EFFECT OF PHONOLOGICAL AND MORPHOLOGICAL FACTORS ON THE FREQUENCY OF STUTTERING IN CHILDREN WHO STUTTER – A SYSTEMATIC REVIEW

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Registration number.: 19SLP010

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(Speech-Language Pathology)

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September 2021

CERTIFICATE

This is to certify that this dissertation entitled "**Effect of Phonological and Morphological Factors on the Frequency of Stuttering In Children Who Stutter – A Systematic Review"** is a bonafide work submitted in part fulfillment for the degree of Masters in Science (Speech-Language Pathology) of the student Registration Number: 18SLP011. Thishas been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled **"Effect of Phonological and Morphological Factors on the Frequency of Stuttering In Children Who Stutter – A Systematic Review"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Effect of Phonological and Morphological Factors on the Frequency of Stuttering In Children Who Stutter – A Systematic Review"** is the result of my own study under the guidance of Dr. Santosh M., Associate Professor, Department of Speech-Language Sciences**,** All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru **Registration No.: 19SLP010**

September 2021

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ACKNOWLEDGEMENT

"Give thanks to the LORD, for He is good. His love endures forever."

Psalms 136:1

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"Alone, I can only do so much, Together we can reach the greatest heights."

Dedicated to my grandparents,

Mrs and Mr. J B Stephen

and

Mrs. and Mr. Pushparaj

CHAPTER I

INTRODUCTION

1.1 Stuttering

Developmental speech fluency disorder is characterized by "frequent or widespread disruption of the normal rhythmic flow and rate of speech, repetitions, and prolongations in sounds, syllables, words, and phrases, and blocking and word avoidance or substitutions" (World Health Organization, 2019). A nervous system disease, a disorder of intellectual development, a structural abnormality, a sensory impairment, or other speech or voice disorder cannot explain speech dysfluency. The age of stuttering onset is usually around 30–48 months (mean=33 months); Prevalence of stuttering was estimated to be 5-8% in preschool children (Bloodstein & Ratner, 2008; Yairi & Ambrose 2005, 2013).

1.2 Stuttering as a Multifactorial Disorder

Smith and Weber (2017) view stuttering as a multifactorial disorder influenced by motor, linguistic, and emotional factors that contribute to its development and persistence. They view dysfluencies as evidence of the ongoing dynamic interaction of various elements that affect speech motor planning and execution, including language and motor aspects. They highlight that stuttering onset usually occurs while the development of linguistic abilities is at its peak and that the effect of language as a factor is variable in Children with stuttering. One child with a robust language system and lagging motor system may be more prone to develop stuttering, or a child with straightforward or subtle language problems combined with immature speech and motor networks also might be prone to develop stuttering. The latter would indicate more weightage of 'language' as a factor in the onset of stuttering.

1.3 Effect of Linguistic factors on stuttering

Recent models of stuttering- Covert Repair hypothesis (Postma & Kolk, 1993), Temporal Dyssynchrony (Perkins et al., 1991), Sentence Plan Alignment (Karniol, 1995), and EXPLAN (Howell, 2004, Howell & Au-Yeung, 2002) also emphasize the involvement of language processing skills. Multiple studies support that linguistic factors influence stuttering in children and adults (Soderberg,1967; Jayaram, 1981; Dworzynski, et al., 2003; Richels et al., 2010). One of the Pioneers who assessed the effect of linguistic factors in individuals with stuttering was Spencer Brown. Brown (1945) pinpointed linguistic factors that are indicative of the prospect of stuttering in particular words. He particularly emphasized four linguistic factors that increase the probability that an adult English speaker with stuttering will stutter on a specific word if the word- (a) Occurs at the initial position (b) Is a Content word and not a function word (c) Long and not a short word (d) Word starting with a consonant and not a vowel. Some studies ensuing the pioneering work of Brown reported similar results in AWS who speak English, Spanish, Kannada (Au-Yeung et al., 2003; Dayalu et al.,2002; Venkatagiri et al., 2016; Wingate, 1967; Dworzynski et al., 2003; Howell & Au-Yeung, 2007; Jayaram, 1981, 1983). Whereas other studies involving AWS who speak Arabic, and German reported contradicting results. (Abdalla et al., 2009; Al-Tamimi et al., 2013; Dworzynski et al., 2003; Dworzynski & Howell, 2004). Further studies that were carried out to find if the same factors affecting the likelihood of stuttering in adults also play a role in CWS show mixed results. Williams et al. (1969) assessed stuttering in CWS aged 5 -13 years and found that the subjects showed the same loci of stuttering as adult stutterers, and hence, the "four factors" as specified by Brown (1945) also play a role in CWS. Dworzynski et al. (2003) found that only the effect of word length from Brown's factor was significant in CWS (7-11 years) who speak German and that children stutter more on short words.

1.4 Phonological factors that affect stuttering

Phonological factors that are suggestive of the likelihood of stuttering include- (A) phoneme category, i.e., whether initial phoneme is consonant/vowel, (B) phoneme position (initial or not initial), (C) word length, i.e., monosyllable, bi-syllable, trisyllable or multi-syllable words, and (D) phonological complexity.

1.4.1 Phoneme Position

Phoneme position can be classified as being word-initial and word-non-initial positions. Children with stuttering are expected to follow the trend of higher rates of stuttering in word-initial position, owing to the load placed on the speech motor system during utterance planning. Children with stuttering have been found to have higher stuttering rates in the initial position (Natke et al., 2004; Alqhazo & Al-Dennawi, 2018).

1.4.2 Phoneme Type

Phoneme Type can be classified as consonants and vowels. This factor is considered important since the precise production of consonants is difficult compared to vowels produced with a relatively open vocal tract. And for this reason, children are expected to have higher rates on consonants or words starting with consonants. CWS stutter more on initial consonants than vowels (Alqhazo & Al-Dennawi, 2018; Seth and Maruthy, 2019).

1.4.3 Word Length

Words can be classified as long and short words based on the number of phonemes or syllables it contains. Children are expected to stutter more on longer words as this would increase the load on the linguistic system to plan the utterance, and also, increasing the length would place a high load on the speech motor system to produce longer words. Studies done on word length show varied results in children with stuttering. Alqhazo and Al-Dennawi (2018) found that Jordanian CWS stutter on longer words, whereas a study by Bloodstein and Grossman (1981) found that five English-speaking CWS stutter more monosyllabic than polysyllabic words. Seth and Maruthy (2019) found no significant effect of word length on the rate of stuttering in CWS who speak Kannada.

1.4.4 Phonological complexity

The phonological complexity can be assessed using WCM (Word Complexity measure) and IPC (Index of phonetic Complexity). IPC is a metric to specify the phonetic difficulty level of words. This measure was developed by Jakielski (1998). The factors included in IPC to rate the phonologic difficulty of the words include – consonant by place (one point assigned for dorsals); consonant by manner (a point for fricatives, affricates, and liquids); Singleton consonants by place (a point for variegated); Vowels by class (point for rhotics); Word shape (A point if the word ends in consonants); Word Length (one point for multi-syllabic words- greater than or equal to 3 syllables); Contiguous consonants (One point for consonant clusters); Cluster by place (one point for heterorganic). WCM is another metric used that is different in terms of scoring a few factors (Stoel-Gammon, 2010). WCM scores a point for voiced fricatives, affricates, and non-initial stress, for which IPC does not score.WCM does not score for place variegations of consonants and consonant clusters and also does not score for inter-syllabic consonant clusters. The phonological complexity does not seem to influence the likelihood of stuttering in younger preschool CWS (Throneburg,1994; Howell & Au-Yeung, 1995).

1.5 Morphological factors that affect stuttering

Morphological factors that are indicators of the probability of stuttering include (A) Word class, (B) Word inflections.

1.5.1 Word Class

Word class is one of the most frequently investigated morphological factors. Words can be classified as content and function words. Nouns, verbs, adjectives, adverbs are categorized as content words and pronouns, articles, prepositions, conjunctions, modals, auxiliary verbs, and inflections are categorized as function words (Brown & Fraser, 1963). Studies show mixed findings. Some studies report higher function word stuttering in CWS (Au-Yeung et al., 1998). Higher content word stuttering rates were seen in Korean-speaking children with stuttering, according to Choi et al. (2020).

1.5.2 Word Inflection

Another morphological factor that is indicative of the odds of stuttering on a particular word is the word inflections, i.e., whether a word consists of a bound morpheme or not (for example, '-s,' '-ed,' '-ing' in English) or not. The effect of word inflections has not been studied in various languages as much as word-class effects. Experiments on the effect of word inflections also revealed mixed results in CWS. Alqhazo and Al-Dennawi (2018) reported an increased stuttering rate on words ending with morphological inflections in Jordanian CWS. On the other hand, Seth and Maruthy (2019) found that word inflections did not affect the stuttering rate in CWS.

Need for the study

The phonological and morphological factors suggestive of the likelihood of stuttering on certain words differ between languages and age range, as indicated by the vast literature comparison in the introduction section. Hence the need to document the factors that indicate the prospect of stuttering in specific linguistic contexts compared to others and how they influence the rate of stuttering. The available evidence on the effect of phonological and morphological factors on the frequency of SLDs in children and adults is contradictory. Such a study might highlight the possible gap in the literature related to the effect of these factors on the frequency of SLDs. Comparison of available literature also shows that the effects observed in children differ considerably from that of adults. Mixed findings in studies done on CWS also indicate the role of chronological age and native language on these effects and hence the need to document the effect of phonological and morphological factors in CWS.

Aim of the study

To systematically review the literature on the effects of phonological and morphological factors on the frequency of speech dysfluencies in children who stutter.

CHAPTER II

METHOD

A systematic literature search was conducted using keywords related to the effect of phonological and morphological factors on stuttering rates in children who stutter. A comprehensive search was done in the PubMed, Science Direct, J-Gate, and ERIC databases. The search approach was first implemented in PubMed, and the same system was then applied to the additional databases indicated. Additional studies were uncovered by browsing the bibliographies of the included papers. To build a sensitive keyword search strategy, a complete list of search phrases was compiled.

The keywords considered for the systematic search include (a) Domain terms: *stuttering, stutter, disfluencies, dysfluencies*; (b) Population terms: *CWS, child, pre-schooler, children, school-age children,* and (c) Skill terms (Exposure terms): *content word, function word, grammatical class, grammatical complexity, hybrid word, inflectional morphology, linguistic factors, morphemes, morphological factors, phoneme category, phoneme class, phoneme position, phonemic, phonetic complexity, phonological complexity, phonological factors, phonological influence, sound category, sound class, syllable shape, word category, word class, word-ending, word inflections, word length, word position, loci of stuttering.* The keywords were combined with the Boolean operations AND or OR to construct search strings for various databases.

Keyword string:

(" Content word "OR " Function word" OR " Grammatical class" OR "Grammatical complexity" OR "Hybrid word " OR " Inflectional morphology" OR "linguistic factors" OR "morphemes" OR "morphological factors" OR "phoneme category" OR "phoneme class" OR "phoneme position" OR "phonemic" OR "phonetic complexity" OR "phonological complexity" OR " phonological factors" OR " phonological influence" OR "sound category" OR "sound class" OR "word category" OR "word class" OR "word ending" OR "word inflections" OR " word length" OR "word position" OR "loci of stuttering") AND ("CWS" OR "Child" OR "pre-schooler" OR "children" OR "school-age children") AND ("stuttering" OR "stutter" OR "disfluencies" OR "dysfluencies")

A three-step search technique was used, including (a) an electronic database search, (b) a snowball search that looked through references of all relevant articles found, and (c) a manual search. All the articles from the search were inputted into Rayyan QCRI to help with the initial screening of abstracts and titles. Rayyan is a free web-based application that speeds up the screening and selection of studies for researchers working on different types of reviews (systematic reviews, scoping reviews) and other projects. (Ouzzani et al., 2016).

2.1 Study Selection

A two-stage selection approach was incorporated to narrow down the final body of publications included in this study. In stage 1, the authors independently reviewed the title and abstracts acquired from the separate database searches. Each author was blindfolded to the others' inclusion choices to reduce bias. The studies were deemed eligible to advance to Stage 2 if they met the inclusion criteria enumerated in Table 2.1. If the study title and abstract were unrelated to the review, the study was excluded from further consideration. In Stage 2, the first author conducted a full-length analysis of the selected abstracts, which she independently assessed, and any uncertainty was resolved by consulting the other two researchers. Only papers that matched all of the inclusion criteria mentioned in the table were considered for the final review.

Table 2.1

Inclusion and Exclusion Criteria for articles to advance to stage 2

Inclusion Criteria	Exclusion Criteria
The study would be included if it - The study was published in peer-reviewed journals. - The study has full-length text available in English. - The study addresses no less than one factor in consideration. Phonological factors included in this review were(A) phoneme category, (B) phoneme position, (C) word length, and (D)phonological complexity. Morphological factors included are (A) Word Class, (B) Word inflection. - The study included children who stutter under 13 years of age. - The study was published before December 2020.	The study would be excluded if - The study was not published in peer-reviewed journals. - The study does not have full-length text available in English. - The study does not address any factor in consideration. - The study included children who have normal nonfluency or children above 13 years of age. - The study was published after December 2020. - The study was case-study or case-series type of study.

There were some disagreements after the blindfolded title and abstract screening, which resulted in 32 conflict articles. The conflict was resolved through a collective discussion between the student, guide, and another speech-language pathologist (with experience of three years in assessment and management of stuttering), in which each stated their point for their decision. It was followed by a discussion regarding the same, after which the authors unanimously agreed to include or exclude that particular conflict article.

The studies included in this review sought to answer the following questions:

(1) Do phonological factors affect the rate of stuttering in children, as various studies have suggested? If yes, How?

(2) Do morphological factors, as reported in various studies, influence the stuttering rate in children? If yes, How?

(3) Is there a trend in the type of the factors that influence stuttering rates as the child's chronological age increases?

(4) Does Language play a role in the effect of the phonological and morphological on stuttering rates of children?

Table2.2 enumerates and defines the phonological factors and morphological factors considered in this review.

Table 2.2

Definition of the phonological and morphological factors considered

Factor	Definition
Phonological factors	
Phoneme Position	It is the position of a stuttered phoneme in a word. It can be in the initial, medial or final position. The frequency of stuttering at a particular phoneme position would be calculated as follows: $$\frac{Total\ number\ of\ words\ stuttered\ in\ initial, medial\ (or)\ final\ position}{Total\ number\ of\ stuttered\ words} \times 100$$
Phoneme type	It is the category under which the stuttered phoneme falls. It can be consonants or vowels. The frequency of stuttering for a phoneme type can be calculated as follows: $$\frac{Total\ number\ of\ stuttered\ words\ beginning\ with\ vowel/consonant}{Total\ number\ of\ stuttered\ words} \times 100$$ *Or* $$\frac{Total\ number\ of\ consonants\ (or) vowels\ stuttered}{Total\ number\ of\ consonants\ (or) vowels} \times 100$$
Word Length	Word length can be defined as the no. of syllables in the word in consideration. Words can be classified as monosyllabic, bisyllabic,

	trisyllabic, and multisyllabic based on the word length. The frequency of stuttering for word length can be calculated as follows: $$\frac{Total\ number\ of\ stuttered\ mono-, bi-, tri-(or)multi-syllabic\ words}{Total\ number\ of\ mono-(or)bi-(or)tri-(or)multi-syllabic\ words} \times 100$$
Phonological complexity	It can be defined as a group of aspects contributing to the complexity of a language's phonological system, such as the proportion of late-developing sounds and sound sequences required to form a target word accurately. It can be calculated with tools like the Index of Phonetic Complexity (IPC) and Word Complexity Measure (WCM), as mentioned earlier.
Morphological factors	
Word Class	Word class can be defined as a set of words that have similar properties and behave similarly. For example, nouns, verbs, adverbs, adjectives are all part of the content word class. Word class can be classified as content word, function word, and content-function word. The frequency of stuttering for word class can be calculated as follows: $$\frac{Total\ number\ of\ stuttered\ content/function/content-function\ words}{Total\ number\ of\ content/function/content-function\ words} \times 100$$
Word Inflection	It can be described as the process in which a word is modified to express different grammatical categories. Word inflection can be classified as

inflected words and uninflected words. The frequency of stuttering for word length can be calculated as follows:

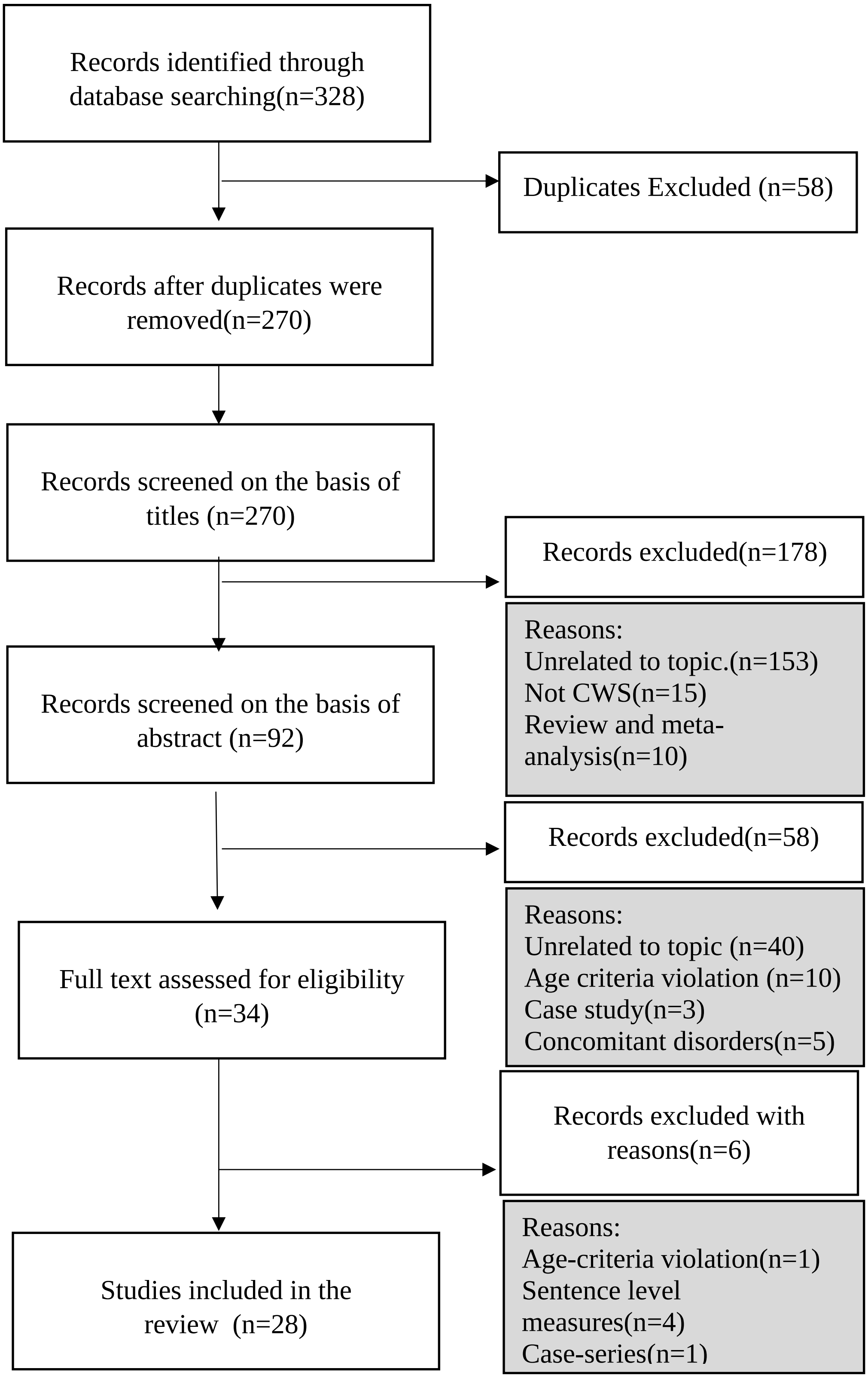
$$\frac{Total\ number\ of\ inflected(or)uninflected\ words\ stuttered}{Total\ number\ of\ inflected\ (or)uninflected\ words} \times 100$$

The electronic search turned up 328 articles, 58 of which were duplicates and therefore removed. Based on the inclusion criteria outlined previously, the remaining 270 titles and abstracts were reviewed for proceeding to a full-text retrieval stage. A total of 236 studies were deleted for failing to meet the inclusion criteria, with most articles being removed for the reasons listed in the PRISMA P flow chart (Figure 2.1).

The first author thoroughly reviewed and analyzed the full texts of the remaining 34 articles to see whether they met the required inclusion criteria. During the full-text screening, one study was eliminated because it was conducted on teenagers or adults. Four studies were omitted because they investigated linguistic characteristics at the syntactic (sentence) level, and one other study was removed because it was a case series. As a result, 28 studies were identified as appropriate for inclusion in the systematic review (Figure 2.1 *for PRISMA P flow Chart*).

Figure 2.1

The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flowchart that outlines this review's steps.



2.2 Data Extraction and Management

The authors created a data extraction form based on the factors they considered. The form contained the following parameters – Study ID; Study Design; Language of the population in the study; Participant characteristics (No. of participants, Age Range, Gender); Task/Tool used to study the phonological factor; Task/Tool used to study the morphological factor; Findings in terms of phonological factor(s) studied; Findings in terms of morphological factor(s) studied.

Data extraction tables were constructed for phonological factors and morphological factors separately. The first author independently coded the research articles for the parameters described above. Any uncertainty was resolved by discussing it with the other two authors.

2.3 Methodological Quality Appraisal

The methodological quality of the included studies was assessed using a quality appraisal tool developed based on standard guidelines for "quality assessment tool for observational cohort and cross-sectional studies" (National Heart, Lung, and Blood Institute, 2014). The formula (obtained score/total score x 100) was used to calculate the percentage for each study. This percentage was used to classify the studies as weak (0–33.9 percent), moderate (34–66.9 percent), and strong (above 67 percent)(Gunjawate et al., 2018). The first author conducted the quality judgment, and any uncertainty was resolved by discussion with the other authors. Table 2.3 shows the methodological quality appraisal tool and the rating for each study. Twenty-five studies were rated as having high methodological quality, three as having moderate methodological quality, and none as having low methodological quality, according to the percent score.

Table 2.3

Methodological Quality Appraisal of the included articles

SL No	Study ID	Q1 (0/1)	Q2 (0/1)	Q3 (0/1)	Q4 (0/1)	Q5 (0/1)	Q6 (0/1)	Q7 (0/1)	Scoring (%)
1	Al-Tamimi et al.,2013	1	1	1	0	1	1	1	85.71
2	Alqhazo & Al-Dennawi, 2018	1	1	1	0	1	1	0	71.43
3	Attieh A, 2010	1	1	1	0	1	1	0	71.43
4	Au-Yeung et al.,1998	1	1	0	0	1	1	0	57.14
5	Au-Yeung et al.,2003	1	1	1	0	1	1	1	85.71
6	Bloodstein & Gantwerk, 1967	1	1	1	0	0	1	0	57.14
7	Bloodstein & Grossman, 1981	1	1	1	0	1	1	0	71.43
8	Buhr et al., 2016	1	1	1	0	1	1	0	71.43
9	Choi et al., 2020	1	1	1	1	1	1	1	100.00
10	Coalson & Byrd, 2016	1	1	1	0	1	1	1	85.71
11	Coalson et al.,2012	1	1	1	0	1	1	1	85.71
12	Dworzynski & Howell, 2004	1	1	1	0	1	1	1	85.71

13	Dworzynski et al., 2003	1	1	1	0	1	1	1	85.71
14	Howell & Au-Yeung, 1995	1	1	1	0	1	1	0	71.43
15	Howell & Au-Yeung, 2007	1	1	1	0	1	1	1	85.71
16	Howell et al., 1999	1	1	1	0	1	1	0	71.43
17	Howell et al., 2000	1	1	1	0	1	1	0	71.43
18	Howell et al., 2006	1	1	1	0	1	1	1	85.71
19	Howell et al., 2010	1	1	1	0	1	1	0	71.43
20	Juste & Andrade, 2006	1	1	1	0	0	1	0	57.14
21	Juste et al., 2012	1	1	1	0	1	1	0	71.43
22	Mehrpour & Meihami, 2017	1	1	1	0	1	1	0	71.43
23	Natke et al., 2004	1	1	1	0	1	1	1	85.71
24	Richels et al., 2010	1	1	1	0	1	1	0	71.43
25	Seth & Maruthy, 2019	1	1	1	1	1	1	0	85.71
26	Throneburg et al., 1994	1	1	1	0	1	1	0	71.43
27	Vahab et al., 2013	1	1	1	0	1	1	0	71.43
28	Williams et al., 1969	1	1	1	0	1	1	0	71.43

Note. The questions considered for rating the research articles are as follows:

1) Was the study topic or goal in this publication described clearly?

2) Was the research population well-defined?

3) Were all participants drawn from the same or similar demographics (around the same period)? Were the study's inclusion and exclusion criteria predetermined and used similarly to all participants?

4) Was there an explanation for the sample size, a power description, or variance and effect estimates?

5) Were the exposure variables well-defined, valid, and consistent across all research participants?

6) Were the outcome variables well-defined, valid, and consistent across all research participants?

7) Was the impact of crucial potential confounding variables on the association between exposure(s) and outcome(s) scientifically quantified and adjusted?

Scoring: 0- Yes; 1-No; Scoring %= (Total score of seven questions/ 7) *100

CHAPTER III

RESULTS

The aim of this research was to examine the current literature for the effect of phonological and morphological factors on stuttering frequency in children. Five electronic databases, as well as back-references of included papers, were used in the search. Twenty-eight studies were identified as being appropriate for inclusion in the systematic review after duly screening them.

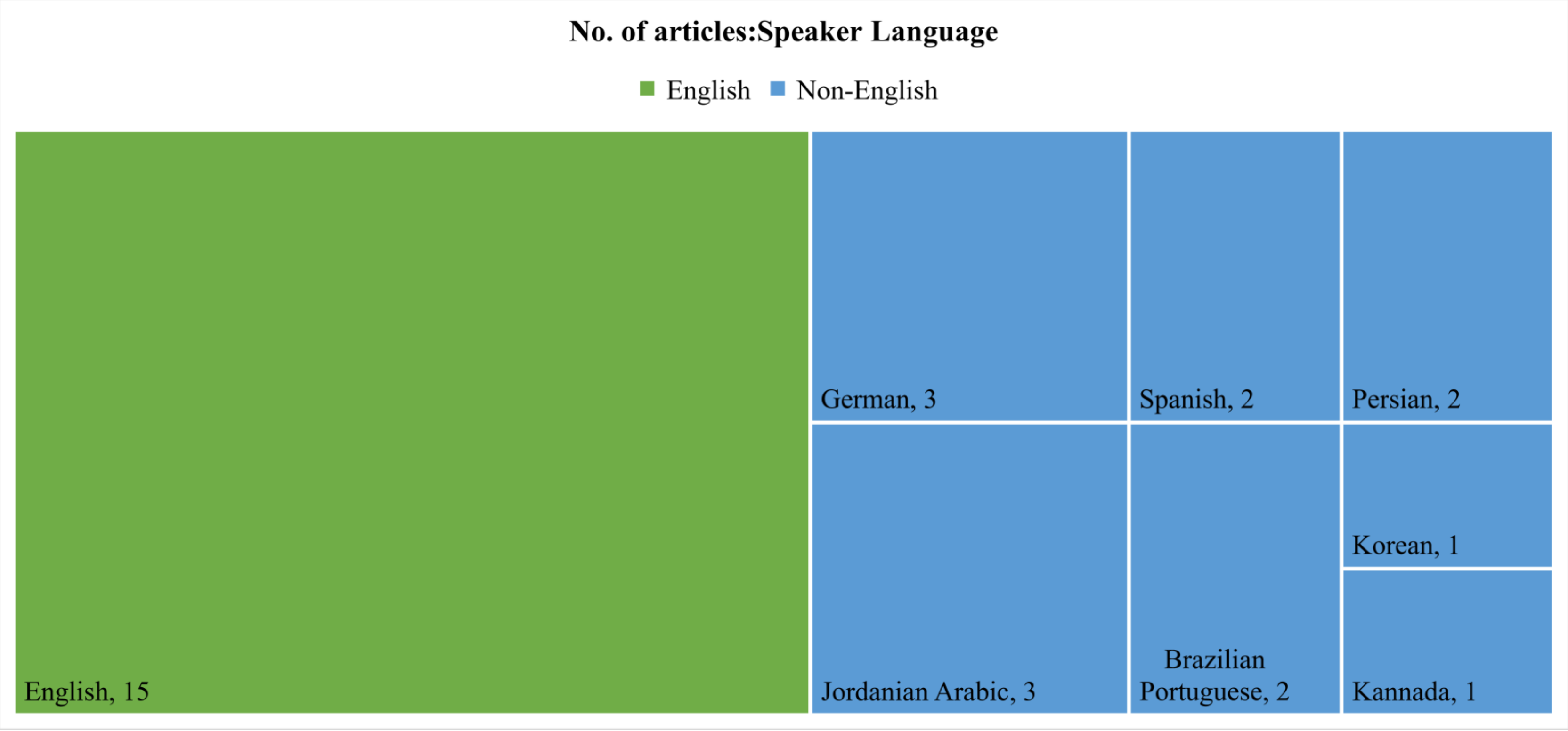
3.1 Data Extraction

The data was tabulated separately for phonological (Appendix A Table1.) and morphological (Appendix A Table 2.) components, including study design, factor studied, participant characteristics, and task or instrument employed. The pooled data were not subjected to a meta-analysis since the included studies lacked uniformity in terms of the study parameters, study design, participant characteristics, tasks employed, and findings.

The investigations that met the criteria for inclusion in the evaluation took place between 1967 and 2020. The sample size of children who stutter varied from n=5 (Bloodstein & Gantwerk, 1967) to n=76 (Williams et al., 1969). Except for two, all of the research studies were cross-sectional. One of the studies was longitudinal, and one was a case series study that was included because it provided statistics for the group of participants. Out of twenty-eight included articles (n=678 CWS), fourteen reported the effect of at least one parameter considered in the review in Non-English Speakers. The distribution of the number of articles across English and Non-English languages is depicted in Figure 3.1.

Figure 3.1

Distribution of the total number of articles based on speaker language- English and non-English languages.

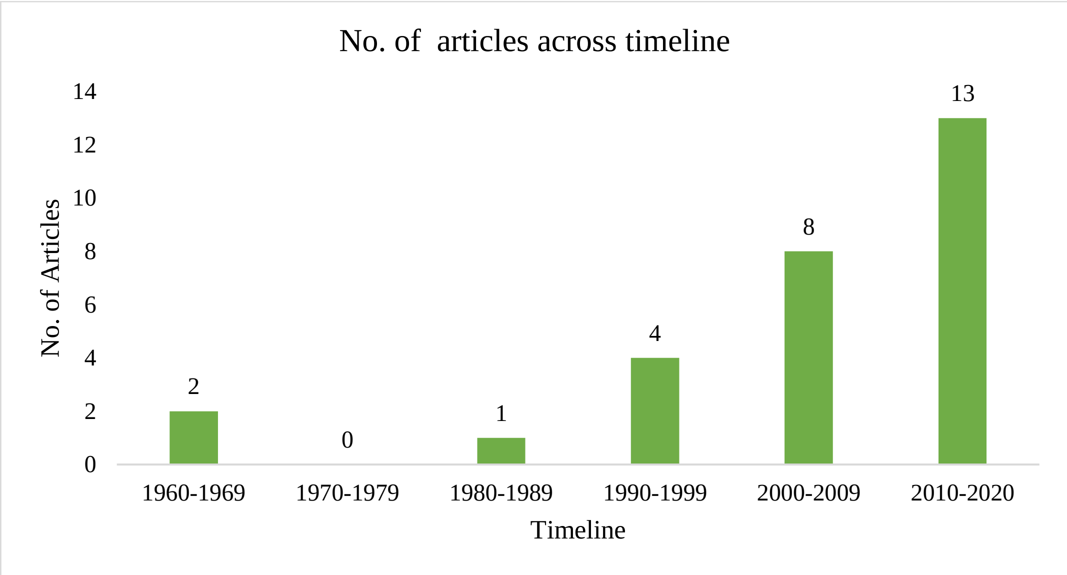


*Note.*The 15 articles in English also consists the article by Choi et al. (2020), since the study included English speakers also in addition to Korean speakers.

The number of articles published every ten years from the 1960s to 2020 is depicted in Figure.3.2. It can be seen that the number of published studies that have assessed the effect of the phonological and morphological factors on stuttering rates in children steadily increased across the timeline, with a maximum of 13 studies published between 2010 and 2020.

Figure 3.2

The number of articles published across the timeline from 1960 to 2020.



Note. The figure shows the total number of included articles that assessed phonological and morphological factors across ten-year intervals (1960-2020) in which they were published.

3.2 Phonological factors

Phonological factors were classified as (a) Phoneme Position, (b) Phoneme type, (c) Word length, and (d) Phonological complexity. Seventeen articles that studied at least one of the aforementioned parameters have been included in this study (*n*=409 CWS). The results of the parameters are outlined in the upcoming subsections.

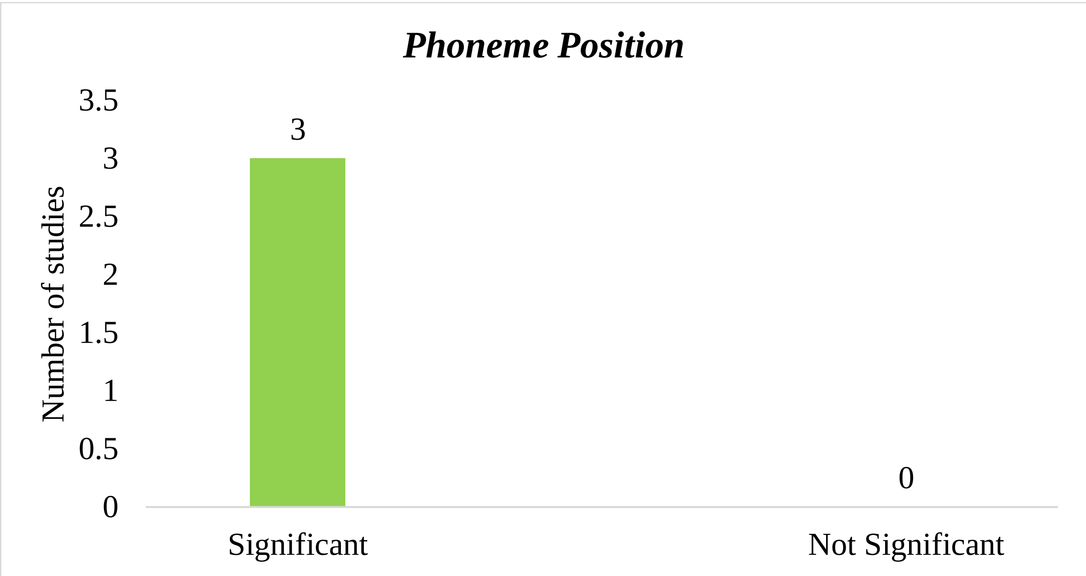
3.2.1 Phoneme Position

Based on this factor, the position of a phoneme can be classified as being in the initial, medial or final position in a word. A total of 83 CWS were involved in the studies that considered this variable.

All the three studies that assessed phoneme position found this factor significant in influencing the frequency of stuttering in children(Alqhazo& Al-Dennawi, 2018; Natke et al., 2004; Seth & Maruthy, 2019), and all of them found that stuttering rates were more on initial-position compared to non-initial positions (Figure 3.3). All the studies that assessed phoneme position were done on non-English speakers.

Figure 3.3

The frequency of articles that evaluated Phoneme Position as a parameter – Significance

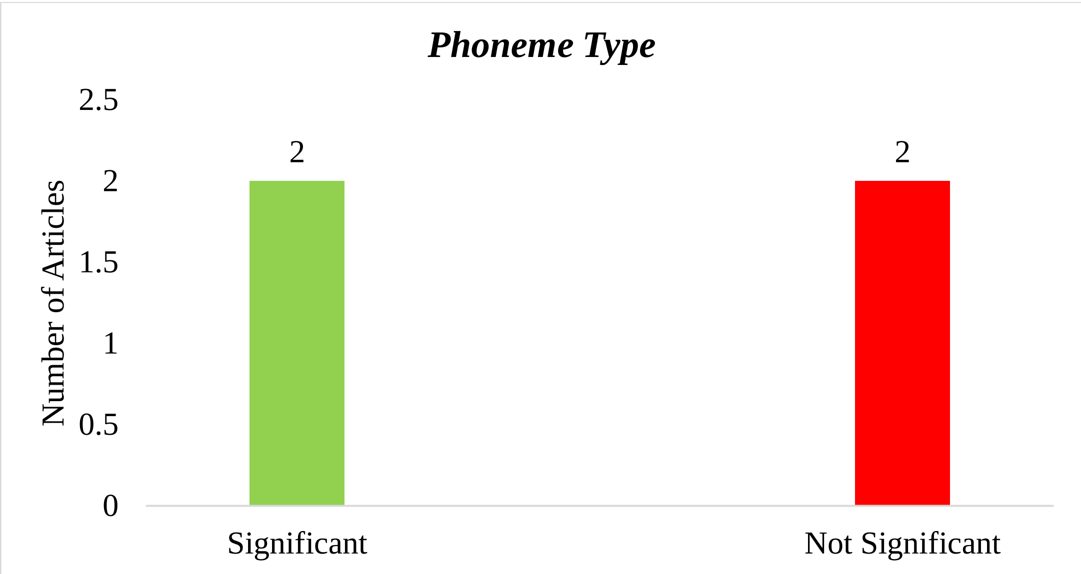


3.2.2 Phoneme Type

Words can be classified as words starting with consonants or with vowels based on phoneme type. There were mixed findings of the effect of phoneme type in children. Out of the five studies (*n*=154 CWS) that assessed phoneme type, two found this parameter significant in affecting the stuttering rates in children(Alqhazo& Al-Dennawi, 2018; Seth & Maruthy, 2019) and found that stuttering rates were more on words starting with consonants compared to vowels. Two other studies found it insignificant (Dworzynski et al., 2003; Williams et al., 1969). Figure 3.4 shows the graphical representation of the results. The studies with significant results were done on JA-Arabic and Kannada-speaking children. In contrast, the studies that found phoneme type, a non-significant factor, included German and English-speaking CWS.

Figure 3.4

The frequency of articles that evaluated Phoneme Type as a parameter – Significance

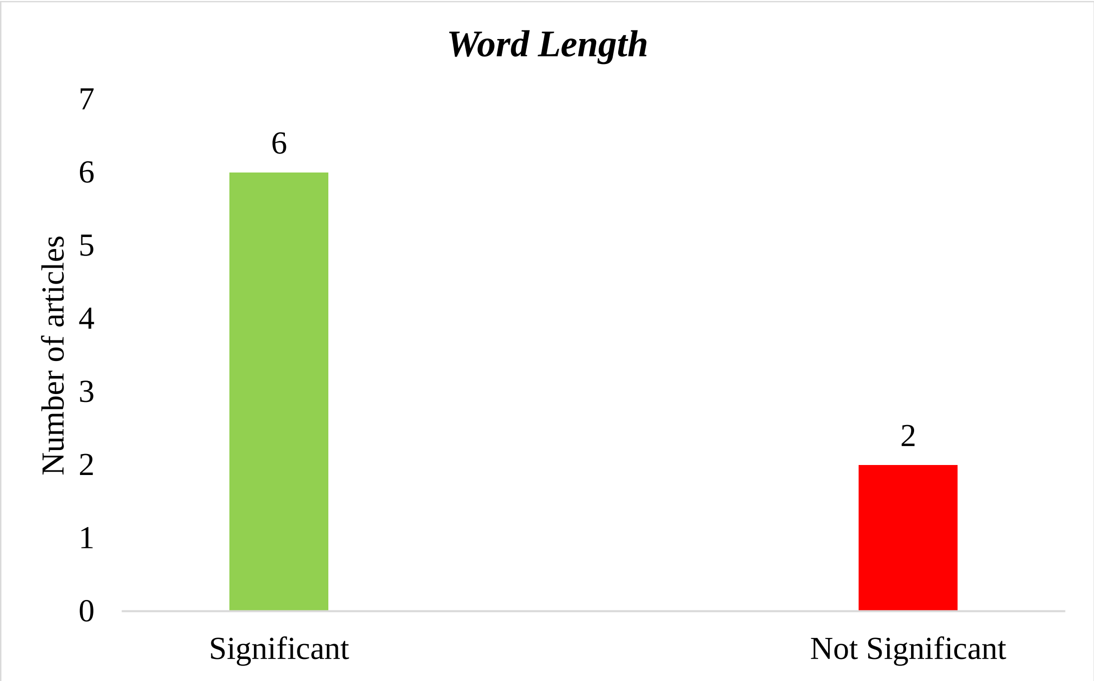


3.2.3 Word Length

The words can be classified as Monosyllabic, Bi-syllabic, Tri-syllabic, and Multi-syllabic based on this factor. There were mixed findings of the effect of word length in children with stuttering. Out of the eight studies (*n*=215) that assessed word length, six found this parameter significant in affecting the stuttering rates in children. Out of the five articles that found word length to be a significant factor, three found stuttering rates to be higher on longer words (Alqhazo & Al-Dennawi, 2018; Attieh, 2010; Dworzynski et al., 2003); one study found increased stuttering rates in shorter words (Bloodstein & Grossman, 1981), and other two studies did not report the results of significance(Howell & Au-Yeung, 1995; Williams et al., 1969). Two studies found the factor insignificant (Seth & Maruthy, 2019). Figure 3.5 shows the graphical representation of the results.

Figure 3.5

The frequency of articles that evaluated Word Length as a parameter – Significance



A study done by Howell et al., 2010 was also included because the study includes the analysis of word length of content words. However, the study did not directly assess the difference between stuttering-like disfluencies in mono-syllabic (C1) and bi-syllabic (C2) content words. According to the Figure in the article, there was no difference in the percentages of Stallings on C1 and C2 and percentages of Advancings on C1 and C2 in children with persistent stuttering. The authors have not included this article in the significant studies since this result was deduced based on the graph in the article.

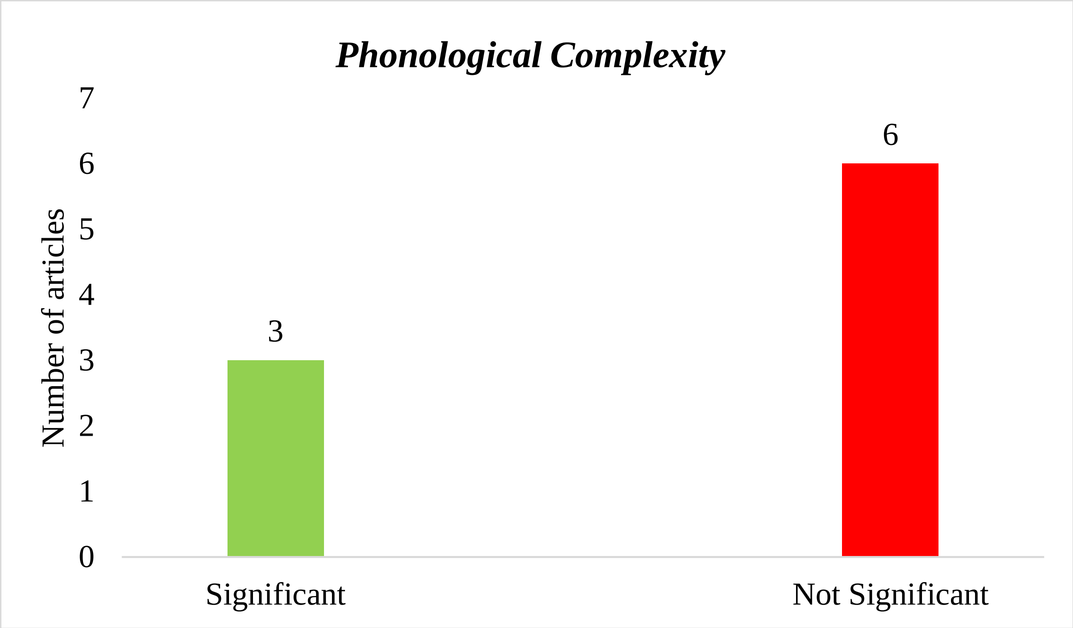
Out of the seven studies that have taken up word length as a factor for assessment, three studies included English-speaking participants. One showed that stuttering rates were higher on shorter words; two did not report any trend in the significance. The remaining four studies involved non-English speakers, and of the four, three studies showed a significant effect of word length on stuttering rates of children (higher on longer words), and one study found the factor insignificant.

3.2.4 Phonological Complexity

Words can be classified as phonologically more complex and less complex and categorized under different complexity scores based on the *Index of phonetic complexity* (IPC) or *Word Complexity measure* (WCM). There were mixed findings of the effect of phonological complexity in children with stuttering. Of the nine (*n*=173) studies that assessed phonological complexity, six studies found this parameter insignificant in affecting the stuttering rates in CWS (Coalson et al., 2012; Coalson & Byrd, 2016; Dworzynski & Howell, 2004; Howell et al., 2006; Howell & Au-Yeung, 1995; Throneburg et al., 1994). Three articles found phonological complexity to be a significant factor. Of the three, one found stuttering rates to be higher on phonologically more complex words in CWS (Al-Tamimi et al., 2013); two studies found stuttering rates to be significantly correlated with phonological complexity scores (Howell et al., 2000; Howell & Au-Yeung, 2007).

Figure 3.6

The frequency of articles that evaluated Phonological Complexity as a parameter – Significance



Out of the nine studies that have taken up phonological complexity as a variable for assessment, six studies include English-speaking participants. Five studies found this factor insignificant in influencing the stuttering rates of English-speaking children, and only one study found the factor significant in English-speaking CWS. The remaining three studies involved non-English speakers, and of the three, two studies showed a significant effect of phonological complexity on stuttering rates of children (higher on phonologically complex words), and one study found the factor insignificant.

All the phonological factors studied in English-speaking, and non-English speaking children with stuttering have been summarized in Table 3.1.

Table 3.1

Summary of Phonological factors: English vs. Non-English Speakers

English							Non-English						
Sl No	Study ID	Age Range	PP	PT	WL	PC	Sl No	Study ID	Age Range	PP	PT	WL	PC
1	Bloodstein& Grossman, 1981	3;10-5;7 yrs					1	Al-Tamimi et al.,2013	6-11 yrs				JA
2	Coalson & Byrd, 2016	2;7-5;9 yrs					2	Alqhazo& Al-Dennawi, 2018	6-13 yrs	JA	JA	JA	
3	Coalson et al.,2012	2;7-5;9 yrs					3	Attieh A, 2010	6;0-8;9 yrs			JA	
4	Howell & Au-Yeung, 1995	2;7- 6;0 yrs					4	Dworzynski& Howell, 2004	2;0-6;5 yrs				Ge
		6;0-9;7 yrs							6;7-8;11 yrs				Ge
		9;4-12;7 yrs							9;2-11;11 yrs				Ge
5	Howell et al, 2000	3-11 yrs					5	Dworzynski et al., 2003	7;4-11;11 yrs		Ge	Ge	
6	Howell et al., 2006	6-11 yrs					6	Howell & Au-Yeung, 2007	6-11 yrs				Sp
7	Throneburg et al., 1994	29-59 months					7	Natke et al., 2004	2;1 -5 yrs	Ge			
8	Williams et al., 1969	5;0-12;10					8	Seth &Maruthy, 2019	3;0-6;0 yrs	Kan	Kan	Kan	

Note. Language Coding: Sp- Spanish; Ge-German; JA-Jordanian Arabic; Kan- Kannada. Factor Coding: PP-Phoneme Position; PT-Phoneme type; WL- Word Length; PC- Phonological Complexity

Blocked cell indicates the factor was Significant   Blocked cell indicates the factor was Not Significant

3.3Morphological Factors

Morphological factors were classified as (a) Word Class and (b) Word Inflection. Twenty-one articles that studied at least one of the previously mentioned parameters have been included in this study (*n*=555 CWS). Out of the twenty-one articles, only two take up word inflection as a factor, and all twenty-one assess word class as a factor influencing the stuttering-like dysfluencies in children. The results of the parameters are outlined in the upcoming subsections.

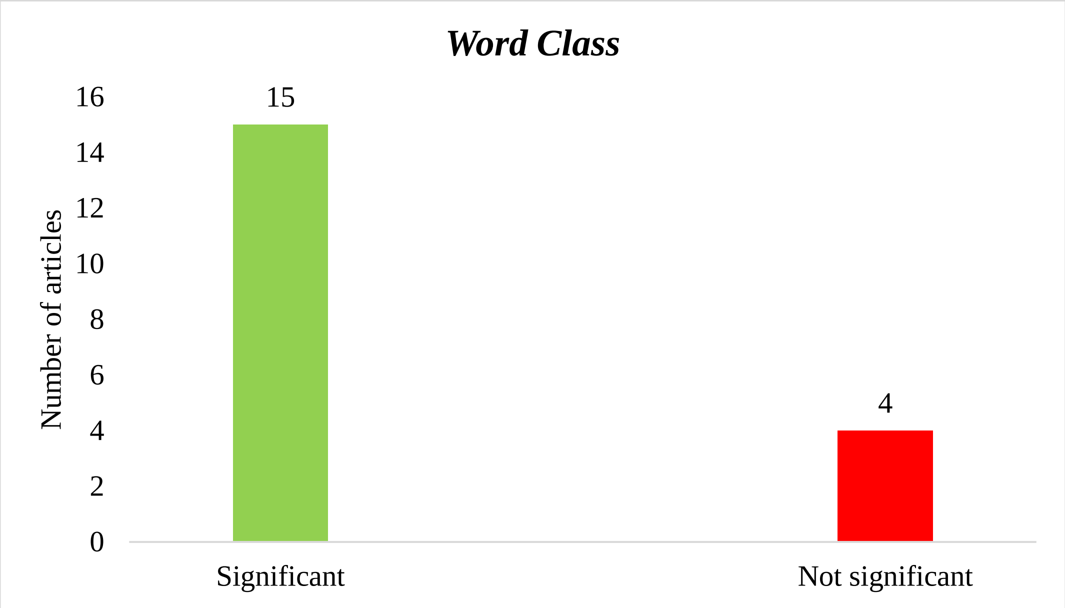
3.3.1 Word Class

The words can be classified as content, function, or content-function words based on word class. A total of 555 CWS were involved in the studies that considered this variable.

Out of the twenty-one studies that assessed word class as a factor, fifteen articles found this factor significant in influencing stuttering frequency in children(Attieh, 2010; Au-Yeung et al., 1998, 2003; Bloodstein & Gantwerk, 1967; Bloodstein & Grossman, 1981; Buhr et al., 2016; Choi et al., 2020; Howell et al., 1999;Howell & Au-Yeung, 1995; Howell & Au-Yeung, 2007; Juste et al., 2012; Natke et al., 2004; Richels et al., 2010; Vahab et al., 2013; Williams et al., 1969). The results are shown in figure 3.7.

Figure 3.7

The frequency of articles that evaluated Word Class as a parameter – Significance



Of the fifteen significant articles, eight found that children who stutter had higher stuttering rates on function words than content words (Figure 3.4). One study found higher content word stuttering rates than function word stuttering rates(Attieh, 2010).

Further, mixed findings were found on four articles. Choi et al. (2020) reported more stuttering rates on function than content words in English-speaking children and the exact opposite findings in Korean-speaking children. Au-Yeung et al. (1998) report that only the English-speaking children who belong to the young (2;7-6 years) age group stutter more on function words and that the factor was not significant for the middle and older age groups. Spanish-speaking children in the young (3-5 years) and middle (6-9 years) age group were found to stutter more on function words than content words, and the word class factor was not significant in the older age group(Au-Yeung et al., 2003).Richels et al. (2010) conducted two studies- study 1 and study 2 that evaluate word class as a factor affecting stuttering rates of English-speaking children.

Study 1 revealed that 83% of the study population stuttered more on function words, and 17% stuttered more on content words. Study 2 revealed that 93% of the study population stuttered more on function words, and 7% stuttered more on content words. The studies by Williams et al. (1969) and Howell and Au-Yeung (1995) only specified that the word class as a factor was significant and did not specify whether the participants stuttered more on function or content words. Four of twenty-one articles found no significant effect of Word class on the stuttering rates in children (Alqhazo & Al-Dennawi, 2018; Dworzynski et al., 2003; F. Juste & Andrade, 2006; Seth & Maruthy, 2019).

Gkalitsiou et al.(2017) conducted a preliminary case series study on 4 CWS (Age range: 46 – 80 months; 2 male and 2 female) to investigate whether the trend of function words being stuttered more than content words is suitable for bilinguals(Spanish and English) also. Narrative and play-based samples were recorded, and SALT- Systematic Analysis of Language Transcripts was used to analyze the samples. For both Spanish and English samples, a 2×2 contingency table analysis, with Pearson's chi-square and Yate's correction was done. The results indicated that all four participants presented with more stuttering on function compared to content words in their Spanish narrative ($p \leq 0.0001$). In conversational samples, all but C3 had significantly more stuttered function words (CSW1, 2 & 4: $p \leq 0.0001$). In English conversational samples, CWS4 produced significantly more stuttering on function words when compared to content words ($p = 0.0005$). CWS1, CWS2 and CWS3 produced similar amounts of stuttering on both content and function words. This article was not included in the review since it was a case series, but it is worth mentioning as it is one of its kind as far as the authors' knowledge.Two more studies were included in the data extraction table but not in the significance studies since the authors have not performed any statistics. From one study, it could be interpreted that both function and content words had similar percentages of Stallings (~60%) and Advancings(~40%) in English-speaking children with persistent stuttering (Howell et al., 2010). Furthermore, the data from another study could be interpreted that Persian-speaking children who stutter produce more repetitions on content than function words (Mehrpour & Meihami, 2017).

Out of the twenty-one studies that have taken up word class as a variable for assessment, nine studies included English-speaking participants. All studies showed a significant effect of the factor except one study, which found mixed findings as mentioned earlier, where the factor was significant only for the younger age group (Au-Yeung et al., 1998). Seven studies found that this factor was significant in influencing the dysfluencies of English-speaking CWS.

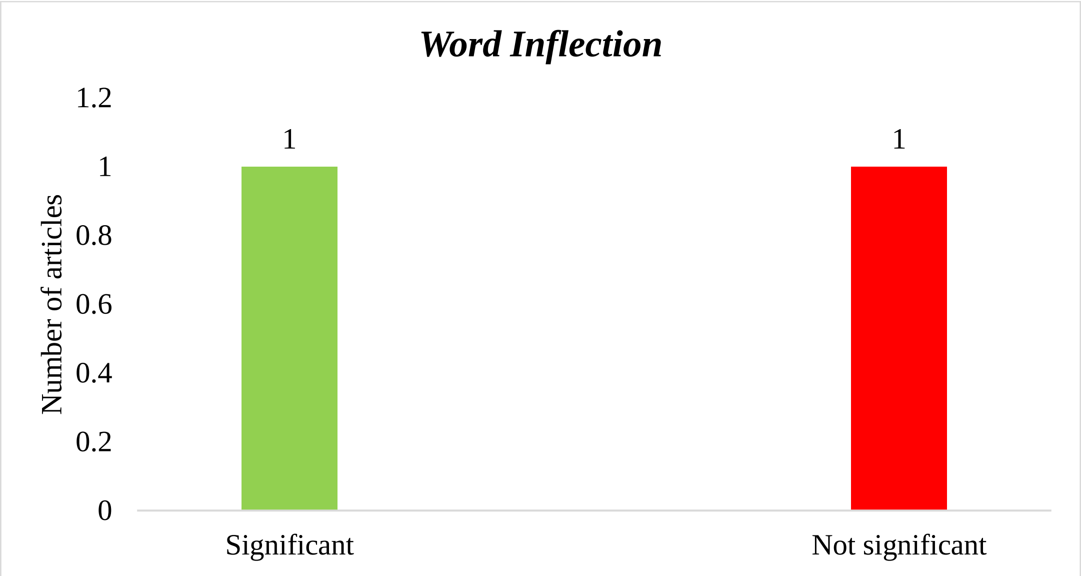
The remaining eleven studies involved non-English speakers, and of the eleven, six studies showed a significant effect of Word Class (usually higher on function words) on stuttering rates of children. Korean and Jordanian Arabic-speaking children had higher stuttering rates on content words. One study found mixed results, as mentioned earlier, where the factor is only significant for children in the young and middle age groups who speak Spanish (Au-Yeung et al., 2003). The other four studies did not find significant differences in stuttering rates between content and function words (Jordanian Arabic: Alqhazo & Al-Dennawi, 2018; German: Dworzynski et al., 2003; Brazilian Portuguese: F. Juste & Andrade, 2006; Kannada: Seth & Maruthy, 2019).

3.3.2 Word Inflection

The words can be classified as inflected (I) vs. Not-inflected (NI) based on bound morphemes. A total of 61 CWS were involved in the two studies that considered this variable. The study on Jordanian Arabic-speaking children showed significant differences in stuttering rates between inflected and non-inflected words (Alqhazo & Al-Dennawi, 2018). On the other hand, the study involving Kannada-speaking CWS showed no significant differences in stuttering rates between inflected and non-inflected words. The results are shown in Figure 3.8

Figure 3.8

The frequency of articles that evaluated Word Inflection as a parameter – Significance



There were no studies in English. One study involving Jordanian Arabic speakers found this factor significant, whereas the study involving Kannada speakers found it insignificant.All the morphological factors studied in English-speaking, and non-English speaking children with stuttering have been summarized in Table 3.2.

Table 3.2

Summary of Morphological factors: English vs. Non-English Speakers

English					Non-English				
Sl No	Study ID	Age Range	Word Class	Word Inflection	Sl No	Study ID	Age Range	Word Class	Word Inflection
1	Au-Yeung et al.,1998	2;7-6 yrs			1	Alqhazo& Al-Dennawi, 2018	6-13 yrs	JA	JA
		6;0-9;6 yrs							
		9;6-12;7 yrs							
2	Bloodstein&Gantwerk, 1967	2;11-6;6 yrs			2	Attieh A, 2010		JA	
3	Bloodstein& Grossman, 1981	3;10-5;7 yrs			3	Au-Yeung et al.,2003	3-5 yrs	Sp	
							6-9 yrs	Sp	
							10-11 yrs	Sp	
4	Buhr et al., 2016	37-60 month			4	Choi et al., 2020	3-7 yrs	Ko	
5	Choi et al., 2020	3-7 yrs			5	Dworzynski et al., 2003	7;4-11;11 yrs	Ge	

Table 3.4 ***Contd.***

6	Howell & Au-Yeung, 1995	2;7-6 yrs			6	Howell & Au-Yeung, 2007	6-11 years	Sp	
		6;0-9;7 yrs							
		9;4-12;7 yrs							
7	Howell et al., 1999	2-7 yrs			7	Juste& Andrade, 2006	4;0-11;11 yrs	BP	
		7-9 yrs							
		10-12 yrs							
8	Richels et al., 2010	49.4 -50.53 months			8	Juste et al., 2012	4:0-11;11 yrs	BP	
9	Williams et al., 1969	5;0-12;10 years			9	Natke et al., 2004	2;1-5;0 yrs	Ge	
10					10	Seth &Maruthy, 2019	3;0-6;0 yrs	Kan	Kan
11					11	Vahab et al., 2013	7;5-10;6 yrs	Pe	

*Note.*Language Coding: Sp- Spanish; Ge-German; Ko- Korean; BP- Brazilian Portuguese; JA- Jordanian Arabic; Pe-Persian; Kan- Kannada.

Blocked cell indicates the factor was Significant   Blocked cell indicates the factor was Not Significant

CHAPTER IV

DISCUSSION

Over the years, many studies have evaluated linguistic factors that affect stuttering rates in both adults and children. It is common knowledge among researchers in the field of speech-language pathology that the stuttering rate varies with these factors. Nevertheless, one seldom knows how it affects the stuttering rate in children who speak languages other than English. To study the effects of the phonological and morphological factors on children who stutter, the authors systematically reviewed the literature on these effects on the frequency of speech dysfluencies in children who stutter. The phonological factors considered in this review were phoneme position, phoneme type, word length, and phonological complexity, and the morphological factors considered include word class and word inflection. The effects of these parameters on the frequency of stuttering in children are discussed further in the upcoming sections.

4.1 Phonological Factors

4.1.1 Phoneme Position

The results of the systematic search revealed three studies that evaluated this parameter, and all three studies found higher stuttering rates at word-initial positions than word-non-initial positions. The significance of this factor in affecting stuttering rates of children who stutter could be due to increased demands placed on the speech motor system during utterance planning that provokes stuttering (Au-Yeung et al., 1998). According to Smith and Weber (2017), disfluencies are evidence of the ongoing dynamic interaction of various elements that affect speech motor planning and execution, including language and motor aspects. This notion would also support the theory that utterance planning would place increased demands on the speech motor system of the child and hence would provoke stuttering at utterance-initial and word-initial positions. Seth and Maruthy (2019) conjectured that the significance of this factor seen in pre-school children who stutter could be because they are more prone to breakdowns in fluent speech due to the ongoing development of their speech motor system. Higher stuttering rates in the word-initial positions can be explained by the EXPLAN model (Howell, 2004; Howell & Au-Yeung, 2002), wherein speech is said to be initiated by a covert internal planning mechanism (PLAN) and executed by motor processes (EX). Fluent speech is a result of the motor process executing the linguistic sequence planned by the planning mechanism. When the linguistic system is unable to generate a plan for the upcoming word or is delayed, the motor system responds by stalling for more time for the plan to be generated or by attempting to continue the linguistic sequence available and move forward. However, when the time is not enough to complete the linguistic plan in advance, the speakers are more likely to have prolongation of the first sound and repetition of the first syllable (Watkins et al., 2007)

4.1.2 Phoneme Type

Consonants are comparatively complex to vowels (Taylor, 1966) due to the requirement of a more precise articulation to produce them and, hence, more prone to stuttering. The systematic search led to four articles, two of which found that children have significantly higher stuttering rates on consonants. However, two of the studies found that this was not the case. One of the studies done on German-speaking children showed a trend of higher stuttering rates on consonants compared to vowels even though the difference was not significant (Dworzynski et al., 2003). The other study on English-speaking children found this parameter insignificant (Williams et al., 1969). This insignificance could be because the authors used the proportions of stutterers who had dysfluencies in words starting with consonants rather than the frequency of dysfluencies on words starting with consonants as the dependent variable.

4.1.3 Word Length

According to the interactive view of Crystal's 'bucket' theory, heightened demands at one level of language production may reduce resources for other levels such as prosody or phonology and result in breakdowns or disruptions in fluency (Crystal, 1987). Starkweather (1987) described a demands and capacities view of stuttering in which he comments that both speech production and language formulation place a simultaneous demand on the child. Consequently, if demands were to increase in either domain, the performance in the other would reduce significantly. These two perspectives form a premise that stuttering is more likely to occur on longer words that place a substantial load on the language formulation system than short words. Another reason for higher stuttering rates on longer words could be due to the deficits in the child's phonological encoding. According to Levelt (1993), phonological encoding is vital for speech planning and production because it acts as a link between lexical processes and speech motor production. Before transmitting the code for articulatory planning and execution, the speakers examine their speech output for faults in the speech plan, and to access sublexical units like phonemes, the process of monitoring is essential. It is said that breakdowns in fluency are due to a fault in such covert monitoring systems in individuals who stutter.

Furthermore, children who stutter were found to have delayed phoneme monitoring compared to their non-stuttering counterparts (Mahesh et al., 2018). This could mean that longer words with more syllables will increase the chances of a faulty monitoring system and stimulate stuttering. Some studies report that longer words place an increased effort on the motor execution system (Attieh, 2010).

The systematic search yielded six studies that found word length to be a significant factor in influencing stuttering rates in children. Three of the six studies found that children stutter more frequently when speaking longer words, which is expected. Two did not report the trend followed. A study by Bloodstein and Grossman (1981) found that five English-speaking CWS stutter more monosyllabic than polysyllabic words. This unpredicted result could be due to the study's small sample size (*n*=5) or because the children use fewer polysyllabic words in their speech. It can also be considered a confounding effect of higher function word stuttering rates since the function words in English are predominantly monosyllabic, which is a plausible explanation considering that Silverman (1975), found that non-stuttering children also produce higher stuttering rates on non-stuttering children.

One study found this factor insignificant. Seth and Maruthy (2019) reason that the insignificance could be due to the spontaneous speech task that allows the child to omit polysyllabic words. They also state that the frequency of occurrence of multisyllabic words in the Kannada language is rare and that several multisyllabic words are shortened in their spoken form.

4.1.4 Phonological Complexity

The systematic search revealed three studies that found phonological complexity to significantly affect the stuttering rates of children who speak Arabic, English, and Spanish, and all three of them found higher stuttering rates in phonologically more complex words. One more common factor in these studies is that all three assess the phonologic complexity of words in different grammatical classes separately. Moreover, all three found the phonologic complexity of content words but not function words to be significant in affecting the stuttering rates of children. This finding suggests that the phonologic complexity is a factor in determining content word stuttering but is not a factor in function word stuttering. Such interaction of phonological complexity and word-class warrants further research for a better understanding of this interaction. The higher stuttering rates in phonologically more complex content words could be because the speaker continues with the execution of a word for which the plan is not available entirely and hence produce disruptions in the fluent productions of that word (EXPLAN: Howell, 2004; Howell & Au-Yeung, 2002). Au-Yeung et al. (1998) suggest that the words for which the phonetic plan is unavailable are highly likely to be phonologically complex content words, and hence it is plausible that the likelihood of stuttering is more for phonologically complex content words. Al-tamimi et al. (2013) found higher stuttering in phonologically complex function-content words than their fluent counterparts. Authors attribute this to the multisyllabicity of the function-content words. Al-tamimi et al. (2013) also state that phonological complexity influences stuttering rates in Arabic-speaking children due to some complex Arabic sounds that emerge later (above 6;0 years) than sounds in English.

Contrary to the expectations, six studies found phonological complexity insignificant in predicting stuttering rates in children. This insignificance could be because phonological complexity may not be a significant factor by itself but becomes significant when combined with other factors such as grammatical class. This notion is supported by findings from studies that phonological complexity is insignificant in predicting the likelihood of stuttering when controlled for variables like grammatical class and neighbourhood frequency (Coalson et al., 2012; Coalson & Byrd, 2016).

4.2 Morphological factors

4.2.1. Word Class

The systematic search revealed fifteen studies that found word class to be a significant factor in influencing the stuttering rates in children. Of the fifteen, eight studies found higher stuttering rates on function words. Attieh (2010) and Choi et al. (2020) reported higher content word stuttering rates on Jordanian Arabic and Korean-speaking children with stuttering. Both these findings could be explained with the EXPLAN (Howell, 2004; Howell & Au-Yeung, 2002) model of stuttering.

First, function word dysfluencies are said to be produced as a stalling mechanism when the phonetic plan for the following content word is unavailable or delayed. This finding is supported by evidence from a study that assesses stuttering rates on Pre-Content function words compared to Content words and Post-Content function words. The assumption here is that if function word stuttering is a result of stalling mechanism, there would be a significant difference between the stuttering rates on Pre-Content Function words and, Content and Post-Content Function words. The study found the assumption to be accurate and found that Pre- Content Function words had higher stuttering rates than Content words. Content words, in turn, had higher stuttering rates when compared to Post-Content function words (Au-Yeung et al., 1998).

Second, the high content word stuttering rates can be explained with the EXPLAN model as dysfluencies resulting from attempting to complete the word with the incomplete plan that manifests as first sound prolongation and syllable repetitions, as mentioned earlier. Higher content word stuttering rates can also be due to their more complex semantic content, phonetic composition, and their greater length when compared to function words(Au-Yeung et al., 1998), which could be taxing for their speech motor system and hence results in speech disruptions.

Four of twenty-one articles found no significant effect of Word class on the stuttering rates in children. This insignificance may be attributed to the non-English languages spoken by the children in that this factor may not be as prominent in influencing stuttering rates as it does in English-speaking children as the studies that found this factor insignificant have non-English speaking participants. Seth and Maruthy (2019) reasoned that the insignificance of this factor could be because function words are rarely present independently in Kannada and are mostly Post-Content (added as suffix).

4.2.2 Word Inflection

Only two studies that studied word inflection resulted from the systematic search conducted, and only one found the parameter significant. Alqhazo and Al-Dennawi (2018) found high stuttering rates on words with inflections and attributed this to the change in the phonologic structure of the word and is more complex compared to uninflected words by increasing the number of syllables, changing the syllable shape, and hence placing more load on the system which ultimately results in speech disruptions. Seth and Maruthy (2019) found this parameter insignificant and reasoned that this could be because children oversimplified complex utterances as simple ones and the spontaneous speech task also permits them to do so of their own accord, although reading tasks could not be used due to their age. There is a dearth of studies that assess this parameter, which can give optimal insight into the interaction between phonological complexity and syntactic complexity.

4.3 Change in dysfluencies with chronological age

Au-Yeung et al. (1998) report that only the English-speaking children who belong to the young (2;7-6 years) age group stutter more on function words and that the factor was not significant for the middle and older age groups. Spanish-speaking children in the young (3-5 years) and middle (6-9 years) age group were found to stutter more on function words than content words, and the word class factor was not significant in the older age group(Au-Yeung et al., 2003). This exchange of dysfluencies from higher stuttering rates in function words with children, which decreases as they age, needs extensive research as this could also predict stuttering persistence. The reduction in the gap between the percent of function and content words stuttered as the child ages can be explained using the proposition made by Au-Yeung et al., 2003 who take insights from the EXPLAN model (Howell, 2004; Howell & Au-Yeung, 2002) and the demands and capacities model (Starkweather, 1987). The authors suggest that when the phonologic encoding capacities do not meet the speech execution demand, the likelihood of stuttering increases and children cope by repeating the function word. As they age and their phonological capacities mature, they tend to reduce the number of function word repetitions. Furthermore, a child who does not recover is said to adopt a maladaptive coping mechanism of trying to complete the execution of a content word whose plan is not fully available and consequently increases his/her content word dysfluencies.

4.4 Effect of Phonological and Morphological Factors:English vs. Non-English speaking CWS

The effect of phonological factors on English and non-English languages seems to be mixed. The number of studies that considered phoneme position and phoneme type is too less to make an inference. As for the word length, all the five studies on English speakers were significant, whereas one of the three done on non-English languages deems this factor insignificant. This insignificance was attributed to the oversimplification of and the dearth of multisyllabic Kannada words in pre-school children who stutter (Seth & Maruthy, 2019). Only one of six studies that evaluated the effect of phonological complexity on stuttering rates in English-speaking CWS found it significant. Of the three studies conducted on non-English speaking children, two found this parameter significant, which can be attributed to the phonetic complexity of the sounds of the languages compared to English.

The Morphological factors taken up in this review were word class and word inflection. All the nine studies done on English-speaking CWS to check the effect of word class found this factor significant. There were mixed findings in eleven studies conducted on non-English speaking CWS. Four of the eleven found this factor insignificant, and of the other seven that found the factor significant, two found higher stuttering rates in content words (Korean and Jordanian Arabic), and the rest found higher stuttering rates in function words similar to the studies on English speakers. The higher stuttering on content words in few languages could be attributed to the higher phonologic complexity of content words than those in English. The insignificance was attributed to reasons like the reduced number of independent function words in the Kannada language (Seth & Maruthy, 2019). Hence, this factor may not be as prominent in influencing stuttering rates as it does in English-speaking children. There is a need to study word inflection as a parameter that influences stuttering in English and non-English languages.

CHAPTER V

SUMMARY AND CONCLUSION

The systematic review was carried out to find the effect of phonological and morphological factors on the frequency of stuttering in children who stutter. The search turned up 328 articles out of which 28 were included in the review. Although it is often known that these factors affect the frequencies of stuttering in children, if one reviews the literature the effects of these factors differ for English and non-English languages. The study highlights the trends observed in stuttering rates that change with these factors in both English and non-English languages and also highlights the changes in disfluency rates with age. This review also highlights the dearth of studies that evaluate word inflection as a factor which warrants future studies that consider this factor. Since this review included only children with stuttering the exchange in dysfluencies of function to content words from children to adults could not be highlighted, this could be taken up for future research as this variable could be imminent for prediction of stuttering persistence.

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APPENDIX A

Table 1

Data Extraction table for phonological factors that affect rate of stuttering in children.

Sl No	Study ID	Study design	Language studied	Participants	Age range (in years)	Phonological Factors studied	Task/tool used	Findings
1	Al-Tamimi et al., 2013	Cross-sectional study. The authors conducted the study on three groups of participants(total=21). G1(8; 6-11 years), G2(8;12-17 years), G3(5; 18+years). They recorded spontaneous speech	Arabic	8 (4M, 4F)	6-11 (Mean=9.5)	Phonetic complexity	Spontaneous speech recordings, AIPC (Arabic Index of phonological complexity)	**(1) Relation between AIPC and word category across participants in G1: 6-11 years** - t-tests with Bonferroni correction found that - In comparison to function words, function-content (p<0.001) and content (p<0.001) words had higher AIPC scores .

samples of 21 participants and classified the words as function-content, content, andfunction words. Then rated the words with scores based on the AIPC. And studied the effect of AIPC scores of the word and stuttering.

- Stuttered function-content and content-word AIPC scores were considerably higher than non-stuttered equivalents (content: p<0.009; function-content: p<0.008).
- Stuttered function-content words had higher AIPC ratings than stuttered content words. (p<0.001).
- There was no significant difference between the stuttered function words and their non-stuttered counterparts.

(2) Relation between AIPC scores and stuttering rate in G1:

The ANCOVA and ensuing Post-hoc Tukey testing demonstrate that the stuttering rate is considerably higher for AIPC scores 6 and 6+ than for AIPC values 0 (p<0.003).

The rate of stuttering has a substantial positive correlation with AIPC scores in this age group, according to Pearson's correlation (Pearson’s r=0.921, p<0.001).

								(3) AIPC factors that increase stuttering rate in G1: The study of G1 revealed that five parameters influenced the relevance of content and function-content words: consonants by places of articulation, consonants by manner of articulation, word shape, word length, and consonant by length.
2	Alqhazo & Al-Dennawi, 2018	Cross-sectional study The authors conducted a study on 41 CWS from 14 schools who fit the inclusion criteria. The schools were chosen at random from a list. They recorded spontaneous speech sample from the children for analysis.	Jordanian Arabic	41 CWS (31 M, 10 F)	6-13	1) Phoneme Category	Spontaneous Speech task	t- test revealed that the mean percentage of consonants (Mean $\pm$ SD = 36.3 ± 18.3) stuttered where significantly higher compared to the mean percent of vowels (Mean $\pm$ SD = 25.1 ± 28.2) stuttered. (n=41, t=2.7, p=0.009)
						2) Phoneme position	Spontaneous Speech task	ANOVA revealed that occurrence of stuttering in word initial, medial and final positions were 87%, 14% and 1.3% respectively. Post-hoc test reveal that the difference between these phoneme positions were statistically significant. (p=0.000)

						3) Word length	Spontaneous Speech task	The effect of monosyllabic, bisyllabic, and trisyllabic words on the frequency of stuttering was investigated using one-way ANOVA. The rate of stuttering was significantly affected by word length (monosyllabic 6%, bisyllabic 31%, trisyllabic 44%, p=0.000). The findings of the post-hoc test revealed that the three word categories differed significantly (p=0.000).
3	Attieh A, 2010	To investigate the relationship between loci of stutteringand stuttering frequency with certainlinguistic factors the authors selected 74 Jordanian children and adults who stutter. The participants were	Jordanian Arabic	G1 25CWS (20M,5F)	6;0 – 8;9 years	Word length	Spontaneous speech – only oral prose for CWS	There was significant difference between stuttering rates between one word length to the next i.e, from monosyllabic to bi-syllabic, bi-syllabic to tri-syllabic (p <±0.001) and not for tri syllabic to 4+ syllabic words in CWS. Although phoneme position in a word was considered there was no data reported for G1 i.e., CWS.

		divided into 3 groups – G1 (Grade1 - Grade3), G2 (Grade4 – Grade9), G3 (senior students and adults). Their spontaneous speech sample and reading sample were transliterated and words divided in terms of grammatical class, word length, Word position factor, Sentence position factor and further statistical analyses was carried out.						
4	Bloodstein & Grossma	Case-Series (Also mentions group results) The authors conducted a case-series study on five	English	5 subjects A (5 years), B (4years 4 months), C (4 years 7 months), D	3 years 10 months to 5 years 7 months	Word length	Spontaneous speech (picture description, narration	Although both word length and phoneme type were taken up only word length results were taken up for inclusion since group results were reported only for that factor.

n, 1981	children with stuttering – A (5 years), B (4years 4 months), C (4 years 7 months), D (5 years 7 months), and E (3 years 10 months). They measured two phonological factors taken up in this review- Phoneme type and Word length. Recordings of the children's spontaneous speech (picture description, narration and monologue) was done, after which it was transcribed and marked for speech disfluencies.	(5 years 7 months), and E (3 years 10 months).		and monologue)	Chi-square tests revealed that subjects A, B, and D showed no significant effect of phoneme type (initial consonant or vowel) on the proportion of stuttering, Subject E showed significantly more stuttering on initial vowels and Subject C showed the exact opposite, significantly more stuttering on words with initial consonants. As for the effect of word length (monosyllabic vs polysyllabic), none of the subjects stuttered more on polysyllabic words in comparison to monosyllabic words, when infact there was a tendency to do the opposite. Only subject C had significantly more stuttering on monosyllabic words compared to polysyllabic words. When the data was combined for the 5 subjects as a group, t test showed that this tendency to stutter more on monosyllabic words was significant ($t=2.90$, $df=4$, $p<0.05$).
5					

	Coalson et al., 2012	Cross-sectional study. The authors recorded conversational samples of 14 monolingual English-speaking CWS. Further the samples were transcribed and was further analysed for linguistic factors.	English	14 CWS (8M, 6F)	2 years 7 months to 5 years 9 months	Phonetic Complexity	Spontaneous speech (Conversation), WCM	When other variables such as phonotactic probability, utterance length, syntactic complexity, Word frequency, neighbourhood density, and neighbourhood frequency were controlled for, binomial logistic regression revealed that phonetic complexity (measured by WCM) is not a significant predictor of higher probability of stuttering on a term (OR= 1.010, p=0.870).
6	Coalson & Byrd, 2016	Cross-sectional study. The authors recorded conversational samples of 14 monolingual English-speaking CWS. Further the samples were transcribed and was further analysed for linguistic factors.	English	14 CWS (8M, 6F)	2 years 7 months to 5 years 9 months	Phonetic complexity	Spontaneous speech (Conversation), WCM	The authors found that while accounting for other variables like grammatical class, neighbourhood frequency and density, length of utterance, grammatical classification and other parameters, the phonetic complexity of the following word was not a significant predictor of greater likelihood of producing sound (OR=1.166, p=0.445) or syllable repetitions (OR=1.057, p=0.756).

								Furthermore, in a function-content word pair, the phonological complexity of the content word was not a good determinant of producing entire word repetitions.
7	Dworzynski et al., 2003	Cross-sectional study. 15 adults and 17 school aged children took part in this study. All were diagnosed as having stuttering by a SLP. Recordings of a monologue on	German	17 CWS (11M, 6F)	7 years 4 months to 11 years 11 months	1) Phoneme type	Spontaneous speech (Monologue on a topic of choice)	There was no significant effect of phoneme type (word starting from consonant vs. Vowel) on the rate of stuttering in CWS although there was a trend of consonants being stuttered more than vowels as can be visualised in the bar graph that shows the adjusted stuttering rates for the factors studied .

		certain topics were done and then transcribed for further analysis. All the words were coded for brown factors. Coded 1 for long (5+), content word, word starting with consonant, first three positions in an utterance and 0 for short (<5), function word, word starting with a vowel, word at other positions in an utterance.				2) Word length	Spontaneous speech (Monologue on a topic of choice)	Children stutter more on shorter words than adults ($p<0.05$). However, a comparison of longer and shorter words suggests that children stutter more on longer words ($p<0.01$).
8	Dworzynski & Howell, 2004	Cross-sectional study. The authors recruited 50 monolingual German speakers (35 CWS, 15 adults) from various places	German English	GERMAN: 26 CWS (20M, 6F) ENGLISH: 16 CWS (12M, 4F)	6-11 years	Phonetic complexity	Spontaneous speech (Conversation)	**Analysis 1: IPC scores for content vs function words in German-speaking CWS and AWS.** G1: 2-6;5 years G2: 6;7-8;11 years G3: 9;2-11;11 years G4: mean age=29;3 years

in Germany and compared them with data of English speakers from Howell et al., 2006. The German speaking CWS were group into three subgroups for Analysis 1 and 2, the German speaking adults and children who stutter were grouped as two : above 11 years and below 11 years for subsequent analyses- 3, 4, 5.

The main effect of word type was significant in ANOVA, demonstrating that content words had higher IPC scores than function words ($p < 0.001$). The interaction between word type and age group was significant ($p<0.001$), indicating that the difference between IPC scores increased with age.

In all age groups, follow-up paired t-tests revealed that content terms had higher IPC values than function words.(G1:$P<0.001$; G2:$P<0.001$; G3:$P<0.001$; G4:$P<0.001$).

There was significant effect of age group ($F(3,45)=28.65$, $p<0.001$). Post hoc tests reveal G1 has words with lower IPC scores compared to G2, G3 and G4(all: $p<0.01$), G2 < G3 ($p<0.001$), no difference between G3 and G4.

The interaction between age group and word type was present and tests reveal that there was a difference between content scores of G1 and all other age groups, G2 and G3 and no difference between G3 and G4. For function words, the IPC scores of G1 were different from all other age groups (all: $p<0.05$).

IPC scores of stuttered vs fluent words in German

G1: 2-6;5 years

G2: 6;7-8;11 years

G3: 9;2-11;11 years

G4: mean age=29;3 years

It was found that there was no significant effect of IPC scores on stuttered vs fluent function or content words in CWS (G1, G2, G3, G4). But stuttered content words had higher IPC scores compared to fluent content words in adults. Similar findings for English.

Phonetic complexity of German compared to English

Child group: 6-11 years in both German and English

Adult group: 11 plus in German and 18+ in English

The results demonstrated that German words had greater IPC scores than words in english, as well as a greater gap between the IPC values of function and content terms in German than in English.

IPC score and stuttering in German

Child group: 6-11 years in both German and English

Adult group: 11 plus in German and 18+ in English

ANOVA showed no difference in stuttering rate for the different IPC scores for either age group for function terms. For the combined data for the two age groups, the results showed that there was a significant impact for IPC category on content words. This component had a substantial linear trend as well(P <0.001). A significant interaction occurred between IPC score category and age group (P = 0.013). When both age groups were combined, the increase for children appeared to be less steep than the total effect, and the

								increase was not as obvious as it was for adults.
9	Howell & Au-Yeung, 1995	Cross-sectional study. Study done on 31 stutterers (6 young, 15 middle, 10 old) and 48 controls. Spontaneous speech was recorded and transcribed and disfluencies were marked and words coded for phonologic difficulty and browns factors.	English	31 CWS Young (6): 4 Mild, 2 Severe Middle(15): 11 Mild, 4 Severe Old (10): 3 Mild, 7 Severe	31 CWS Young (6): 2;7 – 6 years 5 controls Middle(15): 6;0 – 9;7 years 31 controls Old (10): 9;4 – 12;7 years 12 controls	Phonological complexity	Spontaneous speech(conversation)	The proportion of stuttered words for each word in phonological difficulty was assessed by removing effect of browns factors by treating them as covariates revealed that phonologic difficulty is not a major factor in governing incidence of stuttering.
						Word length	Spontaneous speech(conversation)	When the analyses was conducted on the word length score there was a significant difference between target (stuttering like disfluencies and post stuttering like disfluencies) and their controls in CWS.
10	Howell et al., 2000	Cross-sectional study. The authors conducted the study on 51 participants who stutter (21 children, 18	English	21 CWS	3-11 years	Phonologic complexity	Spontaneous speech (conversation)	The factors of phonological complexity were analysed as a single factor for Content and Function words separately: Content word: Late emerging Consonant(LEC): Whilst examining whether stuttering occurred differentially on LEC word classes (

teenagers, 12 adults). They recorded the spontaneous speech of these participants, transcribed and classified them based on factors that would increase the phonologic difficulty and based on grammatical class.	LECx -Words without an LEC, LECi -Words with an LEC in the first place, LECn -Words with an LEC in non-initial place) the Friedman test revealed significant results in CWS ($p<0.05$). Post hoc sign tests revealed that CWS stuttered more on LECi when compared to LECx. Consonant string (CS): While examining whether stuttering occurred differentially on CS word classes (CSx -Words that don't have a CS, CSi-Words with CS in the first place, CSn-Words with CS in non-initial place) the Friedman test revealed significant results in CWS ($p<0.05$). Post hoc sign tests revealed that CWS stuttered more on CSi when compared to CSx. Function word: No significant differences in stuttering rates on LEC or CS Word classes in CWS.

								Interaction between CS and LEC was also not significant in CWS.
11	Howell et al., 2006	Cross-sectional study. Study was conducted on 42 participants (16 CWS, 16 teenagers who stutter, 10 AWS) in United Kingdom. Authors recorded conversational samples which was transcribed and marked for disfluencies and also all the words were coded for IPC scores before further analysis.	English	16 CWS (12M, 4F)	6-11 years	Phonetic complexity	Spontaneous Speech (Conversation)	For CWS, t tests found no significant difference in IPC values for stuttered and non-stuttered words(p=0.604). There was also no difference in IPC scores among stuttered and non-stuttered function and stuttered and non-stuttered content terms for CWS.
12	Howell &	Cross-sectional study.	Spanish	19 CWS (15M,4F)	6-11years	Phonetic	Spontaneous speech	Itwas found that, stuttering rates of functionwords are above those of the

	Au-Yeung, 2007	Study was conducted on 35 participants (19 CWS, 7 teenagers who stutter, 9 AWS) in United Kingdom. Authors recorded conversational samples which was transcribed and marked for disfluencies and also all the words were coded for IPC scores before further analysis.				complexity	(conversation)	content words with corresponding IPC values for all points for CWS.
13	Howell et al., 2010	Longitudinal study. The authors followed a total of 26 children who stutter over a year of time and analysed the stalling and advancing	English	14 CWS classified as persistent at 12+ (10M,2F)	Initially 8-10 years, followed till 12+.	Word length	Spontaneous speech (monologue)	So according to the graph put in the results of this study, there was no difference between the percentage of stalling (~60%) between C1 and C2 words and no difference between the percentage of advancings between C1 and C2 (~40%), even though statistics

		characteristics of different word types (F1- mono-syllabic function word; C1- monosyllabic content word, C2- bi-syllabic content word). The authors measured speech samples at three age levels – 8-10, 10-12, 12+.						was not run to determine the significance.
14	Natke et al., 2004	Cross-section study was conducted on CWS. The authors recorded spontaneous conversations of the children using play activities, transcribed them and classified each word with regards to stress and grammatical class,	German	22 CWS (14M,8F)	2.1 to 5 years	Phoneme Position	Spontaneous Speech (Conversation)	After the analysis the authors found that almost 98% of the time the stuttering occurs at the first syllables. Blocks, prolongations, and sound repetitions occur on the initial sound/phoneme of the first syllable in 76.5 percent of cases, and on the second sound of the first syllable in 19.8 percent of cases.

		also the syllables were classified based on within word positions. Although the within word position and grammatical class here was measured to rule out their effect as confounding variables in measuring the effect of linguistic stress in CWS.						
15	Seth & Maruthy, 2019	Cross-sectional study. The study was done on 20 pre-school CWS. The spontaneous speech was recorded, transcribed and	Kannada	20 CWS (15M,5F)	3;0 – 6;0 years	1) Phoneme type	Spontaneous speech (Conversation)	Paired Wilcoxon signed rank test revealed that there was a significant difference between frequency of stuttering on words starting with consonant vs vowel ($\lvert Z \rvert=2.63$, $p<0.05$, $r=0.58$) Higher stuttering rates were seen in words starting with consonants.

		disfluencies marked. The words were classified according to phonological (phoneme position, phoneme type, word length) and morphological factors (Word class ad word inflection)				2) Phoneme Position	Spontaneous speech (Conversation)	Paired Wilcoxon signed rank test revealed that there was a significant difference between frequency of stuttering on word-initial vs word-medial position ($\lvert Z \rvert=3.97$, $p<0.05$, $r=0.88$). Higher stuttering rates were seen in word-initial compared to word medial positions.
						3) Word length	Spontaneous speech (Conversation)	Friedman test shows no significant differences between frequency of stuttering words with different word length- mono-syllabic, bi-syllabic, tri-syllabic and multi-syllabic ($\chi^2(3)=5.11$, $p>0.05$).
16	Throneburg et al., 1994	Cross-sectional study. The authors chose 24 participants for this study from 75 CWS based on number of SLDs and percentage of occurrence of phonological process. These	English	These children were classified into subgroups: (1)Mild CWS, poor	These children were classified into subgroups: (1) Mild CWS, poor phonology (30 to 47 months)	Phonological complexity	Spontaneous speech- Conversation sample, 8 Different aspects of phonologic difficulty were included by	The data indicated that the largest proportions of disfluent, words after disfluent words and total words in the speech sample, for all groups of CWS, was found to be in the phonologically not difficult category with proportions ranging from 0.43 to 0.56. The second largest proportion of disfluent, words after disfluent words and total words in the speech sample,

	children were classified into subgroups: (1) Mild CWS, poor phonology. (2) Mild CWS, good phonology (3) Severe CWS, poor phonology (4) Severe CWS, good phonology The conversation samples were recorded, transcribed and disfluencies marked. The proportion of SLDs in each phonologic difficulty criteria in relation to the total no. of SLDs were calculated for the disfluent word and the next word following the	phonology (6 CWS) (2)Mild CWS, good phonology (6 CWS) (3)Severe CWS, poor phonology (6 CWS) (4)Severe CWS, good phonology (6 CWS)	(2)Mild CWS, good phonology (30 to 48 months) (3)Severe CWS, poor phonology (29 to 59 months) Severe CWS, good phonology (34 to 51 months)	the authors as single factors and combinations: phonologically not difficult, late-developing sounds, complex syllable shapes (presence of clusters), and multisyllables.	for all groups of CWS, was found to be in the phonological difficulty category of late-emerging sounds with proportions ranging from 0.15 to 0.27. Other phonologically difficulty categories- complex syllable shapes (presenceof clusters), andmultisyllables have very small proportions. For disfluent words, the differences between the observed and expected proportions ranged from 0.00 to 0.07, with 6 out of 24 participants exceeding 0.03. For words after the disfluent words, the differences between the observed and expected proportions exceeded 0.03 for only 4 out of 24. Significant effect of phonologic difficulty and a significant interaction between word type (disfluent, next word, and all words, i.e. anticipated proportion) and phonetic difficulty in a mixed ANOVA.Post hoc tests show proportion of multisyllabic disfluent words was significantly less compared

		disfluent word. Next the proportion of words in a 1000 speech sample was calculated which was the expected value.						to expec6ted proportion and next word. Other factors disfluent word proportions are also lesser than expected. Hence the authors conclude that phonologic difficulty does not influence stuttering in children.
17	Williams et al., 1969	Cross-sectional study. Authors did study on 152 children (76 CWS, 76 CWNS) and recorded their speech sample and analysed the words for disfluencies and categorized them according to 4 brown's factors- grammatical class, Word length, Initial	English	76 CWS (M:F ratio is approximately 4:1)	5;0-12;10 years	Word length	Spontaneous speech – Repetition for younger and Reading for older	For each of the 76 CWS, two percentages were obtained: (1) the percentage of the total number of uttered words that had the attribute, and (2) the percentage of the disfluently uttered words that had the attribute. The child was categorized as being 'disfluent' for that attribute if (2) exceeded (1). X^2 one sample test reveals that there was a significant difference between number of CWS who were and were not classified as 'disfluent' for the word length category ($p<0.05$).

	phoneme, position.	Sentence	Phoneme Type	Spontaneous speech Repetition (younger)& Reading (older)	X^2 one sample test reveals that there was no significant difference between number of CWS who were and were not classified as 'disfluent' for the phoneme type category.

Table 2.

Data Extraction table for morphological factors that affect rate of stuttering in children.

Sl No	Study ID	Study design	Language studied	Participants	Age range (in years)	Morphological Factors studied	Task/tool used	Findings
1	Alqhazo & Al-Dennawi, 2018	Cross-sectional study The authors conducted a study on 41 CWS from 14 schools who fit the inclusion criteria. The schools were chosen at random from a list. They recorded spontaneous speech sample from the children for analysis.	Jordanian Arabic	41 CWS (31 M, 10 F)	6-13	1) Word Class	Spontaneous Speech task	Paired sample t-test revealed that there were no significant differences between stuttering rates of content (mean=36%) and function (mean=33%) words (p=0.563).
						2) Word Inflection	Spontaneous Speech task	Paired sample t-test revealed that there was a significant difference between stuttering rates of inflected (mean=50%) and uninflected (mean=30%) words (n= 41, t=3.9, p=0.000).
2	Attieh A, 2010	To investigate the relationship between loci of stuttering and stuttering	Jordanian	G1 25CWS	6;0 – 8;9 years	Word class	Spontaneous speech	There was significant difference between content word stuttering rates and function word stuttering rates (t=2.6, df=24,

		frequency with certain linguistic factors the authors selected 74 Jordanian children and adults who stutter. The participants were divided into 3 groups –G1 (Grade1 - Grade3), G2 (Grade4 – Grade9), G3 (senior students and adults). Their spontaneous speech sample and reading sample were transliterated and words divided in terms of grammatical class, word length, Word position factor, Sentence position factor and further statistical analyses was carried out.	Arabic	(20M,5F)			– only oral prose for CWS	p=0.015). The content word stuttering rate was higher compared to function words.
3	Au-Yeung et al., 1998	Cross-sectional study. The authors conducted the study on 51 participants- 31children divided as	English	31 CWS (23M, 8F)	Young(6 ; 2 years 7 months	Word Class	Spontaneous speech	**Stuttering Rates: Content vs function words** After determining the percentage of stuttering content and function words for

	younger, middle and older children, 8 teenagers and 12 adults. Spontaneous speech recordings were made before analysis; the recordings were classified as a number of phonological words and the words as content or function.	to 6 years), Middle(1 5, 6 years to 9 years 6 months) Older(9 years 6 months to 12 years 7 months)	recording	each participant, the Wilcoxon matched pairs signed-ranks test was used. The findings revealed that the young group stutters substantially more on function words than on content terms. ($p<0.05$). There were no significant variations between function and content words stuttered in the middle aged children group ($p=0.629$). Although the authors found a trend of content terms being stuttered more than function words in the older group, there were no significant differences between function and content words stuttered($p=0.126$). **Stuttering of function and content words as a function of utterance position** The content words were evaluated first. The authors compiled all content words that occurred in first position of the utterance. Same was carried out for positions 2^{nd} to 6^{th}. All positions beyond 6^{th} were combined to form a group 7+. The stuttering rates of content words at all these positions were calculated. Z scores were calculated and one way ANOVA revealed that the effect of

utterance position on the stuttering of content words was significant in the young group. [F(6,35)=2.56, p<0.05]
Post-hoc Tukey test reveals that the young group had significantly more stuttering rates at the first 2 positions compared to the rest.

Function words with utterance positions ranging from 1 to 5 and 6+ were analysed similarly. For the young medium and older children group, one way ANOVA demonstrates a significant effect of sentence position on the stuttering of function words(Young: $p < .001$, middle:$p < .001$, older: $p < .01$).
Post-hoc Tukey analysis reveals that the stuttering rates of function words in the first position was higher compared to the others.

Effect of absolute position of content and function words in a 'Phonological word'

The position of function words in sentence initial phonological words and non-initial phonological words were studied separately by the authors.

Effect of position of function word in utterance initial phonological word:

Calculated z scores-normalized stuttering rates over position of function words in a phonological word- 1 through 3 and 4+.

One way ANOVA showed significant effect of positions in a phonological word on the stuttering rates of function words for all age groups:(Young:p<0.001, Middle:p<0.001, Older:p<0.001, Teenagers:p<0.001, Adults:p<0.001). For all age groups, phonological word-initial function words were stuttered more than phonological word-non-initial function words, as per post-hoc Tukey test.

Effect of position of function word in utterance non-initial phonological word:

Function words were stuttered more at the initial position of the utterance non-initial phonological word for all age groups, according to ANOVA and Post-hoc Tukey testing (Young:p<0.001], Middle:p<0.001, Older: p<0.001], Teenagers: p<0.05, Adults:p<0.05).

Effect of content word position in a phonological word on stuttering rate:

Analyses revealed no significant effect of content word positions in a phonological word over stuttering rate.

To prove that phonological word position, not utterance position, is the most important factor:

Stuttering rates of function words in the final position of an utterance-initial phonological word were compared to stuttering rates of function words in the starting position of an utterance non-initial phonological word using raw scores. According to Wilcoxon's matched pairs signed-ranks test, the stuttering rate of function words that came late in utterance-initial phonological words was lower than that of function words that appeared at the starting position in utterance non-initial phonological words (young, $p = .142$; middle, $p < .05$; older, $p = .083$; teenager, $p < .05$; adult, $p < .01$).

To see if the strategy of postponing content word production works within phonological words.

								Wilcoxon matched pairs signed-ranked tests were performed to investigate if stuttering rates on pre- and post-content function words differed, and if this was true across utterance positions. *For utterance-initial phonological words:* For all age groups, the rates of stuttering of pre- and post-content function words were significantly different. (young, $p<.005$; older, $p<.01$; teenager, $p<.05$; adult, $p<.05$). *For utterance-non-initial phonological words:* For each group, Wilcoxon tests on non-initial phonological words were also significant (young, $p < .05$; middle, $p < .01$; older, $p < .01$; teenager, $p < .05$; adult, $p < .005$).
4	Au-Yeung et al., 2003	Cross-sectional study. The authors conducted the study on 42 participants (28 children, 9 teenagers (G4:12-16yrs) and 9 adults	Spanish	CWS (28) G1:7 G2:11 G3:10	28 CWS G1:3-5 yrs G2: 6-9 yrs	Word Class	Spontaneous speech	Each word in a phonological word was classed as a Pre-Content function (Pre-F), Content word, or Post-Content function word by the authors (Post-F). The results were reported in terms of

	(G5:20-68yrs), who have been diagnosed as having developmental stuttering with no concomitant disorder. They recorded spontaneous speech samples for later analysis.	G3:10-11 yrs	**Pre-F and Post-F dysfluencies of function words in relation to their position** Word type had a significant effect (p<.001). Pre-F had a substantially greater stuttering rate than Content (p =.0000), which had a higher stuttering rate than Post-F (p =.0039), according to post-hoc Tukey testing. There was no substantial difference in stuttering rates by age group. (p =.953) However, there was a substantial relationship between age groups and word type. The separation of stuttering rates across Pre-F, Post-F, and Content altered between ages (p<0.05). Post-hoc analyses revealed that Pre-F had a significantly greater stuttering rate than Content and Post-F for individuals in G1 and G2. {Pre-F & Content: G1, *p* = .0000; G2, *p*= .0322; Pre-F and Post-F: G1, *p* = .0001; G2, *p* = .0023}. There was no significant effect found for G3. **Dysfluencies of function and Content words in regards to their ordinal position in a Phonological word.**

Separate two way ANCOVAs were done for function and content words.

Function Word:

The main effect of word position was significant ($p<0.001$). Stuttering rates were substantially greater for function words that appeared in the first word position compared to the second and third {Position 2, $p = 0.0000$) and Position 3 ($p = 0.0000$)}, according to post-hoc Tukey analysis. The age group's main influence was not significant.

The interaction between word position and age group was significant ($p < .005$).

Post-hoc Tukey tests reveal that for G1 the function words in first position had higher disfluencies compared to the other positions{position 2 (p = .0000) or position 3 (p = .0000)}.

Content Word: (Positions-1,2,3,4)

The main effect of age group was significant.

Post hoc Tukey test shows adults have higher proportion of content word dysfluencies than children in G1 (p = .0173).

The main effect of word position was not significant and neither was the interaction between age group and word position.

Exchange of disfluencies from Function to content words

The main effect of word type (Content and Pre-F) is found to be significant using ANCOVA. The rate of disfluency on function terms was higher than on content words, according to a post hoc Tukey analysis. There was no discernible primary influence of age group. However, there was a significant interaction between age group and word type, indicating that the rate of stuttering between function and content words has varied over time. Content word stuttering rates were lower in G1 in comparison with G3, G4, and G5 (p =.0073), G4 (p =.0103), and G5 (p =.0085), according to a post hoc Tukey analysis. For G1 and G2, function word stuttering rates were higher than content word stuttering rates (G1, p =.0000; G2, p =.0002).

5	Bloodstein & Gantwerk, 1967	To find the effect of grammatical function on CWS, the authors conducted a study on 13 CWS, recorded their spontaneous speech, and classified them as nouns, adjectives, pronouns, adverbs, conjunctions, interjections, articles, prepositions, verbs.	English	13 CWS (9M,11 F)	2;11 – 6;6 years	Word class	Spontaneous speech (Conversation)	In this study, the average proportions in which the parts of speech were represented among the stuttered words were compared to the proportions in which the subject's total spoken words were dispersed among the various parts of speech. For the purpose of this review, we club nouns, adjectives, adverbs, verbs as Content words and Pronouns, articles, conjunctions, prepositions as function words and interjections as belonging to an open word class. Analysis of variance reveals that the function word, i.e., pronouns (F=17.29, df=1/12, F 0.05 = 4.75) and conjunctions (F=19.68, df=1/12, F 0.05 = 4.75) appear more often than chance in the proportion of stuttered words. And proportion of content word- i.e., nouns in the stuttered words fall below chance factor.

6	Bloodstein & Grossman, 1981	Case-Series (Also mentions group results) The authors conducted a case-series study on five children with stuttering – A (5 years), B (4years 4 months), C (4 years 7 months), D (5 years 7 months), and E (3 years 10 months). They measured one morphological factor taken up in this review- Word class (function vs. content). Recordings of the children's spontaneous speech (picture description, narration and monologue) was done, after which it was transcribed and marked for speech disfluencies.	English	5 CWS A (5 years), B (4years 4 months), C (4 years 7 months), D (5 years 7 months), and E (3 years 10 months).	3 years 10 months to 5 years 7 months	Word class	Spontaneous speech (picture description, narration and monologue)	Chi-square tests revealed that all subjects except subject B stuttered more on function words. Subject B stuttered equally on both content and function words. When the data was combined for the 5 subjects as a group, t test showed that the function words were stuttered more than the content words ($t=3.01$, $df=4$, $p<0.05$).

7	Buhr et al., 2016	Cross-sectional study. 13 preschool CWS were chosen for the study. CWS' narrative samples on any of 4 story books chosen were recorded and transcribed. Later stuttering moments were coded for part word repetitions (PWR) and monosyllabic whole word repetitions (WWR).	English	13 preschool CWS (4M, 9F) 15 preschool CWNS (7M, 8F)	13 CWS (37-60 months) 15 CWNS (37-59 months)	Word Class	Spontaneous speech (narration)	Chi square tests reveal that, CWS tend to produce more repetitions on function words than content words when compared with CWNS. CWS tend to produce more PWR than WWR on content words and more WWR than PWR on function words (χ^2(1, N=625) =4.019, p=0.045, Cramer's V=0.08).
8	Choi et al., 2020	Cross-sectional study The authors recruited a total of 21 monolingual participants from two locations- 10 Korean speaking CWS from Seoul, South Korea and 11 English speaking children from Alabama, United States of America. 5 narratives for each participant was recorded	Korean, English	10 Korean (7M, 3F) 11 English (7M, 4 F)	3-7 years Korean (Mean= 56.6 months) English (Mean= 59.6 months)	Word Class	Spontaneous Speech (Picture description)	The results were presented in 3 parts: **Stuttering on content and function words- Korean speakers and English speakers** *Within-group findings:* Wilcoxon Signed ranks test showed that, Korean-speaking CWS stuttered more on content words than function words{p=0.013} and English-speaking CWS stuttered more on function words than content words{p=0.003}. *Between-group findings:*

and transcribed for further analysis. The participants were paid volunteers.

Mann-Whitney U test revealed that there is differences between percent of function (p = .005) words stuttered by Korean-speaking and English-speaking CWS. Similar results were found for content (p = .016) word dysfluencies also.

Stuttering on utterance initial versus other positions- Korean speakers and English speakers

Within-group findings:

Both Korean and English-speaking CWS stutter more at utterance-initial word locations than at utterance-medial and final word positions{Korean: medial: p=.005, final: p = .005, English: p = .003, final: p = .003}.

Between-group findings:

In terms of stuttering rates at various word positions in an utterance (utterance-initial position, utterance-medial position, and utterance-final position), there was no significant difference between Korean-speaking and English-speaking children.

Proportion of Function/Content words at utterance initial positions- Korean speakers and English speakers

Within-group findings:

Korean-speaking CWS produced more content words at utterance-initial word positions than function words {p = .001}.

English-speaking CWS produced more function words at utterance-initial word positions than content words {p<.001}.

Between-group findings:

There were significant differences in the number of function words produced at utterance initial position between Korean-speaking and English-speaking children, as well as a significantly lower percentage of function words produced at utterance initial position in Korean-speaking CWS than in English-speaking CWS (p<.001).

9	Dworzynski et al., 2003	Cross-sectional study. 15 adults and 17 school aged children took part in this study. All were diagnosed as having stuttering by a SLP. Recordings of a monologue on certain topics were done and then transcribed for further analysis. All the words were coded for brown factors. Coded 1 for long (5+), content word, word starting with consonant, first three positions in an utterance and 0 for short (<5), function word, word starting with a vowel, word at other positions in an utterance.	German	17 CWS (11M, 6F)	7 years 4 months to 11 years 11 months	Word Class	Spontaneous speech (Monologue on a topic of choice)	The interaction between content word/function word factor and age was significant ($F (1, 29) = 4.963$, $p<0.05$). Follow up tests reveal that function word disfluency was higher in children ($F (1, 29) = 5.697$, $p<0.05$) and content word disfluency were lower in the same population ($F (1, 29) = 4.205$, $p<0.05$) in comparison with adults. Although within group analysis reveals that this factor is not significant, there is a trend of content words being stuttered more than function words when inspecting the bar graph that shows adjusted stuttering rates for all the factors studied in German speaking CWS.

10	Howell & Au-Yeung, 1995	Cross-sectional study. Study done on 31 stutterers (6 young, 15 middle, 10 old) and 48 controls. Spontaneous speech was recorded and transcribed and disfluencies were marked and words coded for phonologic difficulty and browns factors.	English	31 CWS Young (6): 4 Mild, 2 Severe Middle(15): 11 Mild, 4 Severe Old (10): 3 Mild, 7 Severe	31 CWS Young (6): 2;7 – 6 years 5 controls Middle(15): 6;0 – 9;7 years 31 controls Old (10): 9;4 – 12;7 years 12 controls	Word class	Spontaneous speech (Conversation)	According to interaction effects in ANOVA, this factor was not significant in incidence of stuttering.
11	Howell & Au-Yeung, 2007	Cross-sectional study. Study was conducted on 35 participants (19 CWS, 7 teenagers who stutter, 9	Spanish	19 CWS (15M,4 F)	6-11years	Word Class	Spontaneous speech	Although the authors did not take the difference between stuttering rates of function and content words, they have still

		AWS) in United Kingdom. Authors recorded conversational samples which was transcribed and marked for disfluencies and also all the words were coded for IPC scores before further analysis.					(conversation)	noted a finding related to word class and present it in relation to phonetic complexity: It was found that, stuttering rates of function words are above those of the content words with corresponding IPC values for all points for CWS.
12	Howell et al., 1999	Cross-sectional study The authors conducted the experiment on 51 individuals who stutter (Children, Teens and Adults) and 68 individuals who do not stutter (Children, Teens and Adults). The spontaneous monologue was recorded, transcribed and marked for disfluencies and for word type- content or function word before further analysis.	English	31 CWS G1:6;(4M,2F) G2:15;(11M,4F) G3:10;(8M,2F)	31 CWS G1: 2-7 years G2: 7-9 years G3: 10-12 years	Word Class	Spontaneous speech (monologue)	It was observed that the effect of word type ($p<0.001$) and the interaction between word type and age group ($p<0.001$) were both significant. There was no discernible effect of age group. For all age groups, including CWS- G1, G2, and G3, this was regarded as function words were stuttered more than content words. G1 was shown to have much greater disfluencies on function terms than on content words, which decreased until the age of 10-12 years old, after which content word dysfluencies increased.

13	Howell et al., 2010	Longitudinal study. The authors followed a total of 26 children who stutter over a year of time and analysed the stalling and advancing characteristics of different word types (F1- mono-syllabic function word; C1- monosyllabic content word, C2- bi-syllabic content word). The advancing for word type are as follows : F1- Sound prolongations, Sound/syllable repetitions and broken words. C1- Sound prolongations, Sound/syllable repetitions, broken words and monosyllabic whole word repetitions involving C1s.	English	14 CWS classified as persistent at 12+ (10M,2 F)	Initially 8-10 years, followed till 12+.	Word class	Spontaneous speech (monologue)	There was a word type interaction between age group and dysfluency type ($p<0.40$), showing that the exchange pattern was reliant on word type. There was also a higher order interaction between these three components and speaker group ($p<0.043$), indicating that the exchange pattern was influenced by more than just word type. This interaction was based on the fact that for both F1 and C1 the de persistent children CWS do not change the percentage of stallings and advancing they use (Stallings account for roughly 60% of all, characteristics, and advancing for 40%). So according to the graph put in the results of this study, there was no difference between the number of stallings(~60%), between F1 and C1 words and no difference between the percentage of advancing(~40%), between F1 and C1, even though statistics was not run to determine the significance.

C2- Sound prolongations, Sound/syllable repetitions, broken words and multisyllabic whole word repetitions involving C2s.

The stallings for word type are as follows :

F1- interjections just before F1, monosyllabic whole word repetitions involving F1.

C1- interjections just before C1, monosyllabic whole word repetitions involving C1.

C2- interjections just before C2, multi-syllabic whole word repetitions involving C2.

The Authors measured speech samples at three age levels – 8-10, 10-12, 12+.

14	Juste & Andrade, 2006	Cross-sectional study. The authors conducted the study on 80 children between 4.0 and 11.11 years of both genders (58 male and 22 female). This population includes CWS and age and gender matched CWNS. The spontaneous speech was recorded, transcribed and disfluencies both typical and atypical and also the words were classified based on the grammatical class. The authors have not mentioned language explicitly here but according to another article published by the same author which was related to this article, it was assumed that it was Brazilian Portuguese.	Brazilian Portuguese	40 CWS (29M, 11F) 40CWNS (29M, 11F)	4;0 – 11;11 years	Word Class	Spontaneous speech (Picture description, conversation)	When the overall disfluencies (typical and atypical) were taken into account the authors found that the function words were significantly stuttered more than content words for both CWS ($p=0.007$) and CWNS ($p<0.001$). For atypical disfluencies the authors found that there was no significant difference between function and content words stuttered for CWS ($p<0.090$) and CWNS ($p<0.860$).

15	Juste et al., 2012	Cross-sectional study. The authors conducted the study on 90 individuals who stutter and their age and gender matched controls (Children, Teenagers, Adults).The authors recorded the spontaneous speech transcribed it and marked the disfluencies and classified the words based on the grammatical class.	Brazilian Portuguese	30 CWS (19M, 11F) 30 CWNS (19M, 11F)	4;0 – 11;11 years	Word Class	Spontaneous speech (Monologue, Conversation)	For CWS (p=0.037) and CWNS (p=0.001), the Wilcoxon matched pairs test demonstrated that the frequency of stuttering for function words is considerably higher than that for content words. For AWS, the reverse was found. There was no discernible difference between function and content word stuttering in teen stutterers. A series of Friedman ANOVA demonstrated that the content word category (noun, verb, adverb, adjective, numeric) has a significant effect on CWS (p<0.001). Verbs were shown to have a higher rate of stuttering than other groups. On verbs, TWS and AWS had higher stuttering rates. A series of Friedman ANOVA demonstrated that the function word category (article, preposition, conjunction, interjection, pronoun) has a significant effect on CWS (p<0.001). Articles had a higher rate of stuttering than the other categories. On prepositions, AWS and TWS have higher stuttering rates.

16	Mehrpour & Meihami, 2017	Cross-sectional study. Done on 6 CWS and 8 CWNS to find the difference in PWR (Part word repetition) and WWR (whole word repetition) in relation to word type (content vs. function). The authors recorded spontaneous speech – conversations using 'positioning theory' as their basis. Then the data was transcribed and words categorized in terms of disfluency types – PWR and WWR and word types- content and function.	Persian	6 CWS (3M,3F)	5-7 years	Word Class	Spontaneous speech (Conversation)	The authors have not done any statistical analysis to see whether the disfluencies occur differently on content vs. function words. But for the purpose of this review, the data from the graph put forth in the article, which gives the mean of PWR and WWR on content and function words produced by CWS and CWNS, it was interpreted that the content word had more disfluencies (mean PWR (10.5) + mean WWR (2.5) = 13) than function words (mean PWR (2.5) + mean WWR (1.2) = 3.7).
17	Natke et al., 2004	Cross-section study was conducted on CWS. The authors recorded	German	22 CWS	2.1 to 5 years	Word class	Spontaneous Speech	After the analysis the authors found that in CWS, the stuttering frequency of function

		spontaneous conversations of the children using play activities, transcribed them and classified each word with regards to stress and grammatical class; also the syllables were classified based on within word positions. Although the within word position and grammatical class here was measured to rule out their effect as confounding variables in measuring the effect of linguistic stress in CWS.		(14M,8F)			(Conversation)	words were higher than that of content words (t (21) =5.04, $p<0.001$).
18	Richels et al., 2010	Cross-sectional study. Authors conducted two studies – study 1 and study 2 each with different set of 30 participants who stutter. The method of data acquisition is similar for	English	STUDY 1 30 CWS (21M,9F)	Mean age = 49.4 months SD=9.7 months	Word Class	Spontaneous speech (Conversation)	Study 1 Results: To investigate if the tendency to stutter on function words differed from the tendency to stutter on content terms, researchers compared the proportion of all function words that were stuttered to the proportion of all content words that were stuttered. According to the

	both Study 1 and 2 except for a different population. Their spontaneous speech was recorded and transcribed, words coded for function and content, disfluencies marked before further statistical analyses. Study 1 was to do with grammatical class and study 2 was more to do with involving the assessment of utterance position and MLU quartile.						results of a 2x2 contingency table analysis , the proportion of all function words that were stuttered (12.0 percent) was substantially higher (p<.001)than the proportion of all content terms that were stuttered (6.2 percent). The 30 participants were subjected to a Wilcoxon signed-rank analysis to check if their tendency to stutter on function words was consistent. The findings revealed that 83 percent (25) of CWS stuttered more on function words, while 17 percent (5) stuttered more on content words (p< 0.001).
		English	STUDY 1 30 CWS (21M,9F)	Mean age = 50.53 months SD = 9.32 months	Word Class	Spontaneous speech (Conversation)	Study 2 Results: According to the results of a 2x2 contingency table analysis, the proportion of all function words that were stuttered (9.6%) was substantially higher than the proportion of all content terms that were stammered (5.5%) (p<.001). The 30 participants were subjected to a Wilcoxon signed-rank analysis to check if their tendency to stutter on function words was consistent. The findings revealed that 93 percent (28) of CWS stuttered more on

								function words and 7% (2) stuttered more on content terms ($p<0.001$).
19	Seth & Maruthy, 2019	Cross-sectional study. The study was done on 20 pre-school CWS. The spontaneous speech was recorded, transcribed and disfluencies marked. The words were classified according to phonological (phoneme position, phoneme type, word length) and morphological factors (Word class ad word inflection)	Kannada	20 CWS (15M,5 F)	3;0 – 6;0 years	Word Class	Spontaneous speech (Conversation)	The frequency of stuttering on content and function words did not differ significantly, according to paired Wilcoxon signed rank test.
						Word Inflection	Spontaneous speech (Conversation)	There was no significant difference in the frequency of stuttering on words with and without inflection, according to paired Wilcoxon signed rank test.
20	Vahab et al., 2013	Cross-sectional study The study was conducted on 12 Persian CWS. The authors studied the influence of lexical categories on stuttering rates in these children. They video recorded the	Persian	12 CWS (10M,2 F)	7;5 years to 10;6 years	Word Class	Spontaneous speech (Narrative task)	The mean percentage of stuttering on the words under each lexical category was- 29.96% on C words, 17.06% on Fwordsand 21.25% on C–F words. Wilcoxon's signed rank test showed that mean rank of stuttered F words was significantly different than that of stuttered C words ($p=0.008$). Stuttering rates of C

	children performing a narrative and reading task. The samples were transcribed and words coded into three lexical categories – Content, Function and Content-Function words.			words were significantly higher than that of F words. The difference between stuttering rates of C and C-F and F and C-F words were not statistically significant.
			Reading task	The mean percentage of stuttering on the words under each lexical category was- 14.6% on C words, 8.86% on Fwordsand 21.24% on C–F words. Wilcoxon's signed rank test showed that mean rank of stuttered F words was significantly different than that of stuttered C words ($p=0.01$). Stuttering rates of C words were significantly higher than that of F words. The difference between mean ranks of C and C-F ($p=0.008$) and mean ranks of F and C-F words ($p=0.005$) were also statistically significant.

21	Williams et al., 1969	Cross-sectional study. Authors did study on 152 children (76 CWS, 76 CWNS) and recorded their speech sample and analysed the words for disfluencies and categorized them according to 4 brown's factors- grammatical class, Word length, Initial phoneme, Sentence position.	English	76 CWS (M:F ratio is approximately 4:1)	5;0-12;10 years	Word class	Spontaneous speech – Repetition for younger and Reading for older	For each of the 76 CWS, two percentages were obtained: (1) the percentage of the total number of uttered words that had the attribute, and (2) the percentage of the disfluently uttered words that had the attribute. The child was categorized as being 'disfluent' for that attribute if (2) exceeded (1). X^2 one sample test reveals that there was a significant difference between number of CWS who were and were not classified as 'disfluent' for the word class (content vs. function) category ($p<0.05$).