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**Tiny Tusk Internship: The Relationship Between Duration of Breastfeeding and the
Development of Attention-Deficit / Hyperactivity Disorder**

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Introduction

My interest in the infant population initially prompted me to seek out the opportunity to work alongside Tiny Tusks Breastfeeding and Infant Support for the past year and a half. This group offers breastfeeding and infant education to mothers in Northwest Arkansas. Tiny Tusks partners with the University of Arkansas athletic department to ensure all nursing mothers have a private area to breastfeed during football and basketball games as well as gymnastic meets.

Additionally, for this internship I have been working on many breastfeeding and infant support continuing education credits, social media updates, and marketing strategies that can be utilized for years to come. Upon graduation, I am hoping to find a job in a neonatal intensive care unit (NICU). This internship experience has allowed for exposure to my future demographic. I have had opportunities to educate mothers, communicate with different types of families and support systems, and observe family dynamics from a community stance. Considering I will be working primarily in an acute setting, I think it is important to see families in a calm, relaxed state with their infants. NICU nurses often do not get to see how family dynamics change once they leave the hospital, which is why all experience in community nursing is valuable. Tiny Tusks has truly furthered my obstetrics and community clinical experiences and allowed me to increase my knowledge and competency related to breastfeeding and infant care.

Challenges

Two months into my internship experience, the University of Arkansas and most of its extracurricular activities got shut down in response to the recent COVID-19 outbreak. This setback took a large toll on my internship experience. What was originally designed as an interactive community outreach internship became an online educational experience and COVID needs focused community experience. We grew our knowledge on breastfeeding and

infant/mother support through online modules of continuing education. We also adjusted to the larger community's health needs with focused modules on the coronavirus and how it may affect the pregnant and breastfeeding populations. Besides completing online modules, Tiny Tusks sought to meet the community needs during this pandemic through community outreach. We reconvened in the fall semester of 2020 hopeful that we would be able to continue our in-person agenda at athletic games. At first, the athletic department was hesitant to let Tiny Tusks participate in their scheduled events; however, since we were part of the medical community there was an important role we could assist with. At the football games we were utilized as temperature takers for the essential staff working the games from the field, we assisted the EMTs at the medical stations, and promoted the proper mask and social distancing regulations. We also were allowed one person to monitor our Tiny Tusk breastfeeding room. During a pandemic, many mothers do not want to expose their infants to large public gatherings such as athletic games which hurt the growth of Tiny Tusks as a program. With less foot traffic came a bigger push for social media outreach. We used our platforms of Facebook and Instagram to keep our community informed. One of this year's main focuses was how to implement strategies in the future to strengthen the program and continue its outreach as the community it is geared towards is ever changing. Meeting the needs of a growing population while in a pandemic has challenged Tiny Tusks to adapt and be innovative to continue the focus of community outreach. Focusing on the future and potential needs, our intern team has developed a sturdy foundation for next years' Tiny Tusk members.

Lessons Learned

One of the most important lessons learned through this experience was the essence of adaptability and creative problem solving. Upon entering this internship, I believed my pediatric

and OB lecture material would prepare me for the educational aspect of community outreach. As I am close to completing my internship, I realize that knowledge did not prepare me for this internship as I thought, but instead, using effective communication and flexibility supported my success. Elanor Mann School of Nursing taught me from the beginning of my nursing career that communicating effectively could solve most problems. I have taken many courses and been in clinicals that have allowed me to practice communication techniques which was not originally one of my natural skills. Change is inevitable however during a pandemic this has been a theme as our nursing school seems to be ever changing with many instances of last-minute changes. On Tuesday we may be going to one hospital for a clinical and on Wednesday morning we are going somewhere completely different. These types of changes have given me much experience with altering my plans quickly to adapt to the circumstances. Nursing is a professional role that requires honesty, compassion, excellence, and adaptability which I have seen first-hand in my experiences with Tiny Tusks Breastfeeding and Infant Support.

As previously noted, one large aspect of this internship was equipping the interns with knowledge on the benefits of breastfeeding. After many continuing education modules, I understood many protective factors of human milk for the infant but continued to wonder how breastfeeding affects certain disease processes and disorders. During a gymnastic meet, Tiny Tusks was hosting a private breastfeeding room and an education station that also served to entertain young siblings. I was drawing with one young boy who had run over eagerly as his father appeared slightly out of breath. The father approached me and apologized for his son's behavior explaining that he was very hyperactive and could not sit still. This is when I began to wonder what effect breastfeeding could have on attention-deficit hyperactivity disorder.

Review of Literature

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that remains highly prevalent in the youth community and may include symptoms of inattention, hyperactivity, and impulsivity (Parekh, 2017). This condition is one of the most common mental health disorders affecting children with 8.4% of this population diagnosed, yet the cause of ADHD cannot be definitively placed (Parekh, 2017). With the idea that this condition is primarily targeting children, the problem and possible solution may lie in infancy. There is evidence to support a genetic correlation contributing to attention-deficit/hyperactivity disorder, while prematurity, fetal brain injury, and substance using mothers may play a role in ADHD development as well (Parekh, 2017).

One large determinant of health in infants is breastfeeding and the superior nutrition a mother can provide for her child. Research by Nieto-Ruiz et al. (2020) supported lower risk associated with developing internalizing problems and better longitudinal behavior development in breastfed infants compared to formula-fed infants. This could be explained by the, “fact that functional nutrients found in human milk must be strictly necessary for the optimal brain development and cognitive functions” (Nieto-Ruiz et al., 2020, p. 11). Breast milk contains vitamins, antibodies and human milk oligosaccharides which are important for the establishment of the gut microbiome. This substance’s long-chain fatty acids have protective effects on the central nervous system, possibly including ADHD (Nieto-Ruiz et al., 2020). Upon investigation of the gut microbiota of breastfed infants, it was discovered a less diverse population exists in comparison to formula-fed infants. Even so, breast milk contains the same or higher amounts of protective components than formula-fed infants meaning “alteration of the microbiome composition could potentially be a reason for the positive correlation between formula-feeding and the risk of developing ADHD” (Bull-Larsen & Mohajeri, 2019, p. 11).

The purpose of this literature review was to integrate evidence from studies published from 2015 to 2021 on the relationships between duration of breastfeeding during infancy and the development of ADHD. Specifically, the research question was: Are children under the age of 18 years who were breastfed for at least the first six months of life at decreased risk for the development of attention-deficit/hyperactivity disorder compared to children who were never breastfed or breastfed less than six months of life?

Methods

Design

This is a systematic review of research on the relationship between duration of breastfeeding and the development of attention-deficit/hyperactivity disorder in children under the age of 18 years. The review was guided by the Preferred Reporting Items for Systemic Reviews and Meta-Analyses statement (Liberati et al., 2009).

Information Sources and Search Strategy

Studies were retrieved by systematically searching PubMed and CINAHL databases. A manual search of references from all articles that met eligibility criteria was also conducted.

The search terms “breastfeeding” and “ADHD or attention-deficit hyperactivity disorder” were used to search for relevant articles in CINAHL. A search of PubMed was performed with terms “breastfeeding” and “attention deficit hyperactivity disorder”. Search limiters applied in CINAHL included English language, time limits from 2015 to 2020, and peer-reviewed journal articles. Search limiters applied in PubMed included human, English language, and time limits from 2015 to 2021.

Eligibility Criteria

PICO is a mnemonic used to describe the four elements of a clinical question. The P explains the target population, the I stands for intervention, the C stands for comparison of that initial intervention, and the O is the outcome one would like to measure. Eligibility of studies was determined by using these PICO elements: (a) the study was conducted in children under the age of 18 years (P); (b) the study presented data on the effect of breastfeeding for children diagnosed with attention-deficit hyperactivity disorder (I); (c) the study demonstrated data on the relationship between extended breastfeeding compared to little or no breastfeeding duration within the youth community (C); and (d) development of attention-deficit hyperactivity disorder in the form of professional diagnosis was evaluated (O). Studies were excluded if they introduced a medication relationship to breastfeeding or did not directly correlate breastfeeding and ADHD.

Search Results and Data Extraction

A combined 57 research articles were identified by CINAHL and PubMed using the search strategy. There were 15 articles duplicated and they were deleted. Of those 42 articles identified, 30 were excluded based on the context of their title's being irrelevant to this literature review. Two articles were excluded after a full text review because the population did not fit the inclusion criteria. Pertinent information from the remaining ten articles was extracted and identified. The selection process is represented in the flow chart (Fig. 1). Publication year, authors, location of study, sample sizes, methods of data collection, results, and limits/confounding variables were analyzed. The articles were analyzed to ensure the findings were current and within the past 6 years.

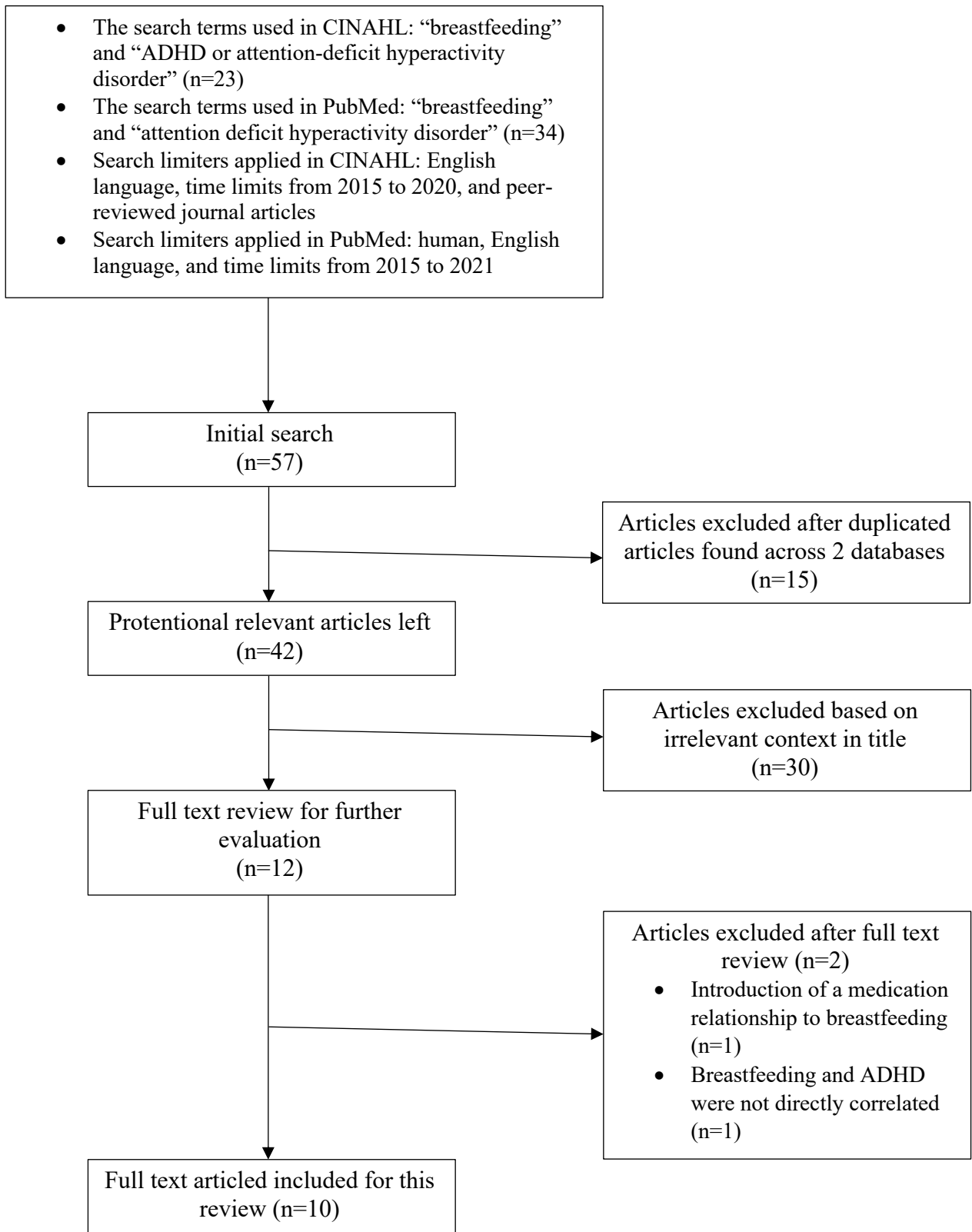


Figure 1. Selection Process of Included Studies

Results

The ten studies included 293,582 participants from eight countries. There were two studies from Germany, two studies from the United States, and one study from Spain, South Africa, China, Iran, Denmark, and Turkey. Demographics varied across these studies, but all included children under the age of 18 years. An overview of the details and key findings of these studies is presented in Table 1. When referencing the control group within the four studies below, this includes the non-ADHD diagnosed children and mothers.

Lemcke et al. (2016) analyzed whether breastfeeding as a developmental deviation was associated with later ADHD diagnosis. Breastfeeding was one of the more significant findings as a protective factor to the development of ADHD during this study's 6-month interview results. In comparison to the control, there were more mothers in the ADHD group who stopped daily breastfeeding early or did not breastfeed their infant. There was a linear correlation at this stage of the child's development between the length of the breastfeeding period and the later diagnoses of this disorder. This study found that the risk of developing ADHD decreased with the additional length of the child's breastfeeding duration; however, the short-term effects of breastfeeding in relation to ADHD are unclear. It is important to note that mothers in the ADHD group had lower levels of education, smoked more during pregnancy, and had higher rates of prematurity than the control group. All of which are known risk factors connected to the short duration of breastfeeding (Lemcke et al., 2016). Even with confounding factors in the development of ADHD, the duration of exclusive breastfeeding and the total breastfeeding period had statistical significance.

An association between shorter breastfeeding duration and the presence of more ADHD symptoms was found in a study by Stadler et al. (2016). Researchers examined a well-

characterized cohort with carefully validated ADHD diagnoses in relation to maternal breastfeeding. This study highlighted the phenomenon that breastfeeding duration could positively influence cognitive development, as well as the development of brain white matter connectivity. Mothers of children with the disorder breastfed for an average of 4.45 months whereas mothers within the non-ADHD control group reported an average of 7.21 months. Additionally, breastfeeding for at least 6 months was reported at a higher rate for the control group (65.6%) as opposed to the ADHD group (48.5%). This study concluded that claims of an association between breastfeeding duration and child ADHD are valid; however, this relationship is not completely understood. It remains possible that children who develop ADHD are more difficult to breastfeed which would lead to a reduction in the duration of breastfeeding.

Using the Centers for Disease Control and Prevention's 2011/2012 National Survey of Children's Health Soled et al. (2021) estimated the association between different feeding mechanisms and ADHD. This study found that children who were never breastfed were much more likely to develop ADHD as opposed to exclusively breastfed infants and there was a correlation with a continuum of neuroprotective benefits associated with breastfeeding duration. For each additional month an infant was breastfed the association of ADHD was reduced by approximately 11 percent. This idea of decreased ADHD risk remains valid regardless of when formula was introduced to the infant. Soled et al. (2021), found the duration of 6 months of exclusive breastfeeding resulted in a significantly lower risk of ADHD development in relation to infants that were breastfed for a shorter duration or not exclusively. There was strong evidence to support the neurodevelopmental benefits of breastfeeding, though noted was the need for the further examination of the relationship between ADHD and infant feeding.

Sepehrmanesh et al. (2020) evaluated the duration of breastfeeding and attention-deficit hyperactivity disorder in school-aged children to determine the protective and risk factors associated with ADHD to help identify prevention mechanisms. This study found that the control group's mean breastfeeding period was 18.59 months with a differential of 6.74 months while the ADHD group's average was 17.05 months with a differential of 7.52 months. Therefore, the average duration of breastfeeding was lower for children with ADHD compared to the control group. It also reported that every additional month of breastfeeding led to a reduction of developing ADHD symptoms by 4 percent. Even as a relevant variable, the study found breastfeeding duration to be the least significant factor in the prevention of ADHD when compared to a history of drug use and hyperthyroidism. Although other factors may play a larger role in the development of ADHD, breastfeeding was supported as a protective factor against developing ADHD in this study.

The six studies that were not included for an in-depth evaluation are discussed below in Table 1. This table highlights the purposes of all ten studies, gives participant demographics, indicates the measured outcomes, and underlines the major findings.

Authors, Year of Publication, Country	Study Design, Sample Size	Purpose of the Study	Participants	Outcome Measures	Major Findings
Zeng et al., 2020, China	Systematic Review and Meta-analysis, 106,907 participants	To summarize the current evidence on the association between maternal breastfeeding and the occurrence of attention deficit/hyperactivity disorder (ADHD) in offspring.	Children under the age of 18 years	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-V, DMS-IV, and ICD-10 	<ul style="list-style-type: none"> Children with any breastfeeding had ADHD less frequently than did children who were never breastfed, with a pooled adjusted OR of 0.70, indicating a negative association between any breastfeeding and ADHD. Children with over 1 month, 3 months, 6 months, and 12 months of breastfeeding had lower occurrences of ADHD than controls. The results of risk factors were not consistent in the sensitivity analysis in the any and over 12-month breastfeeding groups.
van Dyk et al., 2015, South Africa	Case-control study, 100 participants	To investigate familial and environmental risk factors in a cohort of South African children diagnosed with attention-deficit hyperactivity disorder (ADHD).	Children aged 5-13 years old; 50 children diagnosed with ADHD and 50 non-ADHD children	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-IV Interview with children and their relatives 	<ul style="list-style-type: none"> Prolonged breastfeeding has been shown to be protective against the development of ADHD. Short duration of breastfeeding (less than 3 months) was found to be a significant risk factor of ADHD symptoms in the study.
Tseng et al., 2019, Germany	Meta-analysis, 94,324 participants	To examine the difference in the duration of maternal breastfeeding between children with and without ADHD, and the association between maternal breastfeeding and ADHD in children.	Children under the age of 18 years	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-V, DMS-IV, and ICD-10 	<ul style="list-style-type: none"> Our results suggest maternal breastfeeding is associated with a lower risk of ADHD in children. The mean breastfeeding duration is less in children with ADHD than that in controls without ADHD with a mean difference of 2.44 months.

Table 1. Data Extraction of Included Articles

Authors, Year of Publication, Country	Study Design, Sample Size	Purpose of the Study	Participants	Outcome Measures	Major Findings
Schwenke et al., 2018, Germany	573 participants	To evaluate maternal, prenatal, perinatal, and postpartum parameters as risk factors for the later development of an attention deficit hyperactivity disorder (ADHD) in the child.	Children under the age of 18 years	<ul style="list-style-type: none"> ADHD diagnosis not mentioned Interviewer administered questionnaire with mothers 	<ul style="list-style-type: none"> No significant differences were noted in the present study between breastfeeding and formula feeding in relation to the development of ADHD.
Lemcke et al., 2016, Denmark	Longitudinal cohort study, 76,286 participants	To investigate if developmental deviations in the first years of life are associated with later ADHD.	Infants after birth and at 6 or 18 months of age	<ul style="list-style-type: none"> ADHD diagnosis based on ICD-10 Structured telephone interviews with mothers 	<ul style="list-style-type: none"> There was a linear correlation between the length of the breastfeeding period and the subsequent risk that the child would later be diagnosed with ADHD. The risk of ADHD decreased with the length of the breastfeeding period.
Stadler et al., 2016, United States	Retrospective, case control cohort, 474 participants	To address the basic question: Do mothers of children with ADHD initiate breastfeeding less frequently and maintain breastfeeding for shorter periods of time than mothers of typically developing children?	Children aged 7-13 years old; 291 children diagnosed with ADHD and 183 non-ADHD children	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-V Interview with mothers 	<ul style="list-style-type: none"> Mothers of children with ADHD (48.5 %) were less likely than mothers of non-ADHD children (65.6 %) to report having breastfed for at least 6 months. The present study suggests that claims of an association between breastfeeding duration and child ADHD are valid.
Sepehrmanesh et al., 2020, Iran	Case-control study, 404 participants	To evaluate the relationship between duration of breastfeeding and ADHD.	Children aged 6-12 years old; 196 children diagnosed with ADHD and 208 non-ADHD children	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-IV Interview with mothers 	<ul style="list-style-type: none"> The duration of breastfeeding in the ADHD group was significantly lower than the control group. Longer duration of breast feeding can be a protective factor against risk factors of developing ADHD.

Table 1. (continued)

Authors, Year of Publication, Country	Study Design, Sample Size	Purpose of the Study	Participants	Outcome Measures	Major Findings
Boucher et al., 2017, Spain	Multicenter cohort study, 1,346 participants	To investigate the potential protective effects of breastfeeding against behavioral problems such as attention deficit hyperactivity disorder (ADHD) symptoms, and even fewer on autism spectrum disorders (ASD) traits.	Children aged 3-7 years old	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-IV Interviewer administered questionnaire with mothers 	<ul style="list-style-type: none"> None of the associations between breastfeeding duration and ADHD symptoms remained significant in fully adjusted models. Whether duration of any, predominant, or exclusive breastfeeding was used as the exposure variable had little influence on the results of ADHD.
Türkoglu et al., 2015, Turkey	375 participants	The aim of this study was to explore which dimensions of ADHD are specifically associated with overweight/obesity and to investigate the effect of breastfeeding duration on obesity in children.	Children aged 7-17 years old; 300 children diagnosed with ADHD and 75 non-ADHD children	<ul style="list-style-type: none"> ADHD diagnosis based on DSM-IV Interviewer administered questionnaire with children and parents 	<ul style="list-style-type: none"> Breastfeeding duration in the ADHD group was significantly shorter than in the controls. Inattention, oppositionality and breast-feeding duration were associated with overweight/obesity in children and adolescents with ADHD.
Soled et al., 2021, United States	Cross-section sample, 12,793 participants	To investigate, in a nationally representative sample of preschool children in the United States, the associations between ADHD and both age of breastfeeding cessation and age of formula introduction, as well as associations between ADHD and exclusive breastfeeding duration.	Children aged 3-5 years old; 98 children diagnosed with ADHD and 12,695 non-ADHD children	<ul style="list-style-type: none"> ADHD diagnosis not mentioned Data from the Centers for Disease Control and Prevention's 2011/12 National Survey of Children's Health (NSCH) was used 	<ul style="list-style-type: none"> Children who were exclusively breastfed for at least 6 months had much lower odds of ADHD relative to children who were breastfed for less time or not exclusively. An association between breastfeeding duration and decreased ADHD prevalence was noted. This study found a strong association between infant feeding and a later diagnosis of ADHD.

Table 1. (continued)

Discussion

This review of the literature provides a brief overview of the current research on the correlation of duration of breastfeeding and development of ADHD. With the exclusion of two articles used in this review, each study found a statistically significant correlation between the duration of infant breastfeeding and a decreased risk of developing ADHD (Schwenke et al., 2018; Boucher et al., 2017). These eight studies found the breastfeeding duration was shorter in the ADHD group as opposed to the control group and that breastfeeding could be viewed as a protective factor in relation to the diagnosis of ADHD. The two articles that did not find a significant association between ADHD and breastfeeding were focused on maternal factors and environmental factors. The first study (Schwenke et al., 2018) evaluated the maternal, prenatal, perinatal, and postpartum parameters as risk factors for the later development of ADHD. While Boucher et al. (2017) aimed to investigate the effect of environmental exposures and diet on fetal and child development in different areas of Spain.

Upon exploration of the eight studies that support the association between breastfeeding and ADHD or symptom development, the limitation cited the most was that of parent recall for feeding history (Zeng et al., 2020) (Schwenke et al., 2018) (Stadler et al., 2016) (Soled et al., 2021). However, prior literature supports the maternal recall of breastfeeding as being reasonably accurate, especially in smaller families (Li et al., 2005). Limitations that were included in the three articles were a small sample size, residual confounding, and a sample that may not reflect the whole population due to the selection process from generalized or specialized pediatric clinics. Other singular limitations included limited data available, quality of questionnaire, language barriers, not being able to monitor the quality of breastfeeding, and parents providing the report of a provider diagnosis of ADHD.

Conclusion

In conclusion, the majority of the articles presented in this review supported the hypothesis that a longer duration of breastfeeding has a protective effect on childhood development and reduces the risk of developing ADHD symptoms or diagnosis. Additional high-quality studies are needed on this topic to address the limitations of the studies.

Breastfeeding has a host of beneficial properties for mother and baby. I have seen this firsthand while involved in Tiny Tusks Breastfeeding and Infant Support as I have heard mothers' personal breastfeeding stories and had many opportunities for this focused education. I can now take my knowledge of ADHD correlation with breastfeeding back to the online platforms that the internship provides. Social media can be implemented to highlight this evidence-based education opportunity to a large population of mothers. With the commonality of ADHD diagnosis, this information may be invaluable to new mothers.

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