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Effect of Breastfeeding Morphology on Breastfeeding Initiation

Souvislost morfologie prsu a zahájení kojení

Master's thesis

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Prague, 2020

Declaration

I declare that this thesis is my own work and I cited all used information sources and literature. This thesis nor its substantial part was not used for acquiring different or the same academic degree.

Prague, 9.8.2020

Signature

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Abstract

Lactogenesis II is critical stage of lactation and it is hindered by conditions like caesarean section, premature delivery, obesity, age, and parity. Previous studies have shown a connection between morphological characteristics of breast and nipple-areola complex and lactation onset. Higher number of areolar glands and their non-uniform distribution has been linked to earlier onset of lactation. Extremely large breasts and short nipples has been linked to breastfeeding difficulty. Aim of this study was to investigate relationship between morphological characteristics of breast and nipple-areola complex (number and distribution of areolar glands, nipple, areola, and breast area, protrusion of nipple and areola, and contrast of breast and areola) and lactation onset. For this purpose, we collected breasts and areolae photographs of 141 mothers one day postpartum in maternity ward in Prague and compared the morphological traits to lactogenesis II onset. We have found a non-uniform distribution of areolar glands with the highest abundance on upper lateral quadrant of areola. We found that right breast area tends to be bigger than left, and left nipple and areola tends to be longer than right. Parity had significant effect on lactation onset. No morphological characteristics have been linked to lactation onset. These results are most likely due to great mothers' education and support by the nurses and the lactation assistants in the maternity ward. Further research should be conducted with a different sample, preferably not from a WEIRD country.

Keywords

lactation onset, breast morphology, areola, nipple, areolar glands

Abstrakt

Laktogeneze II je kritickým stadiem laktace a ovlivňují ji faktory jako císařský řez, předčasný porod, obezita, věk a primiparita. Předchozí studie poukázaly souvislost mezi morfologickými charakteristikami prsu, bradavky a areoly a nástupem laktace. Vyšší počet areolárních žláz a jejich nerovnoměrné rozložení bylo spojeno s dřívějším nástupem laktace. Ženy s extrémně velkými prsy a krátkými bradavkami mají častěji obtíže s kojením. Cílem této studie bylo prozkoumat vztah mezi morfologickými charakteristikami prsu, bradavky a areoly (počet a distribuce areolárních žláz, plocha prsu, areoly a bradavky, délka bradavky a areoly a kontrast prsu a areoly) s nástupem laktace. Za tímto účelem jsme získali fotografie prsů a areol 141 matek den po porodu v porodnici v Praze a porovnávali morfologické charakteristiky s nástupem laktogeneze II. Našli jsme nerovnoměrné rozložení areolárních žláz s nejvyšší hojností na horním laterálním kvadrantu areoly. Také jsme zjistili, že plocha pravého prsu je častěji větší než levá, a levá bradavka a areola je častěji delší než pravá. S nástupem laktace nebyly spojeny žádné morfologické charakteristiky. Tyto výsledky jsou pravděpodobně způsobeny velkou podporou a vzděláváním matek zdravotními sestrami a laktačními asistentkami v porodnici. Další výzkum by měl být prováděn s jiným vzorkem, nejlépe v zemi, která nepatří do WEIRD (západní, vzdělaná, industrializovaná, bohatá a demokratická země).

Klíčová slova

nástup laktace, morfologie prsu, areola, bradavka, areolární žlázy

1. INTRODUCTION	1
2. THEORETICAL BACKGROUND	2
2.1. Breastfeeding	2
2.1.1. Health benefits	2
2.1.2. Breastfeeding prevalence	3
2.2. Evolutionary background	4
2.2.1. Nursing in primates	4
2.2.2. Human anomaly	5
2.3. Breast Morphology	6
2.3.1. Development of mammary glands	6
2.3.2. Breast size	9
2.3.3. Ptosis	10
2.3.4. Symmetry	11
2.3.5. Nipple-areola complex morphology	12
2.4. Lactation	16
2.5. Effect of morphology on lactation onset	17
2.5.1. Effect of AG on lactation onset	17
2.5.2. Effect of protrusion of nipple and areola on lactation onset	19
2.5.3. Effect of the contrast of the breast and the areola on the onset of the lactation	19
2.5.4. Effect of the breast, areola, and nipple area on the onset of lactation	20
3. AIMS AND HYPOTHESES	21
4. METHODS	22
4.1. Participants	22
4.2. Excluded cases and missing data	22
4.3. Procedure	23
4.4. Questionnaire	24
4.5. Lactation onset estimation	25
4.6. Photographs acquisition	25
4.7. Photographs postprocessing	26
4.8. Photographs analysis	27

4.8.1.	Area measurements	27
4.8.2.	Lightness measurement	29
4.8.3.	Protrusion measurements	30
4.8.4.	Areolar Glands analysis	30
4.9.	Statistical analysis	31
5.	RESULTS	33
5.1.	Descriptive analyses	33
5.1.1.	Factors influencing lactation onset and morphologic variables	34
5.1.2.	Parity	35
5.1.3.	Symmetry	36
5.1.4.	Areolar glands number and distribution	38
5.2.	Effect of morphological characteristics on lactation onset	40
5.2.1.	Areolar glands	40
5.2.1.	Contrast of the breast and the areola	43
5.2.2.	Protrusion	43
5.2.3.	Area	44
6.	DISCUSSION	46
6.1.	Descriptive analyses	46
6.2.	Effect of parity on morphologic variables	49
6.3.	Effect of breast morphology on lactation onset	50
7.	CONCLUSION	54
8.	REFERENCES	55
9.	SUPPLEMENTARY MATERIALS	64

1. Introduction

Breastfeeding is natural and most healthy way of nutrition for a newborn baby. However, lactation initiation can be hindered by various conditions like caesarean section, premature delivery, diabetes, obesity, age, and parity (Hurst, 2007). There are morphological traits of breast and nipple-areola complex that could support the faster or successful initiation of lactation, by helping the baby to effectively latch onto the nipple. Previous studies showed a link between the number and distribution of areolar glands and the onset of lactation (Doucet et al., 2012; Schaal et al., 2006). Also, length of the nipple (Thanaboonyawat et al., 2012) and breast size (Mangel et al., 2019) has been linked to breastfeeding difficulties.

In this study, we investigated these characteristics' as well as other's link to the onset of lactation. We have tested areolar glands count and distribution, protrusion of the nipple, protrusion of the areola, area of the areola, area of the nipple, area of the breast, and contrast of the breast and the areola. For this reason, we took photographs of postpartum mothers' breasts and areolae. We have described the morphological features and then tested them for effect to lactogenesis II, which was estimated by using records of weight gains before and after breastfeeding attempts.

This thesis has two parts, theoretical and empirical. The theoretical part comprises of chapters describing breastfeeding prevalence and health benefits, evolutionary background of mammary glands among primates and hypotheses behind human anomalous permanent breasts. Then each morphological part of the breast (breast, areola, nipple, and areolar glands) and their development is described as well as process of lactogenesis. Last part explores possible effects of morphological characteristics on lactation onset.

Empirical part is introduced by aims and hypotheses. Then we describe our methods (sample, data acquisition procedure, data processing, and statistical analyses) and results, which are subsequently discussed and concluded. Briefing for mothers, informed consent, questionnaire, and sample breastfeeding records can be found in supplementary materials.

2. Theoretical background

2.1. Breastfeeding

Similar to other mammals, breastfeeding is the natural way of feeding the human newborn infants for the first period of their life and for most of the evolutionary history of the human species it has been the only possible way. The breastfeeding was provided either by the mother of the child or any other woman capable of lactation at the time. The latter is called wet nursing in humans or allo-nursing and it's common to encounter it in many other mammal species (Isler & van Schaik, 2012). Another possible infant feeding alternative would be an animal's milk. Its use is recorded at least since 2000 BC with cow's milk as a primary source (Stevens et al., 2009). Though many scientists of 18th and 19th century had improved the animal's milk composition by adding other substances to resemble human milk, only in 20th century, with the introduction of evaporated milk, soya milk and adding of vitamins, formula was widely recognized as an acceptable alternative to breastfeeding (Radbill, 1981). Formula contributed to a decline in breastfeeding rates and especially in the duration of breastfeeding period, probably due to the aggressive marketing to the public (Stevens et al., 2009), as well as breastfeeding might be inconvenient and tiring, and formula enabled possibility to be separated from the baby (e.g., returning to work) (C. R. L. Brown et al., 2014).

Exclusive breastfeeding was recently promoted by medical practitioners as it has been linked to lower risk of mortality and morbidity compared to infants who have been partially breastfed. Early start of breastfeeding is a key factor and delay of breastfeeding initiation doubles the risk of neonatal mortality and infection related diseases (Khan et al., 2014).

2.1.1. Health benefits

Breastfeeding has numerous health benefits for the baby as well as for the mother. Breast milk have ideal nutritional composition for infants and among other substances, it contains proteins like lactoferrin, lactalbumin, membrane proteins and osteopontin that have been shown to protect the infant against the various infections (Lönnerdal, 2016; Mosca & Gianni, 2017). Individual history of breastfeeding has been linked to a reduction in the risk of diseases of the offspring

such as acute otitis media, non-specific gastroenteritis, respiratory tract infections, obesity, type 1 and 2 diabetes, asthma, atopic dermatitis, childhood leukaemia, sudden infant death syndrome and necrotizing enterocolitis (Ip et al., 2007).

In mothers, a history of lactation was associated with a reduced risk of type 2 diabetes, breast, and ovarian cancer (Ip et al., 2007). Breastfeeding might reduce the risk of other diseases like osteoporosis and rheumatoid arthritis of the mother but empirical evidence is scarce (Ip et al., 2007; Rea, 2004). Exclusive breastfeeding could also help with uterine regeneration and weight loss after the child birth (Blincoe, 2005). Lactational amenorrhea (period after the delivery, when woman cannot get pregnant) is prolonged by exclusive breastfeeding and works as a natural contraceptive (though it is not 100% reliable (Rea, 2004). Moreover, breastfeeding has positive impact on mood and stress in mothers and they have lower risk of postpartum depression (Krol & Grossmann, 2018). It is assumed that breastfeeding affects formation of mother-child bonding, but the evidence is inconsistent. The bonding might be affected by other early life interactions between mother and child that are not necessarily connected to breastfeeding (Gibbs et al., 2018; Jansen et al., 2008; Tharner et al., 2012). Nevertheless, oxytocin release during breastfeeding plays essential role in mother-child bonding, though the mechanism is still unknown (Kendrick, 2000; Nagasawa et al., 2012).

2.1.2. Breastfeeding prevalence

Even though it has always been understood that breastfeeding is the best infant nutrition, there are women who use alternative feeding methods for reasons different than health-related. Breastfeeding, exclusive breastfeeding and their duration vary greatly among countries in the world (*Figure 1*). Some trends are nevertheless present. World Health Organization (WHO) advises to exclusively breastfeed up to at least 6 month of infant's age (World Health Organisation, 2017). The rates of exclusive breastfeeding in 6 months in most countries is less than 50% but more than 80% of infants receive some milk in nearly all countries (Victora et al., 2016). This indicates that majority of mothers are capable of providing milk for their child but choose not to. The main reasons why mothers chooses to stop breastfeeding include problems with sucking or latching of the baby, sore or crackled nipples and overall painful breastfeeding, perceived unsatisfactory amount

of milk for the baby, trouble getting the milk flow to start, sickness of the mother or the baby and using a milk pump no longer seemed worth the effort. Many of those problems could be resolved with better support and promotion from the professionals (Odom et al., 2013).

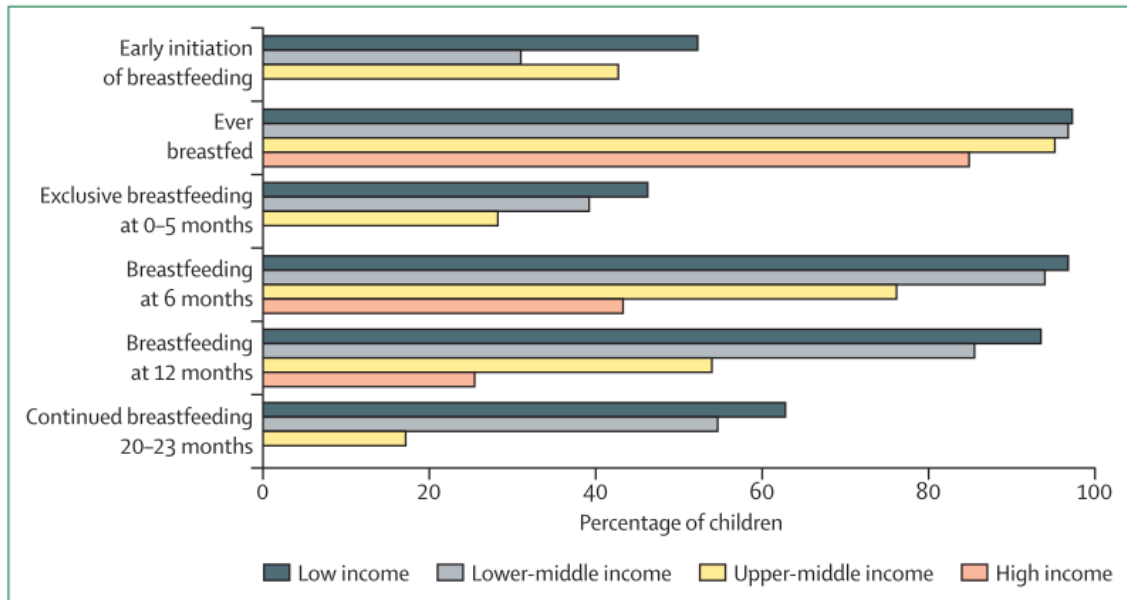


Figure 1: Data from national surveys of 153 countries divided by country income groups in 2010 (Victora et al., 2016)

According to National Lactation League (Národní Laktační Liga – NGO promoting breastfeeding) in the Czech Republic 95.1% mothers started breastfeeding at some point but only 36.9% continued for 6 months in year 2015. Also, from the year 2002 to year 2015, the rate of exclusive breastfeeding, when discharged from hospital, dropped from 91.32% to 81.49% (more recent data are not available) (Kojeni.cz, 2017). These data are consistent with figures in other developed western countries (Victora et al., 2016).

2.2. Evolutionary background

2.2.1. Nursing in primates

Mammary gland and the ability to produce milk for offspring is a defining characteristic of mammals. Mammal species with helpless offspring (altricial) usually make nests and give birth to multiple young and have several pairs of nipples. Species with mature, not so helpless, offspring (precocial) usually give birth to one or two young and have only one pair of nipples in the inguinal region (Rawal, 2019). Primates do not follow this pattern. They evolved to utilize arboreal habitat

and offspring are typically carried by the mothers. Most of the primates (excluding many new world monkeys) have one pair of nipples in the pectoral region and give birth to one or two relatively mature offspring. The location of the nipples on the chest allows the nursing of the infant even when moving through the trees. Even the species of primates that do not live in trees anymore, carry similar morphological and behavioural characteristics. The pectoral location of breasts in human could be an evolutionary heritage of the arboreal monkeys (Koyama et al., 2013).

2.2.2. Human anomaly

Unlike other primates, human female breasts develop during puberty and remain permanently enlarged throughout life. Primates develop breast tissue only during pregnancy. The fact that the human breasts consist not only of tissue needed for lactation (ducts and alveoli) but also a fat tissue, indicates additional functions next to breastfeeding (Gallup, 1982; Morris, 1967). The adaptive role of permanent breasts in humans has not yet been established. Hypotheses can be divided according to their selection pressure, sexual and natural.

2.2.2.1. Sexual selection

In western culture, large breast are consider sexually attractive for men (Gueguen, 2007). However, the evidence of preference for larger size is not consistent. It has been shown, that men prefer large (Dixson et al., 2015; Kościński, 2019; Valentova et al., 2017), medium (Kościński, 2019) or even small breasts (Furnham & Swami, 2007). Only attribute that is consistently preferred is symmetrical and firm breasts (Dixson et al., 2011; Havlíček et al., 2017; Kościński, 2019). Also, the breast size preference differs across cultures, and the breasts are sometimes not even considered sexually appealing (Havlíček et al., 2017; Valentova et al., 2017).

If human permanent breasts are indeed sexually selected, the breast would serve as a cue of woman's biological condition. As breastfeeding is its primary function, it could reflect the lactation capability (Powe et al., 2010; Żelaźniewicz & Pawłowski, 2018b). It could also indicate the nutritional status of the women, as fat reserves in women would be crucial for childbearing (Cant, 1980). Large breast (and low waist-hip ratio) in women are connected to higher levels of E2 oestradiol and progesterone which are linked to higher conception probability. Larger breasts

could be a cue to reproductive potential (Jasieńska et al., 2004). Lastly, the emergence of breasts in puberty could signal sexual maturity and the reduction of volume and ptotic breasts in older women could signal lowered fertility (or no fertility in menopause). Therefore, large, non-ptotic breasts could be a cue of sexual maturity and residual fertility (Gallup, 1982; Marlowe, 1998).

2.2.2.2. Natural selection

It was also suggested that permanent breast enlargement was developed under the influence of natural selection. Due to the loss of fur in our human ancestors, other insulation mechanisms have risen, such as increased subcutaneous fat tissue. Permanent breasts could have been a side effect of this increase. They also provide fat reserves much needed for energy-consuming breastfeeding during food scarcity or insulation for the mother and infant in lower temperatures (Pawlowski, 1999). Furthermore, it has been suggested, that breasts size could be connected to food availability or access to resources. There is evidence, that men from low socioeconomic environment or hungry (prior to the testing) rated women with larger breasts as more attractive (Swami & Tovée, 2013).

It is also possible that permanent breast emerged in evolution as a by-product of other evolutionary changes (Pawlowski, 1999).

2.3. Breast Morphology

Breasts are bilateral body parts encompassing mammary glands in primates, including humans. Only in females it develops into a functional milk producing and feeding structure.

2.3.1. Development of mammary glands

Mammary gland arises during embryogenesis in both sexes from a localized thickening of the epithelial ectoderm and forms a mammary bud and a milk line which can be first observed in 4th week, on which mammary disc appears between the 7th and 8th week, followed by mammary parenchyma growth forming epithelial buds at 12th week. Branching of the parenchyma during the 12th-20th week results in 15-25 epithelial strips that give rise to openings at each nipple. Up to 32nd week, these strips are canalized by apoptosis. From 32nd to 40th week of gestation, limited

lobulo-alveolar development occurs and full-term infant has nipple with rudimentary ducts (Hovey et al., 2002).

The mammary gland has no special postnatal development except growing with the body in both sexes until 8-12 years, when girls start to show additional growth again. In the puberty, both glandular and stromal tissue grow. Glandular increase is due to growth and division of ducts in dichotomous or sympodial way forming clusters – lobules. Formation of mature lobules occurs within 1-2 years after onset of the first menstrual period. The process is driven by hormones – mainly fluctuating estrogen and progesterone level during menstrual cycles, corticosteroids, and thyroxine (also Growth Hormone is essential). This glandular growth is gradual process taking many years. Even in adulthood, there is still some growth fluctuation every menstrual cycle if not intervened by pregnancy. However, the main growth in volume is due to the hypertrophy of adipose and stromal tissue. During pregnancy, breast tissue undergoes major development and it expands even more, but now it involves mainly the glandular tissue. Levels of estrogen and progesterone are 20 times greater than in normal menstrual cycle and are accompanied by prolactin, other lactogens and growth hormones. Lobules not only enlarge but also additional are formed. Most of it is established mid-pregnancy. Second half of pregnancy is characterized by gradually increasing secretory activity (Lactogenesis I). After childbirth when mother starts to lactate (for the process of lactogenesis see chapter Lactation), no further significant morphological changes in breast occur except for the continuous secretion of milk. Following weaning of the infant, milk accumulates in the ducts and lobules, which has an inhibitory effect on milk synthesis. Epithelial cells reduce in volume and consequentially reduce the breast volume (Russo & Russo, 2004).

After successive rounds of pregnancies and increasing age, intra-lobular stroma is gradually replaced by collagen, and the glandular epithelium and lobular connective tissue is replaced by fat (Gusterson & Stein, 2012). Therefore, the lactational capability of mammary glands decreases (*Figure 2*).

Figure 1. Changes in the female breast from preadolescence through menopause (from The Boston Women's Health Book Collective, 1976). (a) child; (b) adolescent; (c) adult (breast shape more "droopy" for many women); (d) pregnant adult; (e) lactating adult; (f) adult after menopause).

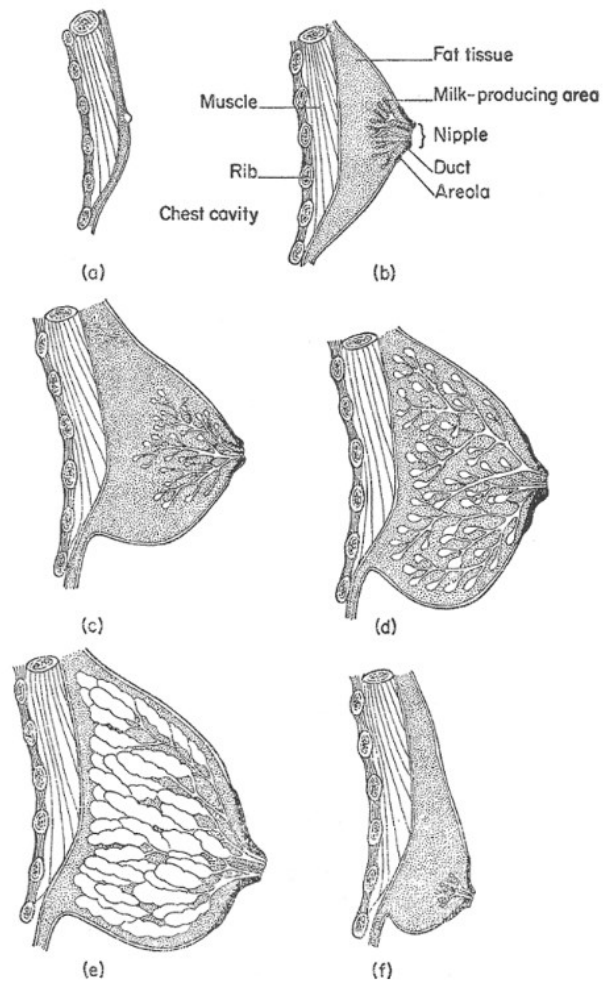


Figure 2: Changes in the female breast from preadolescence through menopause (Gallup, 1982)

2.3.2. Breast size

Breast size could be evaluated by different means. The golden standard, which is most informative, while relatively easy to do, is the measuring of breast volume by immersing in liquid. Study with water displacement method resulted in values from 152 ml to 1900 ml with a mean of 643 ml (McGhee & Steele, 2011). Another method is plaster casting of the chest wall. In a study with unrepresentative sample of advertisement recruited women, the range was measured from 209.0 cc to 1751.8 cc (D. J. Smith et al., 1986). By using biostereometric method (analysing two photographs from different angles by various algorithms), the breast volume ranged from 21.5 ml to 1932.1 ml with an average of 405.1 ml (Loughry et al., 1989). The easiest way to measure breast size is collecting bra size, but this method is the least reliable. Data collected on bra sizes ranges from 10A to 24DD (Australian sizes: the number is the size of band and the letter is the size of cup). In this study, they also measured volume by water displacement method and it is apparent how women with the same volume have very different types of bra (e.g. breast volume 550 ml can fit into bra sizes 10E and 16C), suggesting various breast (and chest) shapes (McGhee & Steele, 2011). Lately, 3D scanning of the breast is on the rise, and it seems to be the most reliable measurement (Yip et al., 2012). In a 3D scanning study of 346 participants of all age groups, they found the range from 48 ml to 3100 ml (*Figure 3*) (Coltman et al., 2017). Even if the methods are different, it is clear that variability in breast size is enormous.

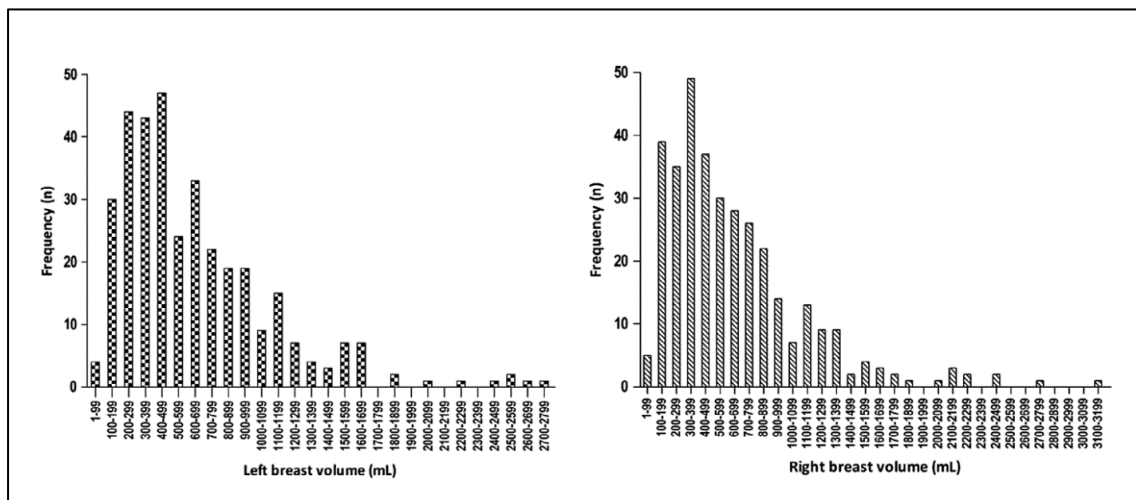


Figure 3: The volume distribution for the right and left breast ($n = 346$) (Coltman et al., 2017)

It is important to note, that breast volume does not correlate with the ability to produce milk. The milk production was not dependent on the breast size before pregnancy at any stage of lactation (Kent et al., 1999). When authors of the study tested breast volume in the first, second and third trimester, they found no correlation with breastfeeding initiation, breastfeeding problems, nutritional value, fat, and protein content of the milk (Żelaźniewicz & Pawłowski, 2018b). Similarly, no relationship was found between the change in breast volume during pregnancy and amount of milk production at 1 month of lactation (Cox et al., 1999). Insufficient milk production has been reported only in cases with extremely low breast enlargement during pregnancy (and extremely small breasts before pregnancy) (M. Neifert et al., 1990), which could be due to other physiological or health problems affecting lactation, or the fact that this study used only self-reported breast enlargement data. Very large breasts were also associated with breastfeeding and lactation difficulties and the effect was stronger in overweight women. In this study, the data were in questionnaires collected by healthcare professionals (Katz et al., 2010).

Body weight and Body Mass Index (BMI) have a significant effect on volume and breast cup size (Avşar et al., 2010, Brown et al., 1999). In the study with 3D scanning, a positive correlation with BMI and breast volume was also found (Coltman et al., 2017).

2.3.3. Ptosis

Breasts are subject to ptosis on account of different causes. Breast ptosis is defined as flattening of breast and nipple pointing downwards. The reason to this so-called “breast sagging” is loss of elasticity of the connective tissue. Significant predictor of breast ptosis is number of past pregnancies due to change in volume and strain of the Cooper’s ligaments (connective tissue) from the engorgement (Rinker et al., 2008). Interestingly enough, breastfeeding is not connected to the ptosis probably because breastfeeding does not intensify the effect beyond the pregnancy alone (Rinker et al., 2010). The change in volume similarly occurs when body weight fluctuated in the past and with greater weight loss, ptosis of breasts occurs. Higher body weight and breast size also influence breast sagginess due to gravity. However, the main predictor for ptosis is advancing age. After menopause, glandular atrophy

occurs, then the amount of fat and connective tissue decreases, breast becomes smaller and insufficient skin elasticity does not prevent the looseness (T. Brown et al., 1999). Another significant risk factor is smoking because it also reduces the dermal elasticity. It is 40.9 more likely to suffer higher degree of ptosis when smoking (Rinker et al., 2010).

Even if we take into consideration all the effects mentioned above, huge variability in breast sizes and shapes still exists, independent of body weight, age etc. There is very little empirical evidence addressing the reasons behind the phenomenon.

2.3.4. Symmetry

Two main types of asymmetry can be distinguished. Fluctuating asymmetry is defined by random deviations in bilateral symmetry on either side of the body, unlike directional asymmetry where the asymmetry tends to be on one side of the body in the given population. About 35.1% (Avşar et al., 2010) or even 44.8% (M. Neifert et al., 1990) of women experience some degree of breast asymmetry. Directional asymmetry was found in favour of the left breast (Westreich, 1997), the right breast (Avşar et al., 2010) or none (Żelaźniewicz & Pawłowski, 2018a), suggesting the asymmetry is more likely fluctuating than directional. The breast asymmetry is more pronounced in larger breasts (note that asymmetry is greater in larger body parts in general) and estrogen level plays role in both those characteristics (Żelaźniewicz et al., 2019), therefore, it might be possible that females with greater biological fitness have large yet symmetrical breasts (Manning et al., 1997). Fluctuating asymmetry of the bilateral parts in the whole body is believed to reflect developmental instability and history of infectious diseases (Żelaźniewicz & Pawłowski, 2018a), and it is used as an indicator of an individual having good genes and ability to resist environmental influence (Harvey et al., 1993). Fluctuating asymmetry in breasts might indicate woman's residual fertility (Møller et al., 1995) and is connected to perceived attractiveness (Singh, 1995). However, it seems it does not affect lactation ability (M. Neifert et al., 1990). Breast asymmetry is not a predictor of child's neonatal condition but composite asymmetry of eight non-sexually selected body features could be a better predictor (Żelaźniewicz & Pawłowski, 2018a). Also, asymmetry of breasts does not seem to be a good indicator of developmental instability.

2.3.5. Nipple-areola complex morphology

Nipple-areola complex is an area of tissue roughly centred on the breast mound (*Figure 4*). Its main function is to provide the infant a way to latch onto and suck maternal milk.

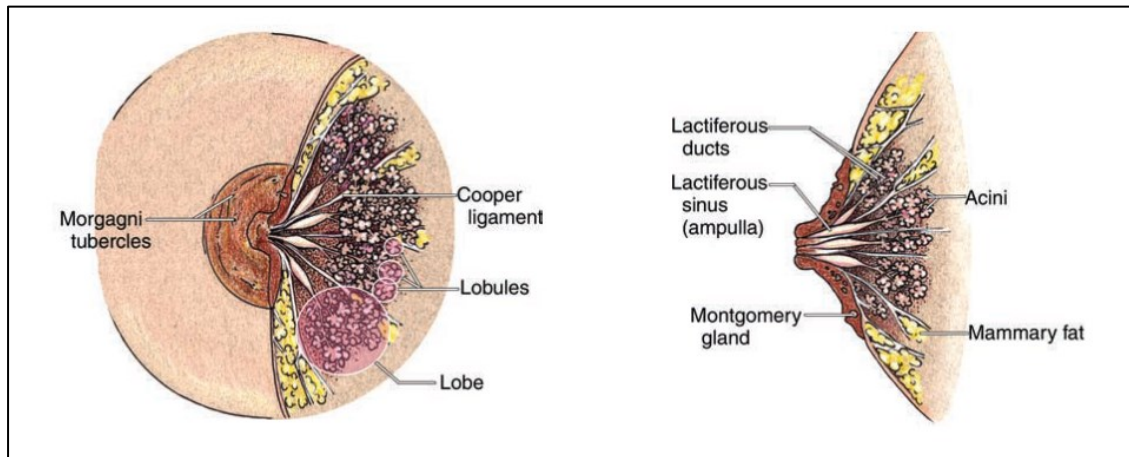


Figure 4: Anatomy of a nipple-areola complex (Nicholson et al., 2009)

2.3.5.1. Nipple

Development of the nipple-areolar complex begins in the 12th – 16th weeks of gestation by differentiation of mesenchymal cells into smooth muscle components. The nipple is a raised part in the middle of the areola containing the outlets of lactiferous ducts. Early studies usually describe 15-20 lobes and milk ducts, but more recent studies show that the number can range from 4-18 with the mean of 9 and due to the merging, the number of main duct outlets on the nipple can be lower than number of lobes (Ramsay et al., 2005).

Though shape variation in nipples exists, the most frequent shape is cylindrical with diameter bigger than height. Diameter can range from 0.6 to 2.3 cm with the mean of 1.3 cm and height ranges from 0 to 2.0 cm with the mean of 0.9 cm (Sanuki et al., 2009). These data were obtained from research on Asian women (nulliparous and parous), but are consistent with studies of European women (Avşar et al., 2010; Mangel et al., 2019; Ramsay et al., 2005). During the pregnancy, the height (or length) of the nipple increases substantially as well as diameter. In the study of Thai primiparas, where their nipples were measured from early gestation to term (excluding women with nipples shorter than 0.7 cm), the length increased from mean 0.93 to 1.12 cm and diameter increased from mean 1.36 to 1.59 cm

(Thanaboonyawat et al., 2013). These changes can be attributed to the preparation for breastfeeding, as the longer nipple is easier for the infant to draw onto. The nipple shorter than 0.7 cm is linked to lower breastfeeding success rate (Thanaboonyawat et al., 2012).

In some women, nipple retraction or nipple inversion can be observed. Retraction refers to a small part pulled inward resulting in a slit on top of the nipple. Inversion describes the whole nipple being pulled inward to different extents. Both phenomena can be congenital or acquired and either unilateral or bilateral (Nicholson et al., 2009). The prevalence for any of these malformations is 3-3.5% (Park et al., 1999; Sanuki et al., 2009). This condition is associated with breastfeeding problems due to difficult latching (M. Neifert et al., 1990). In some cases, it is possible to temporarily restore the inverted nipple to the normal position by suction.

Sometimes, supernumerary nipples occur. They appear anywhere on the lines corresponding to milk lines in breast development. It is an atavistic phenomenon and it has no function. The prevalence in population (both sexes) is surprising 5.6%, occurs more often in males, and seems to be hereditary (Schmidt, 1998).

2.3.5.2. Areola

The nipple is surrounded by pigmented area called areola mammae. Areola has different histology profile to the skin on the rest of the breast and it is usually endowed by areolar glands. Differentiation of the breast parenchyma and development and pigmentation begin around the 32nd week and continue to the 40th week. During the development in puberty of girls, areola forms secondary mound on the breast which later subsides to the level of the breast (Nicholson et al., 2009).

As W. Montagna describes his observations, the morphology of areola varies greatly in individual women in colour, size, shape, contour, texture and even functional capabilities (Montagna & Macpherson, 1974).

Areola diameter is the most measured aspect of the areola. The mean diameter in various studies is 50 mm (SD 19) (T. Brown et al., 1999), 46 mm (SD 11.4) (Hauben et al., 2003), 40 mm (SD 10) (Sanuki et al., 2009), 36 mm (SD 9) (Avşar et al., 2010) or 64 mm (Mangel et al., 2019). Some difference in those results can be associated

with either European or Asian descent of the sample used - Asian women having smaller areola (Brown et al., 1999). The areola diameter positively correlates with breast size (Avşar et al., 2010). During the pregnancy, areola's diameter significantly increases – 37.9 mm (SD 8.9) to 50.1 mm (SD 10.9) (Thanaboonyawat et al., 2013). In the study of newly postpartum women, area of areola was found (with the exclusion of nipple) to be 24.44 cm² (SD 9.16) and follow-up study on a subsample showed further increase of areolar surface in the first postpartum days (Schaal et al., 2006). Areola size is variable among women but size of the breast, parity, state of gravidity and possibly ethnicity have substantial effect.

Pigmentation of areola vary due to hormonal changes (melanocyte-stimulating hormone, estrogen and progesterone), but the exact mechanism is yet unclear. During the puberty, female areolae gets gradually darker (Biro et al., 1992) and it could potentially serve as a signal for sexual maturity (Dixson et al., 2015). In adult females, the quantity of melanin present in areola skin is twice as much as in breast skin (Dean et al., 2005). The second time the areola gets darker is during pregnancy. Most of the pregnant women go through pigmentary changes in areola (90%) but quite a lot of them experience increased pigmentation in other body regions as well (mainly genitalia and linea alba but also generalized hypermelanosis) (Muzaffar et al., 1998). This increased pigmentation is greater in darker skin individuals (though in very dark skin, the changes might not be even visible) (Muallem & Rubeiz, 2006). The hyperpigmentation often recedes postpartum but usually remains to some extent (Barankin et al., 2002). The observation, that the areola is darker around the time of the childbirth, might suggest possible visual cue towards the newborn infant to help him navigate to the nipple (Soussignan & Sagot, 2006).

2.3.5.3. Areolar glands (AG)

On the areola, various skin glands are present. Apart from hair follicles that are always on the edge of the areola, eccrine sweat glands and sebaceous glands can be found on the hairless surface (Montagna & Macpherson, 1974). Accompanying the sebaceous glands, are Montgomery glands (areolar glands), which are named after W. Montgomery, who described them in detail in 1837 (Montgomery, 1837), even though they were first identified by G. Morgagni in 1723 who called them 'tubercles' or 'follicles' (Morgagni, 1723). In older sources, it is usually assumed they are

sebaceous glands or accessory mammary gland (Montagna & Yun, 1972; Naeslund, 1957). However nowadays most researchers believe that the AG are structurally transitional between sweat glands (histological profile) and mammary glands (milk-like secretion) (Kopans, 2007; Tur & Maibach, 2018; Zucca-Matthes et al., 2016). The AG open at the Morgagni tubercles, which are small raised papules on the areola (Nicholson et al., 2009). They are small structure 1-2 mm big, contrasting with the surrounding areolar skin in elevation and/or pigmentation (Alam & Dehnhard, 2013). Development of AG follows the development of nipple-areolar complex in the 12th – 16th weeks of gestation (Nicholson et al., 2009). AG enlarge and get more visible during the late pregnancy and start secreting milk-like liquid as well as volatile odorous substances (Doucet et al., 2009). Originally, Montgomery used this visible glands enlargement to determine the state of pregnancy (Montgomery, 1837). Their secretion has multiple functions including helping the newborn infant navigate and properly latch onto the nipple-areola complex (Schaal et al., 2006). The number of areolar glands vary greatly in women (0-38 glands per breast with mean of 8.9 (SD 5.6) (Schaal et al., 2006); 0-48 glands per breast with mean of 10.39 (SD 9.04) (Doucet et al., 2012)(*Figure 5*). Furthermore, the distribution of areolar glands does not seem to be uniform but more glands can be found in upper-lateral quadrant of areola than in lower-medial quadrant (Doucet et al., 2012; Schaal et al., 2006).

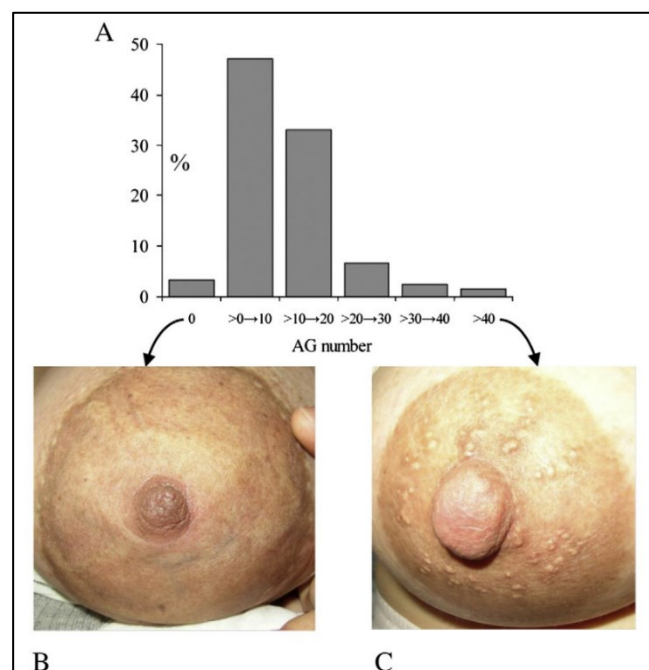


Figure 5: (A) Frequency distribution of AG; (B, C) Two extreme cases of AG endowments. (Doucet et al., 2012)

2.4. Lactation

There are usually recognized three stages of lactogenesis.

- Lactogenesis I occurs during pregnancy at 15-20 weeks of gestation. From this point, the woman would be able to produce milk, when necessary (for example, if the baby was born prematurely). Sometimes small amounts can be secreted from this time. Colostrum can appear during late pregnancy.
- Lactogenesis II occurs 30-40 hours after the delivery. It is initiated by the birth and removal of the placenta – rapid decrease in progesterone and estrogen, and presence of prolactin, cortisol, and insulin. Increase in milk production occurs between 50 to 73 hours postpartum and is accompanied by fullness of breasts. First milk (colostrum) has very different composition than hindmilk (more concentrated in nutritional value, high in protein). The change into hind milk is gradual.
- Lactogenesis III occurs and continues only if the milk is constantly removed and nipple stimulated. Unlike the first two stages, which are hormonally driven, it is under autocrine control (*Figure 6*). Milk removal triggers prolactin release. It works together with oxytocin, which is triggered by tactile stimulation of nipple-areolar complex and causes the milk ejection (contractions of the myoepithelial cells forcing milk into the ducts and out of the nipple).

Hormone	Response
Prolactin	Growth: nipple and areola
Human placental lactogen	
Estrogen	Proliferation and differentiation: ducts and glandular system
Progesterone	Growth: lobes, lobules, alveoli Inhibition of lactation and milk secretion
Decrease of estrogen and progesterone (placenta removal)	Prolactin uninhibited
Increase of prolactin	Milk synthesis
Oxytocin (milk suckling)	Milk ejection reflex (MER) Myoepithelial cell contraction

Figure 6: Hormones involved with Lactation (Sriraman, 2017)

Lactogenesis II is the critical stage of lactation, as it is initiating the secretion of sufficient amounts of milk. It changes the composition of the secreted liquid from

colostrum to mature milk. It is most likely to be affected by various conditions, which concludes usually into delayed, decreased, or even failed onset of lactation. These conditions include obesity (Nommsen-Rivers et al., 2010; Preusting et al., 2017), diabetes (P. & M., 2001), cesarean section, stressful vaginal deliveries, or premature delivery (Pillay & Davis, 2020; Sriraman, 2017), retained placental fragments (M. R. Neifert et al., 1981), age (Nommsen-Rivers et al., 2010), and primiparity (Hurst, 2007; Wiliyanarti et al., 2018). These conditions are (with the exception of obesity) not preventable or dependent on medical care.

2.5. Effect of morphology on lactation onset

Breast, nipple, and areola are structures adapted for effective breastfeeding and successful start of breastfeeding. Together they function as system for canalization of milk from the mother to the baby. Their morphological characteristics could help to optimize this transfer by supporting the baby to successfully attach their mouth to the nipple and effectively extract the milk. When the latching phase fails, the lactation, dependent on nipple stimulation and milk removal, might initiate with delay or not at all. On the other hand, there are certain morphological characteristics of the breast that could impair the onset of lactation (e.g.: flat nipple, large nipple, inverted nipple and large breast) (Vazirinejad et al., 2009).

2.5.1. Effect of AG on lactation onset

Areolar surface is covered by various glands, including Montgomery glands that enlarge during pregnancy and lactation (Montgomery, 1837). The combination of these secretions and milk create a mixture which has a few important functions. The lipid lubrication of the nipple-areola complex helps it to withstand the mechanical action of sucking and corrosive action of saliva. Also, it protects the epidermis and ducts from pathogens as the secretion contains immunoglobulins with antibody activity against common bacteria (Ip et al., 2007). The secretion may combine with infant saliva to create a hermetic seal of the nipple-areola complex and the mouth of the baby, which helps the effectiveness of sucking (Schaal et al., 2006). Note that part of the areola goes into baby's mouth, not only the nipple. Otherwise, the breastfeeding can be very painful.

Apart from these basic functions, the secretion produces complex odour cocktail. The lipid part of the mixture which is produced by sebaceous glands and Montgomery glands might act as an odour fixative for the lacteal part produced by mammary glands itself as milk and lacteal part of Montgomery glands secretion (Schaal et al., 2006). The surface temperature of the areola is slightly higher than the surrounding breast skin. This could help with the evaporation rate of those volatile odours and as maybe also act as a thermal signal to guide the baby (Zanardo & Straface, 2015).

It has been previously described, that newborn find and prefer an unwashed mother's breast within the first 1-2 hours postpartum (Varendi et al., 1994). The exposure to any odorous part of the breast to the baby stimulates behavioural responses (oral activity, eye opening, delay of crying) more than the exposure to the odourless breast (Doucet et al., 2007). When the AG secretion was separated from the other breast odours and taken from non-familiar lactating women, the 3 days old neonates detected and were more attracted to it over other stimuli including sebum, human milk, cow milk, formula milk, water and vanillin (Doucet et al., 2009). Neonates also preferred human milk over formula when both the stimuli was unfamiliar to them (Marlier & Schaal, 2005). With this evidence, we can assume that the AG have a communicative function for newborn babies to locate and latch properly on the nipple-areola complex during the first breast crawls on their mother's chest.

In the study investigating number and distribution of AG on the areola, it was found that AG are present in almost every woman and their variability is great. The number of AG was positively related to neonatal weight gain between birth and day 3 postpartum, moreover, number of AG was positively correlated to the onset of lactation in primiparous mothers. Authors argue that the onset of lactation is highly affected by parity, as the mothers who previously breastfed have more protrusive, prehensile nipples, more experience, lactogenesis has different dynamic in multiparous women and primiparity is associated with various problems including delayed onset of lactation (Schaal et al., 2006). These findings have been replicated and supported in a later study with a bigger sample (Doucet et al., 2012). Both studies have found non-uniform distribution of the AG, with the most AG being on

the upper lateral quadrant of areola. They suggest that the position of the AG overlap with the position of the baby's nose when latching on the nipple (Doucet et al., 2012; Schaal et al., 2006).

2.5.2. Effect of protrusion of nipple and areola on lactation onset

Protrusion (length) of the nipple seems to be closely related to the parity of women. Nipple's length increases during the pregnancy but the length is also affected by previous breastfeeding and their duration. In primiparas, the length of the nipple is shorter than in multiparas (Hyttén & Baird, 1958; Thanaboonyawat et al., 2013). The mechanical pulling of the nipple permanently elongates the nipple. Regardless the parity, nipple protrusion ranges from completely flat to around 2 cm. More protrusive nipples should be easier for the baby to latch onto. Nipples shorter than 0.7 cm have been associated with latching difficulties (Puapornpong et al., 2013; Thanaboonyawat et al., 2012).

When latching, the baby grasps the nipple as well as the areola in its mouth, therefore, we can assume that protrusion of the areola plays similar role for successful latching of the baby and consequential onset of lactation. To our knowledge, variation in protrusion of areola on breastfeeding onset has not been tested yet.

2.5.3. Effect of the contrast of the breast and the areola on the onset of the lactation

The darker pigmentation of the areola occurs not only during the development in puberty but also during the pregnancy. Overall pigmentation of the body is present but most visible changes can be observed on the areola (Muallem & Rubeiz, 2006). Areolar pigmentation plays a role in adults as a cue in perception of sociosexual attributes (Dixon et al., 2015). This role as a cue could as well work on newborn babies but as guide to find the breast. The vision of the neonates at the very beginning of their life is satisfactory only for short distances (max 50 cm), due to lack of accommodation. As highly contrasting objects are easier for them to distinguish (Slater, 2002) and the dark pigmentation of the areola creates a contrast to lighter skin of the surrounding breast, this could be another signal for the baby to help him locate the nipple and therefore accelerate the onset of lactation.

2.5.4. Effect of the breast, areola, and nipple area on the onset of lactation

Large size of the breast is associated with body mass and BMI (Brown et al., 2012; Coltman et al., 2017). BMI is a universal determinant of obesity (although it neglects the amount of muscle mass, in women it generally works better). Maternal obesity has been repeatedly linked to breastfeeding difficulties and has a direct effect on delayed lactogenesis II (Mangel et al., 2019; Preusting et al., 2017; Turcksin et al., 2014). Not only overweight or obese women but also women with very large breasts have been reported to have breastfeeding initiation and continuation difficulties, but for the women that have large breast and also are obese, are these problems more common (Katz et al., 2010). Therefore, when considering large breasts (area), it is difficult to distinguish between the physiological obstacle of obesity and morphological characteristics as areola and nipple pooling due to the size and mass of the breast, which could have effect on the latching of the baby.

Size (area) of the areola is correlated with the size of the breast (Mangel et al., 2019). There is no previous studies investigating the effect of areola area on breastfeeding or lactation.

Nipple diameter (area) is also correlated with the size of the breast, but the variability of the nipple area is presumably low. We would expect no effect or very low negative effect on the onset of lactation.

3. Aims and hypotheses

Aims of this study are to provide descriptive information of breast morphology of Czech sample of mothers early postpartum and explore the possible effect of morphological characteristics of breast and nipple-areola complex on lactation onset – estimation of lactogenesis II.

Hypotheses:

- Distribution of the AG is non-uniform, higher abundance of AG will be found on upper lateral quadrant of areola.
- Number of AG is positively correlated to earlier onset of lactation.
- Number of AG in upper lateral quadrant of areola is positively correlated to earlier onset of lactation.
- Protrusion of the nipple and the areola is positively correlated to earlier onset of lactation.
- Contrast of the skin of the breast and the areola is positively correlated to earlier onset of lactation.
- Size of the breast is negatively correlated to earlier onset of lactation.
- All of those effects have bigger impact in primiparous women or are limited to primiparous women only.

4. Methods

This study was approved by the ethical commission of General University Hospital in Prague and it was part of a broader study investigating factors influencing lactation initiation including postpartum contact of mother and child, postpartum blues, and medical procedures in early postpartum care.

4.1. Participants

We collected data from 141 mothers (mean age = 31.0, SD = 4.15, range 21 – 39) who gave birth at the Department of Obstetrics and Gynaecology of the First Faculty of Medicine and General Teaching Hospital at the Saint Apollinaire maternity ward in Prague. The women had to fall between 18 and 40 years of age, further study inclusion criteria were a physiological childbirth without complication, delivery at term (38. - 42. weeks), mother and child were healthy, and mother was planning to breastfeed. These criteria were chosen as they may interfere with the dependent variable (lactation onset) and therefore we aimed for relatively homogenous sample. They received a voucher worth 300 CZK (approx. 12 EUR) for their time and potential inconvenience caused by participation in our study. Their participation was voluntary, they all signed informed consent (Supplementary material 2), and their data were anonymised by a code.

4.2. Excluded cases and missing data

Cases that were excluded from the statistical analysis, and missing data, are specified in the diagram below (*Figure 7*). Most missing data are those acquired by questionnaires (e.g., age, parity, BMI) because some of them were not returned to us. In some cases, we could not estimate lactation onset from the breastfeeding record. Mainly due to insufficient lighting conditions, we could not perform colour analysis on some photographs (e.g., contrast of breast and areola). The exact numbers can be found in descriptive *Table 1*.

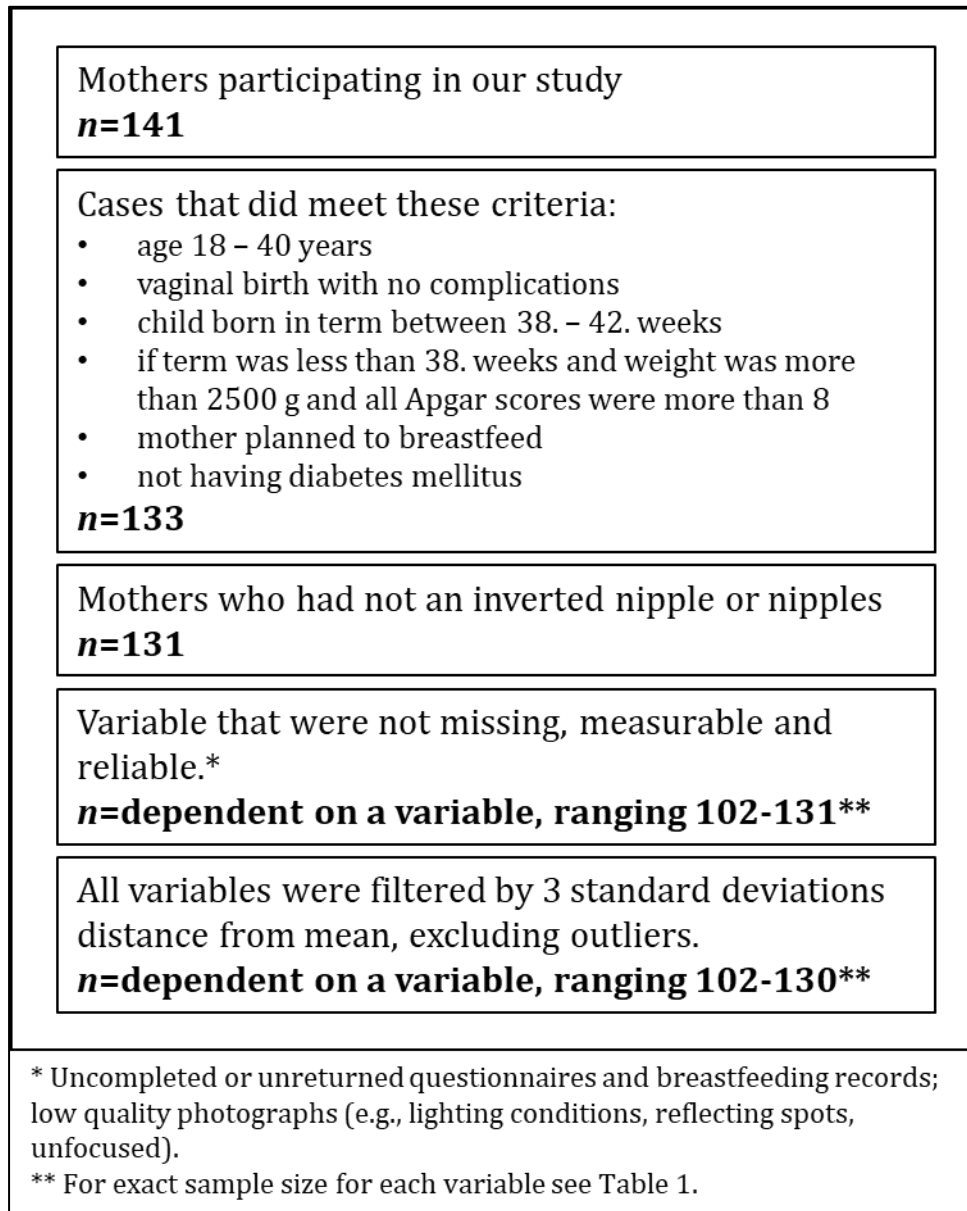


Figure 7: Excluded cases and missing data from the sample

4.3. Procedure

Mothers were first contacted, first day postpartum, by the hospital nurse, who informed them of possibility to participate in the study, provided them informed consent and a questionnaire. On the same day, a researcher visited the mothers in their room. The appointments with mothers were carried out roughly at the same time of the day (1 PM). The participants were expecting us but did not have full instructions of the process. First, the researcher explained details of the questionnaire and then the process of acquisition of the photography. Mothers received remaining questionnaires which were not related to this part of the study,

regarding early postpartum contact with the baby and postpartum depression and blues (for details see – (Šámalová, 2020). Subsequently, the researcher took the photographs. The second day, the researcher visited participants again, collected completed questionnaire and mothers received a voucher. The rest of the questionnaire that included the medical records of the delivery, was completed by the neonatologist on duty. Breastfeeding records were acquired from the hospital archive by researchers with the permission of the hospital. The process is illustrated in the diagram below (*Figure 8*).

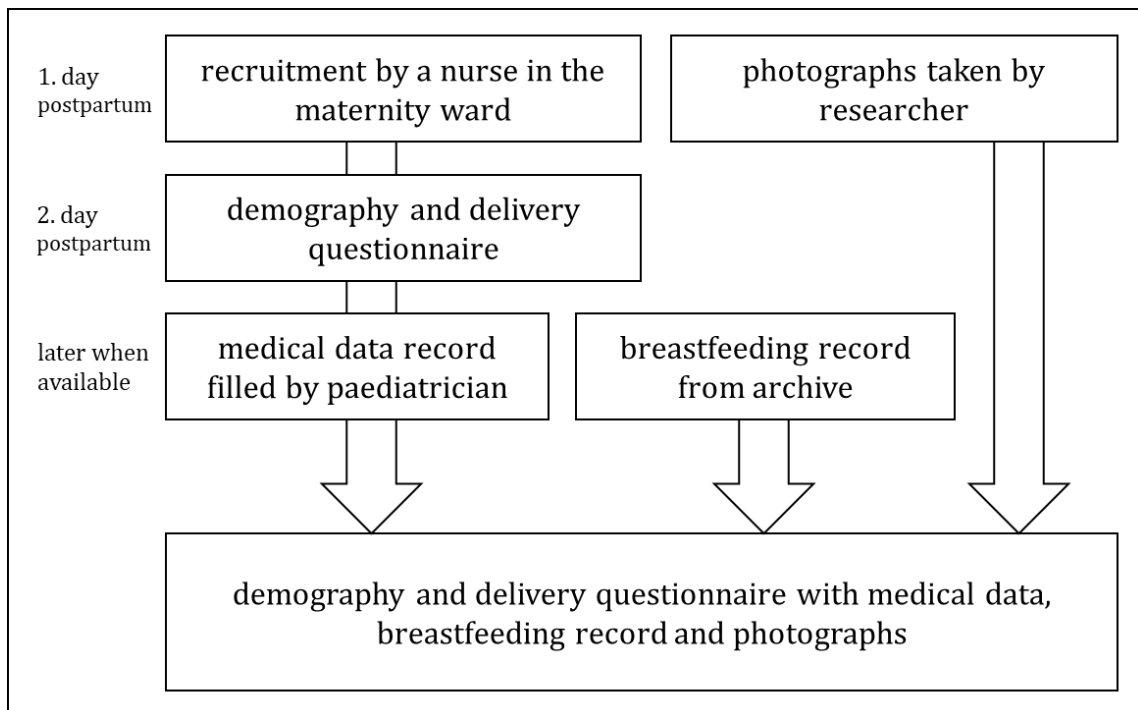


Figure 8: Process of data collection

4.4. Questionnaire

The questionnaire consisted of items regarding mother's basic socio-demographic information (age, education, marital status, partner and/or father information, household income, weight and height before and after pregnancy, diet, size of bra) medical history (including smoking and alcohol consumption during pregnancy), previous delivery/ies and breastfeeding information, and medical information on the current birth and newborn baby. The medical information was filled in by the paediatrician from the hospital medical record. This part included time of delivery, labour duration, anaesthesia, perineotomy, oxytocin administration in the second labour time, birth induction, infant position, APGAR score, sex, weight and length of

the newborn, and other information that could have impact on the breastfeeding initiation (Supplementary material 3).

4.5. Lactation onset estimation

Additionally, we collected breastfeeding records, which contain weight differences of the infant before and after every breastfeeding attempts, which was recorded by the mothers (Supplementary material 4). This record was used to estimate onset of lactogenesis II. We estimated the time of lactogenesis onset followingly: if weight difference in three consecutive breastfeeding attempts was at least 30 g in total with the minimum of 10 g per attempt, we recorded the time of the first attempt as the initiation of lactogenesis. If this criterion was not met, but the weight difference measured in one attempt was more than 30 g, we took this record (Arthur et al., 1989). Not every mother has steady linear onset of lactation, that is why we used the three consecutive attempts.

4.6. Photographs acquisition

The photographs were taken in the ward rooms where the mothers stayed. The ward rooms had different wall colours, sizes, and lighting conditions – the light coming from windows, weather, and room lights. Nevertheless, we maximized the standardization as much as possible. The temperature of the room was measured by infrared thermometer pointed to an inner wall of the room. The ambient temperature affects the colour and shape of the breast and nipple-areola complex (Furlan et al., 2016). We found that the rooms had relatively steady and warm temperature (average 24,78 °C) to keep the newborn babies warm. If it was possible, the photography was taken in the bathroom since it provided some privacy and higher standardization. Otherwise, it was taken in the room.

Photographs were captured with 24 megapixels DSLR camera Nikon D7200 with zoom lens Nikon AF-S NIKKOR 18-140mm DX VR into 14-bit uncompressed raw files (NEF) and Adobe RGB colour space. Exposure values were set to ISO 100, shutter speed 1/100 s and aperture f/5.6. For lighting we used external on-camera flash (Di866 MARK II) combined with Ring Flash Diffuser Soft Box for a uniform lighting.

The images of participants were taken freehand. Camera's distance from each participant was measured with a tape measure. To acquire images of the upper

body, the subject to camera distance was 1 m with focal length set to F35. Camera's height was adjusted individually for each participant so the shoulders and the whole breasts were visible, but the face was not in the frame, and we focused on participant's areolae. For taking images of the detail of areolae, the distance was 50 cm with focal length set to F105. The images of areolae were framed around the areola with part of the breast skin visible and focused on the areola plane. Colour calibration was performed by using Simple Reference Grey Card (Figure X) on the first picture of the body and of each areola.

In total, we took 12 photographs – 4 of the breasts and 4 of the left and right areolae. On the first photograph of each group of 4, the mother was instructed to hold the calibration card on the chest perpendicular to the camera. To keep the exposure constant between individual photographs, we used Auto Exposure-Lock feature measuring the exposure for the first image and locking it for subsequent photographs. Then the three pictures were taken – from front, with the hands hanging freely by the torso, and at 90° angle from the sides. Pictures of areolae were taken similarly from the front and at the side angle roughly 45°. The pictures taken from the angle were used for AG analysis to help in AG identification. It was very important to have the focus exactly on the plane of areola because otherwise the areolar glands were too blurry for correct identification.

4.7. Photographs postprocessing

Photographs were analysed in Adobe Photoshop CC 2020. The photographs were postprocessed and analysed in lossless raw NEF format. Photographs of the chest and the areolae were analysed separately in groups (pictures of the chest together and picture of areolae together in two files). Pictures of each group were put into one file in overlapping layers to apply colour calibration to all photographs in the group. The colour calibration was made with “Adjustment layer” tool to match the colours on the calibration card from the frontal picture (*Figure 9*). The “Levels” adjustment was chosen and with the eyedropper tool, white, grey, and black from the card is selected. The scale was set with “Set measurement scale” feature to match the calibration card ruler. Using the ruler, the line was drawn to match the 5 cm on the card and the units set to centimetre and number of units to 5. The selection was made with the “Lasso” tool or distance measured with the “Ruler” tool, while the

“Measurement log” feature recorded values of the distance, width, length, grey values, area, as well as the name of the file, time of record and scale ratio. The data were then exported to a text file with separators for further processing and analysis.

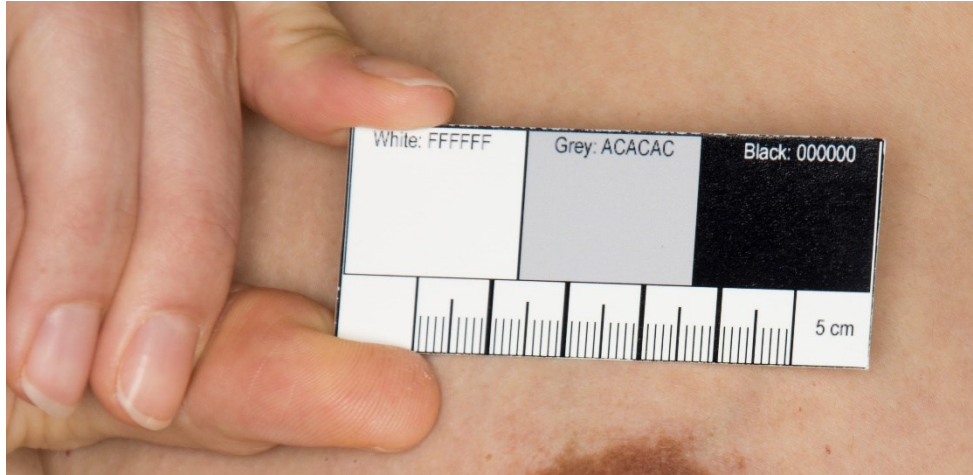


Figure 9: Simple grey calibration card used for colour and scale calibration

4.8. Photographs analysis

4.8.1. Area measurements

The surface of nipples and areolae was measured on close frontal areola photographs and the surface of breasts was measured from the frontal chest images. Lasso tool was used to “draw” along the edge of each region. Nipple edge was measured at the base of the nipple (*Figure 10*). Areolae have different types of edges ranging from very sharp to “fuzzy”, so we decided to measure the most defined dark part of the areola (*Figure 10*). Breast area was measured along the crease of the lower part of the breast and along the visible elevation of the breast mound of the upper part (*Figure 11*).

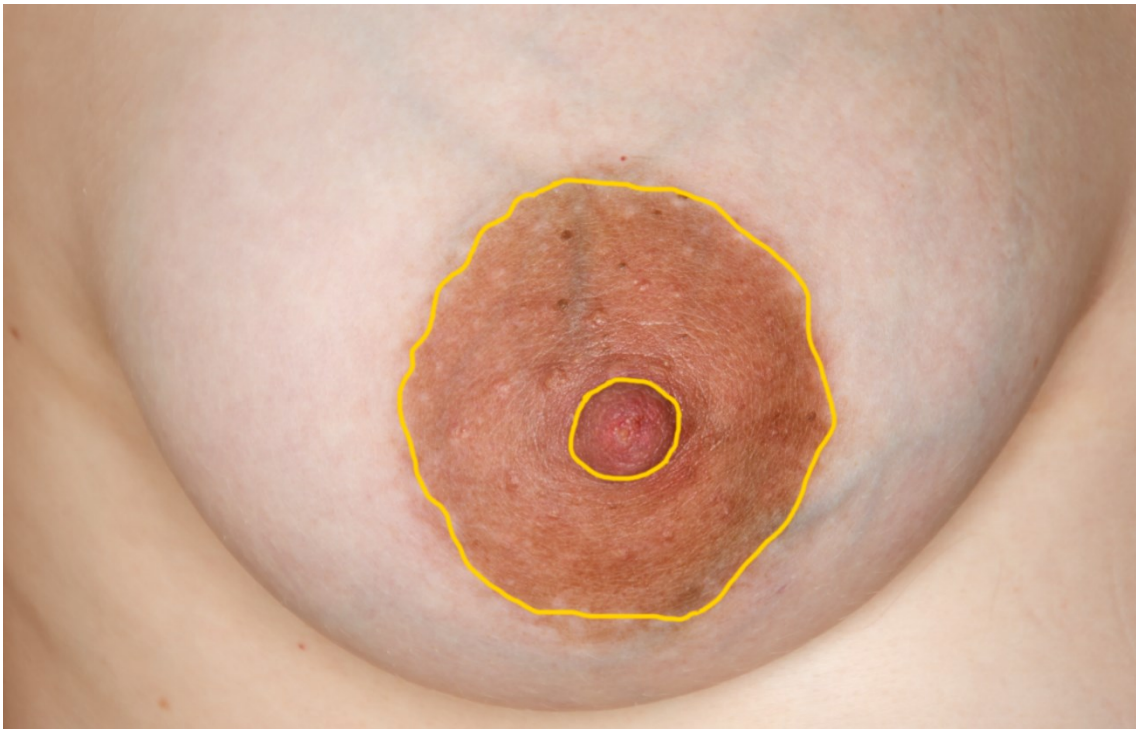


Figure 10: Areola and nipple measurements, yellow lines represent the areola and nipple area measurement



Figure 11: Breast area measurement, yellow line represents breast area measurement

4.8.2. Lightness measurement

The lightness of nipple, areola and breast skin was measured using median grey of fixed sized squares (200x200px) of skin patches placed on each breast region. The ratio of breast and areola values were then used as contrast value. We did not use the nipple lightness in any analyses, because the level of lightness of nipple and areola were very similar. The size of the square was based on the size of the smallest nipple of the sample. The squares were placed in the horizontal line, laid through the lower edge of the square on the nipple region, in the lateral direction to maximize standardization of lighting conditions (the curvature of the breast affect the amount of light with lower parts darker) (*Figure 12*). Similarly, the breast skin colour was measured closest to the areola (the breast curvature decrease lightness of more distant regions). We used the median grey to avoid, the influence of random shiny or dark spots on the skin surface caused by flash light (compared to average grey).

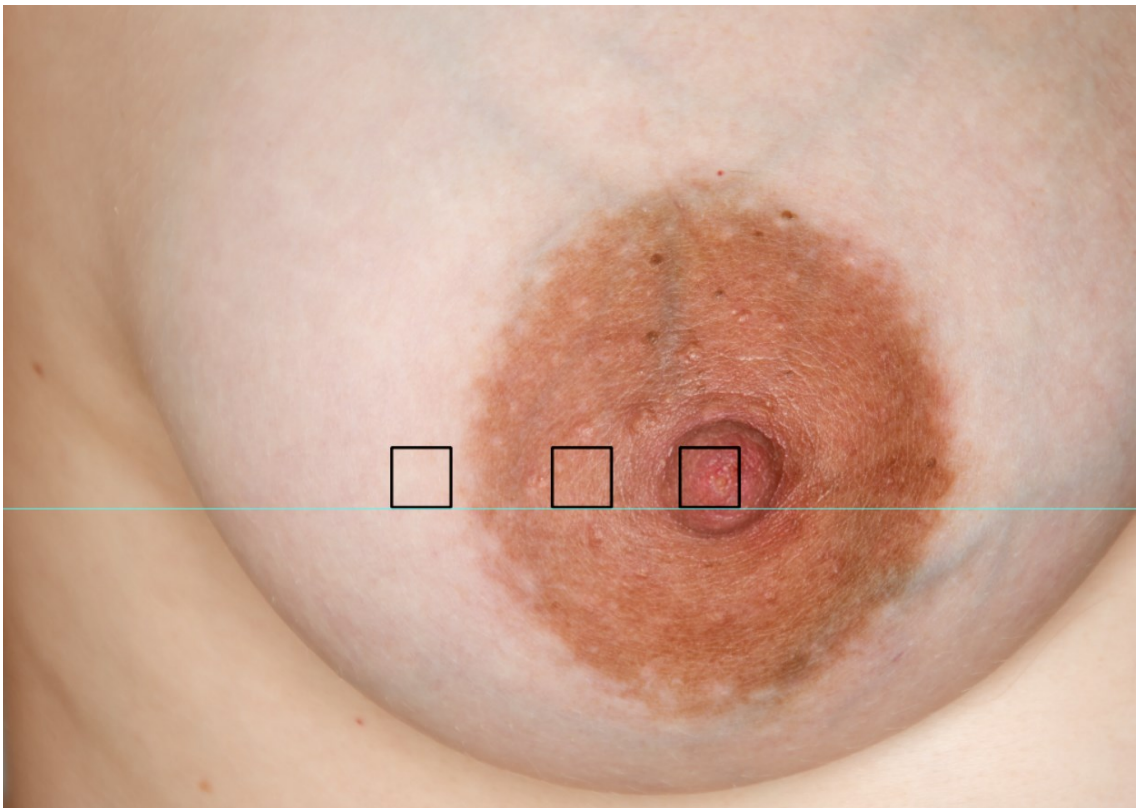


Figure 12: Lightness contrast measurement, black squares represent the patches of skin measured for lightness

4.8.3. Protrusion measurements

The protrusion of the nipple and the areola was measured. The colour calibration card with scale was used on the first frontal photograph of the body only and as the participant turned 90° to the sides, the scale would change slightly. Therefore, to measure the areola protrusion, we used the height of the areola measured on the first picture as reference on the side photograph in perpendicular position to the ground to estimate the scale of the side measurements. Then a “cross” of two perpendicular lines was placed with one line going through the highest and the lowest point of the areola and the second line through the most protruded point of the nipple (*Figure 13*). The distance was measured from the crossing point to this protruded point. Similarly, for the measurement of the nipple protrusion, the one line connected the highest and lowest point of the nipple and the other line same protruded point of the nipple. This way, it was possible to measure even the breasts that were not in perfect 90° angle and pointed slightly more laterally. The length of the nipple measurement was then subtracted from the length of the areola measurement to obtain the areola protrusion value.

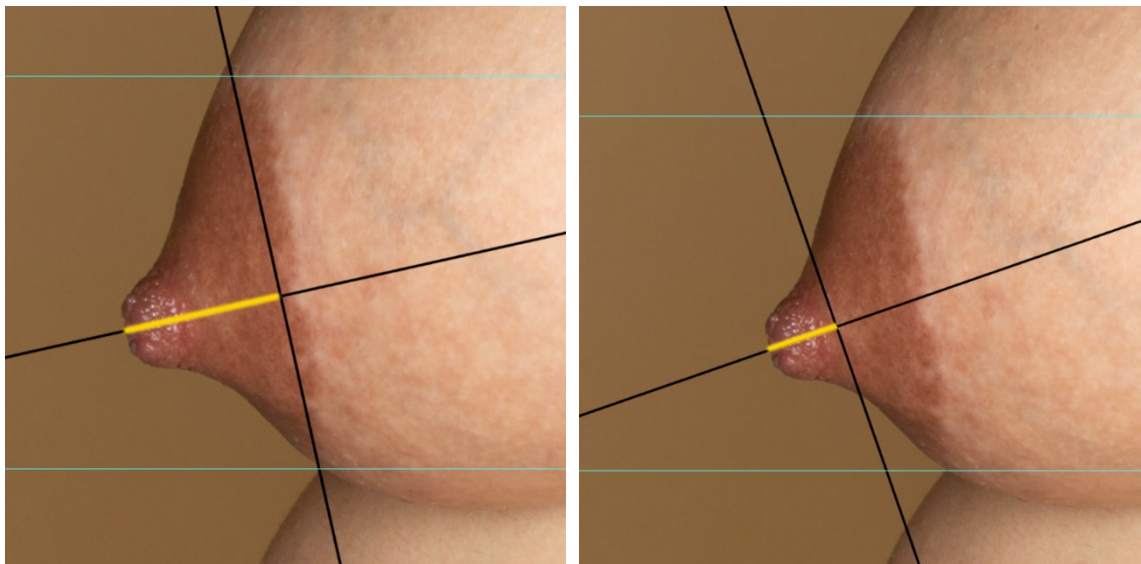


Figure 13: Areola and nipple measurements, yellow lines represent measurement of areola and nipple protrusion

4.8.4. Areolar Glands analysis

We analysed number and distribution of AG and secreting AG in four quadrants of areola – upper lateral, upper medial, lower lateral and lower medial. Frontal and 45° side photographs of the areola were used for recording AG to increase accuracy of successful identification. Horizontal and vertical line was inserted laying through the

centre of the nipple (*Figure 14, A*). Each gland was identified using following morphological criteria – elevation, darker pigmentation, and absence of hair (hairs are located on the edge of the areola and connected with sebaceous glands that look similar to the areola gland) (*Figure 14, B*). We were trained on the identification of AG by the expert in AG research field, Prof. Benoist Schaal. As we were able to identify almost no visibly secreting glands in our photographs, we excluded this variable from further analysis.

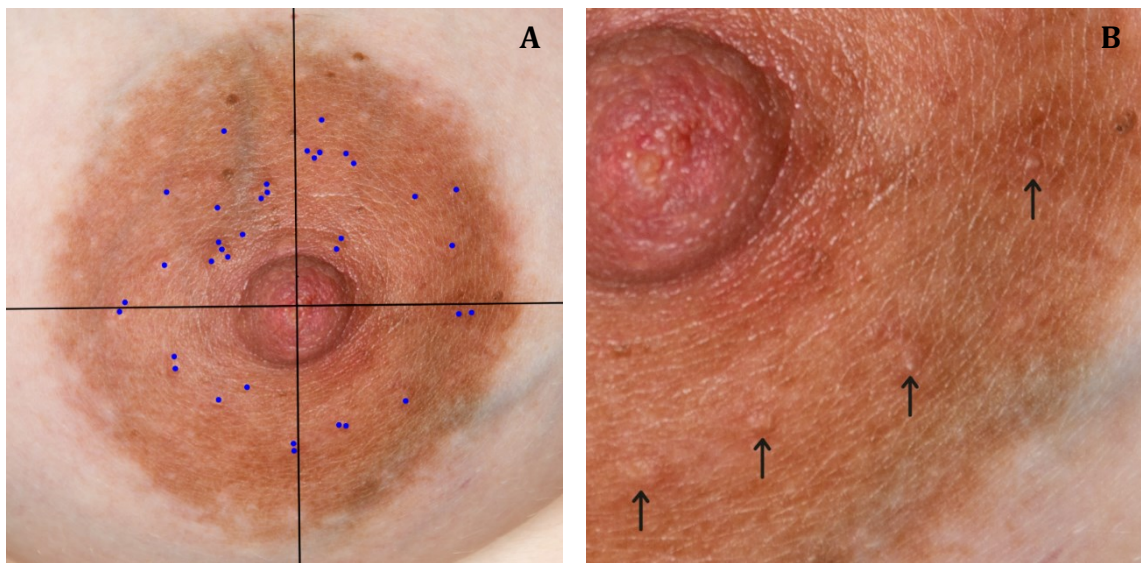


Figure 14: A – blue dots represent AG on the areola, black cross divides the areola into four quadrants; B – arrows point to identified AG

4.9. Statistical analysis

The statistical analyses were performed in Jamovi 1.1.9.0. Level of statistical significance was set to 0.05. Most of the variables were not normally distributed according to Shapiro-Wilk test, therefore, we used nonparametric tests. For assessing correlation between all our variables, we used Kendal Tau B correlation. To compare left and right breast variables, we used Wilcoxon rank paired test. To compare variables of primiparous and multiparous women, we used Mann-Whitney independent samples test. For finding differences among the number of AG in each areolar quadrant, we used Friedman repeated measures ANOVA. Finally, for evaluating effect of morphologic variables on lactation onset, we used linear regression. Parity, age, and BMI before pregnancy have been selected as confounding factors. Parity has been used in every linear regression as it correlated with lactation onset. BMI before pregnancy and age were used only if they correlated

with tested variables. Variables that highly correlated were tested separately to avoid collinearity.

5. Results

5.1. Descriptive analyses

After excluding the cases, that did not meet our criteria or had inverted nipples ($n=2$), we were left with data from 131 women. Missing data due to postprocessing can be seen in the *Table 1* for each variable.

	N	Missing	Mean	Standard deviation	Minimum	Maximum	Skewness	Shapiro-Wilk p
AG UL R	128	3	4.36	4.75	0	21	1.37	< .001
AG UM R	128	3	3.89	4.53	0	21	1.55	< .001
AG LL R	128	3	3.31	3.28	0	16	1.02	< .001
AG LM R	130	1	2.43	2.84	0	11	1.26	< .001
AG UL L	128	3	4.33	4.28	0	20	1.28	< .001
AG UM L	128	3	4.18	4.52	0	21	1.22	< .001
AG LL L	126	5	3.06	3.31	0	12	1.01	< .001
AG LM L	129	2	2.73	3.07	0	13	1.31	< .001
AG R	129	2	14.5	14.7	0	63	1.24	< .001
AG L	128	3	14.5	14.1	0	71	1.23	< .001
AG all	127	4	28	26.5	0	123	1.07	< .001
contrast BA R	112	19	1.41	0.237	0.956	2.13	0.908	< .001
contrast BA L	114	17	1.42	0.273	0.853	2.23	0.827	< .001
area areola R	129	2	24.3	10.9	5.78	57.6	0.8	< .001
area areola L	129	2	24.7	10.8	7.19	58.8	0.83	< .001
area nipple R	130	1	2.4	0.617	0.836	4.32	0.381	0.25
area nipple L	130	1	2.4	0.636	0.886	4.37	0.453	0.026
area breast R	122	9	181	40.4	98.7	289	0.466	0.066
area breast L	122	9	179	45.5	98.4	311	0.612	0.003
protrusion nipple R	124	7	0.826	0.243	0.136	1.3	-0.297	0.074
protrusion nipple L	124	7	0.873	0.24	0.213	1.42	-0.173	0.358
protrusion areola R	121	10	1.06	0.459	0.118	2.64	0.876	< .001
protrusion areola L	123	8	1.14	0.48	0.257	2.54	0.406	0.123
onset of lactation	105	26	57	13.4	35.2	95.9	0.92	< .001
parity	103	28	0.524	0.502	0	1	-0.0986	< .001
age	103	28	31	4.12	21	39	-0.148	0.113
BMI before pregnancy	102	29	23.1	3.68	17.6	34.6	0.872	< .001

Abbreviations: AG=areolar glands, R=right, L=left, UL=upper lateral quadrant, UM=uppermedial quadrant, LL=lower lateral quadrant, LM=lower medial quadrant, BA=breast/areola

Table 1: Descriptive analyses of all measured variables.

5.1.1. Factors influencing lactation onset and morphologic variables

In *Table 2* below you can find correlation of all variables and lactation onset. Only variable correlating with lactation onset is parity, which correlates positively. BMI before pregnancy correlates positively with areola area, breast area and with protrusion of areola. Age correlates positively with parity and breast area. All significant correlations between variables are highlighted in bold font.

Correlation matrix of all measured variables with Kendall's Tau B coefficient

	contrast BA	area areola	area nipple	area breast	protrusion nipple	protrusion areola	AG UL	AG UM	AG LL	AG LM	age	BMI before pregnancy	parity	lactation onset
contrast BA	—													
p-value	—													
area areola	-0.229	—												
p-value	< .001	—												
area nipple	0.015	0.174	—											
p-value	0.819	0.004	—											
area breast	-0.070	0.352	0.203	—										
p-value	0.289	< .001	0.001	—										
protrusion nipple	0.178	-0.049	0.287	0.055	—									
p-value	0.006	0.419	< .001	0.376	—									
protrusion areola	-0.284	0.551	0.064	0.148	-0.102	—								
p-value	< .001	< .001	0.296	0.017	0.094	—								
AG UL	0.137	-0.010	0.068	-0.034	0.139	0.007	—							
p-value	0.041	0.869	0.279	0.596	0.029	0.907	—							
AG UM	0.134	0.005	0.050	-0.070	0.114	-0.043	0.741	—						
p-value	0.046	0.939	0.43	0.282	0.077	0.510	< .001	—						
AG LL	0.207	-0.081	0.016	-0.127	0.103	-0.082	0.703	0.724	—					
p-value	0.002	0.201	0.798	0.052	0.113	0.205	< .001	< .001	—					
AG LM	0.134	0.000	0.056	-0.073	0.097	-0.026	0.649	0.666	0.686	—				
p-value	0.047	0.995	0.375	0.26	0.133	0.692	< .001	< .001	< .001	—				
age	-0.105	0.116	0.126	0.322	0.099	0.027	-0.045	-0.052	-0.042	-0.079	—			
p-value	0.164	0.095	0.07	< .001	0.164	0.703	0.528	0.476	0.558	0.280	—			
BMI before pregnancy	-0.100	0.289	0.008	0.294	-0.039	0.221	-0.088	-0.102	-0.152	-0.099	-0.031	—		
p-value	0.173	< .001	0.902	< .001	0.58	0.002	0.208	0.147	0.031	0.162	0.653	—		
parity	0.029	0.127	0.175	0.165	0.04	0.045	0.138	0.100	0.085	0.159	0.263	-0.020	—	
p-value	0.742	0.123	0.032	0.052	0.636	0.596	0.103	0.243	0.318	0.064	0.002	0.809	—	
lactation onset	-0.043	0.063	-0.059	0.009	-0.058	0.053	-0.022	-0.013	0.018	-0.010	0.024	0.132	-0.175	—
p-value	0.544	0.349	0.375	0.896	0.395	0.443	0.746	0.850	0.795	0.882	0.739	0.059	0.039	—

Table 2: Intercorrelations among individual variables and lactation onset

5.1.2. Parity

Parity has been previously linked to lactation onset. It was the only significant factor influencing lactation onset according to our correlation (Table 2) as well as linear regression (Table 3).

Model	R ²	Overall Model Test			
		F	df1	df2	p
1	0.0977	3.25	3	90	0.026

Model Coefficients - lactation onset

Predictor	SE	t	p
Intercept	14.249	2.05	0.044
parity	2.977	-2.64	0.01
age	0.378	1.5	0.136
BMI before pregnancy	0.384	1.6	0.114

Table 3: Linear regression of lactation onset and parity, age, and BMI before pregnancy

Mann-Whitney independent samples test showed that multiparous women initiate lactation on average 5.74 h sooner than primiparous (Table 4).

Mann-Whitney test of difference between primiparous and multiparous women's lactation onset

			95% CI		Cohen's d	95% CI		
Statistic	p	Mean difference	Lower	Upper		Lower	Upper	
Lactation onset	848	0.039	5.74	0.17	11.5	0.439	0.024	0.85

Group Descriptives

	Parity*	N	Mean	Median	SD	SE
Lactation onset	0	45	59.9	57.3	14.7	2.19
	1	50	54	50.9	12.2	1.73

* 0 - primiparous, 1 - multiparous

Table 4: Difference in lactation onset between primiparous and multiparous women

Further, we tested the effect of previous pregnancies on morphological variables. When testing difference between subsamples of primiparous and multiparous women, we found significant difference in nipple area and non-significant trend in breast area, both with medium effect size ($d=0.45$), multiparous women having higher values (Table 5).

	Statistic	p	Mean difference	Cohen's d
contrast BA	898	0.746	-0.0163	-0.0236
area areola	1045	0.123	-2.7910	-0.3007
area nipple	979	0.033	-0.2427	-0.4506
area breast	858	0.052	-17.0759	-0.4565
protrusion nipple	1083	0.638	-0.0229	-0.0689
protrusion areola	1051	0.599	-0.0852	-0.1184
AG UL	1010	0.103	-1.0000	-0.1409
AG UM	1078	0.244	-0.5000	-0.1053
AG LL	1127	0.320	-0.4999	-0.1886
AG LM	1004	0.064	-0.5000	-0.3192

Table 5: Mann-Whitney test of morphologic variables grouped by parity

5.1.3. Symmetry

To find possible directional asymmetry, we compared left and right breast variables. We found no difference between the left and right quadrants of areola in areolar glands count, as well as in areolar glands on whole areola. We found a significant difference in breast area, where right breast area was larger than left breast area, but the effect size is very small. We also found a significant difference in protrusion of nipple and areola, where the left nipple and areola were longer than the right nipple and areola and effect size was slightly bigger than small (Table 6).

Paired Wilcoxon Test of left and right variable values - contrast, area, protrusion, AG counts

		Statistic	p	Mean difference	SE difference	Cohen's d
contrast BA R	contrast BA L	3159	0.990	-0.00043	0.0211	-0.00126
area areola R	area areola L	3755	0.304	-0.35295	0.3392	-0.11130
area nipple R	area nipple L	4311	0.781	0.00857	0.0295	0.01486
area breast R	area breast L	4564	0.038	3.69870	1.8236	0.13251
protrusion nipple R	protrusion nipple L	2646	0.002	-0.04466	0.0142	-0.29380
protrusion areola R	protrusion areola L	2775	0.025	-0.06117	0.0256	-0.21576
AG UL R	AG UL L	2103	0.971	0.00006	0.2375	-0.02084
AG UM R	AG UM L	1464	0.270	-0.49997	0.2422	-0.08174
AG LL R	AG LL L	1727	0.607	0.00009	0.2302	0.04300
AG LM R	AG LM L	1402	0.119	-0.49999	0.1898	-0.14554
AG R	AG L	2407	0.813	-0.00004	0.5298	-0.03297

Table 6: Comparison of left and right morphologic variables

When we tested those symmetry differences separately for primiparas and multiparas, we found that larger protrusion of left nipple and areola was only significant in multiparas and larger right breast was only significant in primiparas (Table 7, 8).

Wilcoxon test - protrusion of left and right nipple, areola, and breast area in **primiparas**

		Statistic	p	Mean difference	SE difference	Cohen's d
protrusion nipple R	protrusion nipple L	387	0.143	-0.0334	0.0187	-0.259
protrusion areola R	protrusion areola L	349	0.137	-0.0714	0.0431	-0.229
area breast R	area breast L	704	0.005	7.802	2.5178	0.425

Table 7: Comparison of selected left and right variables in primiparas

Wilcoxon test - protrusion of left and right nipple, areola, and breast area in **multiparas**

		Statistic	p	Mean difference	SE difference	Cohen's d
protrusion nipple R	protrusion nipple L	438	0.035	-0.0531	0.021	-0.289
protrusion areola R	protrusion areola L	352	0.009	-0.1024	0.041	-0.3905
area breast R	area breast L	716	0.809	1.0343	2.5805	0.0543

Table 8: Comparison of selected left and right variables in multiparas

5.1.4. Areolar glands number and distribution

We found a significant difference in distribution of AG on right areola quadrants between all quadrants of areola with the exception of upper medial and lower lateral quadrant (*Table 9, Figure 14*).

Repeated Measures ANOVA (Non-parametric)

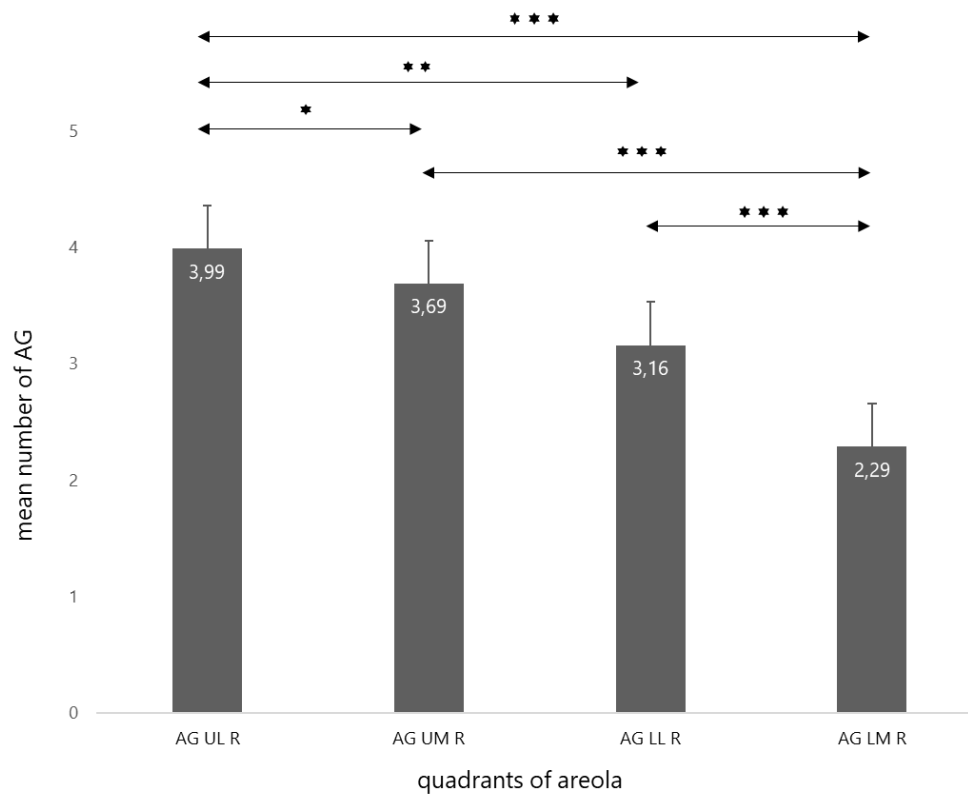
Friedman RM ANOVA

χ^2	df	p
41	3	< .001

Pairwise Comparisons (Durbin-Conover)

			Statistic	p
AG UL R	-	AG UM R	2.048	0.041
AG UL R	-	AG LL R	2.458	0.014
AG UL R	-	AG LM R	6.586	< .001
AG UM R	-	AG LL R	0.41	0.682
AG UM R	-	AG LM R	4.538	< .001
AG LL R	-	AG LM R	4.128	< .001

Table 9: RM ANOVA of numbers of AG in each areola quadrant of right breast



UL=upper lateral, UM=upper medial, LL=lower lateral, LM=lower medial

Error bars: 95% CI

Arrows: significant difference

Figure 14: mean number of AG in each areola quadrant on right breast

We found significant difference in distribution of AG on left areola quadrants between all quadrants of areola with exception of upper lateral and upper medial quadrant and lower lateral and lower medial quadrant (*Table 10, Figure 15*).

Repeated Measures ANOVA (Non-parametric)

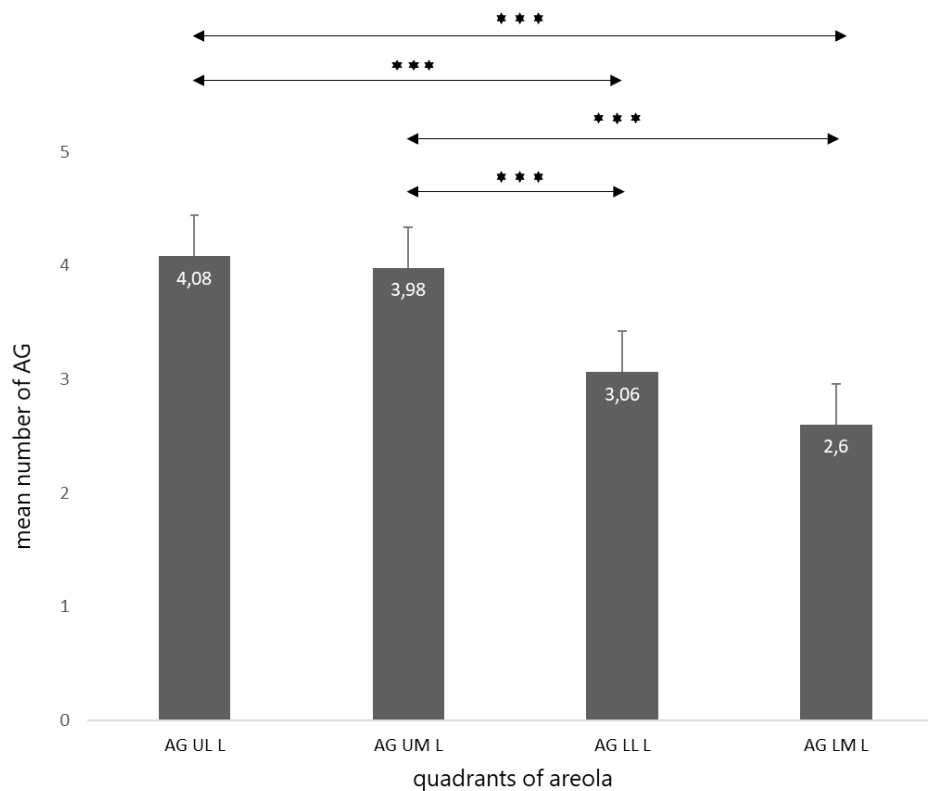
Friedman RM ANOVA

χ^2	df	p
37.9	3	< .001

Pairwise Comparisons (Durbin-Conover)

			Statistic	p
AG UL L	-	AG UM L	0.759	0.449
AG UL L	-	AG LL L	4.248	< .001
AG UL L	-	AG LM L	5.432	< .001
AG UM L	-	AG LL L	3.49	< .001
AG UM L	-	AG LM L	4.673	< .001
AG LL L	-	AG LM L	1.183	0.237

Table 10: RM ANOVA of numbers of AG in each areola quadrant of left breast



UL=upper lateral, UM=upper medial, LL=lower lateral, LM=lower medial

Error bars: 95% CI

Arrows: significant difference

Figure 15: mean number of AG in each areola quadrant on left breast

5.2. Effect of morphological characteristics on lactation onset

5.2.1. Areolar glands

To test the effect of presence of AG on lactation onset, we split the sample into women who have at least one AG and women with no visible AG. We found no significant difference (*Table 11*).

Mann-Whitney test of lactation onset grouped by presence of AG

	Statistic	p	Mean difference	95% CI		Cohen's d	95% CI	
				Lower	Upper		Lower	Upper
Lactation onset	588	0.428	-2.82	-9.17	4.1	-0.00358	-0.55	0.543

Table 11: Difference between women with AG and women with no AG

Next linear regressions involve only a subsample of women having at least one AG. The results are very similar when all women are tested. We found no effect of number of AG on lactation onset (*Table 12*).

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.237	0.0562	2.32	2	78	0.105

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept ^a	62.2254	2.9644	20.99	< .001
all AG	-0.0586	0.0549	-1.07	0.289
parity:	-5.6604	2.9271	-1.93	0.057

^a Represents reference level

Table 12: The effect of presence of AG and parity on lactation onset

When we tested only primiparous women, the effect was not present either (*Table 13*). Similar result was found in multiparous women.

Primiparous women

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.124	0.0153	0.544	1	35	0.466

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept	63.6461	4.0174	15.843	< .001
all AG	-0.0623	0.0845	-0.737	0.466

Table 13: The effect of presence of AG on lactation onset in primiparas

When we tested separately effect of number of AG on each quadrant on lactation onset, we also have not found any effect (*Table 14, 15, 16, 17*). Quadrants were tested separately to avoid collinearity as the quadrants highly correlated.

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.245	0.0599	2.48	2	78	0.09

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept ^a	62.491	2.955	21.14	< .001
AG UL	-0.42	0.348	-1.2	0.232
parity:	-5.82	2.93	-1.99	0.051

^a Represents reference level

Table 14: Effect of number of AG on upper lateral quadrant on lactation onset

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.238	0.0566	2.28	2	76	0.109

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept ^a	62.142	2.936	21.168	< .001
AG UM	-0.384	0.393	-0.977	0.332
parity:	-5.845	3.009	-1.942	0.056

^a Represents reference level

Table 15: Effect of number of AG on upper medial quadrant on lactation onset

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.217	0.047	1.92	2	78	0.153

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept ^a	61.347	2.849	21.535	< .001
AG LL	-0.31	0.468	-0.663	0.509
parity:	-5.337	2.949	-1.81	0.074

^a Represents reference level

Table 16: Effect of number of AG on lower lateral quadrant on lactation onset

Model Fit Measures

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.253	0.0639	2.63	2	77	0.079

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept ^a	61.825	2.655	23.28	< .001
AG LM	-0.658	0.577	-1.14	0.258
parity:	-5.447	2.943	-1.85	0.068

^a Represents reference level

Table 17: Effect of number of AG on lower lateral quadrant on lactation onset

5.2.1. Contrast of the breast and the areola

We found no significant effect of contrast between breast and areola and lactation onset (*Table 18*). When primiparous and multiparous women are tested separately, the results are similar.

Model Fit Measures						
Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.244	0.0595	2.47	2	78	0.091

Model Coefficients - Lactation onset				
Predictor	Estimate	SE	t	p
Intercept	60.666	9.75	6.2233	< .001
contrast BA	-0.379	6.65	-0.0569	0.955
parity	-6.789	3.06	-2.2208	0.029

Table 18: effect of lightness contrast and parity on lactation onset

5.2.2. Protrusion

We found no significant effect of nipple and areola protrusion on lactation onset (*Table 19*).

Model Fit Measures						
Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.254	0.0644	1.39	4	81	0.243

Model Coefficients - Lactation onset				
Predictor	Estimate	SE	t	p
Intercept	45.034	11.284	3.991	< .001
protrusion nipple	-1.459	6.671	-0.219	0.827
protrusion areola	-0.389	1.854	-0.21	0.834
parity	-4.881	2.982	-1.637	0.106
BMI before pregnancy	0.712	0.452	1.574	0.119

Table 19: effect of protrusion or nipple, areola, parity, and BMI on lactation onset

5.2.3. Area

We found no significant effect of nipple, areola, and breast area on lactation onset. Variables are controlled by parity, as it is correlated to lactation onset, and BMI and age, as these have effect on breast area (*Table 20*).

Model Fit Measures						
Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.412	0.17	2.59	6	76	0.025

Model Coefficients - Lactation onset				
Predictor	Estimate	SE	t	p
Intercept	20.6792	16.2861	1.27	0.208
area nipple	-2.9209	2.6501	-1.102	0.274
area areola	-0.1443	0.1833	-0.787	0.434
area breast	-0.0504	0.0482	-1.045	0.299
parity	-7.4812	3.0769	-2.431	0.017
BMI before pregnancy	1.0298	0.4786	2.152	0.035
age	1.1319	0.4499	2.516	0.014

Table 20: effect of nipple, areola and breast area, parity, age, and BMI on lactation onset

When we split the data according to parity, we found a positive significant effect of nipple and areola area on the lactation onset in multiparous women (*Table 22*).

Primiparous women						
Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.396	0.157	1.23	5	33	0.317

Model Coefficients - Lactation onset				
Predictor	Estimate	SE	t	p
Intercept	15.0844	26.9918	0.5589	0.580
area nipple	1.944	4.8356	0.402	0.690
area areola	0.3063	0.3639	0.8418	0.406
area breast	-0.0148	0.0909	-0.1627	0.872
age	1.2911	0.7505	1.7202	0.095
BMI before pregnancy	-0.0511	0.9328	-0.0547	0.957

Table 21: effect of nipple, areola and breast area, parity, age, and BMI on lactation onset in primiparas

Multiparous women

Model	R	R ²	Overall Model Test			
			F	df1	df2	p
1	0.577	0.333	3.99	5	40	0.005

Model Coefficients - Lactation onset

Predictor	Estimate	SE	t	p
Intercept	6.3393	21.133	0.3	0.766
area nipple	-6.6119	2.935	-2.253	0.030
area areola	-0.4623	0.1928	-2.398	0.021
area breast	0.0147	0.0522	0.281	0.780
age	1.0892	0.5586	1.95	0.058
BMI before pregnancy	1.6294	0.5102	3.193	0.003

Table 22: effect of nipple, areola and breast area, parity, age, and BMI on lactation onset in multiparas

6. Discussion

The aim of this study was to describe various morphologic features of the breast. We measured several dimensions such as area of breast, areola and nipple, protrusion (length) of the nipple and areola. Then we measured lightness and contrast of the breast and the areola and number and distribution of areolar glands. We also examined symmetry of those characteristics. As parity plays a role in morphologic changes in breast features, we tested how it affected our variables.

Further we aimed to explore effect of breast morphology on lactation onset. Delay in lactation onset is connected to various conditions (Hurst, 2007). When these conditions have negative impact on lactation onset, any support of morphological characteristics (visual, tactile, or olfactory) guiding the newborn are welcome. Previous studies showed possible link between number and distribution of AG and lactation onset (Doucet et al., 2012; Schaal et al., 2006). We aimed to replicate previous work on AG and further tested other morphologic features of the breast for their potential effect on lactation initiation.

6.1. Descriptive analyses

We found that number of areolar glands on one areola is on average 14.5 (SD 14.4, range 0-71) with no difference between left and right. These values are much higher compared to previous studies, where the AG count on one breast was on average 10.39 (range 0-48) and 8.9 (range 0-38), respectively (Doucet et al., 2012; Schaal et al., 2006). This discrepancy could be explained by either ethnic differences (we investigated Czech population, while previous studies are based on French population), or with methodologically different approach to identification of AG, which would be possible because the identification depends on the judgment of the researcher. However, as we were trained by B. Schaal in identification and many problematic cases were consulted with him, this should not be the case. There is also a possibility that we were using newer, better equipment, and AG could have been more visible on higher quality photographs.

In accordance with previous studies (Doucet et al., 2012; Schaal et al., 2006), we also found non-uniform distribution of AG on areola. AG were most abundant on the upper lateral quadrant of the areola and least on the lower medial quadrant of

areola. They found significant differences between those two quadrants. Our findings support the hypothesis that higher occurrence of AG in upper lateral quadrant is related to nose position of the newborn baby during breastfeeding and even during the first breast crawl on the mother's abdomen (Varendi et al., 1994). In our investigation of AG distribution, we noticed that in some women, AG tend to be in a "ring" with fixed distance from the nipple, which would further support this hypothesis, as this distance could be the same as distance of the baby's nose to the mouth. Unfortunately, we have not measured this feature because it was beyond the scope of this study.

Interestingly enough, there is a substantial number of women in our sample (16.03%) who appear to have no visible AG to be found on the areola. Previous studies reported much lower values (3.3%) (Doucet et al., 2012). Again, this could be the effect of ethnicity of the samples or different approach to identification of AG. Future research on AG occurrence, number and distribution should investigate different ethnic populations, especially indigenous people. There might be populations where women have no AG at all, or on the contrary, there are no women that lack AG completely. If the secretion of AG is indeed important for the lactation initiation, in populations with no possible human milk substitute, one may expect higher occurrence and density of AG.

We found the mean area of areola in our sample was 24.5 cm² (SD 10.8). These findings are consistent with study measuring the areola area in post parturient women (24.44 cm², SD 9.16) (Schaal et al., 2006). In most studies, only the diameter is measured, with different methods than photography, and the sample is rarely pregnant or newly postpartum women. Area is arguably a better measurement as it takes into account imperfect circular shape of the areola. Nevertheless, when the areola area is roughly calculated with the given diameter, our results fall between the findings of other two studies measuring pregnant women – 19.62 cm² for Thai sample and 32.13 cm² for Israeli sample (Mangel et al., 2019; Thanaboonyawat et al., 2013).

Mean area of the nipple was 2.4 cm² (SD 0,62) for both left and right nipple which is slightly bigger than calculated area based on the diameter from the study of pregnant Israeli women – 2.13 cm² (Mangel et al., 2019).

Mean area of the right breast was 181 cm² (SD 40.4) and 179 cm² (SD 45.5) for the left breast (difference is statistically significant, but the effect size is small). Our method of measuring breast area is not comparable to any previous studies. Nevertheless, we can address the directional asymmetry with right breast being on average slightly larger. Previous studies showed inconsistent results, and to our knowledge no systematic review is available yet. Our results are consistent with Avşar et al., (2010) but not with other studies which found no directional asymmetry (Coltman et al., 2017; Møller et al., 1995; Żelaźniewicz & Pawłowski, 2018a) or asymmetry towards left breast (Westreich, 1997).

The mean protrusion (length) of the right nipple was 0.83 cm (SD 0.24) and 0.87 cm (SD 0.24) of the left nipple and this difference is statistically significant. These values are somewhat smaller than in the study of Israeli pregnant women (0.93 cm, SD 0.29) but our method was based on photography of relaxed nipple, while they measured the nipples by tape (state of relaxation is not specified) (Mangel et al., 2019). In the study of Thai women, they linked the length of the nipple smaller than 0.7 cm to breastfeeding problems. They set this value because it is less than average length of the nipple in Thai women (Thanaboonyawat et al., 2012). In our sample, 26.5% of women would fall into this category (and if we would take our average, it would be 42%). However, their method of measurement was very different, as they “rolled” the nipple for 5 seconds before measuring. We estimated the length of the nipple from a photograph of a relaxed nipple. Therefore, these results cannot be directly compared.

The mean protrusion (length) of the right areola was 1.06 cm (SD 0.46) and 1.14 (SD 0.48) of the left areola and this difference is statistically significant. Protrusion of areola was not previously studied to our knowledge.

No previous studies investigated lightness contrast of breast and areola. Our measured values are ratio of median grey level of breast and areola skin (higher value means higher contrast). Mean ratio was 1.42 (SD 0.25) with no difference

between left and right. Lightness contrast positively correlated with the number of glands on all quadrants. It might have been that on a darker areola (which is also usually more contrasting) AG are more visible. It also correlated negatively with areola area and areola protrusion, meaning the bigger the areola the lesser the contrast. Lightness contrast also positively correlated with nipple protrusion.

6.2. Effect of parity on morphologic variables

We found that parity is significantly related to the onset of lactation. Multiparous women start to lactate 5.74 hours sooner on average than primiparous women. This is an expected outcome, as primiparity is one of the main risks for delayed lactation (Nommsen-Rivers et al., 2010; Wiliyanarti et al., 2018).

When we split our sample to primiparous and multiparous women, we found no significant differences in morphological variables except for the nipple area. Multiparous women have slightly larger nipple area. Also, difference in breast area bordered the formal level of significance with larger breasts in multiparous women. Mean values of all morphological variables (even though not statistically significant) were higher in favour of multiparas. Previous pregnancies and history of breastfeeding seems to have an effect on breast morphology, which is in accordance with previous studies (Mangel et al., 2019; Ramsay et al., 2005; Thanaboonyawat et al., 2013). Overall growth of the breast during pregnancy enlarges all parts of the breast and then during breastfeeding, nipple-areola complex is under mechanical stress of the sucking baby, which further elongates the nipple and possibly areola.

When comparing left and right morphological characteristics of breasts, we found significant differences in breast area, protrusion of nipple and protrusion of areola. Right breast area is larger than left breast area, which indicates directional asymmetry, but the effect is very small and in previous studies were inconsistent results (for details see above). Protrusion of nipple and areola was in the direction of left breast with small effect. When these three variables were tested separately for primiparas and multiparas, an interesting pattern appeared. Protrusion asymmetry of the nipple and areola were only significant in multiparous women and breast area asymmetry was significant only in primiparous women. During breastfeeding, the nipple and areola are constantly tugged and suckled by the infant.

These mechanical pressures make permanent changes to the length of these features (Smith et al., 1988). There is a possibility, that infants of mothers prefer breastfeeding on one side than the other (Al-Abdi et al., 2015), and our findings would support the preference of the left breast. The directional asymmetry of right breast area could disappear in mothers due to left side preference and elongating of the left breast. There is widely reported that mothers prefer to hold the baby in left arm or on left side of their body, probably due to the higher prevalence of right-handed people (Bogren, 1984; Packheiser et al., 2019). This bias also occurs in apes and some monkeys and left-nipple preference was found in human and non-human primates (Damerose & Vauclair, 2009; Hopkins & De Lathouwers, 2006; Nishida, 1993; Packheiser et al., 2019; Tomaszewski et al., 1998).

6.3. Effect of breast morphology on lactation onset

Our estimation of the onset of lactation was on average 57 hours postpartum (SD 13.4 h). We estimated the onset by records of weight gain differences before and after breastfeeding attempts. This result is similar to the estimation from previous study (61.2 h, SD 12 h) even though they used a different approach to lactation onset estimation, by direct palpation and interview by midwives twice a day (Schaal et al., 2006) and second study (55.4 h, SD 9.35) which relied on self-report (breast tension, warmth and/or pain) of mothers (Doucet et al., 2012). According to Sriraman (2017) initiation of lactogenesis II is 30-40 hours postpartum and the increase in milk production accompanied by breast fullness occurs between 50 – 73 hours postpartum. Thus, our method of estimation of the lactation onset appears to be reliable. However, we encountered issues concerning non-linear, fluctuating increase of weight gain differences in some women, and women that left the hospital before they started lactating, who were excluded from the study.

Primiparity, advanced age, and higher BMI before pregnancy were selected as confounding variables because they have been previously linked to delayed onset of lactation (Hurst, 2007). We found that parity is significantly related to the onset of lactation (for details see above). Age and BMI before pregnancy indicated no significant effect on the lactation onset, but in our sample, there were no women older than 40 years and no severely obese women according to BMI (mean 23.1, SD 3.68, maximum 34.6). BMI before pregnancy was correlated to several

morphological variables, namely areola area, breast area, and protrusion of areola. Breast and areola size have been previously linked to BMI (Mangel et al., 2019) and protrusion of the areola is correlated with both of those characteristics mainly due to the pushing of the breast mass into the areola space. We observed that in general, areolae that were this large were protrusive more softly like a “hill” and not pointed as smaller areolae. We think that this feature might be an obstacle for latching of the baby. It is important to note that our photographs were taken in a relaxed state, so it is possible that when the nipple-areola complex is erected, this would not be an issue. Age was correlated with the breast area probably because of the ptosis. Flatter, ptotic breasts cover larger area from the front view relatively to non-ptotic breast, and we took our measurements from the frontal photograph. Age is one of the main causes for breast ptosis (Rinker et al., 2010).

Number and distribution of the areolar glands have been previously linked to the onset of lactation due to their secretion which helps the newborn navigate to the nipple (Doucet et al., 2012; Schaal et al., 2006). First, we tested if presence of the AG has an impact on lactation onset and we did not find any significant effect. Next, we used linear regression for the number of all AG and parity as confounding variable, which again did not show any effect of the AG. We found similar results for primiparous and multiparous women when tested separately. There was also no significant effect of the number of AG in each quadrant of areola, including the upper lateral quadrant. Our hypotheses that overall number of AG and number of AG in upper lateral quadrant of areola have positive effect on lactation onset were not supported. The function of AG could have been suppressed by usage of fatty ointments and soap which are both typically perfumed, and soap also removes the layer of secretion on the surface of areola. It is not a common practice to rather use milk as an ointment (and not every mother has enough secretion in the first period after delivery to use it), which would be arguably better. Also, mothers are generally not aware of the areolar glands' secretion and its function. There is space for education in this matter to the public or at least to the expecting mothers.

Protrusion of the nipple has been previously linked to the breastfeeding problems, as the short nipples are more difficult for the newborn baby to grasp (Puapornpong et al., 2013; Thanaboonyawat et al., 2012). Our results do not support this

assumption. Maybe our method of measuring the length of the nipple on the photographs of relaxed nipples is less sensitive. The erection of the nipple is stimulated by the baby before and during breastfeeding and changes the shape of it substantially. The shape of the nipple in a relaxed state might not truly predict the protrusion of it when erected.

Area of the breast was our rather simplified representation of breast size, which is linked to the breastfeeding problems (Katz et al., 2010). It is closely related to the higher BMI and it might be hard to distinguish the origin of this breastfeeding problem – if it is due to poor latching of the baby or physiologic condition of higher weight. When we tested the effect of breast area on lactation onset (controlled for the BMI), we did not find significant effect. This might have been caused by our method of measurement which was one-dimensional and partly approximated from the frontal photographs. Breast size (or volume) is more accurately measured by physical examination or 3D imaging because of its complex and variable shape.

We did not have specific predictions about area of areola and nipple, and we did not find any significant effect on the lactation initiation. When we tested primiparas and multiparas separately, we found a significant positive effect on lactation onset only in multiparous women of nipple area and areola area. Areola area increase in size during pregnancy and breastfeeding, so mothers that breastfed their previous infants have bigger areola, and faster onset of lactation is connected to their experience with breastfeeding. The same principal could be applied to the nipple area (as we also found difference in nipple area between primiparous and multiparous women) which is consistent with one study (Thanaboonyawat et al., 2013) but it is contradictory to the previous findings of no effect of nipple diameter to breastfeeding difficulties (Mangel et al., 2019; Thanaboonyawat et al., 2012).

The last hypothesis expected that higher contrast of the breast and areola would positively affect the onset of lactation, as the higher contrasting areolae would serve as a visual cue for the baby to find the nipple. This was not confirmed, neither in primiparas or multiparas. It is possible that visual cues are not as important as olfactory or tactile for the newborn baby. It is widely believed that visual aspect of human senses is the most important part of our perception. This might be true in

adults but in our first moments in life, other senses could play a bigger role and later we are focused more onto the visual sense.

The fact that we did not find any link between the breast morphology and the lactation onset can have, apart from matters mentioned above, a few reasons. We can argue that morphological characteristics work together as a complex support system and it is difficult to grasp their effect individually. If some of the features are inefficient in an individual mother-child dyad, other features will substitute them to help the initiation. It is also possible that some of the characteristics are not that important in the first moments of life and play their role later. Lactogenesis II is generally driven by hormones and happen naturally. The continuation of Lactogenesis III is dependent on stimulation and milk removal. Maybe the effect of some of our variables would be recognized after the mothers leave the maternity ward. Future research could investigate their role in a longitudinal study, where the mothers would be observed for an extended time to see for how long they continued breastfeeding and if they had breastfeeding related problems. Lastly, the maternity where we conducted this study, is highly motivated to release a mother home after three days while she is fully or at least partially breastfeeding (this is a general consensus in Czech maternities and probably in many other countries). The education and support of the nurses and lactation assistants could hide the natural mechanisms of successful lactation onset. In future studies, the research in non-WEIRD countries or even indigenous populations, could help to reveal the actual functions of the breast morphology in context of lactation initiation.

7. Conclusion

- Distribution of AG was non-uniform, upper lateral quadrant of areola was the most abundant in AG, while in lower medial quadrant we observed the least amount of AG.
- Overall number of AG was not linked to earlier onset of lactation, neither was number of AG in upper lateral quadrant of areola.
- Multiparous women had significantly larger nipple area and all morphologic variables were higher in favour of multiparous women.
- Right breast area was larger than left breast area. Left nipple and areola were longer than right nipple and areola.
- Breast area was not linked to delayed onset of lactation.
- Protrusion of nipple and areola was not linked to earlier onset of lactation.
- Contrast of lightness of breast and areola skin was not linked to earlier onset of lactation.
- Multiparous women had faster lactation onset, but we found no effect of morphological characteristics on lactation onset in primiparous or multiparous women.

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9. Supplementary materials

VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ



STUDIE VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ

Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



INFORMACE PRO MAMINKY

Vážená paní,

rádi bychom Vás informovali o studii zaměřující se na vliv počtu a rozložení žlázek na prsních dvorcích a míry kontaktu mezi matkou a novorozencem na zahájení kojení chtěli bychom Vás tímto pozvat k účasti na této studii.

Kojení hraje ve výživě a zdraví dítěte významnou roli. Mateřské mléko obsahuje všechny živiny zásadní pro vývoj a růst dítěte; zároveň poskytuje dítěti imunologickou ochranu a preventivně působí proti některým civilizačním chorobám jako je např. obezita či cukrovka. U matky pak kojení urychluje regeneraci porodních cest a snižuje krvácivost a současně pomáhá snížit riziko karcinomu prsu a vaječníků. Kojení se také podílí na utváření vztahu mezi matkou a dítětem, čímž napomáhá formovat psychologický a sociální vývoj dítěte.

Tvorba mateřského mléka do značné míry závisí na přiměřené stimulaci bradavek. Rychlejší nástup kojení podporuje nejen vhodná technika přikládání dítěte k prsu, ale i jeho způsob a síla přísátí k bradavce. Některé předchozí studie ukazují, že vonné látky produkované žlázkami na dvorcích bradavek podporují začátek kojení. V naší studii budeme zjišťovat, zda rozmištnění a počet žlázek na prsních dvorcích usnadňuje dítěti vyhledání bradavky, následné sání a tím i zahájení kojení.

Prohloubení pochopení funkce těchto žlázek v procesu kojení může pomoci matkám, u nichž se daří zahájit kojení poměrně obtížně.

Cíle projektu:

Zaznamenávat produkci a rozložení žlázek na prsních dvorcích a jejich vliv na začátek a průběh kojení

Podmínky účasti

Matky po fyziologickém porodu bez zdravotních potíží.

Co účast v projektu obnáší:

První den po porodu Vás zdravotní sestra informuje o způsobu sledování žlázek na prsních dvorcích; jak zaznamenávat jejich počet, rozložení a viditelnou produkci. První záznam provede spolu s Vámi. V odpoledních hodinách pak za Vámi přijde výzkumnice a pořídí dvě fotografie Vašich prsou ze vzdálenosti 20 cm. Abychom byli schopni výstupky žlázek na fotografii přesně určit, každý prs vyfotíme dvakrát z jiného úhlu. Focení bude probíhat v soukromí na Vašem pokoji. Sledování žlázek a fotografování bude probíhat i další dny Vašeho pobytu na porodnickém oddělení. Během studie pořídíme 12-16 fotografií Vašich prsou, v závislosti na délce Vašeho pobytu v nemocnici. V průběhu druhého dne Vás též požádáme o vyplnění dotazníku (zhruba 5-10 min) ohledně základních demografických údajů a průběhu Vašeho porodu a možnosti použití údajů, které zaznamenáváte do kojícího lístku.

Vaše účast ve výzkumu je zcela dobrovolná a v jakémkoliv okamžiku můžete spolupráci na výzkumu bez udání důvodu ukončit. Je možné se též zúčastnit pouze dotazníkové části studie. Před zahájením studie budete požádána o podpis Informovaného souhlasu.

Způsob nakládání s daty:

Veškeré získané údaje a fotografie budou využity pouze pro výzkumné účely, bude s nimi nakládáno v souladu s platnými zákony České republiky o ochraně osobních údajů a budou uchovávány po dobu 5 let; poté budou skartovány. V případě, že se rozhodnete ze studie před jejím ukončením odstoupit, Vaše údaje a fotografie nebudou využity a budou neprodleně skartovány. V rámci studie budete vystupovat pod přiděleným kódem a s výjimkou Informovaného souhlasu se tento kód nebude nikde vyskytovat společně s Vaším jménem a příjmením. Informované souhlasy budou uloženy na sekretariátu primáře oddělení neonatologie VFN Prof. R. Plavky, separátně od ostatních poskytnutých informací, dat a fotografií. Ze získaných údajů a fotografií budou publikovány pouze celkové výsledky, nikoliv údaje o jednotlivcích.

Možná rizika:

Žádná rizika spojená s účastí nejsou známa.

Motivační odměna:

Při účasti v celé studii Vám bude, jako kompenzace za čas strávený projektem a možné nepohodlí, nabídnuta peněžní poukázka v hodnotě 300 Kč (nebo 100 Kč pokud se zúčastníte pouze dotazníkové části studie), kterou lze uplatnit na nákup potřeb pro Vaše miminko. Seznam prodejen, kde lze poukázky uplatnit, a podmínky jejich použití, najdete na www.muypass.cz.

Finanční podpora:

Projekt je podporován grantem GAČR (14-02290S).

Etické aspekty:

Projekt byl schválen etickou komisí VFN v Praze. V případě stížnosti spojené s projektem můžete kontaktovat předsedu etické komise: MUDr. Josef Šedivý, CSc. (tel. 224 964 131).

Hlavní řešitel:

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Přírodovědecká fakulta, Univerzita Karlova

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Adresa: Viničná 7, 128 00 Praha 2

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Prof. MUDr. Richard Plavka, CSc.

Gynekologicko-porodnická klinika 1. LF UK a VFN

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Adresa: Apolinářská 18, 128 51, Praha 2

**VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE**



VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ

Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Informovaný souhlas

1. Byla jsem podrobně informována o cílech studie, o jejích postupech a o tom, co se ode mě očekává.
2. Byla jsem informována o tom, že svou účast ve studii mohu kdykoliv přerušit či z ní odstoupit, aniž by to jakkoliv ovlivnilo moje další práva. Účast ve studii je zcela dobrovolná.
3. Bylo mi sděleno, že získaná osobní data budou uchována s plnou ochranou důvěrnosti dle platných zákonů ČR. Při vlastním provádění studie mohou být osobní údaje použity pro výzkumné a vědecké účely pouze bez identifikačních údajů (anonymní data) nebo s mým výslovným souhlasem.
4. Svým podpisem stvrzuji, že nemám námitek proti tomu, aby mnou poskytnutá data byla za výše uvedených podmínek anonymně použita pro vědecko-výzkumné účely.

V Praze dne:

Identifikační kód:

Jméno a příjmení účastníka výzkumu:

Podpisúčastníka výzkumu:

Jméno a příjmení lékaře/výzkumníka, který přijímal informovaný souhlas:

Podpis lékaře/výzkumníka:



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
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Přírodovědecká fakulta Univerzity Karlovy a
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Identifikační kód (vyplní výzkumník): _____

Datum: _____

Do rukou se Vám dostal dotazník, který je zaměřen na zjištění základních demografických údajů, informací o průběhu porodu a míry kontaktu mezi Vámi a Vaším dítětem. Dále se Vás budeme ptát na Vaše pocity a myšlenky během posledního měsíce.

Prosíme o pravdivé zodpovězení následujících dotazů. Pokud na některou z uvedených otázek nechcete odpovědět, raději ji přeskočte, než abyste uvedla nepravdivý údaj. Celý **dotazník je zcela anonymní**. Zaručujeme se, že všechny získané údaje budou použity pouze k vědeckým účelům a nebudou poskytovány třetím osobám.



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
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Oddíl 1: Demografické údaje

1. Kolik je Vám **let**?
2. Jaký je Váš **mateřský jazyk**?
3. Jakého stupně **vzdělání** jste doposud dosáhla?
 - a) základní škola
 - b) střední škola s výučním listem
 - c) střední škola s maturitou
 - d) vyšší škola
 - e) vysoká škola
4. Pokud studujete, kterou **školu** a na jakém **stupni** studujete?
.....

5. Jaký je Váš **rodinný stav**?
 - a) svobodná
 - b) v partnerském vztahu
 - c) vdaná
 - d) rozvedená
 - e) vdova

Pokud **máte partnera/manžela**, prosím uveďte **délku trvání** Vašeho současného vztahu:

..... měsíců

Je Váš současný partner/manžel **otcem dítěte**?

ANO / NE

6. Kolik let je otci dítěte let

7. S kým žijete ve **společné domácnosti**?
.....



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE

VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ

Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



8. Jaká je výše současného **čistého měsíčního příjmu** Vaší domácnosti?

- a) 0 – 10.000,-
- b) 10.000 – 20.000,-
- c) 20.000 – 35.000,-
- d) 35.000 – 50.000,-
- e) 50.000 – 70.000,-
- f) 70.000 a více

9. Prosím, uveďte Vaši **váhu a výšku před** otěhotněním:

Váha: kg

Výška: cm

10. Prosím, uveďte Vaši **váhu před** porodem:

Váha: kg

11. Prosím, uveďte **velikost** Vaší **podprsenky** (např. 80B):

před otěhotněním

nyní:

12. Vyznačte prosím, zda byl Váš **způsob stravování** v těhotenství:

- a) běžný (jíte vše nebo téměř vše)
- b) vegetariánský
- c) veganský
- d) jiný (různá specifická stravovací omezení jako je např. diabetická dieta)

Prosím, uveďte jaký:

.....

13. Jak často jste během svého těhotenství trpěla **ranními nevolnostmi**?

Méně než jednou měsíčně	Jednou měsíčně	Několikrát za měsíc	Jednou týdně	Několikrát týdně	Obden	Denně
-------------------------------	-------------------	------------------------	-----------------	---------------------	-------	-------

Pokud ano, prosím uveďte kdy (jaký trimestr)

.....



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



14. Jak si myslíte, že se Vám během těhotenství změnily **chuťové preference**?

Vůbec	Skoro vůbec	Trochu	Středně	Docela silně	Silně	Velmi silně
-------	----------------	--------	---------	-----------------	-------	-------------

Pokud ano, prosím uveďte:
které chutě jste vyhledávala:

.....

kterým chutím jste se vyhýbala:

.....

15. Užívala jste v době seznámení s otcem Vašeho dítěte hormonální antikoncepci?

ANO / NE

Pokud ano, prosím uveďte **značku** antikoncepce:

.....

16. Užívala jste během těhotenství nějaké **léky proti bolesti**

(např. Acylpyrin, Aspirin, Ibuprofen, Nalgesin...)?

ANO / NE

Pokud ano, prosím uveďte **názvy** léků a jejich **dávkování**:

.....

17. Užívala jste během těhotenství i jiné **léky**?

ANO / NE

Pokud ano, prosím uveďte **názvy** léků a jejich **dávkování**:

.....

18. Vyznačte prosím, zda jste:

a) **kuřačka**

Pokud ano, prosím uveďte odhadem, kolik **cigaret** za den kouříte:

.....**cigaret za den**



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



b) **bývalá kuřačka**

Pokud ano, prosím uveďte odhadem, před kolika **měsíci** jste přestala a
kolik **cigaret** za den jste kouřila:

.....**měsíci****cigaret** za den

c) **nekuřačka**

19. Užívala jste během těhotenství nějaké **ilegální drogy**?

ANO / NE

Pokud ano, prosím uveďte **jaké** a odhadem **jak často**:

.....

20. Pila jste během těhotenství **alkohol**?

ANO / NE

Pokud ano, prosím uveďte **jaký** a odhadem **jak často**:

.....



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Oddíl 2: Porod a Vaše dítě

21. Tento **porod** byl Váš:

- a) první
- b) druhý
- c) třetí
- d) čtvrtý a více

V případě, že se **nejedná** o Váš první porod, prosím uveďte **datum** svého předchozího porodu:

.....

V případě, že se **nejedná** o Váš první porod, prosím uveďte, **zda a jak dlouho** jste své dítě/děti **kojila**:

Dítě	Kojeno	Délka kojení (v měsících)
První		
Druhé		
Třetí		
Čtvrté a více		

V případě, že jste některé z předchozích dětí nekojila nebo se vyskytly problémy s kojením, prosím uveďte jaké a u kterého dítěte:

.....
.....
.....

22. Trpěla jste během svého těhotenství nějakými **potížemi/chorobami**?

ANO / NE

Pokud ano, prosím uveďte **jakými**:

.....

23. Bylo během Vašeho těhotenství vzneseno podezření na nějaké **vývojové vady**?

ANO / NE

Pokud ano, prosím uveďte na **jaké**:

.....

24. **Pohlaví** dítěte: ŽENA / MUŽ



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Oddíl 3: Kontakt s dítětem po porodu

25. Jak dlouhou **dobu** po porodu jste strávila společně se svým dítětem na porodním sále?

.....

26. Bylo Vám dítě po porodu **položeno na břicho**? ANO / NE

Pokud ano, prosím uveďte:

a) **za jak dlouho** po porodu:

b) **na jak dlouho**:

27. Během pobytu na porodním sále, **přiložila** jste své dítě k prsu? ANO / NE

Pokud ano, prosím uveďte:

a) **za jak dlouho** po porodu:.....

b) **na jak dlouho**:

c) pokusilo se dítě **sát**? ANO / NE

28. Byl na sále přítomen i někdo Vám **blízký** (otec dítěte, Váš rodič či kamarádka)?

ANO / NE

Pokud ano, prosím uveďte:

a) **kdo**:

b) **kdy a jak dlouho** byl přítomen:

c) **pokud měl s dítětem fyzický kontakt** (např. dítě pochoval), jak dlouho trval:

29. Když bylo dítě převezeno ke sledování (do „boxíku“), zůstala jste ještě na porodním sále?

ANO / NE

Pokud ano, prosím uveďte jak dlouho?

30. Za jak dlouho po porodu Vás převezli na nemocniční pokoj?

.....

31. Za jak dlouho po převozu na nemocniční pokoj Vám **přivezli dítě**?

.....



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



32. Za jak dlouho po přivezení dítěte na pokoj jste ho **přiložila k prsu**?

.....

Pokusilo se dítě **sát**? ANO / NE

33. Pokud jste nemohla být od porodu trvale se svým dítětem, jak jste se cítila?

a) uvítala jsem to, prosím uveďte důvod:

.....

b) bylo mi to jedno, prosím uveďte důvod:

.....

c) vadilo mi to, prosím uveďte důvod:

.....

34. Pokud máte pocit, že se během Vašeho těhotenství, porodu a době poporodní odehrálo cokoli, co hodnotíte jako podstatné, případně zvláštní, budeme rádi, když nám o tom zde sdělíte více:

.....

.....

.....

.....

.....

.....



**VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ**
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Oddíl 4: Vaše pocity a myšlenky

Níže jsou uvedeny výroky, které se týkají Vašich **pocitů ohledně sebe sama**. Zaškrtněte možnost, která Vás nejlépe vystihuje.

35. Celkově jsem sama se sebou spokojená.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

36. Někdy mám pocit, že nejsem v ničem dobrá.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

37. Myslím, že mám celou řadu dobrých vlastností.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

38. Jsem schopna dělat věci stejně dobře jako většina ostatních lidí.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

39. Mám dojem, že na sebe nemohu být moc hrdá.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

40. Občas si opravdu připadám k ničemu.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

41. Myslím, že mezi lidmi podobné úrovně mám svou cenu.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

42. Chtěla bych si sama sebe více vážít.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

43. Celkově vzato mám pocit, že jsem neobstála.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------

44. Mám o sobě kladné mínění.

Rozhodně souhlasím	Souhlasím	Nesouhlasím	Rozhodně nesouhlasím
--------------------	-----------	-------------	----------------------



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
 Přírodovědecká fakulta Univerzity Karlovy a
 Gynekologicko-porodnická klinika VFN



Nyní budete hodnotit dvojice osobnostních rysů podle toho, nakolik Vás vystihují. Přiřadte hodnotu dvojici vlastností jako celku, i když se u Vás jedna z nich uplatňuje více.
 Považujete se za ženu, která je:

45. Společenská a energická?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

46. Kritická a hádavá?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

47. Spolehlivá a svědomitá?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

48. Úzkostlivá a snadno rozrušitelná?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

49. Složitá a otevřená novým zkušenostem?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

50. Zdrženlivá a tichá?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

51. Soucitná a vřelá?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

52. Neorganizovaná a lehkomyšlná?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------



**VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ**
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



53. Klidná a vyrovnaná?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

54. Konzervativní a málo tvořivá?

Rozhodně nesouhlasím	Spíše nesouhlasím	Trochu nesouhlasím	Ani souhlas ani nesouhlas	Trochu souhlasím	Spíše souhlasím	Rozhodně souhlasím
-------------------------	----------------------	-----------------------	------------------------------	---------------------	--------------------	-----------------------

Následující otázky se týkají toho, jak se cítíte **právě dnes**. Pokud s daným tvrzením souhlasíte, zakroužkujte prosím ANO. Pokud s daným tvrzením nesouhlasíte, zakroužkujte prosím NE.

55. Je mi do pláče.	Ano	Ne	63. Mám výkyvy nálady.	Ano	Ne
56. Jsem skleslá.	Ano	Ne	64. Mám pocit jistoty a sebedůvěry.	Ano	Ne
57. Prožívám úzkost.	Ano	Ne	65. Cítím se vnitřně uvolněná.	Ano	Ne
58. Přemáhají mě moje emoce.	Ano	Ne	66. Jsem klidná.	Ano	Ne
59. Mám jasnou hlavu.	Ano	Ne	67. Jsem podrážděná.	Ano	Ne
60. Mám pocit vnitřního napětí.	Ano	Ne	68. Jsem smutná.	Ano	Ne
61. Jsem neklidná.	Ano	Ne	69. Jsem sebelítostivá.	Ano	Ne
62. Jsem přecitlivělá.	Ano	Ne	70. Připadám si bezmocná.	Ano	Ne

**VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE**

VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ

Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Následující otázky se týkají Vaší nálady během **posledního týdne** (neodpovídejte prosím jen podle toho, jak se cítíte dnes). Svou odpověď zakroužkujte.

71. Byla jsem schopná se smát a vidět věci i z veselé stránky. ☐ Stejně jako dříve ☐ Ne tak často jako dříve ☐ Rozhodně ne tak často jako dříve ☐ Vůbec ne	76. Věci mi přerůstaly přes hlavu a nestačila jsem na ně. ☐ Ano, většinou ☐ Ano, někdy ☐ Zcela výjimečně ☐ Ne, vůbec ne
72. S radostí jsem se těšila na příští věci. ☐ Stejně jako dříve ☐ Poněkud méně než dříve ☐ Rozhodně méně než dříve ☐ Vůbec ne	77. Byla jsem tak nešťastná, že jsem měla potíže se spánkem. ☐ Ano, většinou ☐ Někdy ☐ Ne moc často ☐ Ne, vůbec ne
73. Zbytečně jsem si vyčítala, když se něco nedařilo. ☐ Ano, většinou ☐ Ano, někdy ☐ Ne moc často ☐ Ne, nikdy	78. Bylo mi smutno nebo mizerně. ☐ Ano, většinou ☐ Ano, dost často ☐ Ne moc často ☐ Ne, vůbec ne
74. Cítila jsem úzkost nebo jsem měla strach bez přiměřeného důvodu. ☐ Ano, hodně ☐ Ano, někdy ☐ Ne, moc ne ☐ Ne, vůbec ne	79. Byla jsem tak nešťastná, že jsem plakala. ☐ Ano, většinou ☐ Ano, dost často ☐ Jen zřídka ☐ Ne, nikdy
75. Měla jsem strach nebo pocit paniky bez přiměřeného důvodu. ☐ Ano, hodně ☐ Ano, někdy ☐ Ne, moc ne ☐ Ne, nikdy	80. Napadaly mě myšlenky, že si něco udělám. ☐ Ano, dost často ☐ Někdy ☐ Sotvakdy ☐ Nikdy

DĚKUJEME ZA VÁŠ ČAS A ÚČAST VE STUDII!

VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE

VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ

Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Pokud souhlasíte, byli bychom rádi, kdyby následující informace vyplnil Váš ošetřující lékař/lékařka.

Způsob porodu?

- a) vaginální porod klasický (hlavičkou vpřed)
 - b) vaginální porod nepravidelný (koncem pánevním, zadní poloha)
 - c) císařským řezem
- důvod:

Vyznačte prosím **jevy**, které se týkaly porodu (i více položek):

- a) vyvolaný porod (hormonálně, mechanicky)
- b) aplikace analgetika pro zmírnění bolesti (např. Pethidin, Entonox)
- c) epidurální anestézie
- d) celková anestézie
- e) nastřížení hráze (tzv. epiziotomie)
- f) natržení hráze
- g) podání Oxytocinu během II. doby porodní
- h) jiné

Uveďte prosím všechny vážnější **komplikace**, které se týkaly porodu:

.....
.....

V kolikátém **týdnu a dnu** těhotenství nastal porod?

Jak **dlouho** porod trval (od prvních kontrakcí po samotný porod dítěte)?

.....

Hodnoty **Apgar** skóre dítěte?

Průběh kontaktů matky a dítěte

Datum porodu	
Čas porodu	
Čas odchodu z porodního sálu	
Čas informování matky na oddělení	



VÝZKUM ČICHOVÝCH PREFERENCÍ NOVOROZENÝCH DĚTÍ
STUDIE
VÝZKUM FAKTORŮ OVLIVŇUJÍCÍCH ZAHÁJENÍ KOJENÍ
Přírodovědecká fakulta Univerzity Karlovy a
Gynekologicko-porodnická klinika VFN



Váha a délka dítěte

	Váha (gramy)	Délka (centimetry)
První den (váha po porodu)		
Druhý den		x
Třetí den		x

Důvody bránící kojení?

.....

.....

.....

.....

U Nemocnice 499/2, 128 08 Praha 2; IČ: 00064165, tel.: 224 961 111

el. 111 121 2

[illegible]

číslo pokoje: _____

normální teplota novorozence: 36,5 - 37,4 °C

ranní teplotu dítěte měřte mezi 5.00-7.00 hod.

večerní teplotu dítěte měřte mezi 17.00-19.00 hod.

[illegible]

Všeobecná fakultní nemocnice v Praze
U Nemocnice 499/2, 128 08 Praha 2; IČ: 00064165, tel.: 224 961 111

GYNEKOLOGICKO-PORODNICKÁ KLINIKA - NEONATOLOGICKÉ ODDĚLENÍ

ZÁZNAM PÉČE MATKY O NOVOROZENCE NA ROOMING-IN

Praha
stř. 1-2
ve 11 2

Tiskněte oboustranně!

číslo pokoje: 29

normální teplota novorozence: 36,5 - 37,4 °C
ranní teplotu dítěte měřte mezi 5.00-7.00 hod.
večerní teplotu dítěte měřte mezi 17.00-19.00 hod.

čas / pobyty	KOJENÍ		DOKRM		TĚLESNÁ TEPLOTA (°C)		VYPRAZDŇOVÁNÍ	
	čas	množství	druh	množství	ranní	večerní	moč	stolice
18 ⁰⁰		příl - květce saje				36,1	+	—
21 ⁰⁰		sač 4 min				36,9	+	—
23 ⁰⁰		přísač, sač 1 min					+	—
5 ⁰⁰		sač 4 min + 1 min				36,6	+	+
8 ⁰⁰		přísač, sač					+	+
11 ⁰⁰		sač 7 min					+	+
15 ⁰⁰		sač 7 min					+	+
18 ⁰⁰		přísač, květce saje				36,2	+	—
20 ³⁰		saje					—	—
23 ¹⁰		saje					+	—
1 ¹⁵		saje					+	+
3 ³⁰		saje					+	+
6 ⁰⁰		saje				36,8	—	+
8 ³⁰		3145 před 70 3210					+	+
11 ³⁰		3180 před 3200 70					+	—
14 ⁰⁰		3180 před 3220 70					—	+
16 ³⁰		3200 3215					+	+
19 ³⁰		3195 3210				36,9	+	—
22 ³⁰		3200 3230					+	+
1 ⁰⁰		3210 3255					—	+
4 ⁰⁰		3250 3265					+	+
4 ⁰⁰		3245 3265				36,8	+	—

nebyla
stolice

hnědo!

U Nemocnice 499/2, 128 08 Praha 2; IČ: 00064165, tel.: 224 961 111

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Tiskněte oboustranně!

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pojištění:

4165,—

číslo pokoje: 111 A - N17

normální teplota novorozence: $36,5 - 37,4\text{ }^{\circ}\text{C}$

anní teplotu dítěte měřte mezi 5.00-7.00 hod.

Rečnickou teplotu dítěte měřte mezi 17.00-19.00 hod.

[illegible]