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# Correlation of Swallowing and Breastfeeding Activities on Children's Craniofacial Development: Systematic Review

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**ABSTRACT**

Craniofacial and development increase is growth occurring within the first four years of life, a period during which a feeding regimen can take effect. Craniofacial growth and development are influenced by the function of stimuli, such as breathing, swallowing, chewing, and sucking. The World Health Organization (WHO) currently recommends exclusive breastfeeding for the first six months of a baby's life, and then continuing breastfeeding alongside solid foods for the next 12 to 24 months, or as long as the mother and baby want. Babies who have slow sucking and swallowing reflexes will usually have an effect on their ability to eat and speech development. If the reflex does not appear, this indicates a slow development of the brain or there is brain damage, for example, there is trauma to the head at birth or LBW conditions (Low Birth Weight Infants). The aim of this study of systematic review is to determine correlation of swallowing and breastfeeding activities on children's craniofacial growth and development. Data source of Pubmed, Web of Science and Google Scholar. Studies published from 2016 to 2020. Article were analyzed 270 articles resulting in 68 articles being excluded. The full-text articles in the remaining 47 articles were re-analyzed and excluded 37 articles and produced 10 articles which were then entered into the analysis. All of these articles show that swallowing and breastfeeding are closely related to the craniofacial development of children.

**Keywords**: Swallowing, Breastfeeding, Craniofacial development

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## Introduction

Craniofacial growth and development are influenced by the function of stimuli, such as breathing, swallowing, chewing, and sucking.[1,2,3,4] In the early stages of mouth development, the palate is still soft and therefore can be formed.[5,6] During breastfeeding, the baby moves the masticatory muscles and facial muscles naturally physiologically to help compress the breast to produce milk.[7] This muscle action is believed to promote optimal craniofacial growth and development compared to bottle feeding.[8] Bottle-feeding, can compress the palate and cause it to develop into an unnatural narrow V-shape, and also lead to insufficient space to accommodate teeth and transverse mismatch. On the other hand, during breastfeeding, when the baby expresses milk from the breast with a peristalsis-like movement of the tongue, the breast becomes flat and enlarged. This action leads to the formation of the palate into a physiologically round U shape which allows room for dentition and reduces the occurrence of crossbites.[9,10,11]

The greatest craniofacial increase is growth occurring within the first four years of life, a period during which a feeding regimen can take effect. The ability to drink in infants is influenced by the presence of rooting (looking for), sucking (sucking), and swallowing (swallowing) reflexes which will become controlled from the age of 3 months and their function develops, namely the ability to eat and drink.[12] Babies who have fast reflexes to certain stimuli will have better brain development than those with slow reflexes. Babies who have slow sucking and swallowing reflexes will usually have an effect on their ability to eat and speech development.[13] If the reflex does not appear, this indicates a slow development of the brain or there is brain damage, for example, there is trauma to the head at birth or LBW conditions (Low Birth Weight Infants). Another problem is that babies are usually unable to carry out drinking activities, so they have growth and development problems, and may have a small chance to live if they are not cared for more intensively[14,15]

The World Health Organization (WHO) currently recommends exclusive breastfeeding for the first six months of a baby's life, and then continuing breastfeeding alongside solid foods for the next 12 to 24 months, or as long as the mother and baby want.[17]This recommendation is supported in the UK by the National Health Service (NHS).[16] Breast milk

is an excellent source of nutrition and contains immune cells, antibodies, and digestive enzymes. Therefore, breast milk offers immunological protection to the immune system of a newborn who is potentially immature and helps the baby's immune and digestive system to develop.[6,7] So the purpose of writing this systematic review is to determine correlation of swallowing and breastfeeding activities on children's craniofacial growth and development.

## Methods

Data source

Data collection was carried out by searching the literature on the article search site, Pubmed, Web of Sciences and Google Scholar, which was published from 2016 to 2020, the search was carried out in December 2020. The data search was carried out systematically using the keywords "*swallowing and breastfeeding in children*" and "*craniofacial growth during breastfeeding and swallowing*. "

Inclusion criteria

1. Articles published from 2016-2020
2. Articles in English
3. Scientific articles that have been published and are available online
4. Articles that examine swallowing and breastfeeding in children's craniofacial development as a result of research

Exclusion criteria

1. Articles in Indonesian
2. Articles that cannot be accessed for free
3. Articles that do not discuss swallowing and breastfeeding in children's craniofacial development

Data collection

The data that will be used in this research is secondary data. The data is obtained from articles that are searched for in the article database which will then be reviewed according to the research criteria set by the researcher.

Procedure Systematic Review

1. Literature search was conducted on the online database PubMed, Web of Sciences, and Google Scholar. In addition, a search for the list of references to articles that fall into the inclusion criteria was also carried out to find out whether there were other related studies that were relevant to this research.
2. Keywords were determined in the literature search, namely "*swallowing and breastfeeding in children*" and "*craniofacial growth during breastfeeding and swallowing*".
3. Eliminate duplicated literature
4. Articles are filtered on the basis of title, abstract, and keywords
5. Read complete or partial articles that have not been eliminated to determine whether the articles meet the eligibility criteria.
6. Data collection was done manually by creating a research matrix containing: author's name, year, title, and conclusion.
7. Processing the data that has been obtained

The literature search was carried out on the online database, Pubmed, using keywords, namely *"swallowing and breastfeeding in children*" and "*craniofacial growth during breastfeeding and swallowing*" of which 270 articles were found

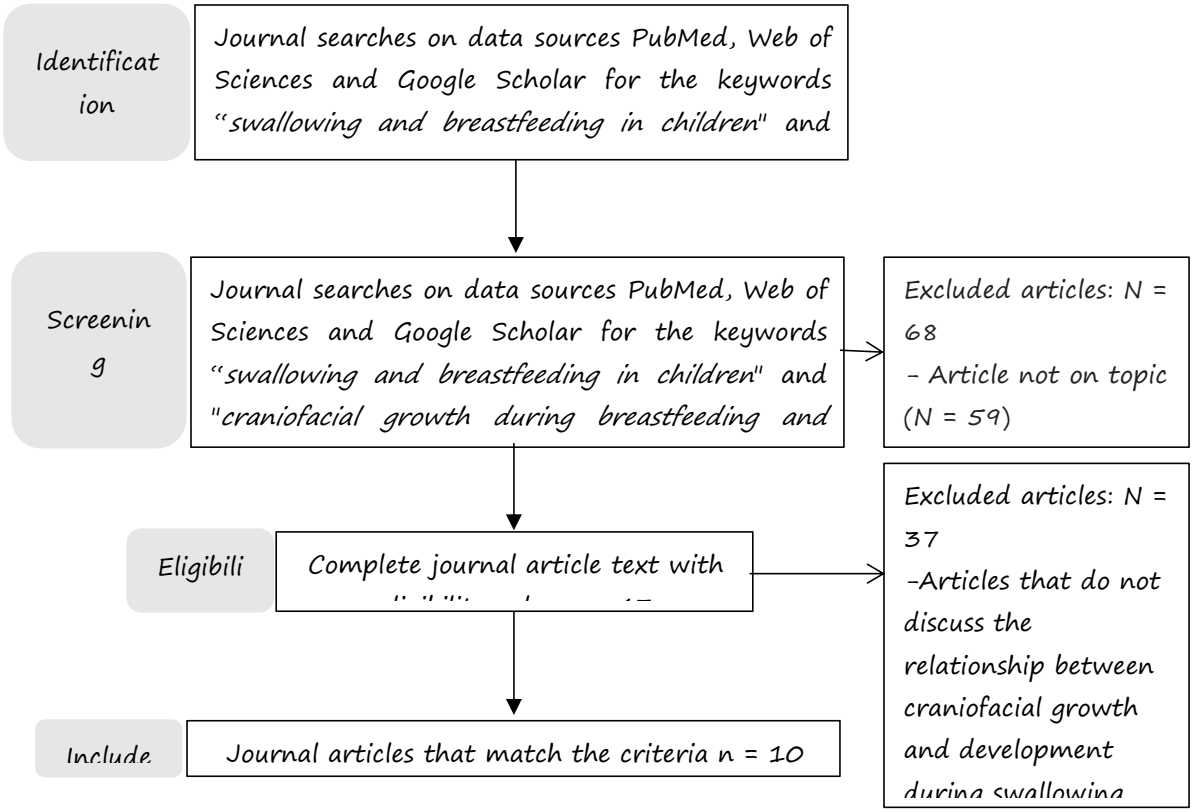


**Figure 1.** Flowchart Systematic Review

## Result

After eliminating duplicated articles, the titles and abstracts of each article were analyzed across 270 articles resulting in 68 articles being excluded. The full-text articles in the remaining 47 articles were re-analyzed and excluded 37

articles and produced 10 articles which were then entered into the analysis.

**Table 1.** The characteristics of each article entered into a systematic review

| No. | Author | Year | Title | Conclusion |
|---|---|---|---|---|
| 1. | Jill M. Merrow[18] | 2016 | Feeding Management in Infants with Craniofacial Anomalies | The ability to eat and swallow in infants born with craniofacial anomalies shows great variability. Infants with the same medical diagnosis or craniofacial anomalies may present very differently in the intrinsic management of food and fluid intake. The instinctual drive to obtain food can be complicated by structural differences, physiological instability, and environmental influences. These factors assessed individually and in combination will assist in producing the most favorable feeding results possible with the overall goal of providing adequate nutrition and hydration for brain development and growth, and facilitating the most positive feeding experience for the infant and caregiver. |
| 2. | Susan Willette, Laura Hinkes Molinaro, Dana M. Thompson, James W. Schroeder[19] | 2016 | Fiberoptic Examination of Swallowing in the Breastfeeding Infant | Fiberoptic endoscopic evaluation is a safe, well-tolerated, and easy-to-perform option for instrument evaluation for infants who are primarily breastfed. This diagnostic tool supports filling the airway and provides objective data that helps in the development of an unbeatable meal plan to optimize patient safety with continued breastfeeding. |
| 3 | Montserrat Boronat-Catalá, José María, Carlos Bellot-Arcís, José Manuel Almerich-Silla & Montserrat Catalá-Pizarro[20] | 2017 | Association between duration of breastfeeding and malocclusions in primary and mixed dentition:a systematic review and metaanalysis | Breastfeeding is a protective factor against posterior crossbite and Class II malocclusion in primary and mixed teeth. The protective effect increases with the month of breastfeeding. There is no clear evidence that breastfeeding provides protection against the risk of other malocclusions such as an open bite. |
| 4 | Suttikamon Sroiwatana and Pawin Puapornpong[21] | 2018 | Outcomes of Video-Assisted Teaching for Latching in Postpartum Women: A Randomized Controlled Trial | Video-assisted teaching of breastfeeding is no better than routine teaching. Routine teaching with small groups and using hands-on teaching techniques is very important in producing better breastfeeding practices. It is intended that the child's craniofacial growth and development can grow well |
| 5 | Erika Barbara Abreu Fonseca Thomaz, Cláudia Maria Coelho Alves, Luciana Freitas Gomes e Silva, Cecília Cláudia Costa Ribeiro de Almeida, Maria Teresa Seabra Soares de Britto e Alves, Juliana Balbinot Hilgert, and Eliana Marcia da Ros Wendland[22] | 2018 | Breastfeeding Versus Bottle Feeding on Malocclusion in Children: A Meta-Analysis Study | Breastfeeding can affect primary occlusion for at least 6 months |
| 6 | Eun Hae Park, Jae-Gon Kim, Yeon-Mi Yang, Jae-Gyu Jeon, Jun-Il Yoo, Jin-Kyu Kim, and Dae-Woo Lee[23] | 2018 | Association Between Breastfeeding and Childhood Breathing Patterns: A Systematic Review and Meta-Analysis | There is a correlation between breastfeeding and childhood breathing patterns. Based on this review, we found that the frequency of normal nasal breathing increased with the duration of breastfeeding. |
| 7. | Abarzúa P. Constanzaa , Godoy M. Ana, Rubilar P. Marianaf, Silva Sch. Maríab, Velásquez Z. Mónicab, Bustos M. Luisd[24] | 2019 | Standardization of Early Feeding Skills (EFS) scale in preterm infants | The EFS scale is a tool that provides relevant information for describing the oral feeding of premature babies, allowing to identify areas of greatest difficulty requiring professional care, however, it is not sufficient to carry out a comprehensive evaluation of the newborn feeding process. |
| 8. | Ana Maria Hernandez, Esther Mandelbaum Gonçalves Bianchini[25] | 2019 | Swallowing Analyses of Neonates and Infants in Breastfeeding and Bottle-feeding: Impact on Videofluoroscopy Swallow Studies | Analysis of the swallowing characteristics of the two feeding methods revealed significant differences among those impacting the diagnosis in the Videofluoroscopy Swallow Studies, particularly regarding the velar function. |
| . | Ellia Christinne Lima França, Lucas | 0 | Surface Electromyographic | Suprahyoid muscle activity was observed with |

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|---|---|---|---|---|
| | Carvalho Aragão Albuquerque, Roberta Lopes Castro Martinelli, Ilda Machado Fiuza Gonçalves, Cejana Baiocchi Souza, Maria Alves Barbosa[26] | | Analysis of the Suprahyoid Muscles in Infants Based on Lingual Frenulum Attachment during Breastfeeding | attachment of the lingual frenulum to the middle third of the tongue / sublingual caruncles, indicating coordination between swallowing, sucking, and breathing. Surface electromyography is effective in diagnosing changes in the lingual frenulum. Thus, it is possible to identify oral motor dysfunction |
| 10. | Kate Parker, Matthew Chia[27] | 2020 | Breastfeeding – does it affect the occlusion? | Although it has been widely suggested that breastfeeding is linked to occlusion, there is not enough quality of evidence to support any of these claims. The majority of the studies in this area were of low quality and assessed only primary teeth. It is therefore not possible to say accurately if the method of feeding has an effect on occlusion and if any of these effects are continued on the permanent teeth. |

## Discussion

The results of this systematic review indicate that ingestion and breastfeeding are associated with craniofacial growth and development. In Merrow's study,[18] that the ability to eat and swallow in babies born with craniofacial anomalies is very different in the intrinsic management of food and liquid consumption, getting food can be complicated due to structural differences, physiological instability, and environmental factors. These factors are judged to be helpful in producing the most favorable feeding results possible with the overall goal of providing adequate nutrition and hydration for brain development and growth, and facilitating the most positive feeding experience for infants and caregivers.

Another study, María et.al,[20] examined fibrotic endoscopic apparatus as an evaluation of swallowing as a safe, well-tolerated, and easy-to-perform option for instrumental evaluation of swallowing for infants who are primarily breastfed. This tool allows for comprehensive investigations of the airway and provides objective data that assists in the development of a customized feeding plan to optimize patient safety with continued breastfeeding. In contrast to the study of Constanzaa et.al,[24] researching the EFS (Early Feeding Skills) scale is a tool that provides relevant information for describing oral feeding in premature infants, allowing to identify areas of greatest difficulty requiring professional care, however, tools this is not sufficient to carry out a comprehensive evaluation of the newborn feeding process. In addition, França et.al,[26] who studied electromyography to analyze greater suprahyoid muscle activity, observed with the attachment of the lingual frenulum to the middle third of the tongue / sublingual caruncles, showing coordination between swallowing, sucking, and breathing. Surface electromyography is effective in diagnosing changes in the lingual frenulum. Thus, it is possible to identify oral motor dysfunction. Meanwhile, research by Geddes et. al,[28] that using ultrasound imaging on infants can identify the process of swallowing when the child is breastfeeding (Fig. 2)

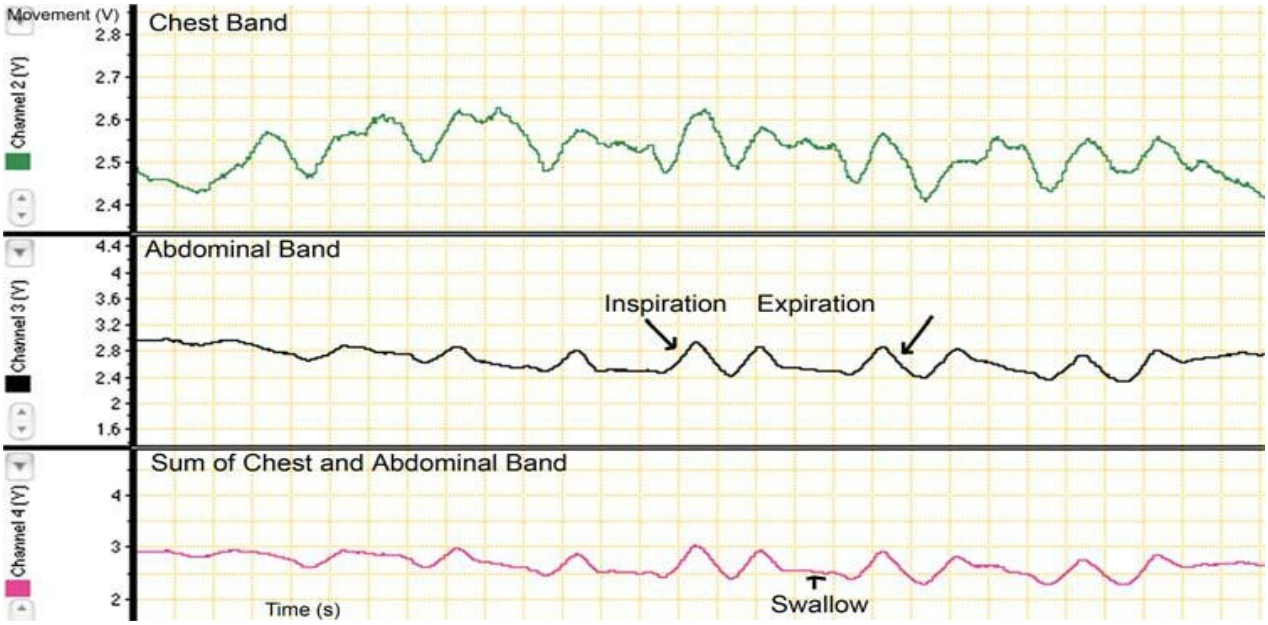
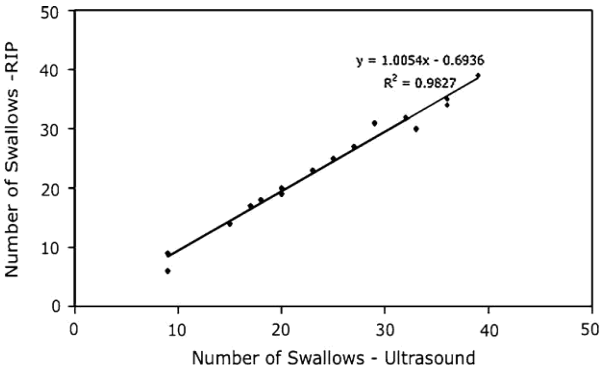



**Figure 2.** An example of the signals obtained by respiratory inductive plethysmography. The top channel records the movement of the chest band, the middle the abdominal band, and the third channel calculates the sum of the two bands.[28]

Ultrasound imaging is a noninvasive accurate method for detection of swallowing by visualization of movement of the milk bolus through the pharyngeal area of a breast-feeding infant. Furthermore, ultrasound imaging of swal-lowing correlates well with swallowing (swallow apnea) detected using respiratory inductive plethysmography. These techniques have the potential to provide useful information for infants experiencing breast-feeding difficulties[28] Until now no one has attempted to noninvasively validate RIP

detection of swallowing in breast-feeding infants. We found a significant correlation between swallow apnea detected by RIP and the movement of milk through the pharyngeal area as detected by ultrasound (Fig. 3) During this study ultrasound occa-sionally detected more swallows than did RIP. It is possible this small discrepancy could be due to movement of the infant during feeding causing a distorted RIP signal and making detection of the swallow difficult. Indeed, excessive movement of the infant's arms can induce noise in the signal from the chest band. Therefore, in our view it is essential to indicate periods of unsettled feeding behaviour on the trace. This also emphasises the importance of the two-band sys-tem, as swallows may not be detected with one chest band during these periods of increased activity. It is possible that the absence of detection of a small number of swallows by ultrasound could be because these were non-nutritive swallows (saliva, which would have a different appearance on ultrasound, as opposed to milk). Alternatively, movement of either the ultrasound transducer or the infant during scanning may have affected visualisation of the milk bolus. Unfortunately, little comparative work between methods of swallowing assessment in infants has been carried out.[28]

**Figure 3.** Correlation between the number of swallows imaged by ultrasound and those detected by respiratory inductive plethysmog-raphy for the breast-feeding infant[28]




**Development of Infant Feeding and Swallowing**

In healthy and developing newborns are reflexive.[29,30] The rooting reflex encourages the newborn to find the nipple and the sucking reflex pulls the milk from the nipple. Milk is extracted from the nipple with positive and negative pressure, otherwise known as compression and suction. Extraction of milk results from coordinated movements of the following oral structures.[31,32,33,34]

1. Jaw

The jaw support structure moves in a vertical dimension. Its inferior movement helps create the suction.

2. Lips

The lips help with an anterior seal around the nipple and support stabilization of the nipple in the oral cavity.

3. Tongue

The tip of the tongue presses against the nipple. The posterior aspect of the tongue closes the oral cavity against the soft palate. As the tongue descends, it enlarges the oral cavity creating suction. The tongue also forms a midline groove for the transfer of the liquid bolus from the mouth to the oropharynx.

4. Cheeks

Cheeks provide stability. The bigger the grease of the bearing, the greater the stability.

5. Hard Palate

The hard palate assists the tongue with compression nipples and stability.

6. Soft Palate

The soft palate helps the tongue close the posterior oral cavity. During swallowing, the soft palate rises to close the nasal cavity, preventing nasal regurgitation and creating suction.

Breastfeeding Management

If an infant is showing breastfeeding difficulty, modifications should be trialed during the evaluative session, including the following:[35,36,37]

1. Positioning of the feeder: Supported position to maintain stability throughout the feeding. Positioning of the infant: Upright or elevated side lying to minimize the effects of nasal regurgitation and glossoptosis (if applicable).
2. Occlusion of the cleft lip and alveolus: With the breast or a wide nipple. Stabilize the jaw and cheeks for better oral closure, being mindful that the infant may rely on oral versus nasal breathing if airway patency issues are present
3. Occlusion of the cleft palate: Obturators are not necessary and used infrequently.
4. Nipple modifications: Wide base and shaft for better occlusion of the cleft, length depends on size of the mouth and cleft, softness for easier compression, and variable hole size to adjust the flow rate of milk.
5. Infant-directed, assisted milk flow by bottle: Use a soft-sided bottle and pliable nipple or a one-way flow valve.
6. Feeder-directed, assisted milk flow by bottle: Use a soft-sided bottle and pliable nipple, angle the
7. nipple to contact a portion of bone for better positive pressure generation, squeeze the bottle when the infant sucks to synchronize positive pressure application with the infant's suck-swallow-breathe pattern.
8. Other: Burp frequently, irrigate the nose only if needed.
9. Breastfeeding (if applicable depending on the type and severity of the cleft): Nurse through let down, use manual expression, use assisted milk flow at the breast (eg, a supplemental nursing system), and close monitoring of growth.
10. Breastfeeding (if the infant is not a good candidate for nutritive feeding at the breast): Put the infant to breast briefly either at the onset of the feeding or after nutritive feeding from the bottle, encourage infant to breast for skin-to-skin contact and stimulation of milk production, elicit assistance from a lactation consultant for milk production strategies.
11. Compensatory strategies for poor feeding: Add supplement to the breastmilk, increase caloric concentration of the formula, provide temporary enteral feedings if necessary.
12. Monitoring: Weight checks with the pediatrician, follow-up with clinician, referral to other specialists as needed, hospital admission for failure to thrive or if physiologic stability is significantly compromised.
13. Postoperative Feeding: Recommendations based on surgeon's preferences, practice preoperatively

The development of feeding and breastfeeding can be seen in the following table:[38,39]

**Table 2.** Baby Feeding Chart for Newborns to 1-Year-Olds

| Age | 0-5 months | 6-8 months | 8-12 months |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Baby's development | Babies can suck and swallow | Babies can eat from spoon and swallow | Babies start using fingers to pick up pieces of food |
| What to feed baby | Breast milk or formula | Purified and mashed soft foods Breast milk or formula | Ground/finely chopped Solid foods Grains (cereal, bread strips, broken up crackers) Breast milk or formula |
| How to feed baby | Breastfeeding of bottle feeding | Spoon feed<br>Introduce a sippy cup | Babies begin to feed themselves with a spoon or fingers |

Basically, breastfeeding starts off as a reflex and then develops into a controllable action (pharyngeal and esophageal phases of swallowing).[40] The development of eating skills begins at the time of the newborn. [41,42,43]The rooting reflex is a movement in which the baby will turn towards the touch in the area of the mouth, lips, cheeks, or chin, and the mouth will open. This reflex gives the baby the ability to search for, find, and attach to the nipple. After that, the suck and swallow reflex occur where the sucking motion begins.[44,45,46] When the liquid enters the mouth, the tongue moves it to the back of the mouth to be swallowed. The tongue-thrust reflex makes the baby stick its tongue out to feed on the nipple or bottle, but not from a spoon or glass. If food is forced into it, a gag reflex will arise, so the food is pushed back out. After 6 months of age, his tongue thrust reflex and rooting reflex began to decrease, and solid food that entered the inside of his mouth would not be regurgitated.[47,48] Babies will also open their mouths immediately when they see the spoon approaches. The chewing movement begins to develop at 7-9 months of age. At the age of 9-12 months, chewing skills are increasingly perfect, coupled with the ability to hold objects with fingers. Furthermore, at the age of 6-18 months, the strength, coordination, and control of these oral structures form the basis of eating activities, such as sucking, swallowing, biting, and chewing. It is very important to give oromotor stimulation (oral motor) to the baby so that he can eat the right way.[49]

Oromotor is defined as a muscular system that covers areas of the oral cavity including the jaw, teeth, tongue, palate, lips, and cheeks.[45,46] Oromotor maturity generally occurs at the age of 4-6 months and is followed by stimulation to develop it. Oromotor development is needed to support the ability to eat and also the ability to speak children.

With the development of reflex sucking and active movement, physiologically the TMJ joint will stimulate maturation of the condyle. In the process of jaw formation, sucking breast milk gives a special role indirectly. When the baby is actively sucking, the baby has made regular, balanced, and continuously open and closed movements.[48,50] This process helps in the compaction of the jawbone cells. The activity of sucking breast milk is also a process in achieving normal occlusion

## Conclusion

Swallowing and breastfeeding are closely related to the craniofacial development of children. Swallowing and breastfeeding begin as reflexes and then progress to controllable actions (pharyngeal and esophageal phases of swallowing). Thus, this is very necessary for child development and suppresses any growth abnormalities

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