Charles University in Prague

Faculty of Science

Department of Zoology

Bc. Iva Leszkowová

Vliv sourozenecké kompetice během přístupu ke struku na mateřské chování u prasete domácího (*Sus scrofa forma domestica*)

Effect of sibling competition during teat access on the maternal behaviour in domestic pigs (*Sus scrofa forma domestica*)

Diploma thesis

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Supervisor: RNDr. Gudrun Illmannová, CSc.

Prohlášení

Prohlašuji, že jsem diplomovou práci vypracovala samostatně s použitím uvedené literatury a pod vedením mé školitelky RNDr. Gudrun Illmannové, CSc.

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Poděkování

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Abstract

This diploma thesis deal with the neonatal sibling competition during nursing within first day after farrowing, focusing on maternal reaction on neonatal sibling competition during nursing. We predicted that the sow will terminate nursing by a changing posture or by a non-nutritive nursing (i.e. nursing without milk ejection) with increasing number of fights and screams. A total of 19 healthy sows and their litters were directly observed and video recorded during first day after farrowing for 6 h. The behaviour of piglets (fighting, screaming, presence at the udder) in the pre massage and the post massage was scored every 15 seconds. Piglets which missed milk ejection, posture changing of the sow and whether the nursing involve milk ejection were noted. A sum of fighting and screaming piglets in the pre massage and the post massage was calculated. A higher sum of fighting and screaming piglets correlated with a higher proportion of non-nutritive nursing ($P<0.001$) as well as with a higher proportion of sow posture changing in the pre massage ($P<0.01$). However, a higher sum of fighting and screaming piglets did not increase the probability of sow posture changing in the post massage. The results show a positive correlation between the litter size and the sum of fighting and screaming piglets in the pre massage ($P<0.01$) as well as in the post massage ($P<0.05$) and also positive correlation between the litter size and proportion of piglets missing milk ejection ($P<0.01$). The proportion of piglets missing milk ejection increases also with increasing sum of fighting and screaming piglets ($P<0.01$). In conclusion, maternal reaction in form of posture changes in pre massage and non nutritive nursing were associated with a higher sibling competition and they might serve as a mechanism to depress intense competition. It is suggested that increasing litter size associated with more piglets compete and more piglets missing milk ejection might indicate a higher risk of mortality among neonatal piglets.

Key words: domestic pig, neonatal sibling competition, maternal behaviour, nursing

Abstrakt

Tato diplomová práce se zabývá neonatální sourozeneckou kompeticí při kojení v průběhu prvního dne po porodu s důrazem na mateřské reakce na sourozeneckou kompetici během kojení. Předpokladem bylo, že s rostoucím počtem soubojů a kvičení bude prasnice častěji ukončovat kojení změnou polohy těla či prostřednictvím ne-nutritivního kojení (kojení bez ejekce mléka). Celkem 19 zdravých prasnic a jejich vrhů bylo přímo pozorováno a nahráváno na kameru během prvního dne po porodu po dobu 6 hodin. Každých 15 sekund premasážní a postmasážní periody probíhal záznam chování selat (souboje, kvičení, přítomnost u struku). Během kojení byla registrována selata, která zmeškala ejekci mléka, změny polohy těla prasnice a zda kojení proběhlo s ejekcí mléka. Byla vypočítána suma bojujících a kvičících selat během premasážní a postmasážní periody. Vyšší suma bojujících a kvičících selat korelovala s větším poměrem nenutritivních kojení ($P<0.001$) a také s vyšším poměrem změn polohy prasnice během premasážní periody ($P<0.01$). Pravděpodobnost změny polohy těla prasnice během postmasážní periody se však s rostoucí sumou bojujících a kvičících selat nezvyšovala. Výsledky prokázaly pozitivní korelaci mezi velikostí vrhu a sumou bojujících a kvičících selat během premasážní periody ($P<0.01$), jakož i během postmasážní periody ($P<0.05$) a dále pozitivní korelaci mezi velikostí vrhu a poměrem selat chybějících u ejekce mléka ($P<0.01$). Poměr selat chybějících u ejekce mléka stoupal také s rostoucí sumou bojujících a kvičících selat ($P<0.01$). Lze konstatovat, že mateřské reakce ve formě změn polohy těla během premasážní periody a prostřednictvím nenutritivního kojení souvisí s vyšší sumou bojujících a kvičících selat a mohly by sloužit jako mechanismy k potlačení intenzivní kompetice. Rostoucí velikost vrhu, asociovaná s vyšším počtem kompetujících selat a s vyšším poměrem selat chybějících u ejekce mléka, může vést k rostoucímu riziku mortality novorozených selat.

Klíčová slova: prase domácí, neonatální sourozenecká kompetice, mateřské chování, kojení

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1. Introduction

Domestic pigs range to the polytocous animals and shown a high mortality rate among neonatal piglets, which may be often caused by the sibling competition. Piglets are born precocious and highly developed which is uncommon among polytocous mammals (Fraser, 1980). Consequently, they are able to compete with their siblings about access to the functional teats already short time after birth. Piglets tend to prefer one or two specific teats from which they suck during whole lactation and which they defend again other littermates. It result in establish the specific teat order during the first days after farrowing.
Sibling competition brings disadvantages for participating piglets as for whole litter. Fights are energetic demanding and can lead to a facial wounding. The loser can be removed from teat during the brief milk ejection and consequently risk the dead by starvation.
From the perspective of mother, sibling competition may by a mechanism of reduction the large litter size on optimal level, which ensuring adequate resources for survival offspring and therefore increasing their survival prospect. Thus, for the mother sibling competition may be essentially beneficial due to ensure the survival of high quality offspring. However, there is a cost for sow by intense sibling competition. The resources are used by piglets that consequently do not survival, also there is an energetically expenditure of piglets that prevail in sibling competition. Furthermore sibling competition can cause discomfort for sow. Thus, sow should react on intense sibling competition in order to suppress it.

2. Sibling competition

Many animals grow up in the company of same or different-age siblings and the relationship among them may be expected to form their developmental enclosure. Individual young may be advantageous by the presence of siblings, for example be providing the environment that ensures normal development. For instance, in mammals can be sufficient stimulation of sucking sometimes achieved only by a group of offspring (see Hudson and Trillmich, 2008). On the other hand, there also can be negative relations among siblings in the form of competition about parental resources (Trivers, 1974). Sibling competition is expected to occur especially when parental resources are poor and current brood needs overbalance possible parental supplies. This situation can possible exist in

every polytocous species. In mammals, the conflict may exists among siblings in one brood over the amount of milk, especially when the litter size increase and the number of offspring exceeds the number of teats, which can be occur for example in guinea pigs (*Cavia aperea f. porcellus*; e.g. Fey and Trillmich, 2008), in spotted hyena (*Crocuta crocuta;* e.g. White, 2008) or in domestic pigs. Within these species sibling competition may play a crucial role early in life of offspring.

2.1. Models of competition

As described Nicholson (1954), there are two general models of competition, scramble, which is equal resource allocation, and contest, based on unequal resource allocation with monopolization. If animals contest for food, they acquire either a sufficient quantity of food or no food at all. This behaviour is based on direct aggression between individuals and can bee seen for example in species with infant dominance, when dominant sibling attack subordinate young in order to gain more parental resource, which is the situation in many precocial fowl, in coyotes, red foxes and other species, probably also in domestic pigs (review Drummond, 2006). The next model, when animals scramble for food, each animal attempt to acquire as much food as possible. It can result in situation where some individuals end up with more food then are necessary for survival, others reach just the minimum amount and some are sentenced to dead because they are not able to reach nor the minimum amount (see De Jong, 1976). Scramble competition not involve direct aggression, but indirectly may lead to lethal consequences. In some cases, scramble competition resemble territoriality, for example when young hyraxes of piglets defend particular prefer teat (Hudson and Trillmich, 2008).

2.2. Direct and indirect sibling competition

Competitive behaviour among siblings has a lot of forms. It ranges from spectacular aggressive interactions, sometimes leading to siblicide, through various milder agonistic interactions, to indirect scramble competition (see Hudson and Trillmich, 2008). In the pigs, as sometimes in guinea pigs (Fey and Trillmich, 2008), direct competition takes the form of fighting for the access to the teat, in piglets often accompanied with load

screaming (e.g. Algers and Jensen, 1985; Illmann et al., 2008). After birth, piglets try to locate and retain possession of a teat. Those who fail to do this are shifted from place to place along the udder, initiating fights and attempting to displace other siblings. Winner in early competition is more often piglet which owned a teat, which is later indentified as preferred one (Hartsock and Graves, 1976; Scheel et al., 1977). This fact suggest that piglets have a “home court advantage”, when fighting at their preferred “home” teat region (Hartsock and Graves, 1976), which is a territorial aspect in many species. Those piglets without access to teats often fail to obtain colostrum and milk during nursing episodes, which can have a lethal consequence (Scheel et al., 1977). A lot of piglet's deaths result from starvation or the crushing of weakened malnourished young (English and Smith, 1975; Dyck and Swierstra, 1987). The failure of piglets to obtaining adequate milk supply during the first days of life may be the result either of agalactia or competition with large and stronger siblings and the competition appears to be the cause of many starvation deaths (English and Smith, 1975; Hartsock and Graves, 1976; Fraser et al., 1995).

In pigs, piglets also can indirectly affect each other's milk intake (Fraser, 1990). This indirect sibling competition can be seen in various ways and it may be induced by both body weight and birth order of piglet. Earlier born piglets are often also larger and more vigorous (Hartsock and Graves, 1976) and thus may be able to more effective withdrawing of milk from teat and this potentially stimulating higher milk production of that udder region (Fraser, 1990).

2.2. Obligate and facultative siblicide

The obligate siblicide, characterized by direct killing of young by other sibling, is specific and well know in many avian species (e.g. black eagles, pelicans; review Mock et al., 1990). In mammals there is no evidence so far of any obligate siblicide. Nevertheless, if mothers are unable to maintain sufficient milk supply, competitive interactions among siblings may lead to the indirect facultative siblicide (review Hudson and Trillmich, 2008). In theory, facultative siblicide is profitable for dominant offspring, when the parental resources are inadequate to the whole litter. Than dominant offspring would receive the resources provided for subordinate sibling as their own resources, even if it can cause a dead of a subordinate young. On the other side, when parental resources are abundant,

siblicide brings only small benefits in the form of a slightly increase of the survival of dominant offspring, which don't fully compensate the loss of fitness through the loss of sibling. This theoretical reasoning is in accordance to several empirical studies (review Hudson and Trillmich, 2008). Facultative siblicide is the method of adjusting brood size for several bird species. This strategy is followed also by a few mammals, such as the spotted hyenas *(Crocuta crocuta*- Smale et al., 1999), several species of canids (Bekoff, 1972, 1974 in Andersen et al., 2011) and also the domestic pigs.

3. Domestic pigs

Pigs belong to the order *Artiodactyla* in family *Suidae.* Domestic pigs are animal with long history associated alongside human. Their domestication is dated since 5000-10000 years ago in Europe and Asia (Zeuner, 1963 in Graves, 1984). Despite this, domestic pigs have still nearly the same maternal behaviour like their ancestor - wild boar *(Sus scrofa* - Linnaeus, 1758) (see e.g. Gustafsson et al., 1999; Špinka et al., 2000). The domestic pig represents a unique mammal due to several characteristics. For example, they produce a large litters as many of rodents (*Rodentia*) or carnivores (*Carnivora*), yet the young are precocial, like in most other ungulates, also they have specific nursing patterns exceptional within all mammals.

3.1. Parent-offspring conflict in pigs

Sibling competition can play a role in reproduction in species which produce litters or broods larger that can be reared, particularly in environment with unpredictable resources. This reproductive characteristic called "*overproduction"* is known in some bird species, for example in eagles, pelicans, cranes or boobies (Mock and Forbes, 1995). Overproduction is based on production of the *"core brood"*, with number of young that can be normally reared, and the "*marginal brood"* of "spare" young. Spare young may act as a insurance against loose of core offspring, may serve as a food or servants for core offspring and also they can survive when the resource are plentiful (Mock and Forbes, 1995). However, should resource are limited, sibling competition may be used to determining the brood size on the level that can be provided for and spare young are

sentenced to dead (Mock, 1984). This using of sibling competition involves several traits. The small costs of production one or more spare young, intense competition among siblings and different body size in brood which lead to different abilities in competition and consequently to ensuring that more advantaged young will not be jeopardized by competition with a spare young (Mock, 1984). Pigs fit these characteristics remarkably well. They gave birth to a large litters - in average 12 piglets in domestic pigs (but even 20 and more piglets in one litter) and around 3-7 piglets in the wild boar (see Bieber and Ruf, 2005). Newborn piglets are much smaller in comparison with their mother, they achieve only about 0, 5% of mother's weight (Fraser and Thompson, 1991) and thus the energetically expenditure of production an extra young is not high. Next, competition among neonatal piglets is often very intense and might result in higher mortality among newborn piglets (English and Smith, 1975). Further, many litter shown relative great differences in body size and weight, when the smallest young can have only one third on the weight of heaviest (Fraser et al., 1995), and heavier piglets are usually more successful in teat disputes (De Passillé and Rushen, 1989).

In mammals, the main component of parent-offspring conflict includes milk provisioning. In pigs, both sow's condition and piglet's weight gain and survival are directly affected by nursing. Thus, conflict occurs through sow's weight loss, piglet's weight gain and nursing frequency. Intervals between nursings are important in pigs because they strongly affect milk production. Shorter intervals between milk ejections ensure higher total milk input for piglets (Špinka et al., 1997). In the first days after farrowing, sows, kept in large outdoor enclosure, appear to allow piglets to suckle frequently and for as long as they wish. However, yet from the first week post-partum frequency of nursings decrease and duration of nursing bouts are shortened through active termination of nursing by the sow (Jensen, 1988; Csermely, 1994). Also the proximity of sows and litters declines gradually over next several weeks, presumably as a result of both sow and piglet behaviour. This situation called weaning process and it is completed at about 16 week's post-partum (Jensen, 1988).

3.2. The litter reduction period

The most critical time for piglets' survival occurs the first 3 days after birth- called

litter reduction period. In this time the rate of neonatal piglet's mortality is highest (e.g. 60% - Dyck and Swierstra, 1987; 80% - Svendsen, 1992). Thus, from the view of the mother and her investment, lactation can be divided into the two periods : first, initial period of litter reduction (about days 1-3), when the litter size is adjusted, and second, the rest of lactation, during which growth rate of piglets, but not litter size, is influenced by maternal investment.

The major causes of neonatal mortality of live born piglets can be divided in three parts: maternal infanticide, starvation and insufficient milk production (see Andersen et al., 2011), from which 50-80% of the deaths may explain crushing by the sow and starvation (English and Morison, 1984; Svendsen et al., 1986; Dyck and Swierstra, 1987; Marchant et al., 2000). Both mechanism work either independently or in the same time, and within a short period after birth, thus reducing the litter size quickly.

Crushing or overlying by the sow or savaging of piglets are a common parts of direct litter reduction. Savaging, i.e. biting its own piglet to dead, is widely variable among individual sows and occur in domestic as in wild sows (e.g. Harris et al., 2001; Chen et al., 2008). Crushing or overlying by sow happens predominantly when the sow change her posture within the first three days after farrowing, with a peak during the first 24 hours (e.g. Weary et al., 1996; Marchant et al., 2001). The probability of crushing increase in accordance to some maternal characteristics, such as a low responsiveness of piglet's distress calls, high frequency of posture changes, low carefulness during this body movements or lower nose contact with piglets after posture changing (e.g. Wechsler and Hegglin, 1997; Andersen et al., 2005). Historically, maternal crushing has been viewed as an accident. However, in the last time emerge evidences that crushing may be a selective event. Andersen et al. (2011) observed an increase in crushing deaths with increasing litter size, but only for piglets without milk in their stomach. Furthermore, crushing quite often occurs immediately after the mother has nosed or oriented towards the piglets (Andersen et al., 2005), indicating that she know about piglet's present. Crushing behaviour is also highly variable among sows and it seems to be related to personality or temperament (Andersen et al., 2005).

Sibling competition plays a crucial role as a second mechanism in the litter reduction period. It has been suggest, that the cause of many starvation deaths appears to be just the sibling competition, rather than a general inability to thrive (see Drake et al.,

2008). The neonatal sibling competition occurs through the adequate access to functional teats. Piglets tend to suck form the same teat within whole lactation and defend it against other littermates (Puppe and Tuchscherer, 1999), which lead to the establishment of a specific teat order (McBride, 1963). Because piglets belong to precocial young, they are able to compete within a several minutes after the birth (e.g. Hartsock and Graves, 1976; De Passillé and Rushen, 1989). Furthermore, piglets are born with fully erupted and specifically oriented deciduous canines and third incisors (Figure 1) which often use during a teat disputes (Fraser and Thompson, 1991). The loser in the competition pays double costs; they lose energy in attempt to display siblings from their teats and they often consume less colostrum and missing more milk ejections (Scheel et al., 1977), which result in decreasing probability of survival.

From the perspective of the mother, both mechanisms have a similar effect of reducing the number of surviving offspring and increasing the amount of resource for the survivors. However, sibling competition is a more costly process of litter reduction: resources are used by offspring that do not survive, some resources are expended by the surviving offspring in order to defend own teat and aggressive competition about access to teat may cause discomfort for sow and may result to teat injuries. On the other hand, sibling competition may be a more precise mechanism compared to infanticide for ensuring the elimination of smallest and /or least healthy piglets (see Drake et al., 2008; Andersen et al., 2011).

Figure 1. The bottom jaw of piglet first day after birth, arrow indicate specifically oriented third incisor (from Drake et al., 2008)

3.3. Nursing in domestic pigs

In order to understand the principles of sibling competition, it is necessary to become acquainted with the characterizations of the nursing in pigs. Domestic pigs have complex

unique nursing-suckling behavioural patterns with a number of characteristic features, which makes them different from other mammals. Every nursing bout consist of several distinct phases of sucking by the piglets and characteristic grunting patterns by the sow. The milk is available only in very brief period about 15 - 20 s in every sucking bouts (Gill and Thomson, 1956). To achieve a milk ejection, it is necessary to almost all piglets participate in the pre massage period (Illmann et al., 1999). These specifics of nursing and sucking are interpreted as adaptation in order to ensure the distribution of milk among relative large number of littermates (Fraser, 1980).

3.3.1. Characteristic of nursing

During the parturition and in the next few hours the colostrum is available continuously (Lewis and Hurnik, 1981) and piglets suckle from a lot of teats in order to maximize colostrum intake (so called „*teat sampling*"; Hartsock and Graves, 1976). After this period milk ejection changes to discrete cyclical nursing bouts about every 30 - 70min (Jensen et al., 1991) and piglets start to suck synchronously. However, the characteristic sucking patterns are established after the first 24 h post-partum (Špinka et al., 1997). Typically cyclical sucking can be divided into 5 phases (Figure 2), according to Whittemore and Fraser (1974) (in Fraser, 1980).

1. In the first phase piglets assemble to the sow and arrange themselves to the teats. Duration of this period is variable, from several seconds to several minutes.

2. Piglets are settled into the udder and they start to massage teats with rhythmically up and down movements of snout. This pre massage last usually about one minute or more and generally all littermates participating massage (Illmann et al., 1999). The sow is gradually increasing her grunting rate.

3. Mechanic stimulation of the udder in phase two lead to the release of the oxytocin from sow's neurohypophysis, which causes rapid increasing in sow's grunting rate. This change in sow's grunting may by a signal for piglets that milk ejection is approaching. Piglets start to suck the teats with slow mouth movements for about 20s.

4. In fourth phase a milk ejection occurs. The milk ejection period can be recognized by the rapid sucking movements of the piglets (Rushen and Fraser, 1989) and second increase in grunting rate of the sow. Milk ejection last only very brief time, about

15-20s. Because of pigs haven't no anatomic cistern for milk storage, this is the only period of the nursing when the piglets actually ingest milk.

5. The milk letdown is followed by the fifth phase and that is the post massage, when piglets again massage the udder with slow mouth movements or nosing the udder from relative long time for up to 15 min. The duration of post-ejection massage differ between nurslings and also between littermates (e.g. Illmann and Madlafousek, 1995; Valros et al., 2002). Possible functions of this massage may be stimulation of higher total milk output or redistribution of milk production among the teats (Špinka and Algers, 1995; Jensen et al., 1998).

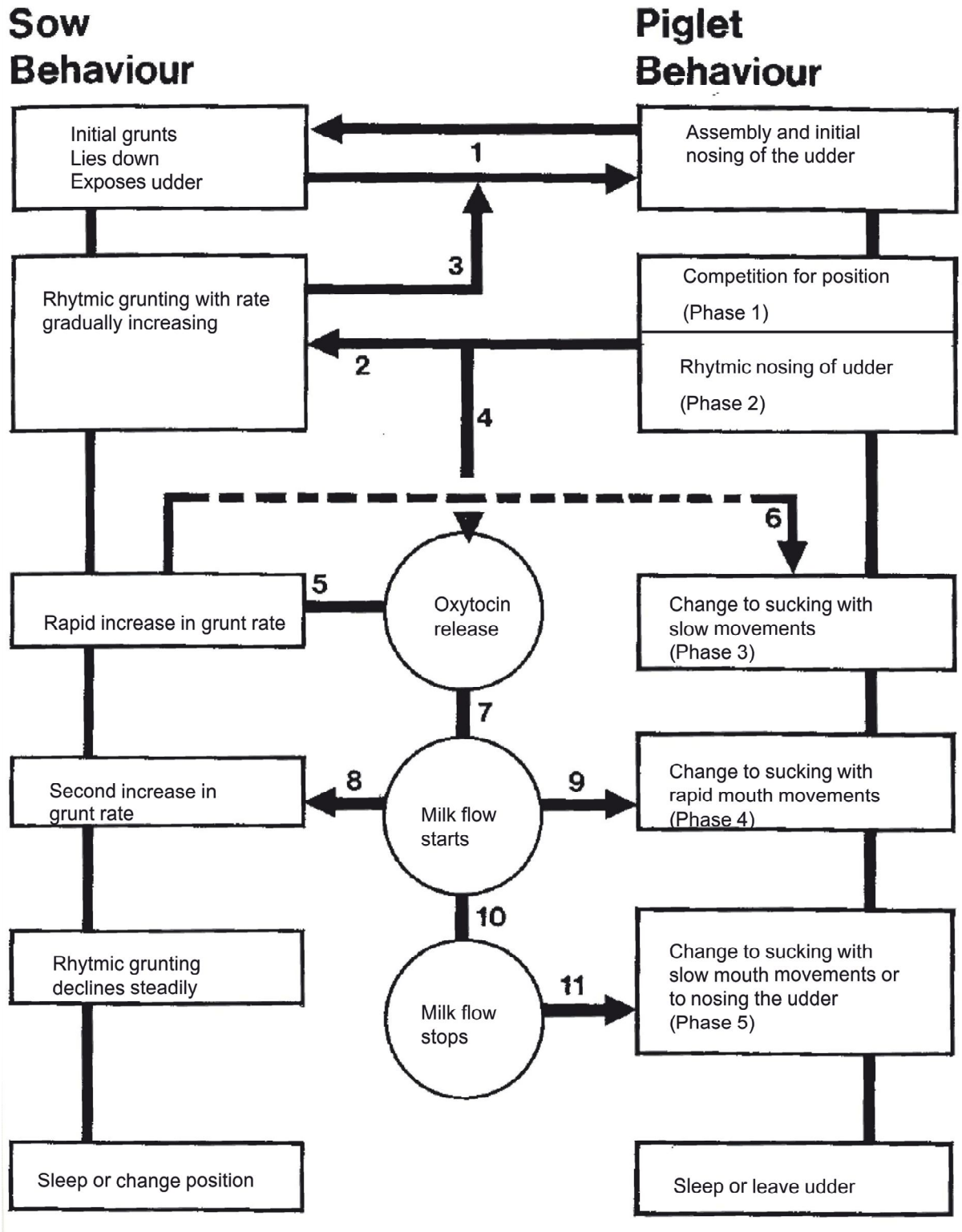

Figure 2. Nursing patterns of domestic pigs (from Fraser, 1980)

3.3.2. Sucking intervals

The milk production and accordingly the total amount of milk is strongly affected by sucking intervals. The study by Špinka et al. (1997) showed that mammal gland of sow is refilled early after last ejection, almost after 35 minutes. When a sow nurses in longer intervals, for example after 70 min or 100 min, the milk intake of the piglets increases, but only weakly (Figure 3). However, this low increase in milk input after longer inter nursing intervals can not fully compensate the time deviation. Thus, the total milk intake is greater when the intervals between nursings are shorter. Generally, sucking intervals during the first week of lactation ranged between 30-70 minutes (Jensen et al., 1991) although some sows abruptly changing their sucking intervals within this period (Illmann and Madlafousek, 1995).

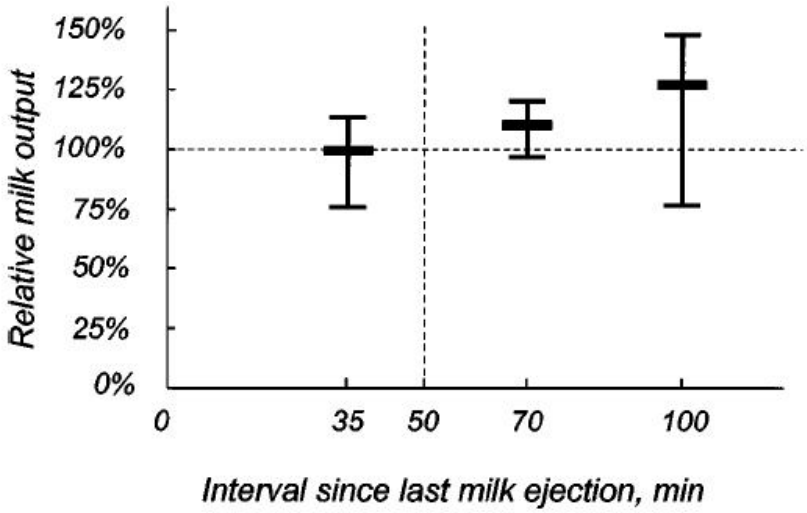

Figure 3. Relative milk output after inter nursing intervals 35, 70 and 100 minutes expressed as a percentage of milk output after interval 50 minutes (form Špinka et al., 1997).

3.3.3. Non nutritive nursing

Some nursing bouts in pigs end without milk ejection. Based on no available milk, these events are called „*non- nutritive nursings'*"(NNNs). NNNs can occur in until 30% of

all nurslings' within lactation (e.g. Castrén et al., 1989; Illmann and Madlafousek, 1995) and was examined in different enclosures and during various time of lactation (e.g. Newberry and Wood-Gush, 1985; Illmann and Madlafousek, 1995; Valros et al., 2002) and also in a wild boar (Horrell, 1997). In contrast to nutritive nursing, during NNN sows do not increase her grunting rate, oxytocin is not release (Ellendorf et al., 1982), piglets do not show uniform rapid mouth movements (Rushen and Fraser, 1989) and milk ejection does not occur (Fraser, 1977 in Špinka et al., 2011; Špinka et al., 1997). However, the sow and her litter enter an NNN with full motivation to accomplish a normal sucking - piglets solicit milk with vigorous teat massaging and the sow accept teat massaging in normal laterally nursing posture and grunts initially in the same rate as during nutritive nursing (Illmann et al., 1999). The consequence of NNN may be prolongation of the intervals between milk ejections (Castrén et al., 1989; Illmann and Madlafousek, 1995) which result in a decrease of total milk output and body weight gain of piglets (Špinka et al., 1997). Although piglets are fully depended on maternal milk provisioning during an early lactation and milk output influence weight and survival of piglets, it is important to know about the reason of NNN.

NNNs can be the result of some disruption of the nursing behaviour, for example when a lot of piglets are missing at the udder during the initial massage (Fraser, 1973) or when they are fighting for teats. However, Illmann et al. (1999) observed NNN even if all piglets were present at the udder and massaged the teats with the same intensity as in nutritive nursing during the initial massage. Recently it has been suggested that NNNs might be a part of honest signalling system in pigs (Špinka et al., 2011).

In general NNNs can be divided in physiological and behavioural NNNs. Physiological NNNs looks like a nursing with milk ejection but oxytocin in not released and there is no milk ejection. During behavioural NNNs the sow terminates nursing by posture changing during the pre-massage at the time, when the milk ejection is still possible. The duration of such NNNs is shorter.

3.4. Teat order

A specific teat order in pigs is noticeable during the nursing (McBride, 1963). The principle is that every piglets suck from their own teats (or teat pair - e.g. Hartsock and Graves, 1976; Illmann et al., 2007) for the whole lactation period and the piglets defend their teat against other siblings. An similar phenomenon of preferences for a particular teat or nipple is known in domestic cats (*Felis silvestris catus*), mountain lions (*Felis concolor*) or in hyrax (*Procavia johnstonii, Heterohyrax brucei*) (review Drummond, 2006).

The function of the teat order in domestic pigs may be in a suppressing the sibling competition about teats and consequently to eliminate the chance on missing milk ejection (De Passillé et al., 1988), which can ensures a survival of piglets (Hartsock et al. 1977). Moreover, piglets may influence the productivity of individual teats through effectiveness of suckling behaviour, such as vigorous pre massage, effective withdrawing of milk from teat (Fraser et al., 1979) and prolonged final massage (Gill and Thomson 1956; Algers and Jensen, 1991). Although a lot of energy is spent by piglets during teat massages (Klaver et al., 1981), piglets should investigate only in one specific teat in order to stimulate a milk flow. Furthermore, individual teats may differ in their effectiveness of stimulation and/or in milk production (Gill and Thomson 1956), which means, at least for some piglets could be advantageous to return always to the same functional teat. In piglets often occur preference for anterior teats (e.g. Newberry and Wood-Gush, 1985; Puppe and Tuchscherer, 1999). Several studies showed that anterior teats are more productive than the rest of udder (e.g. Gill and Thomson 1956; Rosillon-Warnier and Paquay 1984). In accordance with these authors, Fraser and Jones (1975) noted that piglets suck from teats in anterior region have better weight development. However these differences in teat quality are very questionable. Hemsworth et al. (1976) showed that keeping anterior teats bring only slight increasing in milk intake and Puppe and Tuchscherer (1999) observed the differences in weight gain only in piglets at the end of the udder (posterior region), whereas piglets sucking other teats showed no differences. Moreover, Algers and Jensen (1991) noted that milk yield depend on the time and intensity of stimulation, rather than on teat quality. Anterior preference may be also explained by other factors, for example that anterior part of the udder may be safer region than posterior region, given the risk of trampling by hind legs of sow (Hafez and Signoret 1976 in Orihuela and Solano, 1995). Or, piglets may be attract rather to anterior teats by grunting of sow (Jeppesen, 1982) and so on. When we look at

stability of the teat order in individual udder region, there are some evidences that anterior and posterior teats have higher sucking stability and lower competition rate, while in the middle teats occur more frequent sibling competition, less sucking stability (De Passillé et al., 1989; Puppe and Tuchscherer, 1999) and consequently increasing chance of missing ejection (Fraser and Thompson, 1986).

The teat order probably stays on the principle of territoriality (De Passillé and Rushen, 1989), although there is also a tendency to equate the teat order with dominance hierarchy (Scheel et al., 1977; but see McBride, 1963).

3.4.1. Ontogeny of the teat order

Ontogeny of the teat order seems to be a continuous learning process (Puppe and Tuchscherer, 1999) with gradual increase (Hemsworth et al., 1976; De Passillé et al., 1988). Though piglets from birth suckled on average from 7 different teats, already at the 4 hours of age the most of piglets spent average 55% of the time by a single teat (Hemsworth et al., 1976) and further during the first day of live 50% of piglets suck form their preferred teat pair (De Passillé et al., 1988). During the next days an extremely sharply increasing of teat consistency occurs (McBride 1963; De Passillé et al., 1988; Puppe and Tuchscherer, 1999), which is followed by a slowly increase with final stabilization within the second week after parturition. Than piglets suck from the preferred teat or teat pair with about 95% of stability (Puppe and Tuchscherer, 1999).

3.5. Sibling competition in pigs

Although the parental resources are limited, every piglet try to derive a greater fitness benefits from the parental investment received by other littermates, and thus the sibling competition occur (see Drake et al., 2008). In pigs, characterizing by the unique combination of production of a large litters and precocial young, sibling competition play a major role in early life of piglets.

3.5.1. Function and consequences of neonatal sibling competition

The functional view on early sibling competition can be through ensuring the access to teat and consequently the adequate milk intake for piglets due to establishment the teat order. On the other hand, competition may bring negative consequences for piglets in the form of energetically expenditure and possible injuries of fighting piglets.

Based on the fact that the actual milk intake is important for piglets, it is expected that during pre massage period (i.e. before milk ejection) there will be a higher number of piglets fighting and screaming, than in the time of post massage period (i.e. after milk ejection). Appleby et al. (1999) suggest that screaming of competed piglets is mainly a signal from piglets to mother that they are excluded from teats and consequently from ongoing milk ejection. However, some fighting and screaming of piglets occur also in post massage period. This teat disputes during post massage may be important in order to increasing the chance of future teat access for piglets without own teat (Milligan et al., 2001).

The most important factors affecting sibling competition is probably the litter size and piglet's birth weight. Large litter size brings lot of risks for all littermates. It is associated with an increasing number of piglets missing milk ejection, at least during early lactation (Milligan et al., 2001; Andersen et al., 2011). Increasing litter size lead to higher mortality among piglets, both as a result of competition and crushing (Andersen et al., 2011). Consistent with Andresen et al. (2011), some other authors noted that large litter size results in increasing of sibling competition (Hartsock and Graves, 1976; De Passillé and Rushen, 1989; D'Eath and Lawrence, 2004), which was similar examined in guinea pigs (Fey and Trillmich, 2008). On the other hand, some other authors did not find this relationship in domestic pigs (Scheel et al., 1977; De Passillé and Rushen, 1989).It is possible that the proportion between the number of functional teats and the litter size („teat ratio“) may be a more important factor for the intensity of sibling competition (Vasdal et al., 2011), but this aspect has never been study yet. Also birth weight of the piglet influences the sibling competition. Heavier piglets win more fights about teats (Scheel et al., 1977; De Passillé et al., 1988), gain more weight (Milligan et al., 2001) and experience lower mortality (Hartsock and Graves 1976; Hartsock et al. 1977; Scheel et al. 1977; Tuchscherer et al., 2000) compared to lighter siblings. Thus, sibling competition can ensure survival of high quality offspring.

3.6. Sow's response towards neonatal sibling competition

The question arises whether and how a sow should react on fighting and screaming during nursing? Because sow has a specific immobile sucking posture, it is not possible for her to prevent only specific piglets from sucking. Therefore, mother's reaction affects a whole litter. Sibling competition may by for sow disadvantageous because the resource are used by piglets that do not survival, some resource are using by survival offspring in order to compete and furthermore, sibling competition may cause a discomfort for the sow. Thus, it is suggest that the sow would react on an intense sibling competition during a nursing and this response might be an adaptive strategy how to depress intense sibling competition. Otherwise, the sow don't should react towards low sibling competition, because early sibling competition may be advantageous for sow in order to limited weak piglets and thus establish the litter size on the optimal level and ensured a more resource for a survival piglets.

Sow's reaction on sibling competition could include a termination of nursing without milk ejection and/or posture changes of sow (Appleby et al., 1999; Illmann et al., 2008), trough which sow terminate nursing. Sow's posture changing can occurred both in pre massage and in post massage period. Thus, we distinguish this reactions according to the time on sows posture changing in the pre massage (i.e. before milk ejection) or in the post massage (i.e. after milk ejection).

Posture changing during the pre massage (behavioural NNN):

During this reaction, sow changes her posture during the pre-massage (i.e. before milk ejection). There is some evidence that sow exposed to screaming of piglets in competition sometimes react through a posture changing in the pre massage (Appleby et al., 1999; Illmann et al., 2008), but there is a lack of information about this reaction. Generally, a sow posture changes are dangerous events due to the increasing risk of piglet crushing. Also, there is a negative impact for whole litter through no actual milk input, because the posture changes in the pre massage ranges in the non-nutritive nursings, i.e.

without milk intake.

Posture changing during the post massage:

Posture changing during the post massage, means in other words nursing termination by sow after milk ejection, leads probably to shortened time of massaging teats. The posture changing of mother during the post massage often occurs within later phase of lactation as a result of weaning conflict. However, in early lactation period sow usually stay in recumbence for whole nursing bout and thus the post massage may be terminate by piglets. However, Appleby et al. (1999) has shown that posture changes by the sow during the post massage was caused by screaming of the piglets and it was associated with shorter post massage duration. Shorter post massage period may result decreasing future milk intake.

Non-nutritive nursing (physiological NNN):

During non-nutritive nursings there is actually not available any milk for whole litter, the interval to the next milk ejection is prolonged (e.g. Castrén et al., 1989; Illmann and Madlafousek, 1995) and so the milk input per time decrease (Špinka et al., 1997). Furthermore, piglets pay an accelerating cost in terms of non-nutritive nursings for each additional milk ejection (Špinka et al., 2011). Sow could initiate another nursing in the short time after she terminated last nursing. The piglets have to go through the whole phase of pre-massage again and maybe more than once and thus the cost for piglets may further increase (Špinka et al., 2011).

4. Aim of diploma thesis

In the neonatal period, sibling competition is strong during a nursing and might causes injuries and starvation. A sow should suppress sibling competition when more piglets are fighting indicating that more piglets have no access to a teat. However, almost nothing is known about the sow response on neonatal sibling competition. Accordingly, this study focused on neonatal sibling competition during a nursing on day 1 post partum

and its influence of sow response. Specifically the impact of the number of fighting and screaming piglets during the pre and post massage was analyzed. We predicted:

A. Sow will react on a higher number of fighting and screaming piglets with:

- A higher proportion of physiological non-nutritive nursings (i.e. stay lying)

- More posture changing during the pre massage (behavioural NNNs)

- More posture changing during the post massage

B. The number of fighting and screaming piglets during the pre and post massage will increase with increasing litter size

C. The number of piglets missing milk ejection will increase with:

- Increasing litter size

- More fighting and screaming piglets during the pre massage

5. Material and methods

Table of terms of observed behaviour

DEFINITION	**DESCRIPTION**
nutritive nursing (NN)	nursing with milk ejection, judged by rapid and synchronous mouth sucking movements by piglets and increasing grunting rate by sow
non-nutritive nursing (NNN)	nursing without milk ejection, judged by absence of characteristic mouth sucking movements by piglets and increasing in grunting rate by sow
pre-massage	nursing period before milk ejection, when piglets are arranged to teats and massaged teats by their snouts or their front legs
post-massage	nursing period after milk ejection, when piglets can massaged teats same manner as in pre-massage period, leaved the udder or fall asleep

Table of terms of calculated variables

DEFINITION	DESCRIBTION
teat ratio	proportion of number of functional teats / number of piglets in litter
parity	number of farrowing per sow life
SumPigPreScream	the sum of all piglets screaming during all 15 sec intervals before milk ejection, i.e. during the pre massage
SumPigPreFight	the sum of all piglets fighting during all 15 sec intervals before milk ejection, i.e. during the pre massage
SumPigPostScream	the sum of all piglets screaming during all 15 sec intervals after milk ejection, i.e. during the post massage
SumPigPostFight	the sum of all piglets fighting during all 15 sec intervals after milk ejection, i.e. during the post massage
IntervalPrevNurs	time period between the last milk ejection and start of the next nursing

5.1. Experimental design

A total of 19 healthy loose housed sows and their piglets were directly observed for 6 hours during Day 1 post partum ranged from 20.5 to 40 hours (average 26.4 hours) from birth of first piglet to assess the sow responsiveness towards fighting and screaming piglets during the pre and post massage period.

5.2. Animals and housing

We used 19 Large White x Landrace sows inseminated with Large White x Pietrain boar semen and ranging between their 1st and 15th lactation (average 6.6±3.1) and functional teats ranging from 11 to 16 (average 14.1±0.9).

The experiment was carried out during June to December 2012 at the Institute of Animal Science in Prague, Czech Republic. Sows were housed in pens with concrete floors and straw bedding measuring 2.3 m X 2.0 m within a room containing 14 such pens. Each pen was equipped with a 'walk around' ellipsoid farrowing crate (2.3 m X 1.4 m) with a small partition in its centre. The crate allowed the sow to walk around in one direction, but not to turn around or to reach the piglets creep area (2.3 m X 0.6 m) corners in the pen. Supplementary heat from a warm plate in the creep area was provided. The sows were fed a standard lactation diet twice a day. Water was continuously available from one nipple for the sow and another for the piglets. Then pens were cleaned out and new sawdust was provided both in the sow area and the creep area twice a day.

Before observation, piglets were marked on their backs for individual recognition. Litter size in this study was calculated as the number of piglets alive in the time of observation, ranged from 8 to 17 (average 12.2±2.4).

5.3. Behavioural observation

All nursing episodes during these 6 hours were directly observed, and supplemented by video recordings using a hand held video camera (Panasonic SDR-H85)

and static close-circuit video camera (Panasonic WV CP 450/G, Panasonic WV CL350) with microphone (Sennheiser E845S). The close-circuit video camera was positioned 2 m above the pen and a microphone was connected via cables to the VCR in an adjacent room.

A nursing episode was considered to start when more then 50% piglets in litter were performing pre-massage of teats and the nursing was considered to finish when 2 or less piglets were performing post-massage of teats or when sow was changing her posture.

The following variables were registered: initiator of the nursing (sow or piglets), duration of pre-massage (duration between the start of a nursing and the milk ejection), duration of post-massage (duration between milk ejection and termination of a nursing), who terminated the nursing (sow or piglets), posture changes of the sow (rolling, sitting and standing) during the nursing and occurrence of non-nutritive nursing (NNNs). Milk ejection was judged by the rapid mouth sucking movements by the piglets and the increase in the grunting rate by the sow (Whittemore and Fraser, 1974). These characteristics were missing in non-nutritive nursings (Illmann et al., 1999).

The number of piglets performing each of these categories was scored every 15 seconds after the start until the end of a nursing: present at the udder, fighting at the udder (involved a piglet biting and pushing its head or shoulders against another piglet when one or both piglets were attempting to stimulate the udder (De Passillé et al., 1988)), screaming at the udder (high pitched calls during teat disputes) and not getting access to a teat during milk ejection (i.e. missing ejection). For the analysis the sum of fighting piglets during all 15 sec intervals in pre massage (*SumPigPreFight*) and in post massage period (*SumPigPostFight*) and the sum of screaming piglets in pre massage (*SumPigPreScream*) and post massage period (*SumPigPostScream*) was calculated.

5.4. Statistical methods

During the pre massage *SumPigPreFight* and *SumPigPreScream* were highly positive correlated (0.95, $P < 2.2e-16$) and as well during the post massage there was a highly significant correlation between *SumPigPostFight* and *SumPigPostScream* (0.94, $P < 2.2e-16$). The effect of the number of fighting piglets during a nursing was a clear predictor for the effect number of screaming piglets during the nursing and it causes multicollinearity. Based on this fact, only the effect of the number of fighting piglets before

and after milk ejection was included to the statistical models.

The following continuous variables were included to all models as the fixed effects: litter size and parity. The effects of litter size and teat ratio were highly negative correlated (-0.92, $P < 2.2e-16$) and because of the multicollinearity only the litter size enter all models as fixed effect. The individual sow was assumed as an independent subject.

5.4.1. Probability of non-nutritive nursing (NNN)

Logistic regression models with binomic distribution were applied to calculate whether the probability of NNNs was influenced by *SumPigPreFight.* One continuous variable was added in these models: intervals between last milk ejection and start of next nursing (*IntervalPrevNurs*). In the analysis were included 110 nursing episodes, from which 74 was NNs and 36 NNNs. Based on the fact that the number of physiological NNNs was too small (n=11) (some NNNs were excluded from the statistical analysis, physiological and behavioural NNNs were analysed together.

5.4.2. Probability of sow's posture changes

- *During the pre massage:*

Logistic regression models with binomic distribution (PROC GENMODE, SAS 9.2) were applied to assess whether the probability that sow terminated nursing by a posture change during the pre massage was influenced by *SumPigPreFight.* In the models was added variable *IntervalPrevNur.* In this analysis were included 85 nursings, from which 74 NNs and 11 behavioural NNNs.

- *During the post massage:*

Logistic regression models with binomic distribution (PROC GENMODE, SAS 9.2) were applied to assess whether the probability that sow terminated nursings by a posture change during the post massage was influenced by *SumPigPostFight.* In the analysis were included 95 NNs.

5.4.3. Effect of litter size

Mixed models (PROC MIXED, SAS 9.2) were applied to assess whether the litter size affects the *SumPigPreFight* and *SumPigPostFight.* The values of *SumPigPreFight* and *SumPigPostFight* were used in logarithms (response variable = log (#fights + 1)) to improve normality. In the analysis of *SumPigPreFight* were included 171 nursings (NNs + NNNs) and in the analysis of *SumPigPostFight* 95 nursings (NNs).

5.4.4. Proportion of piglets missing milk ejection

Logistic regression models with binomic distribution (PROC GENMOD, SAS 9.2) were applied to assess whether the number of piglets without access to a teat during milk ejection was influenced by the *SumPigPreFight.* In the analysis were included 93 NNs.

6. Results

From all 172 observed nursing bouts were 95 nursings with milk ejection (55,2%) and 77 nursings without milk ejection (44.8 %), from which 54 was physiological NNNs (31,4%) and 23 behavioural NNNs (13,4%) (Figure 4).

The total of 89 piglets missed milk ejection during entire observation.

In NNs, sows terminated the post massage by a posture change in 19.0 % (n=18) and allowed the post massage in 81.05% of the nursings (n=77).

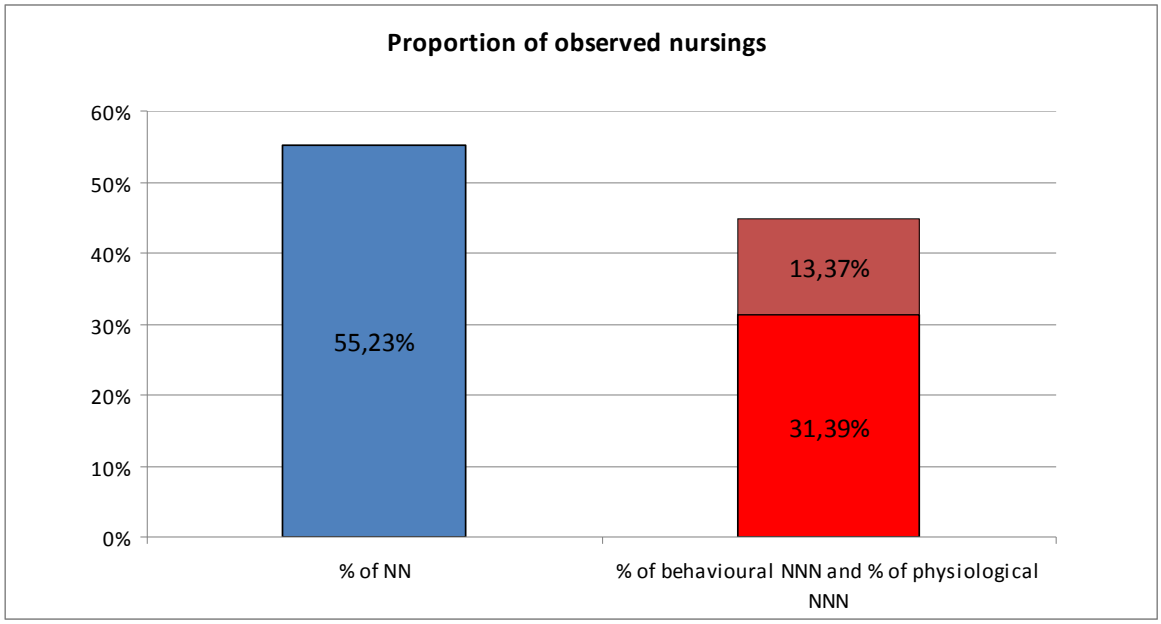

Figure 4. Graph shows the proportion of individual type of all observed nursings: NN versus behavioural NNN (upper part on right side) and physiological NNN (lower part on right side).

6.1. Effect of *SumPigPreFight* on the probability of non-nutritive nursing (NNN)

A higher *SumPigPreFight* was associated with a lower probability of milk ejection ($Z = -3.41$, $P < 0.001$) (Figure 5), and thus result in increasing of the probability of non-nutritive nursing. Furthermore, with shorter intervals between nursings decreased the probability of milk ejection ($Z = 4.75$, $P < 0.0001$) (Figure 6) and thus increase the likelihood of NNNs. There was a tendency that with increasing parity of the sow increased the probability of milk ejection ($Z = 1.68$, $P < 0.1$).

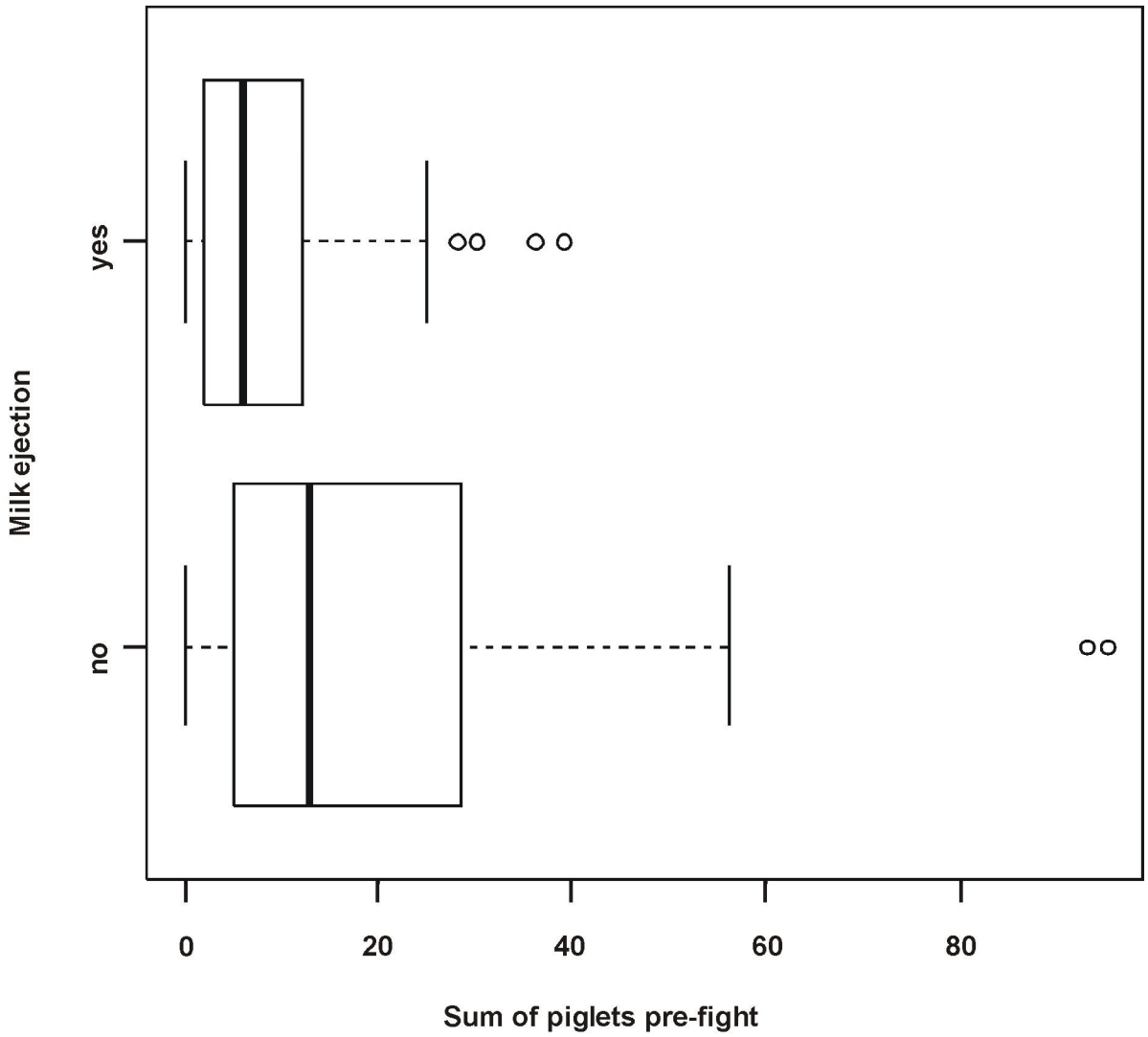

Figure 5. Graph shows the effect of sum of fighting piglets during pre massage on the probability of NNN. The sum of piglets pre fights was calculated per individual nursing. In the cases of NNN, the sum of piglets pre fights is equal to the sum of piglets fighting during the whole nursing bout.

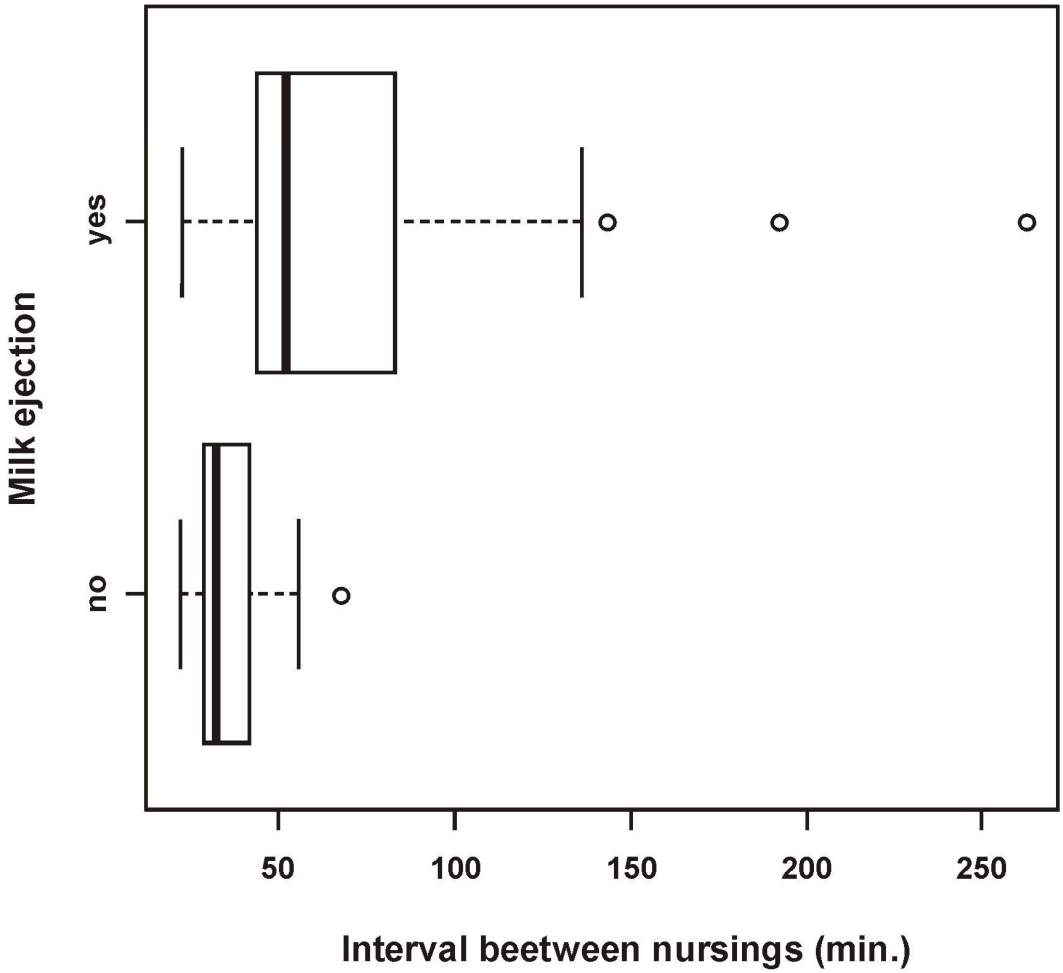

Figure 6. Graph shows the effect of intervals between the last milk ejection and start of the next nursing (in minutes) on the probability of non- nutritive nursing.

6.2. Effect of a sum of piglets fighting on the probability of sow's posture changes

- *During the pre massage:*

The probability that sow terminated nursing by a posture changing during the pre massage is higher with increasing *SumPigPreFight* (Z= 3.21, P< 0.01) (Figure 7).

Increasing intervals since last milk ejection result in decreasing probability that sow terminated nursing by a posture changing in the pre massage (Z= -2.64, P<0.01) (Figure 8).

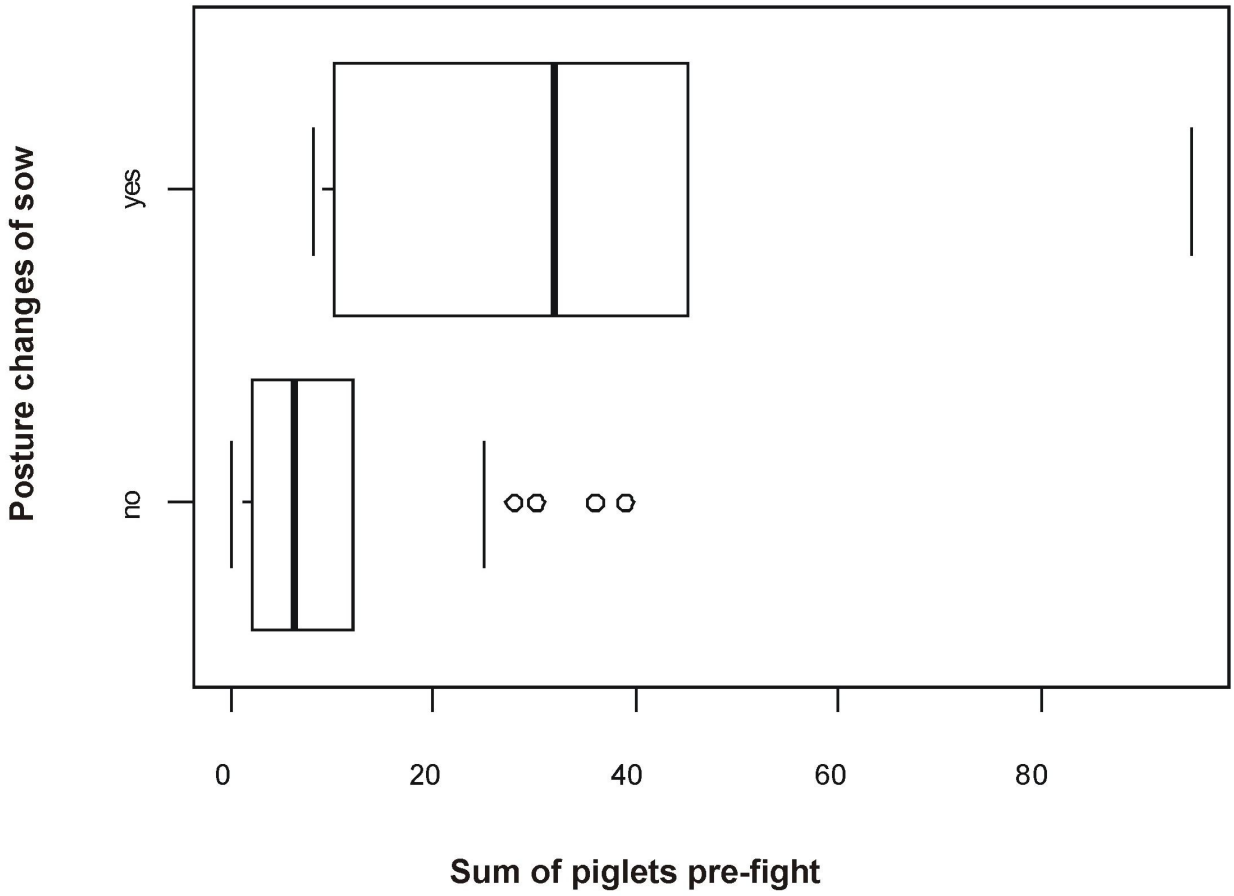

Figure 7. Graph shows the effect of a sum of piglets fighting in the pre massage on a posture changing of sow during the pre massage.

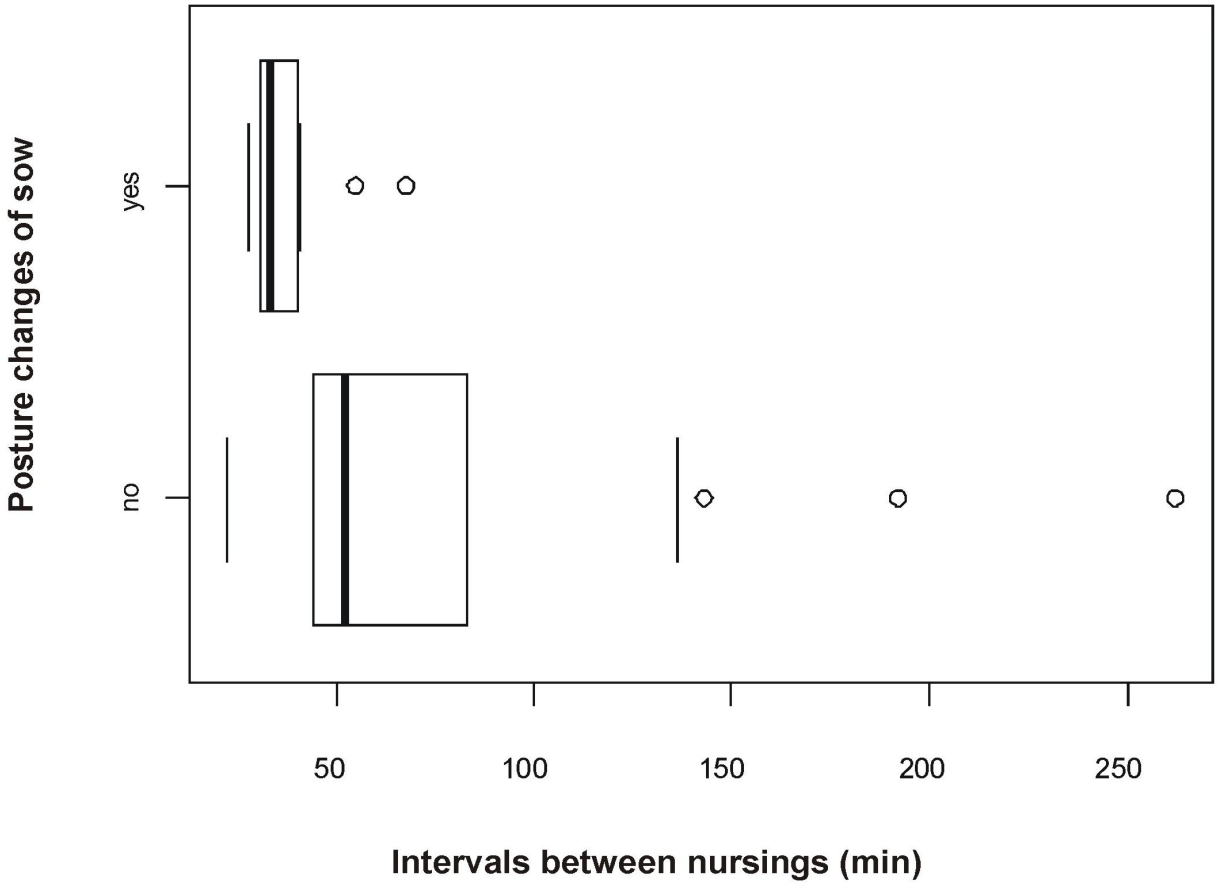

Figure 8. Graph shows the effect of intervals between the last milk ejection and start of the next nursing (in minutes) on a posture changing of sow during the pre massage.

- *During the post massage:*

Probability that sow terminated nursing by a posture change during the post massage is higher with increasing litter size ($Z= 2.10$, $P< 0.05$) (Figure 9). There was no significant effect of *SumPigPostFight*.

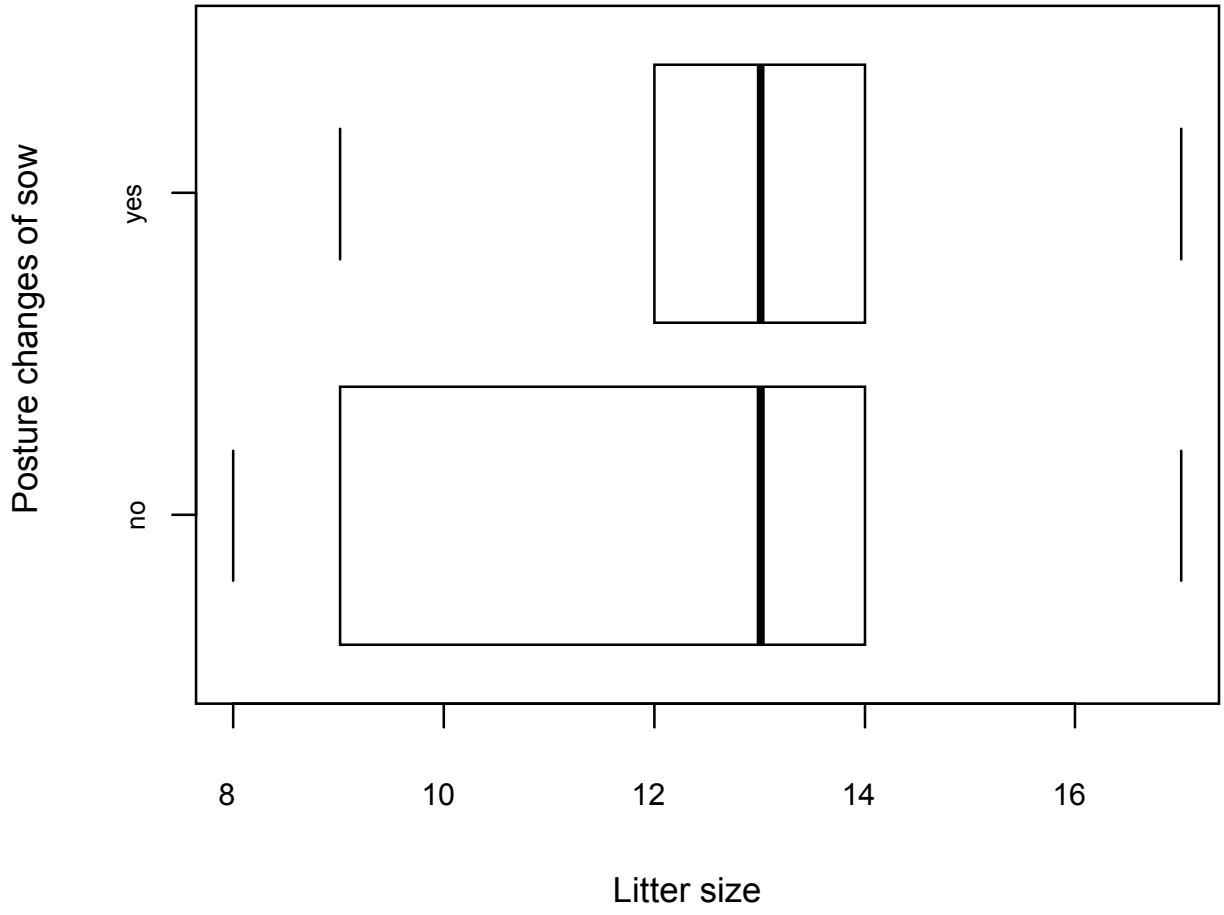

Figure 9. Graph shows the effect of litter size on a posture changing of sow during the post massage.

6.3. Effect of the litter size on a sum of fighting piglets

An increasing litter size lead to increase of *SumPigPreFight (t*=3.24*, P*< 0.01) (Figure 10) and *SumPigPostFight (t*=2.26*, P*<0.05*)* (Figure 11).

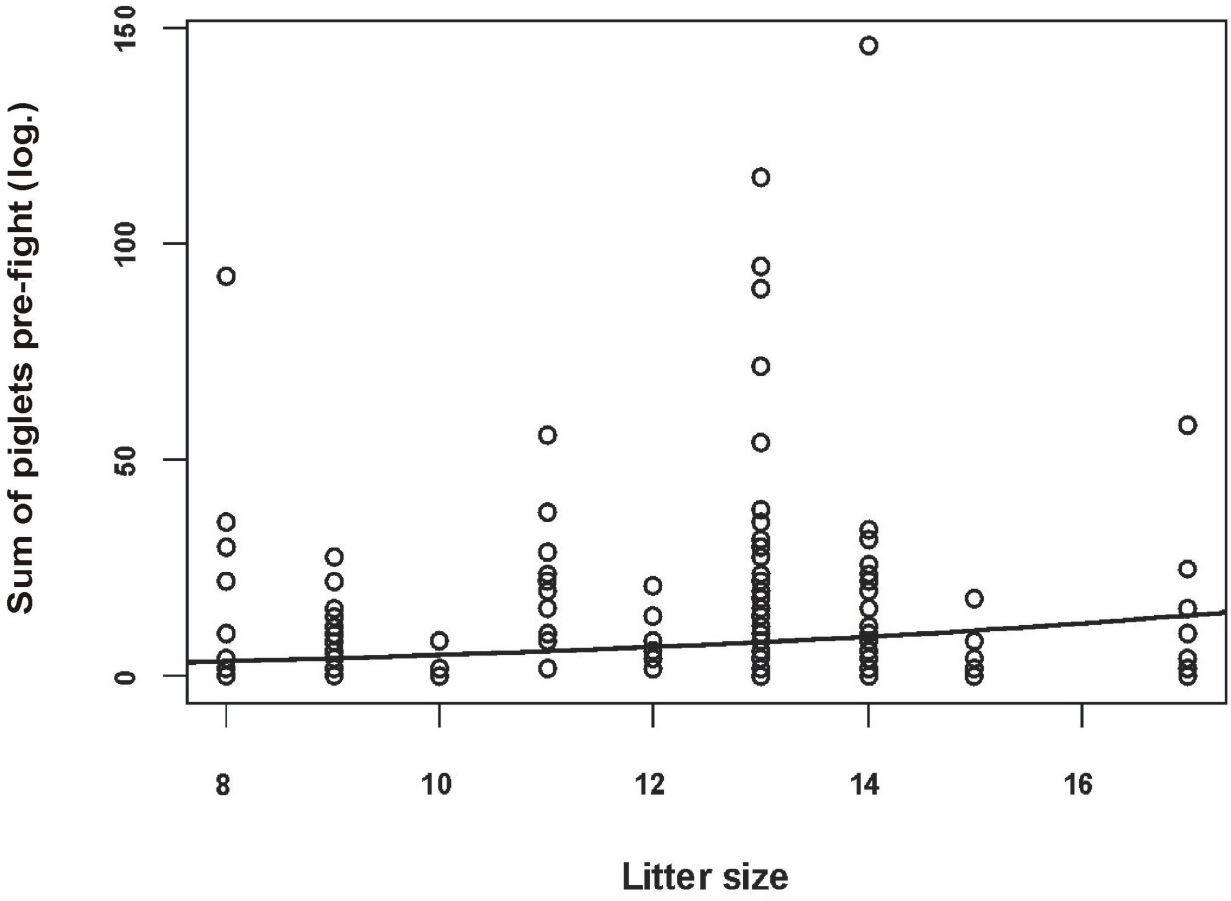

Figure 10. Graph shows the effect of litter size on a logarithm of sum of piglets fighting during the pre massage. The curve showing the predicted values, circles represent the actual values.

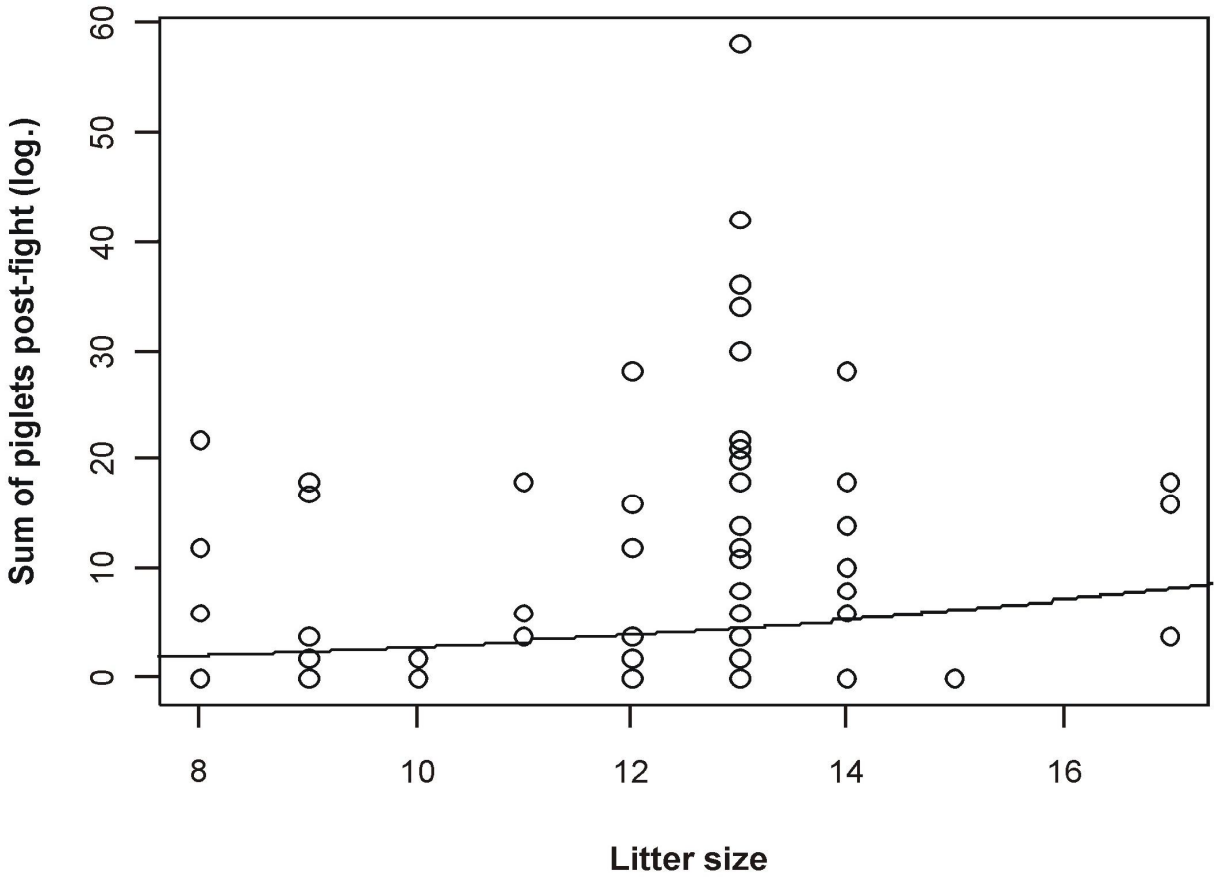

Figure 11. Graph shows the effect of litter size on a logarithm of sum of piglets fighting during the post massage. The curve showing the predicted values, circles represent the actual values.

6.4. Effect of *SumPigPreFight* on the proportion of piglets missing milk ejection

Average 0.95 piglets missed milk ejection per nursing. An increasing of *SumPigPreFight* was associated with a higher proportion of piglets missing milk ejection ($Z= 3.22$, $P< 0.01$) (Figure 12). A higher proportion of piglets missed milk ejection was associated with an increasing litter size ($Z= 3.29$, $P < 0.01$) (Figure 13).

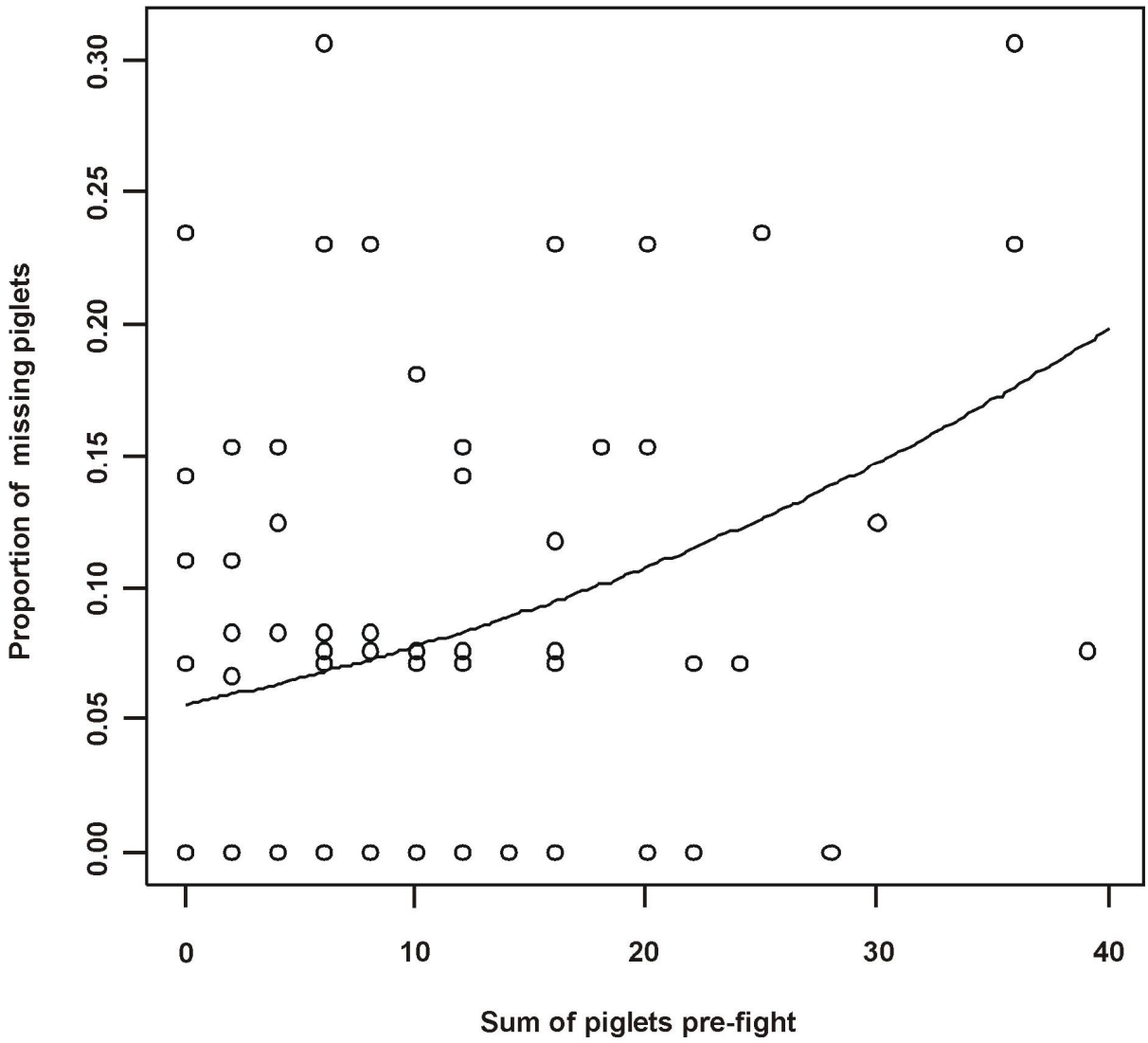

Figure 12. Graph shows the effect of sum of piglets pre fights on the proportion of piglets missing milk ejection. The curve showing the predicted values, circles represent the actual values.

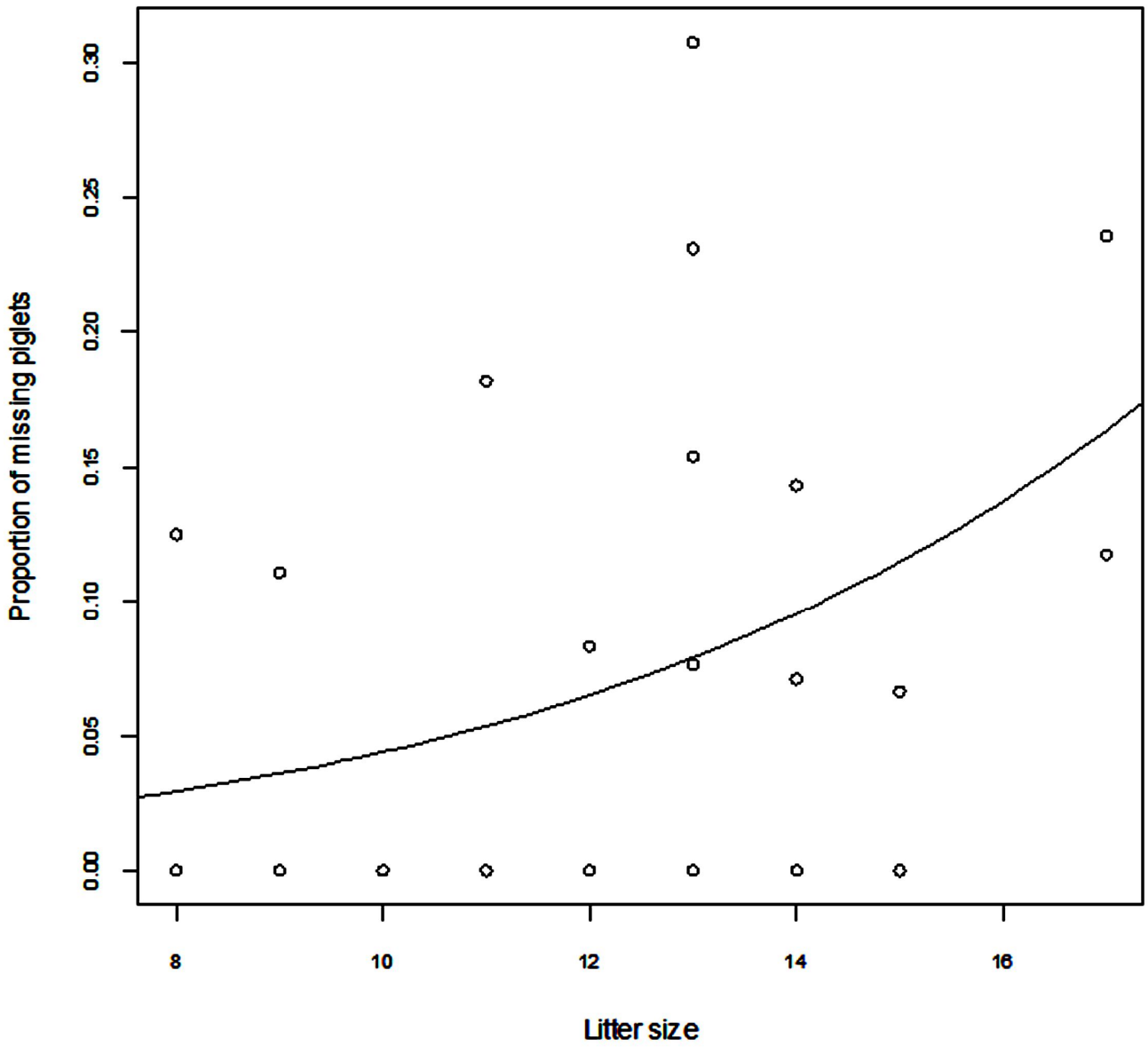

Figure 13. Graph shows the effect of litter size on the proportion of piglets missing milk ejection. The curve showing the predicted values, circles represent the actual values.

7. Discussion

We confirmed our predictions that increasing sibling competition (fights and screams) during the nursing can caused an increased maternal response in form of non nutritive nursings and nursing termination through posture changing during the pre massage. We didn't confirm our last prediction that increases sibling competition caused nursing termination through posture changing during the post massage.

We showed that increasing litter size leads to increasing number of compete piglets and this consequently leads to increasing proportion of piglets missing ongoing milk ejection, which is in accordance to our predictions.

7.1. Effect of SumPigPreFight on the probability of non-nutritive nursing (NNN)

As predicted, a higher sum o piglets fighting as well as screaming during nursing resulted in a higher probability of NNNs. During later lactation there was a similar effect, that screaming of piglet resulted in a higher occurrence of NNN (Appleby et al., 1999). This suggest that actual number of fighting and screaming piglets might be for mother an indicator, that piglets are excluded from the ongoing milk ejection. Then, if the number of compete piglets exceed certain level, mother can react by NNN in order to suppress intense sibling competition. However, NNNs have negative consequences for the whole litter. Hence, mother should respond with an NNN only in cases when the competition is too intense.

We observed a surprisingly large number of non-nutritive nursings, about 45% from all nursings. The proportion of NNNs ranges between 5% and 30% (e.g. Illmann and Madlafousek, 1995; Illmann et al., 1999; Puppe and Tuchscherer, 2000; Valros, 2002) and can varied between individual sow and is often influence by nursing intervals.

This study showed that shorter nursing intervals can result in increasing probability of NNNs, which support the results by Fraser (1977) and Špinka et al. (2011). When the

sow nurses at long intervals (every 90min or 4 nursings per 6 hours) the proportion of NNN can be close to zero, but if the intervals are shortened (every 30 min or 12 nursing per 6 hours) the proportion of NNN may increase up to 40% (Špinka et al., 2011). According to this, a functional view on NNNs can be a component of parent-offspring conflict. When the demand of piglets is too high and hence the nursing starts very soon after last milk ejection, than mother can react with an NNN. Addition of NNN between NNs resulted in prolonging intervals between NNs (e.g. Castrén et al., 1898; Illmann and Madlafousek, 1995) and consequently to decreasing the total milk output (Špinka et al., 1997). Thus, NNN resulted in acceleration costs of each additional NN than piglets instigate and so determines the limit for piglets' ability to solicit higher maternal investment through intense nursing solicitation (Špinka et al., 2011). However, there is a problem to identify clearly whether the initiator of nursing was the piglets or the sow. Thus we can only speculate about the role of high milk begging. Nevertheless, considering the fact that refilling on mammary glance is completed after 35 min (Špinka et al., 1997), nursing in shorter intervals can have a greater chance to be non-nutritive.

In conclusion, this study indicates that NNNs can occur both as a consequence of intense sibling competition and of short intervals between nursings.

It was observed the tendency of increasing probability of NNN in sows with lower parity. From the view of life history, it is possible that sows with higher parity will invest in current litter more resources that younger, lower parity sows. Hence, older sows would prefer to nurse with milk ejection. Also, the older and more experienced sows may be less reactive in comparison with younger sows (Held et al., 2006).

7.2. Effect of sum of piglets fighting on the probability of sow's posture changes

- *During the pre massage:*

A posture changing of the sow during the pre massage period, which means disruption of nursing by sow before milk ejection, can be described also as non-nutritive, because milk ejection does not occur. As in physiological NNN, this reaction can brings decrease in milk input for piglets. Furthermore, posture changing of sow is often linked

with the risk of crushing piglets, especially in early lactation (e.g. Weary et al., 1998; Johnson et al., 2007). One possible reason of this maternal reaction may be a disruption of mother by fighting and screaming piglets (Illmann and Madlafousek, 1995). When sows are disturbed by an external factor, they may interrupt actual nursing bout (Rushen et al., 1995). However, it was shown that sows stressed via hypothalamo-pituitary-adrenocortical (HPA) activity doesn't inhibited milk ejection (Rushen et al., 1995). Our results showed that sow changed posture in the pre massage period due to sibling competition. This suggestion was made by Appleby et al. (1999). In that study sows react on playbacks with screams of fighting piglets by posture changing in pre massage. A similar result was examined by Illmann et al. (2008) during first 24 hours after farrowing. This suggests that screaming of fighting piglets could serve as a signal for mother that some piglets are excluded from teat. Than, when the number of compete piglets exceed certain level, mother start to react in order to depress sibling competition and prevent missing milk ejection for a lot of offspring. Although posture changing of sow includes a risk of crushing piglets (e.g. Wechsler and Hegglin, 1997; Andersen et al., 2005) and no actual milk supplies can negative influence piglets survival, mother should compromise between reaction and latency on competition. Only when a lot of piglets are excluded form access to teat due to competition, it can be beneficial to react and depress competition.

Our results shown the next reason of sow posture changing during the pre massage may be short intervals since last milk ejection, similar as in the case of physiological NNN. About the sow response in form of posture changing during the pre massage is almost nothing known from the literature. Due to a higher significance in the models, we suggest that this maternal reaction occur mainly due to intense sibling competition and than in second case due to short intervals since last milk ejection.

- *During the post massage:*

Nursing termination by the sow through posture changing during post massage was not influenced by the sum of fighting as well screaming piglets in our study. That means sow didn't react on the sum of fighting and screaming piglets after milk ejection. Opposed to this fact, study by Appleby et al. (1999) found that screaming of piglets can lead to higher proportion of nursing termination by the sow momentarily after milk ejection in later phase of lactation. When sow changes her posture in post massage period, she probably don't want accept full post massage by piglets and thus shorted this period.

Consequently, shorter duration of post massage can impair further milk production (Algers and Jensen, 1985; Algers and Jensen, 1991; Jensen et al., 1998) which can disrupt weight gain of piglets. Furthermore, shorter post massage can slow down establishment of preferences for specific teat (Puppe and Tuchscherer, 1999). Before the teat order is not fully stabilized, competition is not reduced and missing ejection still occurred (De Passillé et al., 1988). No detected effect of sibling competition in our study can be the consequence of the fact that during early lactation sow usually doesn't terminate any nursing bout (Jensen, 1988). Nursing termination by sow occur almost in the time of weaning conflict, which start later, at about 8 days post partum (Puppe and Tuchscherer, 2000). It is also possible, that competition during post massage was lower than during the pre massage period, and thus mother hasn't any need to react. However, there is some evidence that teat disputes continue also in post massage period and it may increasing change of future teat access for piglets without own teat (Milligan et al., 2001). So, for mother may be advantageous to allows the post massage in order to earlier development of teat order and consequently decreasing in competition and also to possible increasing in total milk output or redistribution of milk production among the teats (Špinka and Algers, 1995; Jensen et al., 1998). To depress intense piglet competition may sow use other mechanisms – both physiological and behavioural NNN.

Further, it was detected a positive effect of litter size on posture changing during the post massage. Large litter size may result in too intense demand of piglets. It is possible, that high piglets' beginning in the form of post massage of teats can perhaps causes increasing of parent offspring conflict. Therefore, mother with large litter would terminate nursing in more cases.

7.3. Litter size and teat ratio

In this study, these two components were highly negative correlated. Most studies dealing with litter size in pigs didn't analyzed the teat ratio. Vasdal et al. (2011) suggest that the teat ratio may be more decisive mechanism for describing intensity of sibling competition, than litter size per se. Based on the colinearity between litter size and teat ratio in our results, only the litter size was included in analysis. We examined the increasing number of compete piglets with increasing litter size. In domestic pigs, higher rate of sibling competition in large litters was noted by several authors (e.g. Milligan et al.,

2001; D'Eath and Lawrence, 2004; Andersen et al, 2011) although some studies did not find such result (Scheel et al., 1977; De Passillé and Rushen, 1989). Large litters are associated with decreasing birth weight and increasing weight variability among littermates (Milligan et al., 2002, Quiniou et al., 2002; Wolf et al., 2008). Both piglet birth weight and variability in weight of littermates strongly affect mortality of pre weaning piglets (Milligan et al., 2002; Weintjes et al., 2012). Moreover, these characteristics may lead to more lethal consequences of sibling competition, for example due to the fact that heavier piglets exclude easily a low weight sibling from access to teat (English, 1998), and thus yet more increase the pre weaning mortality. Although average litter size has increased gradually due to intense artificial selection, number of weaning piglets has decreasing and number of piglets with small size per litter have increased (Cutler et al., 1999 in Milligan et al., 2002), and thus this selective breeding may often miss the point. Furthermore, more aggressive behaviour in piglets from large litters persist at least for whole pre weaning period (D'Eath and Lawrence, 2004) and may have negative consequences on subsequent meat quality. For example , pre weaning environment affect pH value of meat and it is suggest, that when piglets are stressed, pH of meat decrease (Chaloupková et al., 2007) and than meat may becomes undesirable PSE (pale, soft, exudative).

Fighting and screaming

We observed high correlation between the number of fighting and screaming piglets. It was noted that sibling competition is often accompanied with load screaming of piglets (Fraser et al., 1995; Appleby et al. 1999; Illmann et al., 2008). Fraser et al. (1995) suggest that screaming is a common part of fighting during early phase of lactation, when piglets establish the teat order. In later phase piglets screaming mainly when the access to teat is obstructed, for example by the sow lying on teats or by the bars of farrowing crate (Fraser et al., 1995). In accordance, it was suggest that screaming of compete piglets work primarily as signal for mother that some offspring are excluded from teat and thus possibly from ongoing milk ejection (Appleby et al., 1999). The other function of screams during fighting could be intimidated rival littermates, but Appleby et al. (1999) did not find any evidences.

Although screaming may bring some disadvantageous in the form of energy expenditure and, in nature, risk of attraction predator, the positive effect probably exceed,

because of the regular access to teat is too important for piglets' survival.

7.4. Effect of *SumPigPreFight* on the proportion of piglets missing milk ejection

In this study, a higher number of fighting as well as the number of screaming piglets during the pre massage resulted in a higher proportion of piglets missing milk ejection. This suggests that the number of fighting and screaming piglets is an indicator for the proportion of piglets which will miss the actual milk ejection. Missing milk ejection could be very dangerous for piglets, because prolonging the time since last milk ejection decrease the total milk intake (Špinka et al., 1997) and consequently impaired the weight gain of piglet (Jensen et al., 1998; Appleby et al., 1999). For younger piglets with very small energetically reserves it can be fatal

Increasing litter size lead to missing milk ejection for more piglets and this is in accordance to the results by Milligan et al. (2001) and Andersen et al. (2011). Vasdal et al. (2010) suggested that the value of teat ratio is a better indicator of the proportion piglets missing milk ejection. In our study, both litter size and teat ratio has the same significant effect. We observed only 3 litters when the value of teat ratio was less then one, which means that the number of piglets in litter exceed the number of functional teats. These litters had the greatest probability of missing milk ejection. However, Andersen et al. (2011) shown that even in litters with 12 piglets on average one piglet per nursing missed the milk ejection, although the number of functional teats range usually between 13 and 17 (Vasdal et al., 2011). Also in our study we observed the cases of piglets missing ejection even in litters with positive teat ratio, when the number of teats exceeds the number of piglets. It can be explained by the fact that some piglets may monopolize more than one teat (Illmann et al., 2007). However, considering the very brief time of milk ejection (about 15s), it is still not clear whether a piglet monopolizes two teats had a higher milk intake. The cases of missing milk ejection in litters with more teats than piglets may be related also with different preferences of piglets for a certain udder region. There is evidences for piglets' preferences for the anterior teats (e.g. De Passillé and Rushen, 1989; Puppe and Tuchscherer, 1999). Thus, it is possible that some piglets fought about access to anterior teats and thus increasing the chance of missing milk ejection even if some other teats are available.

8. Conclusions

Large litter size result in increase proportion of piglets competes about access to teat during nursing and consequently in increasing number of piglets missed milk ejection. The more piglets fighting and screaming during nursing, the more mother react in form of non nutritive nursing, either physiological or behavioural (i.e. posture changing in the pre massage). We suggest that these reactions may serve as a mechanism limiting intense competition. Further studies should focus on the impact of sow response (behavioural and physiological NNNs) on subsequent intensity of sibling competition and on short and long lasting consequences of early sibling competition during nursings for the whole litter and individual piglets.

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