0	34.923	5.686	20.5	12	84
Defecate	13	0	6.3077	0.8799	3.1724	3	13
Urinate	13	0	0.5385	0.1831	0.6602	0	2
Sniff	13	0	87.54	11.53	41.59	40	170
Drink	13	0	0	0	0	0	0
Scratch/Self Groom	13	0	2.3846	0.6844	2.4677	0	10
Kick/Jump	13	0	3.3077	0.9896	3.568	0	11
Shake Head	13	0	11.462	2.183	7.87	3	27
Paw Ground	13	0	1.8462	0.5867	2.1153	0	6

Panel B - Descriptive Statistics for Abrupt Method behaviours

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	7	0	14.429	3.046	8.059	7	26
Walk	7	0	143.86	13.52	35.77	92	190
Trot	7	0	54.429	8.26	21.854	26	82
Canter	7	0	8.714	2.044	5.407	3	18
Vocalise	7	0	59.43	12.04	31.85	32	108
Swish Tail	7	0	30.71	12.58	33.29	7	93
Bite/Aggression	7	0	34.71	20.89	55.27	2	158
Stand - Head Up	7	0	104.86	13.16	34.82	79	168
Stand - Head Down	7	0	33.714	8.903	23.556	12	84
Defecate	7	0	6.286	1.229	3.251	3	13
Urinate	7	0	0.2857	0.1844	0.488	0	1
Sniff	7	0	113.43	14.66	38.78	56	170
Drink	7	0	0	0	0	0	0

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Scratch/Self Groom	7	0	1.4286	0.2974	0.7868	0	2
Kick/Jump	7	0	4.429	1.645	4.353	0	11
Shake Head	7	0	15	3.43	9.074	6	27
Paw Ground	7	0	0.8571	0.4592	1.215	0	3

Panel C - Descriptive Statistics for Gradual Method

Variable	N	N*	Mean	SE Mean	St.Dev	Minimum	Maximum
Eat	6	0	5.833	1.621	3.971	1	12
Walk	6	0	115	8.25	20.209	89	142
Trot	6	0	14.167	4.151	10.167	1	29
Canter	6	0	7.333	1.382	3.386	1	11
Vocalise	6	0	40.333	6.323	15.488	29	66
Swish Tail	6	0	12.833	8.499	20.817	1	55
Bite/Aggression	6	0	7.5	3.413	8.361	0	22
Stand - Head Up	6	0	97.667	8.16	19.987	74	125
Stand - Head Down	6	0	36.333	7.509	18.392	14	66
Defecate	6	0	6.333	1.382	3.386	3	11
Urinate	6	0	0.8333	0.3073	0.7528	0	2
Sniff	6	0	57.333	7.219	17.682	40	79
Drink	6	0	0	0	0	0	0
Scratch/Self Groom	6	0	3.5	1.36	3.332	1	10
Kick/Jump	6	0	2	0.8165	2	0	5
Shake Head	6	0	7.333	1.406	3.445	3	10
Paw Ground	6	0	3	1	2.449	0	6

3.2.2.1. Behavioural analysis – post-mare removal

Behaviours observed were correlated to examine evidence of interrelationships. Correlations between behaviours displayed in abrupt group post-mare removal are shown in Table 3.18. There are no correlations between extroverted behaviours, oral behaviours or introverted behaviours at the $p<0.05$ level. However, significant positive correlations between behavioural categories are apparent in vocalise and scratch/self-groom. Significant and negative correlations can be seen in eat and stand head up and eat and walk.

Table 3.18 - Correlations - Post Mare Removal - Abrupt

	Eat	Walk	Trot	Canter	Vocalise	Swish Tail	Bite/ Aggression	Stand - Head Up	Stand - Head Down	Defecate	Urinate	Sniff	Scratch/ Self Groom	Kick/ Jump	Shake Head	Paw
Eat	1.00000	**-0.75455**	0.57660	0.36364	0.14545	-0.50909	0.18182	0.73877	-0.09009	0.01818	0.23932	-0.35455	-0.33166	0.40909	-0.09091	0.44732
		0.0500	0.1754	0.4227	0.7557	0.2432	0.6964	0.0579	0.8477	0.6964	0.6053	0.4352	0.4674	0.3621	0.8463	0.3142
Walk	-0.720790	1.00000	-0.27028	-0.09091	-0.39091	0.56364	0.20909	-0.52254	-0.21622	0.14545	-0.07977	0.20909	0.54272	0.18182	0.31818	-0.43738
	0.0676		0.5577	0.84363	0.3859	0.1876	0.6527	0.2289	0.6414	0.7557	0.8650	0.6527	0.2081	0.6964	0.4868	0.3264
Trot	**0.773770**	-0.496521	1.00000	-0.16217	-0.6669	0.23424	0.18019	0.21429	-0.42857	**0.77481**	-0.15811	-0.57660	-0.41833	0.6669	0.46849	0.59108
	0.0412	0.2570		0.7283	0.1019	0.6132	0.6990	0.6445	0.3374	**0.0408**	0.7349	0.1754	0.3503	0.1019	0.2890	0.1622
Canter	0.075944	-0.176919	0.005440	1.00000	0.23636	**-0.79091**	-0.3000	0.18019	-0.23424	-0.50000	0.07977	0.29091	0.48242	0.38182	-0.01818	-0.41750
	0.8714	0.7043	0.9908		0.6099	**0.0342**	0.5133	0.6990	0.6132	0.2532	0.86550	0.5268	0.2729	0.3980	0.9691	0.3513
Vocalise	-0.329995	-0.044851	**-0.807146**	0.096628	1.00000	-0.50000	0.08182	0.34236	0.45047	**-0.86364**	0.31909	0.17273	-0.06030	-0.61818	**-0.76364**	-0.03976
	0.4698	0.9239	**0.0282**	0.8367		0.2532	0.8616	0.4523	0.3104	**0.0122**	0.4854	0.711	0.8978	0.1390	**0.0457**	0.9326
Swish Tail	-0.164111	0.462111	0.180511	-0.635783	-0.461398	1.00000	0.44545	-0.4143	-0.18019	0.60000	-0.23932	-0.37273	-0.24121	0.00000	0.25455	0.34792
	0.7251	0.2965	0.6985	0.1249	0.2973		0.3165	0.3553	0.6990	0.1544	0.6053	0.4103	0.6023	1.0000	0.5817	0.4444
Bite/ Aggression	0.585532	-0.030884	0.544608	-0.241802	-0.357685	0.407371	1.00000	0.50452	0.12613	0.15455	0.39886	-0.29091	-0.06030	0.16364	-0.07273	0.30816
	0.1672	0.9476	0.2062	0.6014	0.4309	0.3644		0.2482	0.7876	0.7408	0.3754	0.5268	0.8987	0.7259	0.8769	0.5013
Stand - Head Up	0.728972	-0.743309	0.299048	0.100659	0.098338	-0.414762	-0.013015	1.00000	0.50000	-0.05406	0.47434	0.10811	0.05976	0.0909	-0.05406	0.05911
	0.0631	0.0555	0.5147	0.8300	0.8339	0.3548	0.9779		0.2532	0.9084	0.2822	0.8175	0.8987	0.8477	0.9084	0.8998
Stand - Head Down	-0.035241	-0.137347	-0.481126	0.156269	0.650780	-0.118307	-0.250601	0.448789	1.00000	-0.14415	0.15811	0.6669	0.29881	-0.68471	-0.01802	-0.39406
	0.9402	0.7690	0.2744	0.7379	0.1134	0.8006	0.5878	0.3125		0.7578	0.7349	0.1019	0.5151	0.0897	0.9694	0.3817
Defecate	-0.107218	0.334357	0.331055	-0.430662	-0.666010	**0.881780**	0.143363	-0.232175	-0.122792	1.00000	-0.39886	-0.20909	-0.12060	0.38182	**0.78182**	0.26839
	0.8190	0.4636	0.4683	0.3348	0.1024	**0.0087**	0.7591	0.6164	0.7931		0.3754	0.6527	0.7967	0.3980	**0.0378**	0.5606
Urinate	0.217962	-0.054573	-0.060283	-0.153409	0.055148	-0.445654	-0.126251	0.444220	-0.151213	-0.375188	1.00000	-0.07977	0.00000	0.15954	-0.55841	-0.08723
	0.6387	0.9075	0.8978	0.7426	0.9065	0.3163	0.7874	0.3180	0.7462	0.4069		0.8650	1.0000	0.7326	0.1926	0.8525
Sniff	-0.444353	0.225118	-0.552245	0.175537	0.350082	0.035101	-0.640054	0.146185	**0.760388**	0.227538	-0.139663	1.00000	**0.84423**	-0.36364	0.31818	**-0.91453**
	0.3179	0.6274	0.1986	0.7066	0.4414	0.9404	0.1215	0.7545	**0.0472**	0.6236	0.7652		**0.0169**	0.4227	0.4868	**0.0039**
Scratch/Self Groom	-0.244064	0.529668	-0.283858	0.503682	-0.035151	-0.032730	-0.199851	-0.046060	0.331436	0.139609	0.062017	0.604746	1.00000	0.09045	0.45227	**-0.92313**
	0.5979	0.2214	0.5373	0.2491	0.9404	0.9445	0.6675	0.9219	0.4677	0.7653	0.8949	0.1503		0.8471	0.3083	**0.0030**
Kick/Jump	0.492672	-0.124781	**0.754511**	0.445038	-0.737103	-0.089878	0.436299	-0.033612	-0.634061	0.060556	0.011208	-0.561005	0.132072	1.00000	0.37273	0.10935
	0.2613	0.7898	**0.0500**	0.3170	0.0587	0.3278	0.3278	0.9430	0.1262	0.8974	0.9810	0.1901	0.7777		0.4103	0.8155
Shake Head	-0.013675	0.334335	0.447968	0.176640	-0.730611	0.606467	0.266871	-0.356591	-0.215209	**0.757005**	-0.564647	0.095674	0.420215	0.527399	1.00000	-0.26839
	0.9768	0.4636	0.3135	0.7048	0.0622	0.1448	0.5629	0.4324	0.6431	**0.0488**	0.1866	0.8383	0.3479	0.2238		0.5606
Paw Ground	0.517919	-0.403272	0.529939	-0.413152	-0.179028	0.246096	0.741410	0.000563	-0.362708	-0.030136	-0.200805	-0.797893	**-0.797017**	0.202563	-0.090707	1.0000
	0.2338	0.3697	0.2212	0.3569	0.7009	0.5947	0.0565	0.9990	0.4239	0.9489	0.6659	0.1503	**0.0319**	0.6631	0.8466	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Behaviours observed were correlated to examine evidence of interrelationships. Correlations between behaviours displayed in gradual group post-mare removal are shown in Table 3.19. Some extroverted behaviours are positively correlated at the $p<0.05$ level (kick/jump and trot). There are no correlations between oral behaviours or introverted behaviours. Significant positive correlations between behavioural categories are also apparent (eat and trot, defecate and swish tail, sniff and stand head down, shake head and defecate). Significant and negative correlations can be seen in vocalise and trot and paw ground and scratch/self-groom.

Table 3.19 - Correlations - Post Mare Removal – Gradual

	Eat	Walk	Trot	Canter	Vocalise	Swish Tail	Bite/ Aggression	Stand - Head Up	Stand - Head Down	Defecate	Urinate	Sniff	Scratch/ Self Groom	Kick/ Jump	Shake Head	Paw
Eat	1.00000	**-0.81168**	-0.75370	-0.77941	0.16176	0.02899	0.75370	**-0.89865**	-0.11595	-0.25000	-0.39139	-0.40584	0.39139	-0.17912	-0.23483	-0.46967
		0.0499	0.0835	0.0676	0.7595	0.9565	0.0835	**0.0149**	0.8268	0.6328	0.4429	0.4247	0.4429	0.7342	0.6542	0.3473
Walk	**-0.857385**	1.00000	0.42857	0.37685	-0.40584	-0.08571	-0.48571	**0.82857**	0.54286	-0.02899	0.61721	0.77143	-0.46291	0.26482	0.27775	0.46291
	0.0291		0.3965	0.4615	0.4247	0.3287	0.3287	**0.0416**	0.2657	0.9565	0.1917	0.0724	0.3552	0.6121	0.5941	0.3552
Trot	-0.682848	0.400072	1.00000	0.66674	0.11595	-0.02857	**-0.94286**	0.65714	-0.48571	-0.11595	0.33947	-0.02857	-0.21602	0.26482	0.61721	-0.12344
	0.1349	0.4319		0.1481	0.8268	0.9572	**0.0048**	0.1562	0.3287	0.8268	0.5104	0.9572	0.6810	0.6121	.1917	0.8158
Canter	-0.426401	0.075987	0.695175	1.00000	0.33824	0.40584	-0.52179	0.75370	-0.20292	0.45588	0.07828	-0.20292	-0.18787	0.40303	0.21918	0.54795
	0.3992	0.8862	0.1252		0.5120	0.4247	0.2883	0.0835	0.6998	0.3635	0.8828	0.6998	0.7215	0.4282	0.6765	0.2603
Vocalise	0.378337	-0.258157	0.066895	0.321607	1.00000	**0.86966**	-0.02899	-0.17393	-0.63775	0.32353	0.18787	**-0.81168**	0.70450	0.58215	0.39139	0.10959
	0.4596	0.6214	0.8998	0.5342		**0.0244**	0.9565	0.7417	0.1731	0.5316	0.7215	**0.0499**	0.1181	0.2254	0.4429	0.8363
Swish Tail	-0.508506	0.562398	0.335617	0.56554	0.484678	1.00000	0.14286	0.08571	-0.20000	0.34786	0.30861	-0.54286	0.49377	0.79446	0.37033	0.46291
	0.303	0.2453	0.5155	0.2421	0.3299		0.7872	0.8717	0.7040	0.4993	0.5518	0.2657	0.3195	0.0590	0.4699	0.3552
Bite/ Aggression	0.472924	-0.275806	-0.770571	-0.38854	-0.23014	-0.339564	1.00000	-0.54286	0.42857	0.02899	-0.49377	-0.14286	0.06172	-0.08827	-0.52463	0.12344
	0.3435	0.5968	0.0729	0.4465	0.6609	0.5102		0.2657	0.3965	0.9565	0.3195	0.7872	0.9075	0.8679	0.2853	0.8158
Stand - Head Up	**-0.855158**	0.739276	0.627287	0.649135	-0.146882	0.627616	-0.181926	1.00000	0.25714	0.00000	0.30861	0.37143	-0.61721	0.44137	0.37033	0.46291
	0.0299	0.0931	0.1825	0.1631	0.7813	0.1822	0.7301		0.6228	1.0000	0.5518	0.4685	0.1917	0.3809	0.4699	0.3552
Stand - Head Down	-0.174358	0.47137	-0.530864	-0.657247	-0.629574	-0.127283	0.542373	0.06674	1.00000	0.02899	0.06172	0.77143	-0.46291	-0.08827	-0.40119	0.52463
	0.7411	0.3453	0.2785	0.1561	0.1804	0.8101	0.2662	0.9		0.9565	0.9075	0.0724	0.3552	0.8679	0.4305	0.2853
Defecate	-0.32228	0.116904	0.067775	0.354651	0.050847	0.534332	-0.381475	0.140859	-0.117748	1.00000	-0.04697	-0.14494	0.42270	-0.17912	-0.53229	0.73581
	0.5333	0.8254	0.8985	0.4903	0.9238	0.2748	0.4555	0.7901	0.8242		0.9296	0.7841	0.4037	0.7342	0.2770	0.0955
Urinate	-0.412617	0.670492	0.370206	0.104613	0.486048	0.72534	-0.524338	0.354482	-0.024076	0.104613	1.00000	0.37033	0.31667	0.47673	0.61667	0.1667
	0.4162	0.145	0.4701	0.8437	0.3283	0.1028	0.2856	0.4905	0.9639	0.8437		0.4699	0.5409	0.3391	0.1923	0.7523
Sniff	-0.565906	0.792519	0.193204	-0.443131	-0.443052	0.042561	-0.263806	0.249944	0.596119	-0.162556	0.515871	1.0000	-0.46291	-0.26482	-0.15430	0.21602
	0.2418	0.0601	0.7138	0.3788	0.3789	0.9362	0.6135	0.6329	0.2117	0.7583	0.2948		0.3552	0.6121	0.7704	0.6810
Scratch/ Self Groom	0.73323	-0.588154	-0.221416	-0.088638	**0.848844**	0.010093	-0.125652	-0.639746	-0.55813	-0.088638	0.199363	-0.448128	1.00000	0.04767	0.0333	-0.01667
	0.0973	-0.2195	0.6733	0.8674	**0.0325**	0.9849	0.8125	0.1713	0.2497	0.8674	0.7049	0.3728		0.9285	0.9500	0.9750
Kick/Jump	-0.015111	0.262261	0.226223	0.590624	0.671504	0.787800	0.023922	0.550367	-0.260983	0.029531	0.531369	-0.254491	0.210105	1.00000	0.76277	0.23837
	0.7751	0.6156	0.6665	0.2171	0.1441	0.0628	0.9641	0.2578	0.6174	0.9557	0.2780	0.6265	0.6895		0.0777	0.6492
Shake Head	-0.170586	0.215469	0.574859	0.537222	0.552308	0.402536	-0.201384	0.495763	-0.456672	-0.440065	0.488466	-0.058007	0.209115	0.754760	1.00000	-0.30000
	0.7466	0.6818	0.2327	0.2717	0.2558	0.4288	0.7020	0.3173	0.3626	0.3825	0.3256	0.9131	0.6909	0.0828		0.5635
Paw Ground	-0.390650	0.412109	-0.248958	0.144673	-0.168702	0.592248	0.185554	0.392180	0.452819	0.723364	0.108465	0.027705	-0.416622	0.244949	-0.379236	1.00000
	0.4438	0.4168	0.6343	0.7845	0.7493	0.2155	0.7249	0.4419	0.3672	0.1042	0.8379	0.9585	0.4112	0.6399	0.4584	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Behaviours observed were correlated to examine evidence of interrelationships. Correlations between behaviours displayed in all foals, (gradual and abrupt) post-mare removal are shown in Table 3.20. Some extroverted behaviours are positively correlated at the $p<0.05$ level (kick/jump and trot, shake head and trot, shake-head and kick/jump). There are no correlations between oral behaviours or introverted behaviours. Significant positive correlations between behavioural categories are also apparent (eat and trot, eat and bite/aggression, walk and swish tail, swish tail and defecate). Kick/jump is significant and negatively correlated with shake head.

Table 3.20 - Correlations Post Mare Removal All

	Eat	Walk	Trot	Canter	Vocalise	Swish Tail	Bite/ Aggression	Stand - Head Up	Stand - Head Down	Defecate	Urinate	Sniff	Scratch/ Self Groom	Kick/ jump	Shake Head	Paw
Eat	1.00000	-0.20834	**0.57897**	-0.08123	0.42957	0.25348	0.54093	0.01248	-0.31207	-0.13324	-0.26160	0.28850	-0.27230	0.37149	0.28771	-0.38845
		0.4946	**0.0381**	0.7919	0.1429	0.4034	0.0563	0.9677	0.2993	0.6643	0.3879	0.3391	0.3681	0.2114	0.3405	0.1896
Walk	-0.266432	1.00000	0.35262	0.06407	-0.06796	0.54571	0.07310	-0.13241	-0.02621	-0.15900	-0.05575	0.52276	-0.12114	0.23739	0.38889	-0.20845
	0.3789		0.2373	0.8353	0.8254	0.0537	0.8124	0.6663	0.9323	0.6039	0.8565	0.0668	0.6934	0.4348	0.1891	0.4943
Trot	**0.72819**	0.177545	1.00000	0.02778	0.15491	0.54697	0.22558	0.21458	-0.34938	0.24202	-0.33356	0.48693	**-0.55430**	0.45947	**0.60944**	-0.37506
	0.0048	0.5617		0.9282	0.6133	0.0531	0.4587	0.4814	0.2420	0.4257	0.2654	0.0915	**0.0493**	0.1142	**0.027**	0.2067
Canter	0.071859	-0.029353	0.211246	1.00000	0.20979	-0.19553	-0.50906	0.40614	-0.10293	-0.14627	-0.07495	0.06398	0.15234	0.23797	0.20728	-0.07644
	0.8155	0.9242	0.4884		0.4915	0.5220	0.0756	0.1685	0.7379	0.6335	0.8077	0.8355	0.6193	0.4337	0.4968	0.8040
Vocalise	0.056526	0.104377	-0.097725	0.189421	1.00000	0.40890	0.16898	0.07895	-0.13020	-0.23390	0.03732	0.19114	0.02719	-0.02680	-0.03487	-0.18005
	0.8545	0.7343	0.7508	0.5354		0.1653	0.5810	0.7977	0.6716	0.4418	0.9037	0.5316	0.9297	0.9370	0.91	0.5561
Swish Tail	0.008424	**0.556461**	0.376523	-0.265644	-0.115081	1.00000	0.40941	-0.13555	-0.26833	0.42519	-0.11180	0.23790	-0.12005	0.43948	0.47911	-0.06432
	0.9782	**0.0483**	0.2048	0.3804	0.7081		0.1648	0.6588	0.3754	0.1475	0.7161	0.4338	0.6961	0.1329	0.0976	0.8346
Bite/ Aggression	**0.621491**	0.119859	0.531246	-0.16364	-0.168343	0.400794	1.00000	-0.01928	0.04959	0.05014	-0.14845	0.13774	-0.19071	0.24127	0.02219	-0.06551
	0.0234	0.6965	0.0617	0.5932	0.5825	0.1747		0.9501	0.8722	0.8708	0.6284	0.6536	0.5326	0.4271	0.9426	0.8316
Stand - Head Up	0.421006	-0.313323	0.325723	0.243357	0.097405	-0.120654	0.023395	1.00000	0.47383	-0.01671	0.16701	0.13912	-0.26615	0.15010	0.11512	0.17905
	0.152	0.2972	0.2775	0.423	0.7516	0.6946	0.9395		0.1019	0.9568	0.5855	0.6504	0.3794	0.6245	0.7080	0.5583
Stand - Head Down	-0.09348	-0.007896	-0.352364	-0.088299	0.286457	-0.135029	-0.171795	0.329094	1.00000	-0.06686	0.11134	0.31680	0.00285	-0.47133	-0.11928	0.20089
	0.7613	0.9796	0.2377	0.7742	0.3427	0.6601	0.5747	0.2722		0.8282	0.7173	0.2916	0.9926	0.1040	0.6979	0.5105
Defecate	-0.136341	0.219628	0.1437	-0.148986	-0.399033	**0.69522**	0.060423	-0.104107	-0.118775	1.00000	-0.22518	-0.05154	0.24754	0.12199	0.19215	0.44749
	0.6569	0.4709	0.6395	0.6271	0.1768	**0.0083**	0.8445	0.735	0.6991		0.4595	0.8672	0.4148	0.6914	0.5294	0.1252
Urinate	-0.266855	-0.022646	-0.286915	-0.100093	-0.001462	-0.080328	-0.256271	0.266561	-0.045941	-0.085695	1.00000	-0.16701	0.36431	0.15119	-0.24292	0.09806
	0.3781	0.9415	0.3419	0.7449	0.9962	0.7942	0.398	0.3787	0.8815	0.7807		0.5855	0.2210	0.6220	0.4239	0.7500
Sniff	0.137237	0.530909	0.348571	0.151998	0.411087	0.251181	-0.167094	0.209287	0.455762	0.072543	-0.245143	1.00000	-0.22772	-0.05892	0.34536	-0.53729
	0.6548	0.0619	0.2431	0.6201	0.1629	0.4078	0.5853	0.4926	0.1175	0.8138	0.4195		0.4543	0.8484	0.2478	0.0608
Scratch/Self Groom	-0.080531	-0.316838	-0.423644	-0.010479	0.109246	-0.143002	-0.202901	-0.323517	-0.192099	-0.027021	0.322625	-0.322122	1.00000	-0.10581	-0.08456	0.07972
	0.7937	0.2915	0.1491	0.9729	0.7224	0.6412	0.5062	0.2809	0.5295	0.9302	0.2823	0.2831		0.7308	0.7836	0.7957
Kick/Jump	0.502447	0.118283	**0.670672**	0.490407	-0.316096	0.184386	0.471202	0.113126	-0.522591	0.042474	-0.005442	-0.097246	-0.061882	1.00000	0.49862	-0.06078
	0.0801	0.7003	**0.0121**	0.0889	0.2927	0.5465	0.1041	0.7129	0.0669	0.8904	0.9859	0.7520	0.8408		0.0828	0.8436
Shake Head	0.269281	0.474455	**0.644356**	0.278926	-0.257822	-0.257822	0.365932	-0.123545	-0.250796	0.357658	-0.356541	0.400716	-0.091429	**0.626642**	1.00000	-0.49985
	0.3736	0.1014	**0.0174**	0.3561	0.3951	0.3951	0.2188	0.6876	0.4085	0.2302	0.2318	0.1748	0.7664	**0.0219**		0.0820
Paw Ground	-0.246718	-0.248621	-0.331188	-0.175223	-0.305217	-0.305217	0.121574	0.064723	0.111167	0.367776	0.243273	**-0.575904**	-0.115435	-0.048413	-0.375828	1.00000
	0.4164	0.4127	0.2690	0.5669	0.3106	0.3106	0.6924	0.8336	0.7177	0.2163	0.4232	**0.0394**	0.7073	0.8752	0.2057	

The top value in each cell is recorded as the correlation coefficient; bottom value is recorded as the P value. The lower half of the table exhibits Pearson correlation results; the upper half of the table exhibits Spearman correlation results, Significant values ($p<0.05$) showing correlated behaviours are noted in bold, correlations noted in bold for both measures indicates a strong relationship.

Given the multiple correlations between behaviours identified, a Principal Components Analysis further reduces the number of correlated variables and then derives three independent composite measures. Using the eigenvalue-one criteria (Kaiser, 1960) and scree test (Cattell, 1966), this study retains only three components for all behaviours post-mare removal which account for 58% of the total variance (Table 3.21).

Table 3.21. Eigenvalues of the Correlation Matrix for Post-mare removal, abrupt and gradual groups.

	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	4.12948454	1.52307431	0.2581	0.2581
2	2.60641023	0.17324265	0.1629	0.421
3	2.43316758	0.65297643	0.1521	0.5731

Following eigenvalue, using a Factor pattern analysis for each of the above components, behaviours can be grouped accordingly, behaviours determined by factor one show foals tend to trot, kick and shake their head. Behaviours determined by factor two show that foals sniff, vocalise and paw. Behaviours determined by factor three shows that foals walk and sniff but do not eat (Table 3.22). Printed values are multiplied by 100 and rounded to the nearest integer. The top three values for each factor are shown in bold.

Table 3.22 –Factor Pattern for all behaviours post-mare removal.

	PC1	**PC2**	**PC3**
Eat	58%	28%	**-56%**
Walk	42%	1%	**72%**

	PC1	PC2	PC3
Trot	**91%**	16%	-23%
Canter	22%	38%	-29%
Vocalise	-19%	**67%**	17%
Swish	59%	-41%	53%
Bite	62%	-24%	-27%
Head-up	9%	44%	-38%
Head-Lowered	-32%	48%	34%
Defecate	31%	-57%	42%
Urinate	-39%	-17%	-13%
Sniff	37%	**68%**	**57%**
Drink	0%	0%	0%
Scratch	-35%	-20%	-17%
Kick	**72%**	-16%	-48%
Shake head	**87%**	-7%	21%
Paw	-30%	**-61%**	-12%

Behaviour correlations can be further determined using a correlation coefficient (Table 3.23). Factor one shows foals that eat also trot, bite, shake their head and kick but do not stand head lowered, interpreted as active behaviours. Factor two shows foals that walk also sniff, paw and shake their heads, interpreted as stress behaviours. Factor three shows that foals that swish their tails and defecate do not stand with their head up, interpreted as hind-quarter factors.

Table 3.23 Correlation Coefficients of variables with Principal Components Factor Scores – All behaviours post-mare removal.

Variable	Factor 1	Factor 2	Factor 3
Eat	**0.63502** **0.019**	0.20364 0.504	-0.53974 0.056

Variable	Factor 1	Factor 2	Factor 3
Walk	-0.05028 0.870	**0.67458** **0.011**	0.4876 0.090
Trot	**0.75773** **0.002**	0.52971 0.062	-0.20714 0.497
Canter	0.17511 0.567	0.18045 0.555	-0.45925 0.114
Vocalise	-0.48037 0.096	0.33668 0.260	-0.41363 0.16
Swish Tail	0.33672 0.260	0.44819 0.124	**0.69005** **0.009**
Bite	**0.70382** **0.007**	0.10953 0.721	0.04784 0.876
Head up	0.10509 0.732	0.08216 0.789	**-0.56823** **0.042**
Head lowered	**-0.60077** **0.029**	0.24472 0.420	-0.16525 0.589
Defecate	0.23664 0.436	0.11719 0.703	**0.72632** **0.004**
Urinate	-0.17125 0.575	-0.41573 0.157	0.01762 0.954
Sniff	-0.25336 0.403	**0.92059** **<0.0001**	-0.11672 0.704
Scratch	-0.11229 0.714	-0.42748 0.145	0.01854 0.952
Kick	**0.86005** **0.0002**	0.1008 0.7432	-0.14135 0.6451
Shake head	**0.5895** **0.034**	**0.62198** **0.023**	0.24861 0.412
Paw	0.05482 0.858	**-0.58081** **0.037**	0.36673 0.217

Correlation coefficients are the top value, p value is the bottom value. Significant figures noted in bold.

Foals in the abrupt weaned group typically display more behaviours than foals in the gradual group post-mare removal (Figure 3.10), Mann-Whitney W=68, p=<0.01.

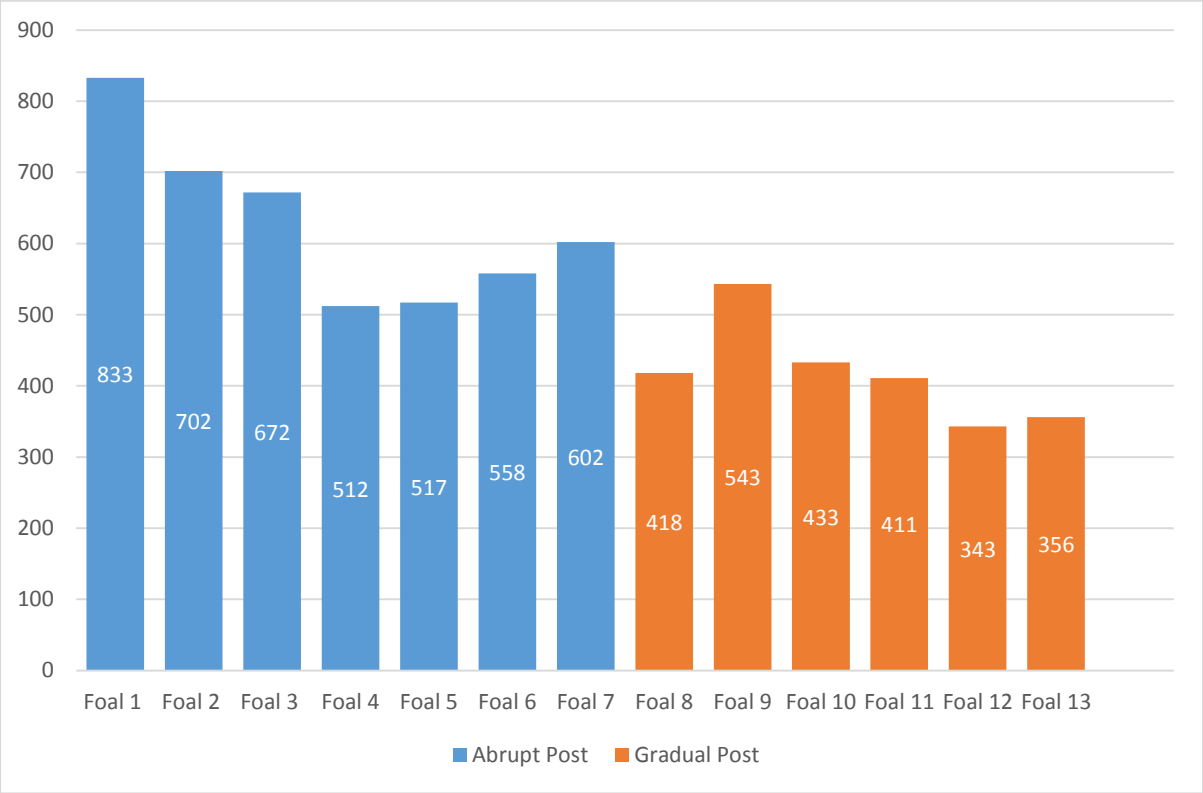

Figure 3.10, Comparison of all behaviours recorded in abrupt versus gradual group post mare removal.

Total number of foal behaviours recorded per foal. Foals 1-7 abrupt group, foals 8-13 gradual group.

Foals display significantly more behaviours post-mare removal (Figure 3.11), Mean 492.86±52.99, n=13, than pre-mare removal (Mean 58.5±5.72, n=14, Mann-Whitney W=105, p=<0.0001).

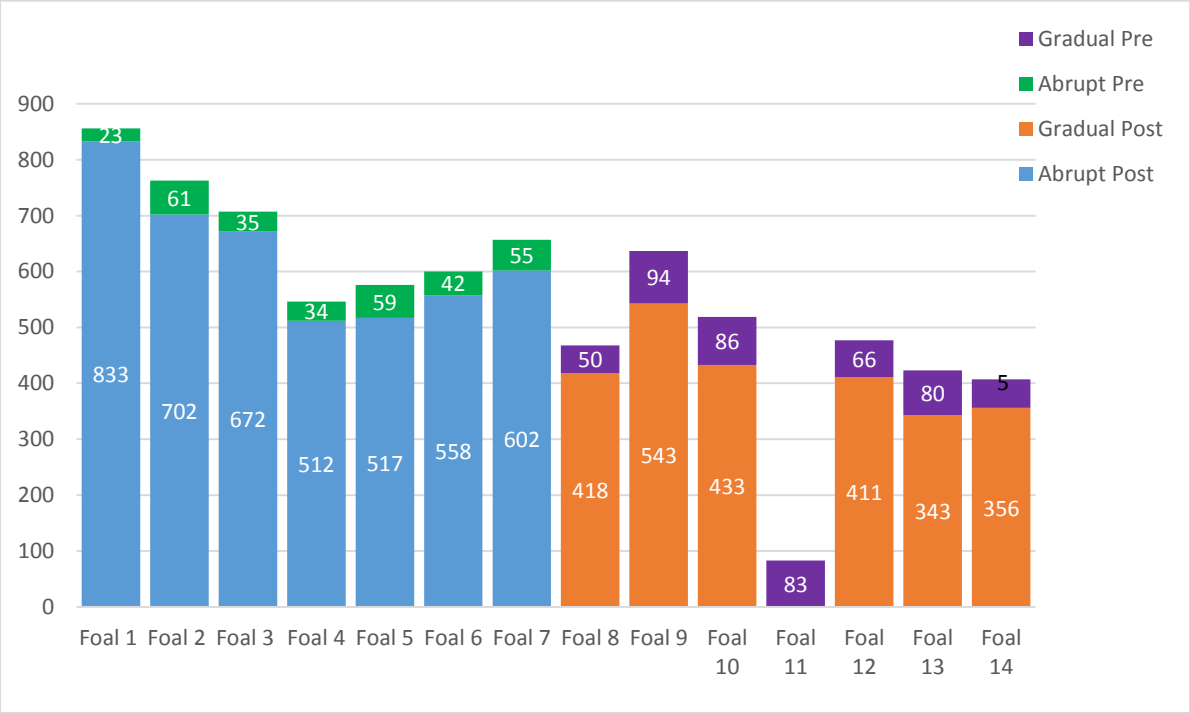

Figure 3.11, Comparison of all behaviours recorded in pre versus post mare removal.

Total number of foal behaviours recorded per foal, recorded pre-mare removal and post-mare removal. Foals 1-7 abrupt group, foals 8-14 gradual group. Note foal 11 was removed from the group prior to weaning.

A clear increase in behaviours recorded pre, versus post mare removal as seen in Figure 3.11. Foals eight to 13 (gradual group) generally display a smaller margin of increase than foals one to seven (abrupt group).

Behaviours displayed in colts shows a wider range (mean=554.00±84.83) post-mare removal than fillies (mean=510±25.65), however there is no significant difference between total amount of behaviours displayed for colts compared to fillies (p=0.94).

Chi squared analysis shown in Table 3.24 shows distribution for behaviours recorded post-mare removal. No recordings shown here mark significant differences with the assumed population for each frequency recorded per behaviour.

Table 3.24 - Chi squared analysis post-mare removal

Variable	**Chi Sq**	**Pr >Chi Sq**
Eat	3.0256	0.9327
Walk	1.0383	0.9998
Trot	0.0002	1.000
Canter	4.4242	0.817
Vocalise	3.1538	0.9579
Swish Tail	3.1538	0.9776
Bite/Aggression	0.8498	1.000
Head Up	0.8498	1.000
Head lowered	0.8498	1.000
Defecate	3.6154	0.823
Urinate	4.4757	0.107
Sniff	0.8498	1.000
Scratch/Self Groom	3.5385	0.472
Kick/Jump	6.0769	0.531
Shake Head	3.0256	0.933
Paw	9.6953	0.084

Foals in abrupt group (mean=32.79, St.Dev 11.10) spent more time moving than those in gradual group (mean=19.94, St.Dev 8.29), $F_{1,11}$=5.41, p=<0.05. (Figure 3.12).

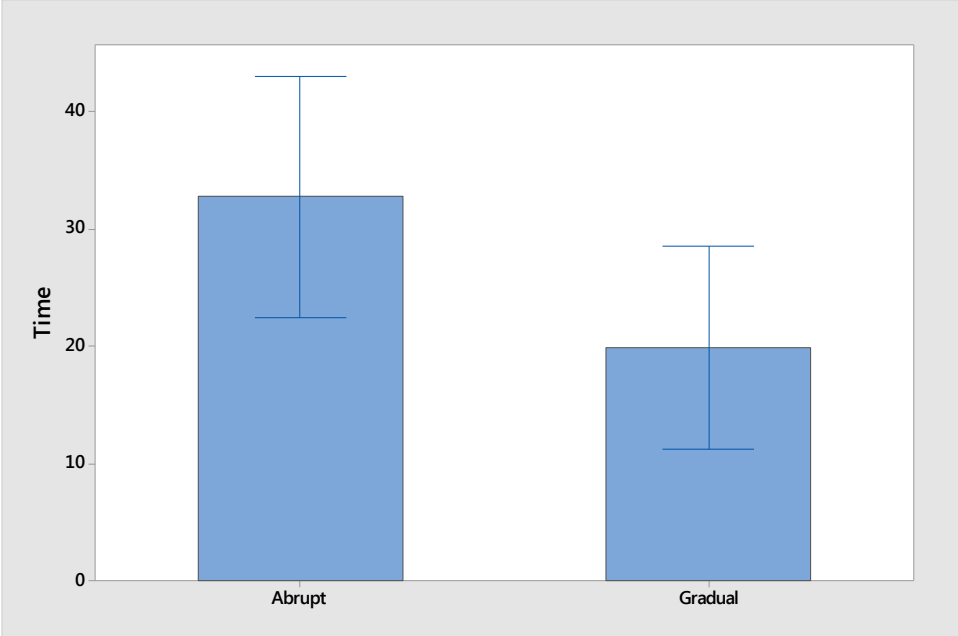

Figure 3.12. Time spent moving abrupt and gradual post-mare removal.
Time spent by foals moving following mare removal for both the abrupt (n=7, mean=32.80±4.20, St.Dev 11.11) and gradual (n=7, mean=19.93±3.39, St.Dev 8.30) weaning groups, time is noted in minutes. Individual standard deviations are used to calculate the intervals.

Foals display locomotion behaviours more post-mare removal (mean=26.85±3.22, St.Dev 11.61) compared with pre-mare removal (mean=5.08±0.45, St.Dev 1.71). Mann Whitney W=105, p=<0.0001.

There is no significant difference between fillies and colts for the amount of time displaying locomotion behaviours post-mare removal (p=0.22).

3.3.3. Defecation and vocalisation

Foals display increased vocalisation post-mare removal (n=658) compared with pre-mare removal (n=0). Foals did not show any vocalisation behaviours pre-mare removal, therefore no statistical test was used for comparison. There is no significant difference in frequency (p=0.17) of vocalisation for foals in the abrupt group compared to the gradual group post-mare removal.

Foals defecated more frequently post-mare removal (n=82, mean=6.30±0.87, St.Dev 3.17) compared to foals pre-mare removal (n=8, mean=0.5±0.2, St.Dev 0.75). Mann Whitney W=105, p=<0.0001. There is no significant difference in frequency (p=0.88) of defection post-mare removal for foals in the abrupt group compared to the gradual group.

There is no significant difference between vocalising (p=0.88) or defecation (p=0.39) behaviours displayed for colts compared to fillies.

3.3.4. Time spent with head lowered.

Foals spent varied total of time within the one hour, with their heads lowered in the abrupt group (mean=13.43±3.27, St.Dev 8.66) (Figure 3.14),

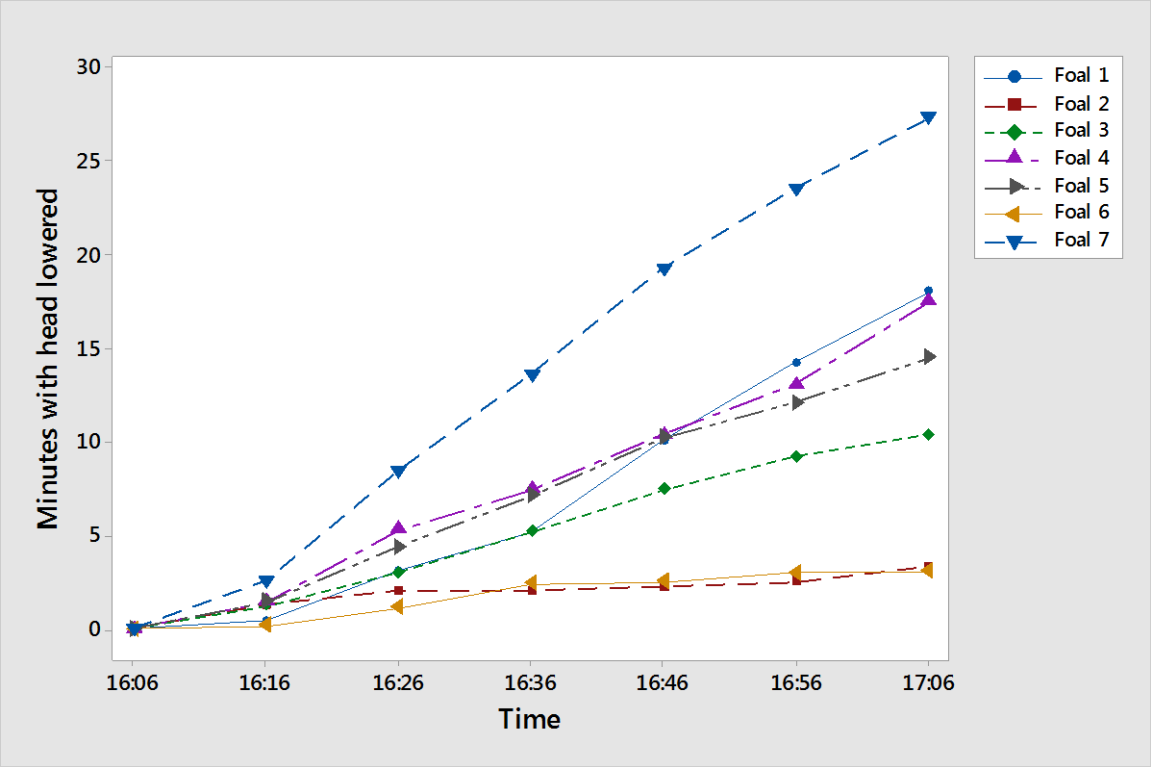

Figure 3.13 – Time spent with head lowered, ears below the wither– Abrupt group.
Time is shown here in minutes, recorded at 10 minute intervals, head lowered is defined as ears below the wither.

Recordings show a varied frequency of time spent with the head lowered per foal for gradual group (mean=7.63±1.79, St.Dev 4.39), (Figure 3.14), but a lower overall frequency than foals in the abrupt group (mean=13.43±3.27, St.Dev 8.66) (Figure 3.16).

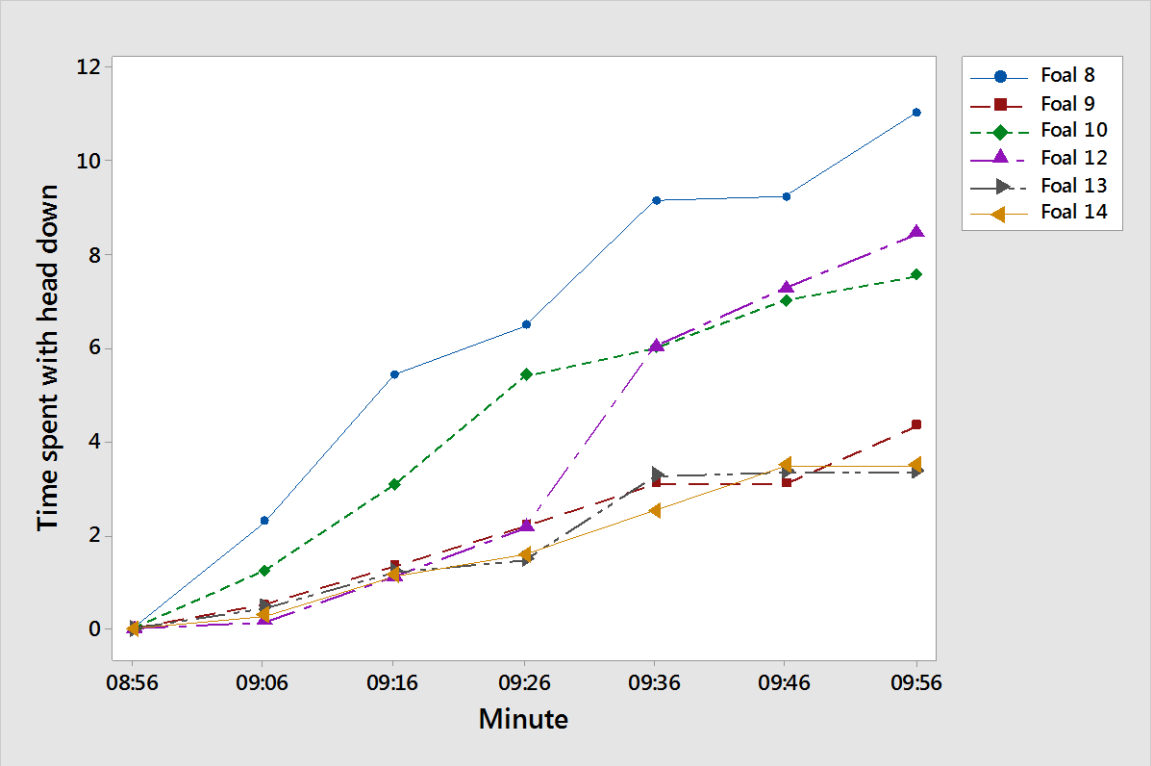

Figure 3.14- Time spent with head lowered, ears below the wither– Gradual group.
Time is shown here in minutes, recorded at 10 minute intervals, head lowered is defined as ears below the wither.

3.3.5. Time foals spent eating

Foals in the gradual group spent more time eating (mean=9.71±4.20, St.Dev 10.29) than foals in the abrupt group (mean=6.60±2.50, St.Dev 6.62), though the distribution in the gradual group is wider, the findings are non-significant ($F_{1,11}$0.43, p=0.52).

Foals spend significantly less time eating post-mare removal (Figure 3.15), Mean 8.04±2.299, n=13, than pre-mare removal Mean 36.16±3.59, n=14, Mann-Whitney W=277.00, p=<0.0001.

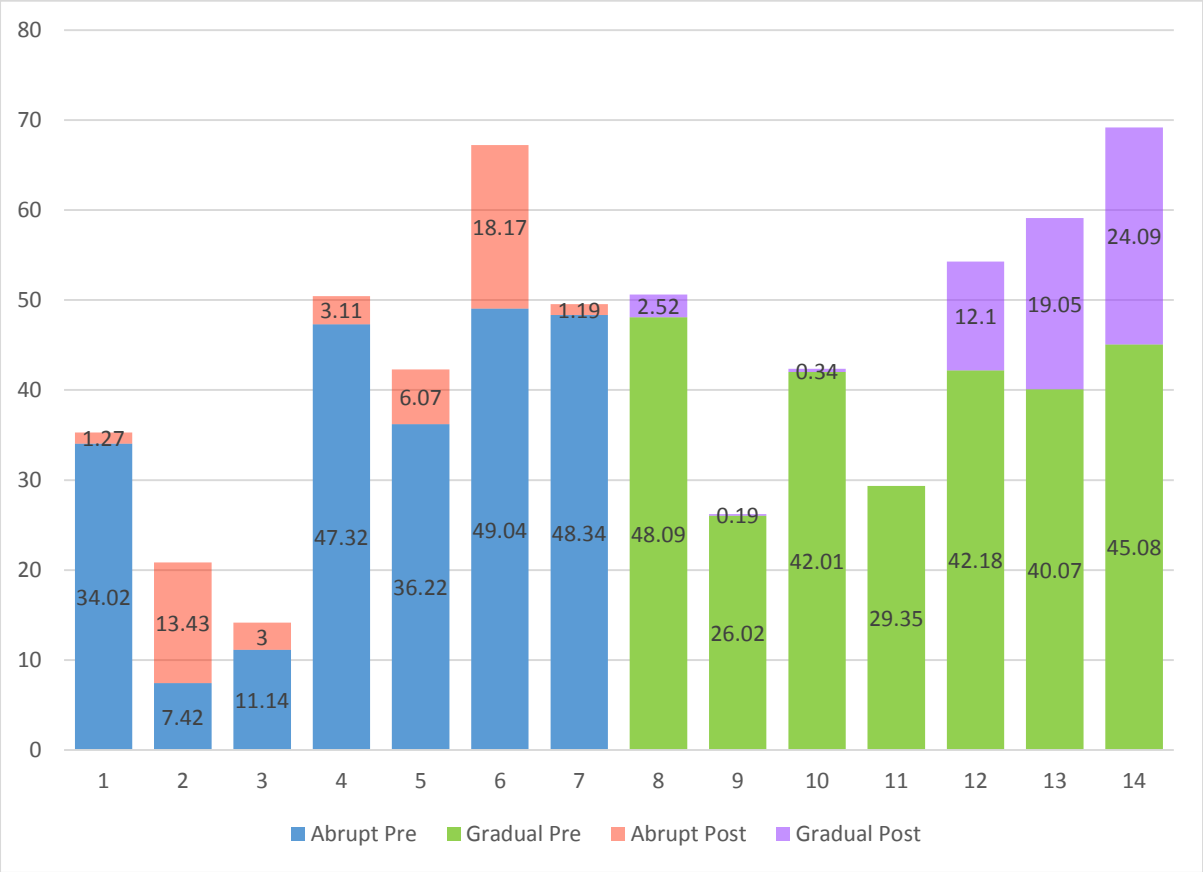

Figure 3.15. Comparison of time spent eating recorded in pre versus post mare removal.

Time is noted per minute and second, foals 1-7 are abrupt group, foals 8-13 are gradual group. Note foal 11 is missing from post=mare removal as it was removed from the group prior to weaning.

Foals lie down more often pre-mare removal (mean=6.12±3.00, St.Dev 11.24) than post-mare removal. Foals did not lie down following mare removal, therefore no statistics were run.

4.0 Discussion

The first aim of this study, which examines data from common practices within the industry, clearly shows that stud owners tend to wean using either the gradual or abrupt method and wean at six months or earlier (49%). Additionally, larger studs housing more horses, tend to breed more foals per annum and weaning using either abrupt or barn methods and at an earlier age than smaller studs. Aim two of this study which examines foal behaviour pre and post mare removal, clearly shows a higher frequency of behaviours displayed following mare removal compared with behaviours displayed pre-mare removal. Pre-mare removal oral behaviours, active behaviours and passive behaviours are the three most commonly observed variables following Principal Components Analysis. Post-mare removal active behaviours, stress behaviours and hind-quarter behaviours are the three most commonly observed variables following Principal Components Analysis.

4.1. Questionnaire

Examination of respondent data shows that nearly half (45%) believe that chosen method is least stress inducing, this is despite variation in method utilised. This concurs with the earlier study in Greening & Febery, (2009) who also found that the majority of respondent studs in their study reported that chosen method was, in their opinion, the best for the foals. Reasons cited for use of method as found in the questionnaire data, could be categorised into those who give most consideration to their foal and those who wean for convenience/ease to themselves. By doing this, 16.8% cited reasons such as easier, more convenient, tradition as the reason for use of method, thus highlighting that not all breeders consider the welfare of their foals at this critical time.

Those who wean at six months account for approximately one quarter of data in this study, (Figure 3.2) and is the most common age to wean, yet approximately 25% wean a either four of five months despite conclusions drawn by Randle (2011) and McBane (2000) that suggest that weaning pre-six months can cause nutritional, physiological and psychological issues (McBane 2000, Waters *et al.* 2002, Heleski *et al.* 2002, Widowski *et al.* 2008). The trend for weaning foals between four to six months (circa 50% in this study), is a worrying one when prior evidence suggest that early weaning is detrimental to the foals health in the short term and potentially long term. Thus the need for further research in this area, which sets out guidelines for best weaning age is critical.

Whilst the most frequently used method of this study is the gradual method, the common theme shown for use of the abrupt method also, is one similarly noted in Greening, L and Febery, E (2009). Upon further inspection of respondent data supplied via open ended questions, there is a wide range in adopted method, categorised within the gradual process. Additionally, further information provided under 'other' method, which equates to 15.2% of the overall data, would suggest that the majority of breeders who marked the method of mare removal within the 'other' category, actually could be considered a form of gradual weaning. This highlights the ambiguity of defining and understanding weaning methods and perhaps does not reflect a true picture of the methods used. Due to the variability within methods, some could be considered to fall within more than one category, for example, foals who are barn kept, as a group but abruptly have their dams removed, may be considered to fall within abrupt or barn weaned methods. The nature of weaning is

so complex, it is perhaps not possible to completely categorise each form. Inspection of the data for gradual method, shows a variation in the procedures employed, whether single or multiple foal weaning or length of time until full removal was achieved. The variety within method as well as the variety of method used clearly shows the lack of full understanding or guidance of best method.

Breeders of low numbers exhibit significantly higher values than larger studs with the majority of studs breeding one to two foals per annum (Figure 3.4). Of the number of responses collected, only 2.5% of studs breed more than 10 foals per year. There is a clear relationship between the size of the stud, the method used and the age of the foal at the time of weaning as shown in Figure 3.5, Figure 3.6 and Figure 3.7. This contradicts findings in in Greening & Febery (2009) whose study of British studs did not see a significant relationship between method and stud size. The majority of respondents from the questionnaire in this study, derive from small studs that breed less than five foals per year and distribution across all variables is therefore not even. Those who breed more than five foals a year equate to just 13.2% (N= 58) overall, while the remainder for smaller studs is 86.8% (N= 382), data is likely skewed by the heavier weighted, smaller studs, however this does show a true representation of stud variability within the industry. The variability of response indicates that the best time to wean a foal from its mother is an interesting research question for further study.

Respondents in this study, originated from a wide variety of countries worldwide, thus data collected shows a good sample size and spread. Interestingly, while the response rate for location is smaller than the overall response rate (approx. 50%),

many countries show a trend towards one or two preferred methods, in particular, Sweden shows a high preference for the use of the gradual method, 23 of the 30 responses that came from this country noted this as method of choice. Holland and the UK show a high frequency of both abrupt and gradual methods used versus all other options. The most common method used in New Zealand, according to this study is paddock weaning, this could be dictated by circumstances or the availability of large paddocks versus other countries. The responses given for behaviours displayed at the time of weaning is an interesting observation. Whilst the majority of behaviours cited are those to be expected during what is understood as an incredibly stressful period, some are not expected. Behaviours such as ‘calm’ or ‘happy’ are not only unexpected behaviours normally observed during weaning, but also ones which are hard to quantify via observation only. Whilst studies demonstrate that equid emotion is a developing field (Waran & Randle 2017), positive states such as those noted are difficult to measure. Negative state such as fear or pain has traditionally been measured when assessing welfare in equids, whilst positive state is an important consideration and is driving welfare changes, current assessment of positive emotion is still developing. However, it must be noted that these responses are opinion based only and not field based scientific study. Understanding weaning practice within the industry is important when considering weaning stress. The majority of breeders believed they were limiting the stress caused to the foal where possible, showing that breeders are aware of welfare implications and wish to improve this, however use of method was not based on any scientific evidence or clear guidelines. Additionally, of 440 responses, only four respondents stated that their choice of weaning method was based on research, highlighting the gap between current weaning research and practice. There are clear relationships shown

across research questions and the need for a more defined understanding of weaning stress and impact is distinctly highlighted in the responses given.

A limitation on this study was the lack of clarity in some questions, by deliberately allowing respondents the opportunity to divulge their thoughts and opinions. The results of this questionnaire show that breeders wish to reduce stress in foals at the time of mare removal. Stress reduction has been cited as a primary concern by some authors (Waran *et al.* 2008, Xiao *et al.* 2015), and it appears that breeders, although misguided, are attempting to combat this. It must be noted that due to the opinion based responses to the open questions, the sample may be biased, providing subjective data rather than objective depending on opinion rather than fact. It is important to recognise the need for more objective research that is not opinion based and uses more defined methodologies.

The data collected in this study is a pioneering study in this area, it sets out a basic understanding of the current methods of weaning employed in the industry, along with the age of the foal at the time of mare removal. The lack of conclusive evidence and the clear variation in methods utilised within the industry show that there is a definite need for further investigation and clarification on what may or may not be the best method of mare removal for the equid foal.

4.2. Behavioural Observation of abruptly weaned and gradually weaned foals.

4.2.1. Behaviour

A number of behavioural observations can be made when weaning foals, those cited and noted in this study range from a variety of types of behavioural characteristics.

The majority of these can be labelled as extroverted behaviours such as searching, or vocalising, and we can often see that one behaviour will relate to another.

A significant difference in the number of behaviours displayed pre vs post mare removal is observed in this study, the deviation of behaviours post-mare removal is one found in prior literature (Henry *et al.* 2012, Merkies *et al.* 2017). A significant difference between abrupt group and gradual group can also be seen following weaning (Figure 3.11). This finding concurs with some prior studies (e.g. Hayley *et al.* 2009, Enriquez *et al.* 2011) but is in contrast to others (egg. Latham & Mason 2008). The gradual method adopted for the purposes of this study uses a two-stage approach, nutritional separation followed by physical separation. Findings in a similar study conducted by Merkies *et al. (*2016) using a two-phase approach contradict the positive conclusions noted in stress-related behaviour reduction found in this study. Their findings show minimal benefit in the use of this method. It must be noted that the limited dataset for their report, may skew the results by one variable where data is particularly high, or low in comparison to other recordings, a weakness also prevalent in this study. The limited scope of the dataset leaves scope for further study with a larger sample size in order to accurately gain more conclusive results

Assessment of horse behaviour is important when considering welfare and stimuli response, the use of an ethogram (Table 2.2) helps to define individual behaviour and allow further evaluation. Stress behaviours arise when the equines fear response is stimulated. Foals in both weaning methods display increased frequency in locomotor, vocalisation and defecation activities, these are commonly agreed

stress related behaviours (e.g. Moons *et al.* 2005). Stress related behaviours in foals, induced by weaning can be clearly seen upon mare removal and has been well documented in prior literature (McCall *et al.* 1985, Moons *et al.* 2005, Waran *et al.*2008, Henry *et al.* 2012, Xiao *et al.* 2015). Previous attempts to alleviate stress related behaviours and ease the transition of mare removal via a gradual removal process shows very little conclusive evidence in gradual group versus abrupt group when comparing behaviours displayed following mare removal.

The most common behaviours exhibited by foals during the weaning process are searching (locomotion), aggression and vocalisation, all of which have been linked to the desire to reunite and subsequent recorded stress levels (Weary *et al.* 1999, Newberry & Swanson 2008). Upon commencing the observation, it quickly became clear that foals spent a part of the time with their nose either touching or very close to the floor, both whilst walking and standing. The amount of time each foal displays this particular behaviour varies quite considerably (Figure 3.14 and Figure 3.15). This is not a behaviour noted in prior studies, however was of significance in this study, more predominantly in the abrupt group. While the cause is not investigated in this study, it may link to searching behaviours and is an area of interest and possible further exploration. Foals increase in locomotor behaviours are observed following weaning, a finding also supported in other studies (egg Merkies *et al.* 2016). These behaviours are noted via walk, trot and canter with walk recorded as the most common. While there has been some study with the use of GPS to recorded distance travelled by foals following weaning (Merkies *et al.* 2016), there appears to be little investigation into the differing paces of locomotor behaviours.

A limitation of this study shows impacted recordings from one variable, for example, in abrupt group, foal two displayed very aggressive behaviour towards foal six, foal two chased foal six continuously for a period of approximately 10 minutes, repeatedly biting and kicking foal six. Interestingly, however, once this behaviour had ceased, foal two and foal six can be observed eating hay together quietly. Foal six's observed behaviour recordings, will be skewed by the behavioural response to foal two at this time, and we can argue that this is not typical behaviour displayed compared to all other foal behavioural recordings in this study. A clear increase in the frequency of foal six's recorded movement between 16:26pm and 16:36pm was observed, it is also possible that the number of moving behaviours such as trot and canter, as well as moving frequency would be vastly reduced in these foals had this occurrence not happened. Foal six in particular, spends little time moving outside of this period, and records just 15 minutes in total, 8 minutes approximately were recorded during this aggressive period. Behaviours such as these displayed may be explained via the shy-bold continuum and personality types which have been found to be a key element to group life (Briard *et al.* 2015).

4.1.2. Housing and other environmental factors.

A number of other variables have been shown to have an impact on stress seen at weaning. Diet and housing factors are not investigated in this study, but have been cited previously as impactful on foal stress during weaning (Coleman 1999, Nicol *et al.* 2005, Waran *et al.* 2008). The foals in this study, remained within their social group, within their normal housing, and were not moved following mare-removal, or fed a different diet. These are all factors cited in previous studies and stress inducing to foals during weaning (Waran *et al.* 2008). An interesting observation in Williams

(2014), where older foals (>6 months) displayed confidence leaving their dams (who remained in the field out of sight) to be fed. Further investigation would be an interesting extension to weaning studies. Removal of the dams while foals were feeding out of sight, and before the foal returned to the field; the foal would be weaned, without visually seeing the dam removed, leaving the foals within an already established social group, within their normal husbandry and housing system. Locomotion is a common behaviour noted during weaning, time spent moving however, could be influenced by the size of housing area. This was a point noted in Merkies *et al.* (2016) who hypothesised that foals were encouraged to move more due to higher stock density, though this has not been tested and is not supported by the findings in the post mare removal recordings of this study where gradual group were housed in the larger barn.

Relocation following weaning has been found a stress inducing factor (Apter & Householder (1996) and Weary *et al.* (2008). Data recorded in Dubcová *et al.* (2015) finds that foals immediately relocated following weaning is less stressful than foals relocated at a later stage. Their findings show presumed lessening of stress in foals not relocated after weaning, is not mirrored in the measurement of weight gain during this period, although it was mirrored in cortisol concentrates measured immediately after weaning. Weight gain measured in the week following mare removal, showed that foals that were relocated, increased weight at a quicker weight than those not relocated. This is yet another example of the many variables to consider when removing mares from their foals. However, as the study was over consecutive seasons, the authors noted that the findings varied from one season to another, and that this could be due to other factors such as the social structure within

the group. Foal 2 in this study showed excessive aggression behaviours towards foal 6, foals with tendencies such as these, can skew data, and/or change the dynamic of a group. It must also be noted that in Dubcová *et al.* (2015) there were differences in how each season was managed, those weaned in season one, were subjected to different housing systems and human interactions than those in season two. This would have an impact on the data from one season to another, but is a note-worthy thought for further investigation.

4.2.4. Social Interaction

Social interaction has been cited by some as of significance during the weaning process (Waran *et al.* 2008), however while their study looks at the positive impact social interactions may have on foals during weaning, versus responses seen via social isolation it does not look at the potential influence foals may have over others when weaned in a group, as seen in this study. Foals displaying overtly higher frequency of particular behaviours such as aggression will have an impact on other foals within the group, as displayed in the abrupt group of this study. While aggressive behaviours have been noted in prior studies (Weeks, *et al.* 2000, Merkies *et al.* 2016), focus has been on the aggressive foal rather than the recipient. The implications on social interactions in foals needs further investigation, short and long term, in particular, the impact social isolation may have versus those weaned in groups, and those weaned in pairs versus group/singularly weaned foals. The findings in aim one of this study show that the majority of studs do not wean either via barn or paddock weaning (Figure 3.1) where foals are normally weaned while remaining in their social groups, yet while studies state the importance of social interaction, practical findings do not reflect this.

4.2.5. Weaning and influences by sex.

Sex was not found to influence foal behaviour response to weaning in this study. This is contradictory to the results found in Wulf *et al.* (2018) who found, amongst other findings, an increased vocalisation and defecation in colts compared to fillies. Neither locomotion nor total behaviour frequency were measured in their study. Investigation of other measures such as heart rate and cortisol found variability in the responses of foals to weaning depending on sex. Their study of weaning and sex influence, while larger than this study (n=14) was not conducted on a substantial dataset (n=22) and provides scope for further investigation.

4.2.6. Weaning and Welfare.

Varying, weaning studies have discussed stress behaviour and the impact on welfare, many conclude that foals must be subjected to poor welfare due to stress recorded. Assessment of animal welfare is a complex matter (Rushen *et al.* 2011); however, while studies often discuss poor welfare in line with stress, there does not appear to be a commonly agreed consensus of what constitutes good welfare. It has been agreed that a combination of different measurements should be used when evaluating stress in animals as single measurement parameters may be misleading (Broom & Johnson 1993, Rushen *et al.* 2011). With this in mind, while we can agree that stress behaviours are prevalent in foals following mare removal, we cannot clearly state that in this study foals were deemed to have poor welfare, as there are no parameters to compare with what may constitute good welfare. Studies of stress hormone increase in farm animals has had some notable success (Palme 2012), and increased cortisol concentrations post-mare removal have been found in foals

(Moons *et al.* 2005, Dubcová *et al.* 2015, Merkies *et al.* 2016). Further, Palme (2012) believes that the use of non-invasive monitoring of glucocorticoid metabolites in faecal samples can be used to assess welfare. However, there are difficulties in introducing this form of measurement in studies such as this study. It is difficult determining individual faeces for foals kept in groups and/or large spaces, additionally; the introduction of a human collecting faeces samples adds another variable to the study, thus potentially affecting results. The use of heart rate monitors has been used to investigate stress (v. Borstel *et al.* 2017). To gain more consistent, robust results, use of a variety of measures in further study should be employed such as behavioural analysis, heart rate, weight loss/gain, eye temperature and cortisol measures to ensure strength in findings.

5.0 Conclusion

The results of this study are two-fold, aim one clearly demonstrates that there is a wide variety of weaning methods employed worldwide and that opinion about best method to adopt is mixed. A clear underlying thought that methods used are the least stress inducing, show the industry is generally aware of welfare concerns regarding mare removal and are attempting to ensure that this is addressed. However, it is also clear that there is a lack of consensus about the best method and no guidelines to steer the industry, thus highlighting a need for further research in this area in order to address welfare concerns.

Inspection of respondents' data suggest that large studs and those who breed many foals are more likely to breed every year and tend to remove foals from their mother earlier. Using objectively measured data, this study demonstrates that although

current weaning practices vary in terms of method used and age at removal, there are significant trends according to method, stud size and number, and frequency of foals bred per annum.

The findings in aim two suggest that there are some differences shown between the abrupt method and the gradual method adopted for this study. Significant differences in terms of the behaviours and/or stress displayed following mare removal can be seen between the two methods. However, it is not yet possible to define one from the other in terms of which method may be the better in order to address welfare concerns, and further investigation is warranted. This study has only explored a small area of weaning. There are a variety of differing methods and environmental concerns that impact weaning related stress. With the use of scientific instruments, such as heart rate monitors or cortisol measurements available today, there is the capacity to investigate much further to enable clear guidelines to be created. It is abundantly clear that supplementary, more in depth research is needed to address the stress caused during weaning and the many variables that can and do affect this.

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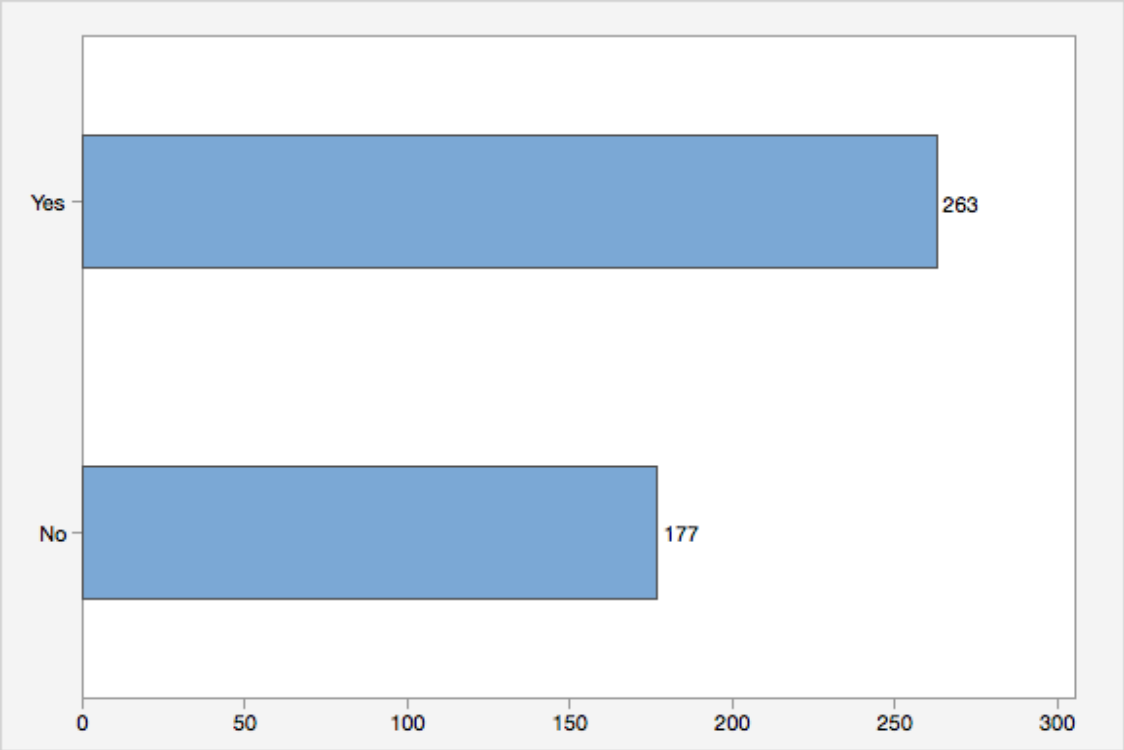
7.0 Appendix

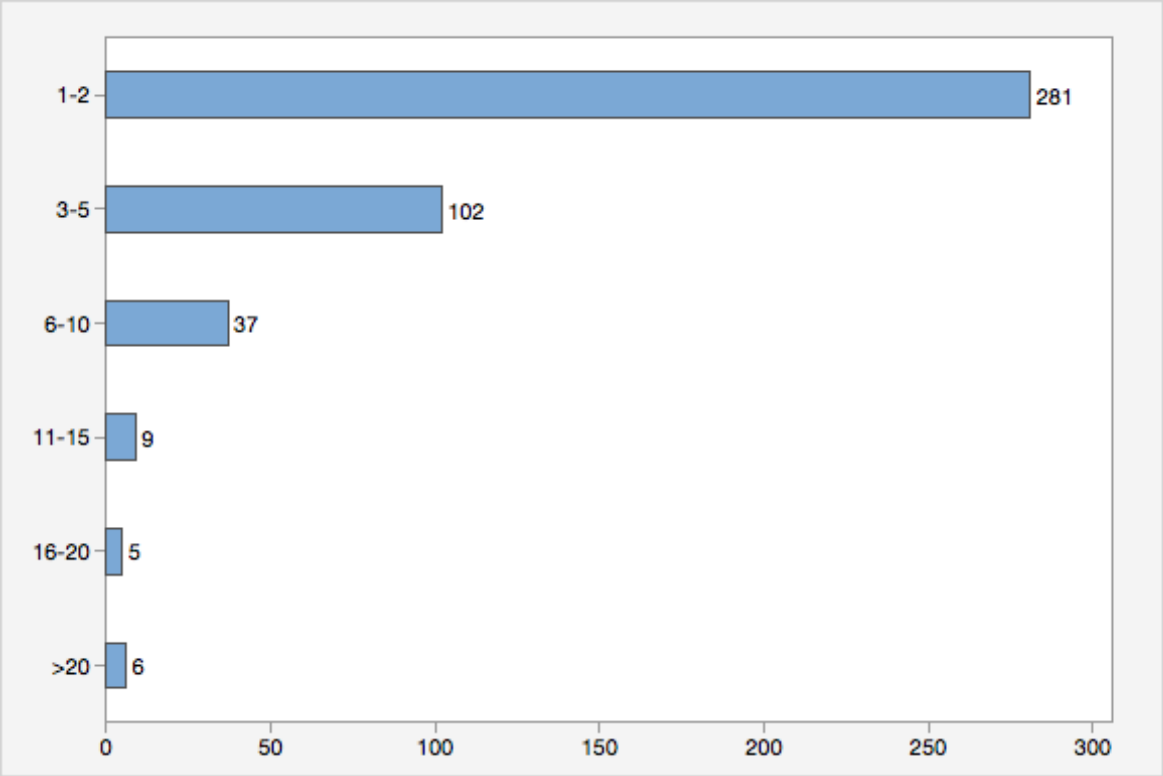
Questionnaire distributed via SurveyMonkey online.

Q1 Do you breed foals every year? Answered: 440 Skipped:0



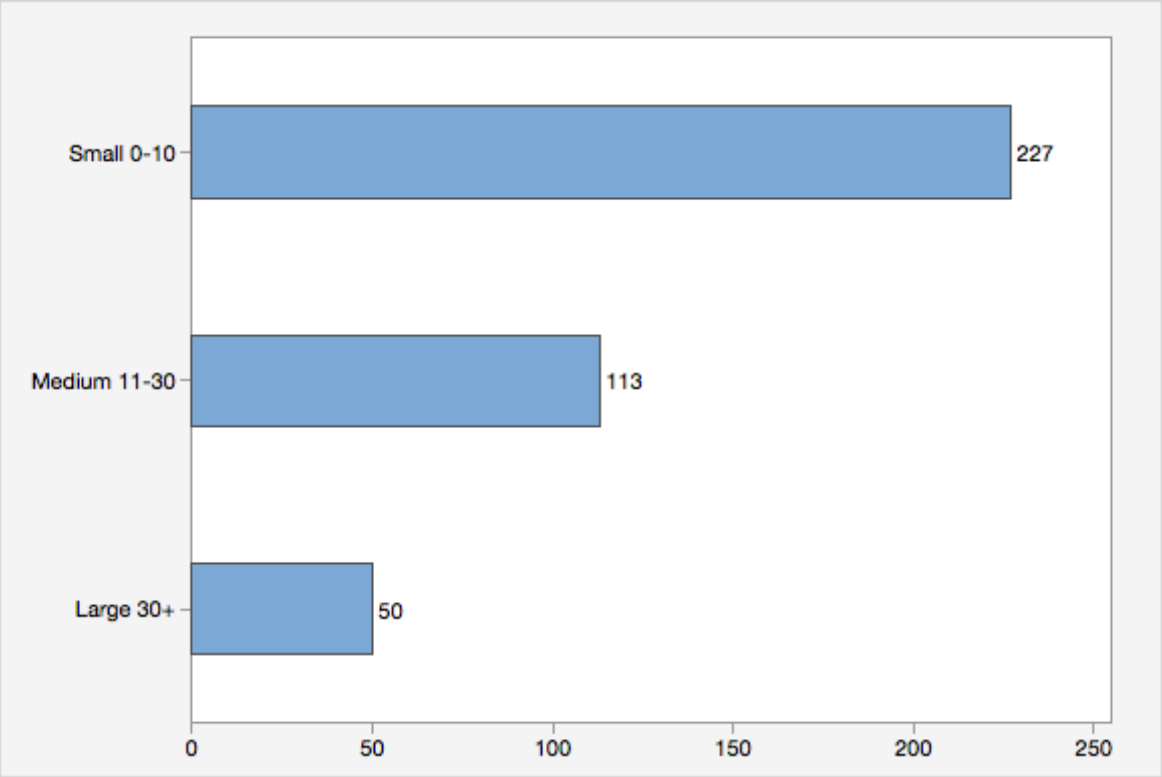
Answer Choices	Responses	
Yes	**59.77%**	263
No	**40.22%**	177
Total		**440**

Q2 How many foals on average do you breed each year? Answered: 440 Skipped 0



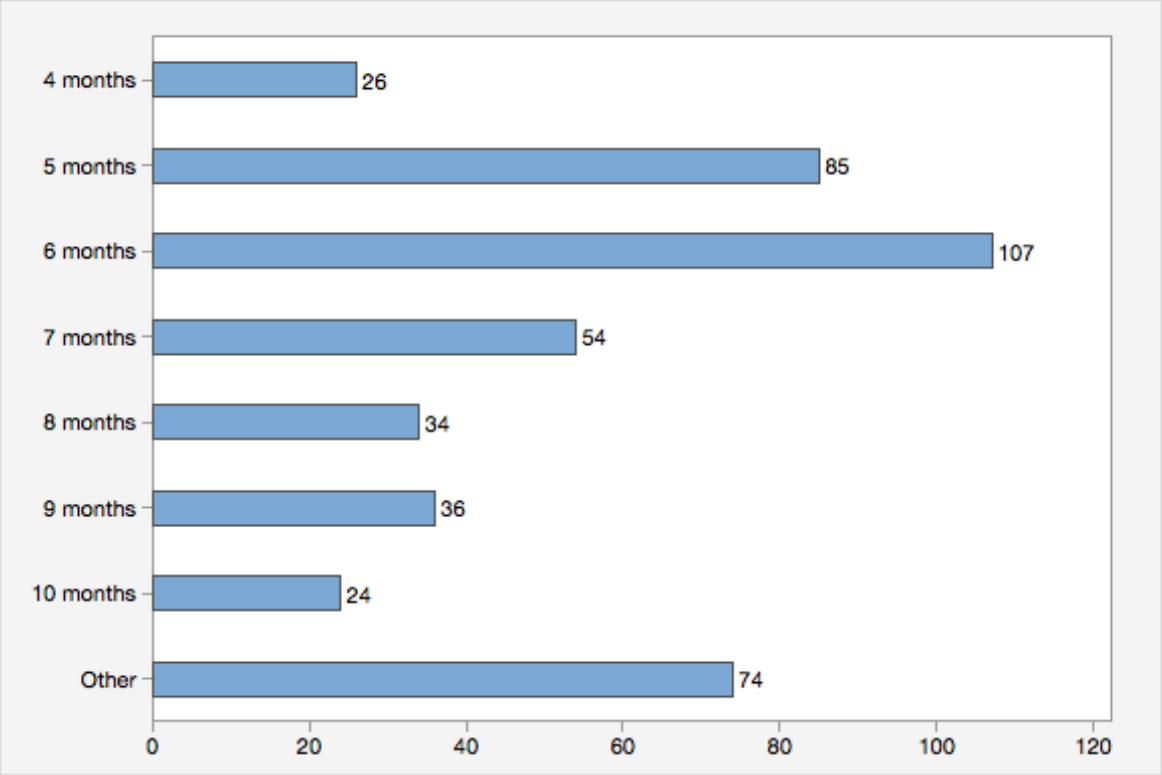
Answer Choices	Responses	
1-2	**63.86%**	281
3-5	**23.18%**	102
6-10	**8.40%**	37
11-15	**2.04%**	9
16-20	**1.13%**	5
>20	**1.36%**	6
Total		**440**

Q3 How big is your stud? Answered: 440 Skipped: 0



Answer Choices	Responses	
Small 0-10	**58.20%**	227
Medium 11-30	**28.97%**	113
Large 30+	**12.82%**	50
Total		**440**

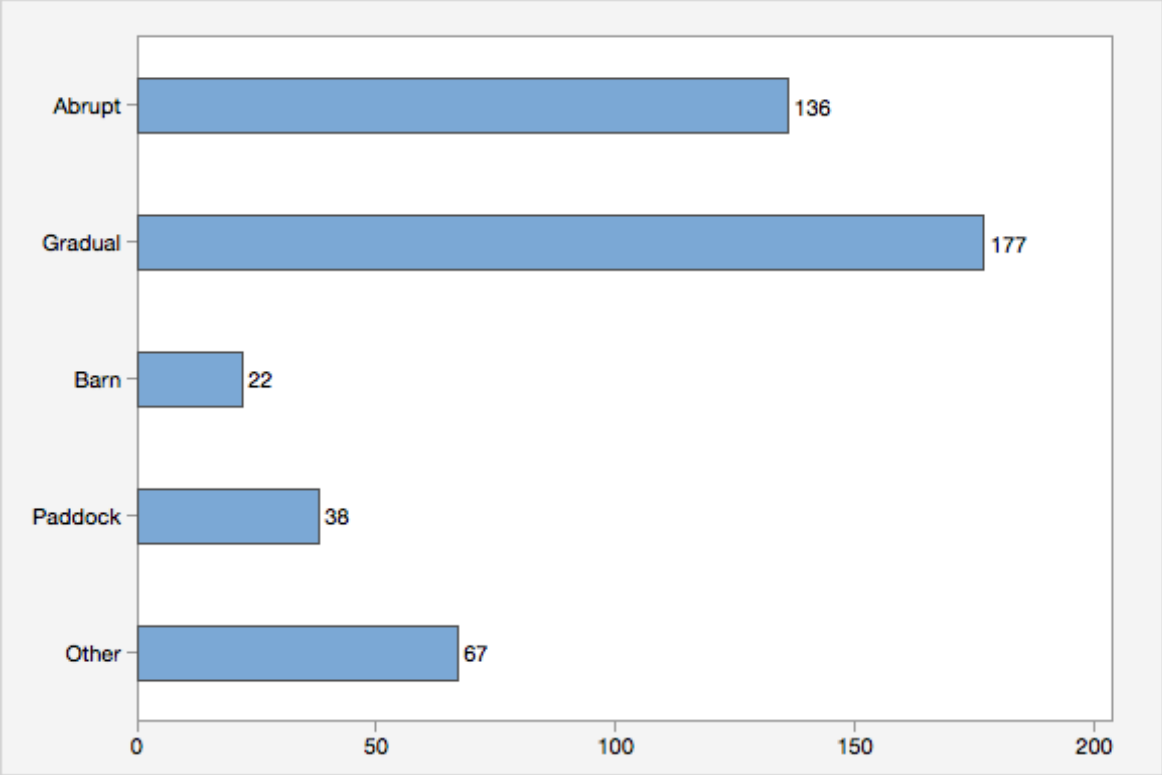
Q4 At what age do you remove foals from their mothers? Answered: 440 Skipped: 0



Answer Choices	Responses	
4 months	**5.90%**	26
5 months	**19.31%**	85
6 months	**24.31%**	107
7 months	**12.27%**	54
8 months	**7.72%**	34
9 months	**8.18%**	36
10 months	**5.45%**	24
Other	**16.81%**	74
Total		**440**

Q5 What method of weaning do you use? Abrupt/Gradual/Barn/Paddock/Other

Answered: 440 Skipped: 0



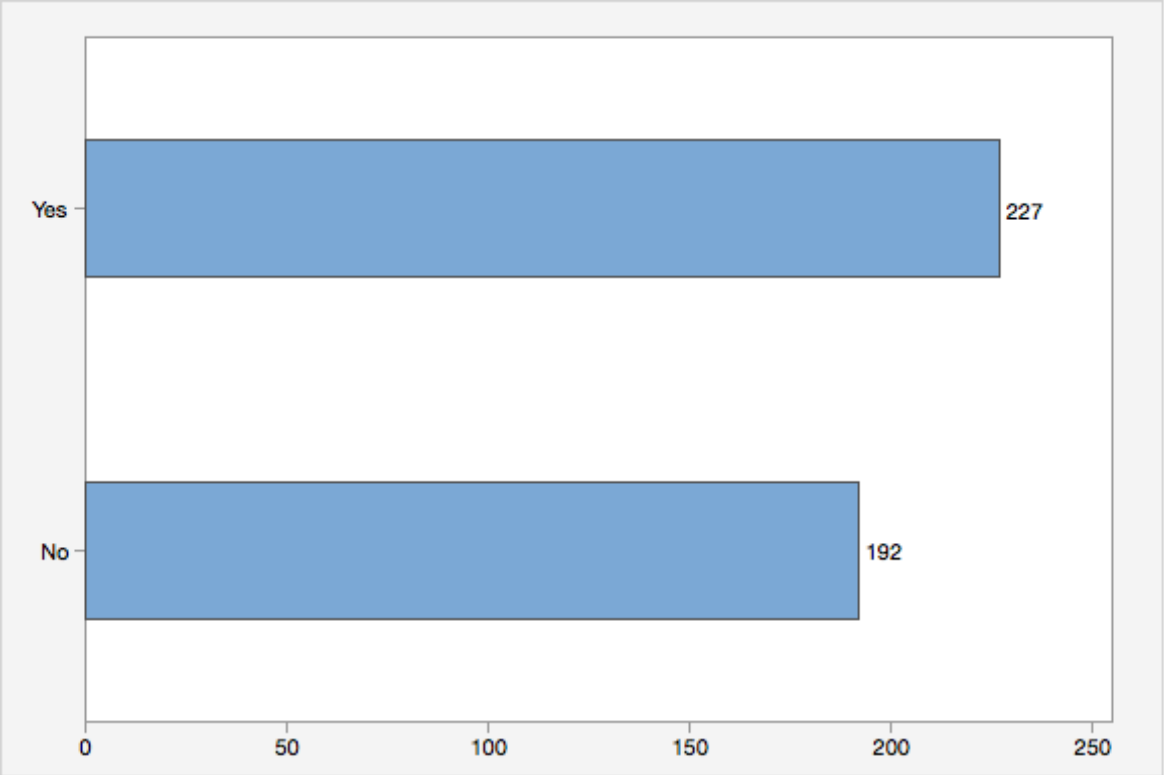
Answer Choices	Responses	
Abrupt	**30.90%**	136
Gradual	**40.22%**	177
Barn	**5%**	22
Paddock	**8.63%**	38
Other	**15.22%**	67
Total		**440**

Q6 Why do you use this method of weaning? **Answered: 440 Skipped: 0** (Open ended question)

Q7 Would you like to add anything else? **Answered: 242 Skipped: 198** (Open ended question)

Q8 What behaviours do you see in the foal during the weaning process/mare removal? **Answered: 440 Skipped: 0** (Open ended question)

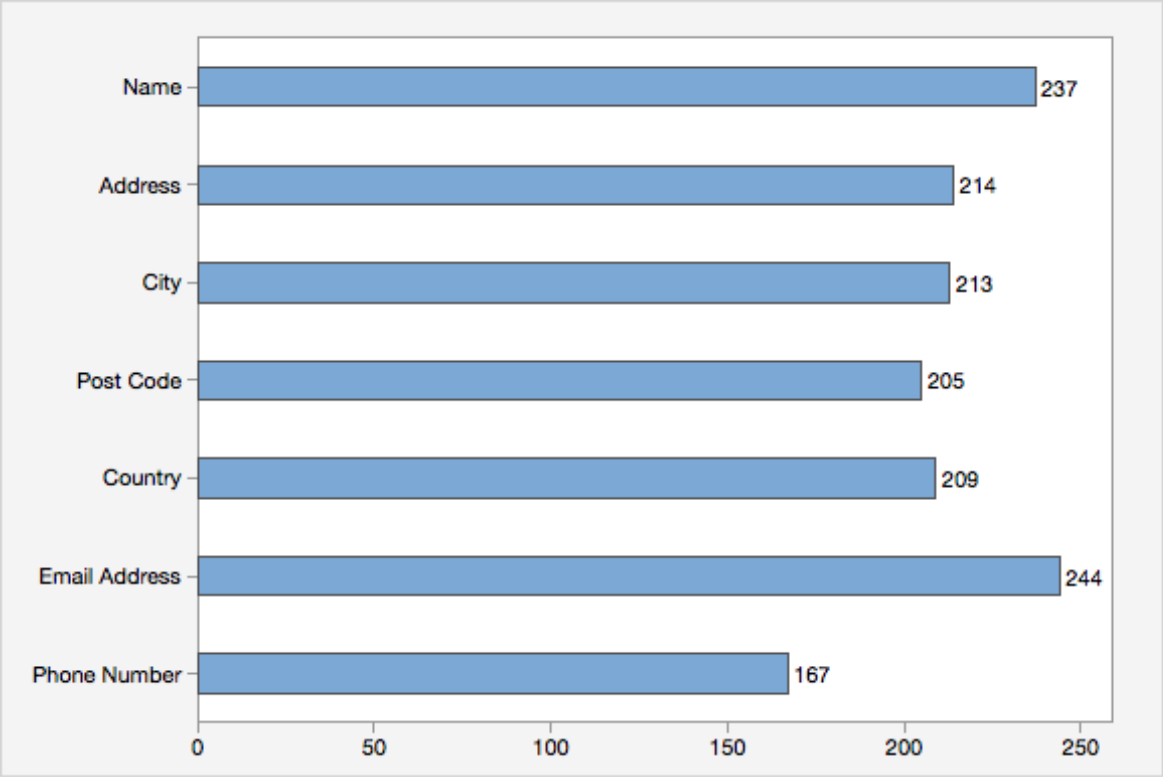
Q9 Would you be interested in participating in further research regarding equine weaning? **Answered: 419 Skipped: 21**



Answer Choices	Responses	
Yes	**54.17%**	244
No	**45.82%**	196
Total		**419**

Q10 Please add your contact details if you answered yes to question 9.

Answered: 244 Skipped: 196



Answer Choices	Responses	
Name	**97.13%**	237
Address	**87.70%**	214
City	**87.29%**	213
Post Code	**84.01%**	205
Country	**85.65%**	209
Email Address	**100%**	244
Phone Number	**68.44%**	167
Total		**244**