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## **Association of non-nutritive sucking habits with speech sound disorders: A scoping review**

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**Abstract**--The impact of non-nutritive sucking (NNS) habits on dentofacial structures and occlusion is well proven. It has been hypothesised that NNS also effect speech due to its effect on dentition and oral musculature. However, the results of the existing studies are inconsistent, therefore this scoping review was undertaken to systemically evaluate the existing literature and to identify any research gaps. The database search resulted in 869 studies of which 861 articles were excluded as they were duplicates, irrelevant, published in languages other than English, and data were not available. The remaining 8 full-text articles were evaluated for their eligibility and were included in the present review. After the qualitative analysis of the studies, we conclude that the non-nutritive sucking is associated with speech sound disorders in children. However, the of quality of evidence is not satisfactory, more studies with detailed measures of sucking habits are needed to completely understand the effect of NNS on speech disorders.

**Keywords**---non-nutritive sucking, speech sound disorders, systemically

## Introduction

Sucking is the first co-ordinated muscular activity of an infant. It is considered as a component of the rooting reflex and has been detected as early as 29 weeks of gestation. An inborn biological drive for sucking is present in normally developed infants and children resort to the behaviour when the child's security is threatened or if they are feeling anxious, tired, bored, unwell or while trying to adjust to new challenges. Sucking behaviours can thus be classified as Nutritive sucking and Non-nutritive sucking (NNS). The former which occurs during breast-feeding or bottle feeding, is related to the process of obtaining nutrition and the latter is a habit which involves the use of pacifiers, blanket sucking and digit sucking. A variety of Non-nutritive sucking (NNS) habits exist with thumb, digit and pacifier sucking being the most common.

The association of non-nutritive sucking (NNS) habits on dentofacial structures and occlusion is widely recognized in literature. The possibility of developing a malocclusion is higher in a child with a history of NNS habit as compared to a child with no NNS history<sup>1-3</sup>. The higher the duration, frequency and intensity of the habit, the more severe the developing malocclusion tends to be.<sup>4</sup>

Since both sucking and speech functions share the same musculature, it is hypothesised that speech sound disorders (SSD) are influenced by a child's early experience of feeding and non-nutritive sucking habits. Understanding the function of speech depends on the growth and development of the SS (stomatognathic system), requiring harmonious relationship between the phonological system / phono-articulatory organs, to make the specific modifications of the sound originating from the larynx. Speech disorders in children may be caused by ineffective organization or alterations to these systems. Dental arches act as structural boundaries for placement of the tongue and lips and are essentially involved in production of sounds for meaningful communication. In the anterior portion of the oral cavity almost 90% of all consonants are made, which suggests that one of the most important factors affecting articulation is the dental arch relationship.

Any deviation in dental alignment or structure could obstruct the proper lip and tongue contouring and placement as well as the natural process of air flow and pressure, thus affecting the integrity of speech sound production.<sup>5,6</sup> In a study by Laine in 1987, a notable relationship between increased overjet and distortions of the "s" sound was observed.<sup>7</sup> Bernstein in 1954 observed that speech is commonly defective in presence of an open bite, which often presents with a lisp.<sup>8</sup> In children with Class II and Class III dental malocclusions, variations in vowel production and acoustic changes have been found probably due to changes in mandibular movement due to increased overjet,<sup>9</sup> adaptive changes in tongue contouring and placement,<sup>10</sup> changes in incisor, lip position, and tongue position and the changes in production of /s/ affecting velocity, amplitude, and duration of manner and placement.<sup>11</sup> NSS habits have a direct detrimental impact on SSD

due to its effect on dentition and the shared physical oral mechanisms of these two processes. The effect of non-nutritive sucking on speech has been subject of interest among healthcare professionals but the results from the existing studies are inconsistent.

Thus the present study undertakes a scoping review on the effects of NNS on speech, with an objective of systematically mapping the research conducted in this area as well as to identify any existing gaps in knowledge.

## **Materials and Methods**

### **Research Strategy**

The protocol for conducting this scoping review was constructed using the Prisma SCR guidelines. The focused question was “Is there any association between NNS and SSD”. The A predefined search strategy was prepared according to the focused question. A comprehensive and systematic search was carried out using key words in a structured PICO format in databases PubMed, Scopus, Web of science and Google scholar. Search terms used were - Non-nutritive sucking, NNS, digit sucking, thumb sucking, SSD, speech disorder, speech sound disorder, speech implications, speech pathology in various combinations.

### **Selection criteria**

Selection criteria was based on the PRISMA statement flow chart. Randomized control trials, quasi-randomized control trials and observational studies were included for assessment. Relevant cross-references were evaluated. Gray literature, narrative reviews, conference papers, comments, editorials, short communications, letters , studies published in languages other than English were excluded from the review. Full text articles published in the English language until Dec 2021 were considered as qualified for the search strategy.

The search and screening process was carried out independently by 2 reviewers. At first, titles and abstracts screened followed by the full-text articles, which were then selected and analysed with careful and thorough reading based on the inclusion and exclusion criteria for the future data extraction. In case there was a disagreement between the two reviewers , the third reviewer was consulted. The extraction of data was done in a preformed data extraction sheet.

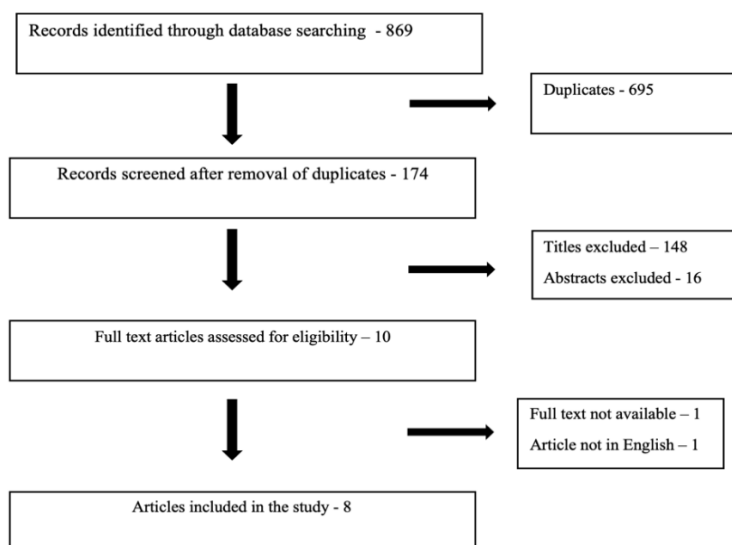
### **Data Analysis**

After the final assessment of the selected articles by the two reviewers, following data was extracted: Study type , age group of the study sample , criteria for speech assessment, criteria for evaluating non-nutritive sucking and key findings of the included studies. Qualitative analysis of all the included studies was done and the research gaps identified were summarized.

### **Results :**

Results of electronic data base

The database search resulted in 869 studies of which 861 articles were excluded as they were duplicates, irrelevant, published in languages other than English, and data were not available. The results from the data extraction stage were discussed and agreed between the first and second authors. The remaining 8 full-text articles were evaluated for their eligibility and were included in the present review (Flowchart). The age of the subjects included in these studies ranged till 12 years. The key findings of these studies are summarized in Table 1.



Sr no	Author	Year	Age group	Sample size	Speech assessment	NNS evaluation	Key findings
1	AV Fox et al. <sup>12</sup>	2002	4 - 10 years	65	Self-administered Parental questionnaire Speech disorder	History of Dummy, bottle or thumb duration  Dichotomized into > 24 months - 0 < 24 months - 1	Significant association- Sucking (p value- 0.007) Sucking habits were identified as risk factors for speech disorders in children
2	Laura L. Shotts D. Mike McDaniel Richard A. Neeley <sup>13</sup>	2008	24 and 79 months	68	Goldman Fristoe Test of articulation - 2nd edition	History of use of pacifier  Based on duration of pacifier use divided into:  minimal	No significant difference between children who had minimal dummy use (less than 1 month), typical

						history of pacifier up to 15 months 18-55 months	dummy use (up to 15 months) and prolonged dummy use (beyond 18 months)
3	Barbosa et al. <sup>14</sup>	2009	37-70 months	128	TEPROSIF assessment Phonological disorder	<p>History of pacifier use and digit sucking</p> <p>Based on duration of pacifier use divided into: 2-12 months 12-24 months 24-36 months</p> <p>Based on duration of digit sucking divided into: 0-12 months 12-30 months &gt;30 months</p>	<p>Use of Pacifiers, bottle and finger-sucking habits were linked with SSD in preschool children</p> <p>Delaying bottle-feeding up to 9 months may act as a protective factor from subsequent SSD</p> <p>A child who sucked his fingers was 3 times more likely to have SSD (p = 0.02)</p> <p>Pacifier use for more than 3 years increased the possibility of SSD threefold</p>
4	Vieira et al. <sup>15</sup>	2016	36-71 months	273	Self-administered Parental questionnaire + ABFW child's language test assessment	<p>History of Pacifier use and digit sucking</p> <p>Not categorised according to time/duration in groups</p>	<p>Significant association of gender with SSD (p value-0.038)</p> <p>Significant association between feeding, NNS</p>

							and SSD was not found Significant association between socio economic status and SSD was not found Significant association between age and “speech alterations” was not found although majority of the subjects from case group were aged 3 years
5	Goulart et al. <sup>16</sup>	2017	0 - 6 years	95	Structured interview + TERDAF articulation testing	Not specified	22% prevalence of speech disorders in children 12.5% prevalence in children who reported with learning disabilities Significant association of oral breathing and speech disorders Significant association between sex, age, hearing and pacifier and/or bottle use with detectable speech disorders
6	Pereira et al. <sup>17</sup>	2017	1 - 12 years	289	Self-administered	History of pacifier use	Positive correlation

					Parental questionnaire  Diagnostic test for speech evaluation not mentioned	and thumb sucking  Duration of pacifier use divided into: <1 year up to 4 years  Duration of thumb sucking divided into <1 year up to 2 years	between bottle feeding and SSD (p = 0.056) Positive correlation between pacifier use and SSD (p = 0.046) Use of pacifier for less than a year was not associated with SSD Positive Correlation between thumb-sucking up to the age of 4 , duration and SSD (p = 0.012)
7	Baker et al. <sup>18</sup>	2018	48 -66 months	199	Self-administered parent questionnaire + DEAP phonology assessment	History of pacifier use and digit sucking  Based on duration of Pacifier use, divided into: no use minimal use <12 months prolonged use >12 months  Based On duration of Digit sucking, divided into: <12 months >12 months	No significant association between breastfeeding duration (p = 0.055) and severity (p = 0.396) Longer duration of breastfeeding showed higher PCC scores in PI group No significant association between PI and duration (p = 0.745) or severity (p = 0.106) of pacifier use Longer pacifier

							duration showed lower Percentage Consonants Correct (PCC) scores (Pacifier although not significant ,a relation was seen)
8	Charlie Strutt, Ghada Khattab and Joe Willoughby <sup>19</sup>	2021	4-61 months	100	Self-administered parent questionnaire + DEAP phonology assessment	History of duration and frequency of dummy use Based on duration of dummy use divided into: 0-12 months 13-24 months 25-36 months 36+ months Based on Frequency of dummy use divided into: 1-2 hours 3-4 hours 5-8 hours 9+ hours	No significant association between duration of dummy use and any of the speech outcome measures except for typical errors, which are not considered a concern for a child's speech development No significant association between frequency of dummy use and PCC, or delayed errors exhibited by the children on the DEAP phonological assessment. Frequency of dummy use was associated with a lower number of age-appropriate errors.

Table 1- Summary of the included studies

### **Analysis of individual studies**

The main challenge in summarizing and analysing the articles for this scoping review was the disparity in assessing speech sound disorders and non-nutritive sucking habits among different studies.

Diagnostic Evaluation of Articulation and Phonology (DEAP) assessment test was used by **Strutt et al (2021) and Baker (2018)** .<sup>19,18</sup> However only a subset of the DEAP assessment test was utilized by Strutt (2021)<sup>19</sup> . Moreover, both the studies differed in defining their objectives, Strutt et al (2021)<sup>19</sup> used the term “development of speech” as an outcome measure and quantified the use of pacifier (dummy) based on the frequency of pacifier use per day and the time duration for which pacifier was used. On the other hand, the term “phonological impairment” was used by Baker (2018)<sup>18</sup> and study subjects were categorized into four groups based on their score of DEAP test. The duration of pacifier use was dichotomized into less than and more than 12 months usage. Although digit sucking was recorded in their study and was found in 8% of study samples, it was not considered in result analysis.

Goulart (2017)<sup>16</sup> evaluated the effect of only pacifier use on speech disorders, but the duration of pacifier use was not recorded. In their study, the subjects were evaluated for speech articulation disorders using Screening Test for Speech Articulation Disorders (TERDAF),

Similarly, the association of pacifier use with speech articulation was evaluated by Shotts (2008)<sup>13</sup> However, their criteria for assessing speech was different from that of Goulart(2017)<sup>16</sup>. They used the Goldman-Fristoe Test of Articulation - Second Edition (GFTA-2).

The phonological evaluation assessed using ABFW Child Language Test and TEPROSIF (Test para evaluar procesos de simplificacion fonologica teprosif ) by Viera (2016)<sup>15</sup> and Barbosa (2009)<sup>14</sup> respectively. They also categorized children with phonological disorders into below normal, normal and above normal. Both the studies evaluated the role of both pacifier and thumb sucking in development of phonological disorder, but the duration of these non-nutritive sucking habits was taken into consideration only by Barbosa (2009)<sup>14</sup>. Fox et al (2002)<sup>12</sup> evaluated the risk factors for functional developmental speech disorders in children. They categorized the subjects using two classification systems, Dodd’s classification in German (1995) and Shriberg’s classification system (1994). The data regarding probable risk factors was recorded through questionnaire filled by parents and the sucking habits (pacifier use and thumb sucking) were recorded under headings of more than 24 months and less than 24 months. Pereira et al (2017)<sup>17</sup> used only questionnaire filled by parents as a diagnostic criteria for evaluating speech disorders. They made no attempt to clinically evaluate speech in their study subjects. However duration of the pacifier use and thumb sucking were recorded and they found that these non-nutritive sucking habits persistent up to four years of age were associated with speech disorders.

### Research Gaps :

Apart from the diversity in assessing and classifying speech disorders, the main disparity found among the included studies was in the objective measurement of non-nutritive sucking. Thumb sucking is considered a normal reflex in children up to the age of 3 (*Nowak AJ 1996*).<sup>20</sup> Persistence of thumb/digit sucking beyond this age has been associated with a variety of orofacial effects. The impact of thumb/digit sucking depends upon its duration, frequency and intensity. Out of the 8 studies included in this review 5 evaluated the possible role of thumb/digit sucking as a risk factor for speech disorders, however only 4 studies recorded its duration. Viera et al (2016)<sup>15</sup> did not categorise the habit according to duration in group . Even when it was documented , the duration of digit/thumb sucking was recorded only as less or more than 24 months by Fox et al (2002)<sup>12</sup>, less or more than 12 months by Baker et al (2018)<sup>18</sup> whereas Barbosa (2009)<sup>14</sup> categorised it into 0-12 months,12-30 months and more than 30 months. Only Pereira (2017)<sup>17</sup> considered it up to four years of age (**Ref to table 1**). None of the included studies aimed to record the frequency and intensity of thumb sucking habit. This is in extreme contrast to the fact that thumb/digit sucking has been found to have significant effect on stomatognathic system only when it is persistent beyond a certain age.

Moreover, the documentation of NNS was purely based upon the parental recall which leads to the incorporation of recall bias in the studies.

Therefore ,the major research gap which was identified in the existing studies was the recoding of NNS. Moreover, the disparity in the results obtained in various studies may also be attributed to the fact that various authors used different measures for collecting data and due to inconsistencies in the term “speech sound disorder”

### Conclusion

After the qualitative analysis of the studies ,we conclude that the non-nutritive sucking is associated with speech sound disorders in children. However ,the of quality of evidence is not satisfactory. Greater clarity is required with regard to the nature of SSD being explored and coherence of approaches to outcome measurement. Future studies should use more precise and detailed measures for sucking habits and speech sound development with explicit considerations of different types of Speech Sound Disorders.

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