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Benefits of Breastfeeding

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Abstract-

When a child is born, a mother can choose to breastfeed her infant or to use an alternative source of nutrition such as formula. To choose properly, the mother must be informed about the pros and cons of each method of feeding. This paper will elaborate on the process of breastfeeding and present some of the benefits that are conferred to both infant and mother through the act of breastfeeding, benefits that formula does not provide. Breastfeeding positively affects infants in both the short- and long-term by providing protection from infectious diseases, fostering the psychological bond with their mothers, and increasing cognitive development later in life. In addition, mothers benefit from choosing to breastfeed their infants by having a quicker delivery of the placenta, retaining less weight postpartum, and having a decreased risk of breast cancer. In conclusion, this paper will show that while formula does contain essential nutrients for infants, it does not provide the protective and curative benefits that breast milk does.

Introduction-

Lactation is a fundamental part of the reproductive cycle of all mammals, including humans. After intrauterine and parenteral nourishment has terminated, and before individuals can independently sustain themselves, mothers can naturally provide their newly born children with necessary nutrition through breastfeeding. In the early twentieth century, statistics reveal a decrease in the percentage of infants who were breastfed, most likely due to a lack of knowledge of the health benefits that are associated with breastfeeding. However, as science continues to improve and more studies are conducted, it is becoming increasingly clear that human milk is the ideal source of nutrition for infants. Early scientific literature, generally from countries other than the United States, claimed that breastfeeding was better than bottle-feeding, as evidenced in mortality charts comparing the risk of death in both groups, but no reasons could be given to explain this assertion (Grulee et al., 1934,1935). Refinements in the analysis of food constituents have allowed for further studies of breast milk, revealing how it is physiologically suited for newborns. Developments in the study of infections have also identified the anti-infectious properties of breast milk, offering protection for the infant until weaning. Still other studies acknowledge various other health benefits of breastfeeding to both mother and infant. Recent statistics show an increased trend toward breastfeeding in the Western world, due to increased education of the benefits of human lactation. The objective of this paper is to show why breast milk is better for infants than alternative sources of nutrition, whether milk from animals or formula.

Discussion-

Anatomy and Physiology of breastfeeding-

Mammary glands begin to develop embryologically at six weeks, maintaining growth until milk ducts are developed by the time of birth. At puberty of a female, the breasts expand to their adult size, the left usually being slightly bigger than the right. During lactation, the breast weighs between 600 and 800 grams, compared to the roughly 200 grams in a nonpregnant woman and 400-600 grams in a pregnant woman (Lawrence, 1989).

The breast is made up of many different independent glands. The stroma and the parenchyma are two divisions that make up the corpus mammae. The stroma includes the connective tissue, fat tissue, blood vessels, nerves, and lymphatics. The parenchyma is comprised of the alveolar gland with ductular branching alveoli. Each gland opens into a lactiferous duct, whose distal end is dilated to form the lactiferous sinus. There is a slight constriction before opening onto the surface of the nipple (Lawrence, 1989).

The nipple, or papilla mammae, contains 15 to 25 lactiferous ducts, as well as smooth muscle fibers, sensory nerve endings, and sweat glands. The areola, which surrounds the nipple, contains Montgomery glands that become enlarged during pregnancy and lactation. They secrete a substance that lubricates and protects the nipples and areolae during lactation (Lawrence, 1989).

The lactating mammary gland is characterized by a large number of alveoli. Its functioning depends on the interplay of numerous intricate nervous and endocrine factors. Some are involved in mammogenesis, preparing the glands for lactation; others in lactogenesis, and others are responsible for the maintenance of lactation, or galactopoeisis. During pregnancy, a complex sequence of events, involving the hormone prolactin being synthesized by the adenohypophysis and released into circulation, as well as other hormones, prepares the breast for lactation. At delivery, with the ejection of the placenta, there is an abrupt decline in estrogens and progesterone. Since estrogens have an inhibiting effect on the secretion of milk by prolactin, their withdrawal triggers the onset of lactation. Suckling stimulates the release of prolactin, as well as oxytocin from the neurohypophysis. Prolactin stimulates milk synthesis, while oxytocin is involved in milk secretion (Mader, 2000).

Human breast milk is comprised of many different molecules, such as carbohydrates, proteins, and lipids, as well as minerals and vitamins. However, the composition varies with time of day, stage of lactation, maternal nutrition, and several other factors. Colostrum, the yellowish, thick fluid produced in the first few days following delivery, has a higher protein and lower fat content than mature milk, but energy and carbohydrate content are similar in both. It is rich in fat-soluble vitamin A, carotenoids, and vitamin E. This distribution reflects the needs and reserves of the newborn child (Sarkar, 2004). From approximately 7 -10 days to two weeks postpartum, the content of breast milk gradually changes to become mature milk. Mature milk is mainly made of water; all other constituents are dissolved or suspended in the water. Because 25% of the newborn's heat loss is from evaporation of water from the skin and lungs, water from breast milk helps regulate the infant's body temperature. Lipids represent the second largest percentage of the total breast milk composition. Proteins constitute about .9% of breast milk contents, with eight out of the twenty amino acids present being essential. The most prevalent carbohydrate in breast milk is lactose, or milk sugar, which is synthesized by the mammary gland. A number of other carbohydrates are present in the milk as well. Vitamins, minerals, enzymes, and hormones make up the rest of the components of breast milk (Lawrence, 1989).

Short Term Health Benefits to Infant-

The World Health Organization (WHO) recommends exclusive breastfeeding until the infant is six months of age because it protects against infectious morbidity, mortality, and promotes adequate growth and development (Kramer and Kakuma, 2001). The most important short-term immunological benefit of breastfeeding is the protection against infectious diseases. When the infant is first born, the immune system is in its nascent stage, placing the child at risk of infection. Colostrum, the specialized milk produced for the first few days following delivery, is much richer in immunoglobulins, antimicrobial peptides, and growth factors than mature milk (Playford, 2001). These components allow colostrum to be an important immune modulator, inducing maturation and differentiation of thymocytes, promoting peripheral blood leukocyte proliferation, and inducing cytokine production (Boldogh et al., 2008). Boldogh et al. (2008) conducted a study to investigate whether colostrum causes allergies and what its impact is on allergic sensitivity. The researchers found that colostrum does not increase IgE or IgG levels, which are the antibodies that cause the majority of allergic reactions. They also found that colostrum significantly decreased IgE and IgG production, airway eosinophilia, mucin production, and hypersensitivity to common allergens. These findings show the importance of feeding colostrum to newborn babies, as it is the best form of nutrition for the immature immune system. No other animal's milk or formula can provide for the precise physiological needs of the newborn human as well.

Mature human milk also contains numerous immune-related compounds, including oligosaccharides, cytokines, and interferons. Several of these components of milk offer passive protection in the upper respiratory system and gastrointestinal tract, preventing adherence of pathogens to the mucosa, and thereby protect the infant against invasive infections (Schack-Neilson and Michaelsen, 2007). One liter of human milk contains about five to ten grams of unbound oligosaccharides, which represents a major component of human milk, exceeding the amount of lipids. More than 130 different human milk oligosaccharides have been identified, both neutral and acidic, as well as combinations of the two. Compared with human milk, the concentration of oligosaccharides in the milk of domestic animals that is usually fed to infants is smaller by a factor of ten to a hundred. Infant formula contains only trace amounts of less complex oligosaccharides (Bode, 2006). The neutral fraction of human milk oligosaccharides appears to be the most relevant factor for the development of the intestinal flora typical for breastfed infants (Boehm and Stahl, 2007). Human milk oligosaccharides withstand the low pH of the stomach and resist degradation by enzymes from the pancreas and brush border membrane. Because of this resistance, these oligosaccharides are able to rinse the infant's esophagus, stomach, and small intestine, finally serving as nutrients for colon bacteria (Bode, 2006).

Most pathogenic microorganisms (e.g. *Campylobacter jejuni, Escherichia coli, Vibrio cholera,* and strains of *Shigella* and *Salmonella*) are only virulent with adhesion to the host's epithelial surface. Acidic oligosaccharides have been found to play an important role in the prevention of adhesion of these bacteria on the intestinal epithelial surface (Boehm and Stahl, 2007). Human milk oligosaccharides rinse the laryngopharyngeal region and may also reduce pathogen adhesion at the entry to the upper respiratory tract. Adhesion of *Streptococcus pneumonia* and *Hemophilus influenza* to pharyngeal epithelial cells, the most common cause of oritis media and respiratory tract infections in infants, is also inhibited by human milk (Bode, 2006). Acidic oligosaccharides are also involved in immune reactions, such as interacting with selectins in inflammation processes. Sialization of oligosaccharides can interfere with binding of

certain selectins and affect important regulators of the immune system (Boehm and Stahl, 2007). These effects of human milk oligosaccharides combine to provide extremely effective protection against intestinal infection and postnatal stimulation of the immune system. Because the quantity and diversity of oligosaccharides in human milk are distinct compared to those of other species, the use of other forms of nutrition aside from breast milk cannot offer the same oligosaccharide absorption, metabolism, function, and beneficial effects.

As stated previously, exclusive breastfeeding protects against gastrointestinal morbidity (Schack-Nielsen and Michaelsen, 2007). However, because iron concentration in human milk is low, breastfeeding may increase the risk for iron deficiency in some infants. Although iron-fortified formula may provide the necessary iron, the infant will be placed at risk for gastrointestinal infection. This is the case especially for infants of low-income households and communities where hygienic preparation of foods may be compromised, leading to more gastrointestinal infections and malnutrition. Monterrosa et al. (2008) conducted a study of infants born to low-income women in Guadalajara, Mexico. The researchers sought to investigate whether infants in this setting who were predominantly breastfed through the first six months of life would experience fewer gastrointestinal infections but be more likely to be iron deficient compared with infants who were fed iron-fortified formula on a regular basis. One hundred and fifty four mother-child pairs were recruited from the Hospital Civil Dr. Juan Menchaca, a certified Baby Friendly Hospital, where most of the patients are low income. Baseline data were collected while the mother and infant pairs were in the hospital, and follow-up visits on the infants' monthly birthdays were conducted as well. The study found that the non-predominantly breastfed infants (55 partially breastfed and 50 exclusively formula-fed) were almost twice as likely to have a gastrointestinal infection compared with the 49 predominantly breastfed infants. Mean iron concentration, however, was lower in the predominantly breastfed infants than in partially breastfed and formula-fed infants. The researchers concluded that even with the risk of iron deficiency, it is better for mothers to primarily breastfeed their infants until age six months. Iron deficiencies can be prevented by iron supplementation in pregnancy and by feeding the infant iron-rich foods at six months of age, but gastrointestinal infections can cause morbidity and mortality in infants (Monterrosa et al., 2008).

Another important aspect of breastfeeding is the close psychological relationship it fosters between mother and child because of the increased bonding opportunities. Research shows that breastfeeding mothers touch their infants more often both during feeding and while playing together. Mothers who breastfeed commonly exhibit more physiological and social responsiveness toward their infants. Infants who are breastfed are also generally more alert and responsive (Jones et al., 2004). Many women experience some kind of emotional imbalance in the first week after delivery, due to the enormous change in hormonal levels after the delivery of the placenta. However, some women become clinically depressed, suffering from post-partum depression. Depression can occur in all women, regardless of whether they are breastfeeding or not (Lawrence, 1989). Newborns of depressed mothers are found to demonstrate less left frontal brain activity, lower heart rate variability, and abnormal biochemical patterns, such as lower levels of dopamine and serotonin and higher levels of norepinephrine and cortisol, compared to newborns of mothers who are not depressed (Jones et al., 2004). One study (Jones et al., 2004) suggests that breastfeeding may protect newborns against some of the negative effects of maternal depression. The researchers compared infants of depressed mothers who were predominantly breastfed to those who were fully formula-fed by three months of age. In a

measurement of electroencephalographic activity, the breastfed infants displayed the same left frontal brain activity patterns as those demonstrated by infants of non-depressed mothers. Conversely, the formula-fed infants of depressed mothers showed less left frontal brain activity, indicating deficits in approach motivation. The study thus effectively demonstrates that "a stable breastfeeding relationship protects infants from some of the negative psychological and physiological effects in an environment of maternal depression" (Jones et al., 2004). Expectedly, though, depressed mothers are less likely to breastfeed and they breastfeed for shorter periods of time than non-depressed mothers. It is possible that if depressed mothers were to be informed of the significant benefits of breastfeeding and its protective factors for their infants, they would choose to continue breastfeeding.

Long-Term Health Benefits to Infant-

Aside from offering short-term protection from several diseases and infections, studies show that breast milk influences the child's own immune system. Infants are born with their immune systems not fully developed, dominated by subtype-2 helper T cells. Breastfeeding, through human milk oligosaccharides, speeds up the maturation of the immune system by stimulating the development of subtype-1 helper T cells. In fact, ultrasound measures of the thymus, an important structure necessary for T cell development and maturation, reveals that the thymus of breastfed infants at four months of age is twice the size of that in formula-fed infants (Schack-Nielsen and Michaelsen, 2007). Because breast milk contains immunomodulatory properties, breastfeeding has been found to protect against the later development of many immune-mediated diseases such as bronchial asthma, atopic dermatitis, type I diabetes, ulcerative colitis and Crohn disease (Klement et al., 2004, Schack-Nielsen and Michaelsen, 2007).

Another one of the most consistent findings of breastfeeding is a positive effect on later intelligence tests with a few test points advantage for breastfed infants (Uauy and De Andraca, 1995; Gomez-Sanchiz et al., 2003, 2004; Schack-Nielsen and Michaelsen, 2007). A meta-analysis of several studies by Anderson et al. (1997), as quoted by Schack-Nielsen and Michaelsen (2007) found that breastfeeding conferred a benefit of 5.3 points in cognitive function between six months and 16 years of age compared with formula-feeding and a benefit of 3.2 after adjusting for relevant variables like sociodemographic, environmental, and biomedical factors. The authors noted that the longer the infant was breastfed, the better the scores in cognitive function. Two studies conducted by Gomez-Sanchiz et al. (2003, 2004) that measured the difference in mental capabilities in breastfed versus formula-fed children at ages 18 and 24 months, respectively, confirmed these findings. In both studies, the authors found that breastfeeding for more than four months had a beneficial effect on cognitive development at the ages measured. They do add that parental intelligence clearly influences cognitive development as well. To limit familial covariant factors, Schack-Nielsen and Michaelsen (2007) cite a study comparing breastfeeding and intelligence that was conducted among 2734 adolescent sibling pairs in 2005. The children who were breastfed scored 1.7 and 2.4 points higher in intelligence within and between families, respectively. Furthermore, the longer the child was breastfed, the higher he or she scored, as the study's results showed increased scores of 0.2 points per month of breastfeeding.

A possible hypothesis for the disparities observed in cognitive development in breastfed and formula-fed infants lies in the essential and nonessential long-chain fatty acid content in each

source of nutrition. In particular, docosahexaenoic acid (DHA) present in human milk has been shown to be necessary for retinal and brain development, as it can be incorporated into cell membranes in the central nervous system (Uauy and De Andraca, 1995; Schack-Nielsen and Michaelsen, 2007). Since plasma DHA concentrations of breastfed infants are higher than that of infants who are fed formula, present formulas are thought not to provide adequate alpha-linolenic acid to support DHA accumulation in tissues. A study of full-term infants fed either human milk or cow milk formula containing 12-18% linoleic and 0.5-1.0% alpha-linolenic acids showed that at four months of age, indexes of visual acuity were more mature in the breastfed infants (Uauy and De Andraca, 1995). Additionally, psychomotor indexes are found to be higher in breastfed infants whose mothers had been supplemented with DHA in order to increase DHA content of milk, when measured at 30 months, reinforcing the suggestion that the DHA concentration in human milk increases cognitive development (Schack-Nielsen and Michaelsen, 2007).

Aside from the composition of breast milk, other factors involved in breastfeeding could be responsible for the stimulated cognitive development. Physical and psychological behavior by the mother during breastfeeding could promote cognitive development as well. Some suggest that hormones triggered in the mother through breastfeeding, such as oxytocin and prolactin, or the actual bonding experience, could influence the mother to focus more on the infant, to use more affectionate touch, and to lessen the likelihood of maternal depression, all of which could foster cognitive development in the child (Schack-Nielsen and Michaelsen, 2007).

Health Benefits to Mother-

Breastfeeding does not only provide numerous benefits to the infant, but the mother also gains several benefits. The most immediate benefit is apparent within the first thirty minutes after delivery, the time that the infant is highly alert and can therefore successfully latch on to the breast (Lawrence, 1989). Breastfeeding in this interval is beneficial to the mother because it allows for a quick expulsion of the placenta, a physiological process that must occur within the first thirty minutes after birth. As explained previously (Mader, 2000), suckling by the infant stimulates the release of the hormones oxytocin and prolactin, which begin the process of breast milk production and secretion. The hormone oxytocin, though, also performs a vital function for delivery. While the smooth walls of the uterus are relatively insensitive to oxytocin during pregnancy, sensitivity increases when the fetus is fully developed. Sudden increased levels of oxytocin in the uterus stimulate the contraction of the uterine wall, triggering labor and delivery. Therefore, as the newborn infant suckles at the breast immediately following delivery, the oxytocin that is released by the neurohypophysis in response to that stimulus will also continue to contract the uterus. These increased contractions will speed up the process of the tearing of the connections between the endometrium and the placenta, resulting in the ejection of the placenta. If this placenta expulsion does not occur within the first thirty minutes of birth, a complication termed retained placenta, the mother will be in danger of excessive bleeding. Therefore, when a mother puts the newborn to her breast during the first thirty minutes after birth, a time when the infant is highly alert and receptive to touch (Lawrence, 1989), she decreases the catastrophe of a postpartum hemorrhage (Ladewig, et al., 2010).

One of the most commonly reported benefits of breastfeeding for the mother is maternal weight loss. A large prospective cohort study conducted by Baker et al. (2008) sought to answer many questions, such as how quickly a woman can return to her pre-pregnancy weight while

breastfeeding and if the amount of weight gained during pregnancy affects one's ability to lose weight while breastfeeding. The researchers collected data on pregnant Danish women during the first trimester of pregnancy, and interviewed them by phone at two prenatal (12 and 26 weeks of gestation) and at two postpartum (6 and 18 months postpartum) time points. Based on self-reported data on pre-pregnancy weight and height, the researchers categorized the ~36,000 women by body mass index (BMI) value as underweight, normal weight, overweight, obese I, and obese II and III. During each of the interviews, the women reported their weight gain or loss. At the postpartum interviews, the women also related the method of infant feeding. The authors observed that the more the women breastfed, the lower the amounts of weight retention were at both postpartum interviews. They conclude that at six months postpartum, normal-weight women who have exclusively breastfed their infants are predicted to retain 2 kg less than women who gained a similar amount during pregnancy but breastfed for less than a week. Obese women are also expected to return to pre-pregnancy weight at six months postpartum. This study is significant because of it has several strengths: a very large cohort, prospective data collection, careful collection of infant feeding data, and others. The results are also noteworthy since they show the relationship between breastfeeding, gestational weight gain, and postpartum weight retention. Similar results were also found in a study, conducted by Kac et al. (2004), of a cohort of Brazilian women. Although the studies are somewhat limited because they do not take into account the mothers' eating and exercise habits, the significant difference in weight retention in breastfeeding and non-breastfeeding women in such a large cohort still reveals an association between breastfeeding and postpartum weight loss. In a society where obesity has become an epidemic, especially among women, research indicating a method to reduce postpartum weight retention may help decrease the number of overweight women.

Perhaps the most major benefit that mothers may receive from breastfeeding is a reduced risk of developing breast cancer. In an extremely large international study analyzing data of many different smaller studies (Collaborative Group on Hormonal Factors in Breast Cancer, 2002), results indicate that the risk of breast cancer is reduced by 4.3% for women who breastfed for a cumulative total of 12 months and by 27% for women who breastfed for a cumulative total of 55 months or more. In one hospital-based case-control study in Shandong Province, China, Zheng et al. (2008) investigated the relationship between lactation and breast cancer risk. Four hundred and four women with histologically confirmed incident breast cancer cases, along with an equal number of controls, were included. The women were all interviewed by blind interviewers and were asked whether they had ever been pregnant and how many live births they had, at what ages did they give birth, and whether they had only breastfed or gave their children formula since birth. If the respondents had breastfed, they were asked to report how many months on average they had breastfed each child. After calculating results, the authors found "a significant inverse association between lactation and breast cancer risk". They found that the mean duration of lactation per child was significantly associated with reduced risk of breast cancer for women who breastfed for more than two years per child compared to women who breastfed for less time. This reduced risk is associated with a longer duration of breast-feeding for both pre- and post-menopausal women, although the risk was generally lower for pre-menopausal women. The protective effect of breastfeeding noted in post-menopausal women implies that the benefits of breastfeeding are maintained for years after women wean their youngest children. This is significant because breast cancer risk increases with increasing age (Shema et al. 2007), so breastfeeding may reduce the risk of cancer even in the period of high occurrence. A similar study conducted by Shema et al. (2007) of ~800 Israeli Jewish women

produced comparable results. This group of authors added that the decrease in breast cancer risk with longer lifetime duration of breastfeeding is not linear, as most of the protective effect of breastfeeding is gained during the first year of breastfeeding. Additional length of breastfeeding did confer some benefit in terms of decreasing breast cancer risk. Mechanisms that have been proposed to explain the observed association between breastfeeding and breast cancer risk (Zheng et al., 2000, Shema et al., 2007) are: (1) a reduced exposure of breast cells to cyclic hormones of reproductive life because of ovulatory suppression that occurs with prolonged breastfeeding, (2) direct physical changes in the breast that accompany milk production, (3) a reduction in the concentrations of toxic organochlorines in the breast, and (4) an expression of change in growth factor beta during lactation, a negative growth factor in human breast cancer cells.

However, not all results of studies on the relationship between various lactative factors, such as number of children breastfed, mean duration of lactation for each child breastfed, and lifetime duration of lactation, and breast cancer risk have been consistent. As referenced in Shema et al. (2007), some studies suggest that the inverse relationship between breastfeeding and breast cancer risk only exists among pre-menopausal women, especially with long durations of breastfeeding and early age at first breastfeeding. Others imply that breastfeeding only confers the benefit of a reduced breast cancer risk in post-menopausal women. Still others find no association at all. Nonetheless, the overwhelming majority of studies do indicate that breastfeeding does reduce the risk of breast cancer.

Whereas studies conducted in China and Japan have all shown that breastfeeding and breast cancer risk are inversely associated, it is the results from studies of western populations that have been conflicting (Zheng et al., 2000). This could be due to the fact that studies investigating breastfeeding in western populations are usually rather limited. Most women in western cultures have two or less children, and breast-feed for an average of four months per child, usually with formula supplementation. Interestingly, a study conducted of Nigerian women (Huo et al., 2008), also investigating the association between breastfeeding and breast cancer risk and finding an inverse relationship between the two, noted that younger women in their study had an increased risk of developing breast cancer. The authors hypothesized that because the majority of older Nigerian women almost always breastfed their babies, usually for 12 months or longer per child, breast cancer did not used to be so prevalent in Nigeria. However, the younger women have begun to adopt a more western lifestyle, changing their reproductive factors to have less children and breastfeed for less amount of time per child, and therefore the protective effects of breastfeeding have diminished.

Conclusion and Summary-

While this paper has shown the many salubrious effects of breastfeeding for both infants and mothers, using formula or alternative sources of nutrition is not necessarily unhealthy for infants. Most infant formulas available in the market today are nutritionally adequate, however, as this paper has elucidated, do not provide any remedial or preventive benefits as breastfeeding does (Sarkar, 2004). For example, while formula does contain necessary nutritional contents mimicking breast milk as much as possible, human milk oligosaccharides are impossible to replicate exactly because of their diversity and complexity. Consequently, infants who are exclusively fed formula will not receive the health benefits that oligosaccharides in breast milk provide. Also, infants who are not breastfed do not have the same bonding opportunities with their mothers as infants who are breastfed do, and thus will not experience the same

psychological closeness to their mothers. Finally, mothers who choose not to breastfeed are missing out on the numerous benefits for them that come from the act of breastfeeding. In conclusion, breastfeeding is considered a superior source of nutrition over other modified milk formulas because of its many intrinsic nutritional and salutary properties, and because no formula can duplicate breast milk completely. However, in the case of absence or insufficient production of breast milk, infant formula is a suitable and convenient substitute, as long as one is careful to prepare it properly, sterilizing the feeding equipment to avoid contamination.

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