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

Vijayeshwari S

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(Speech-Language Pathology)

University of Mysore

Mysuru

ALL INDIA INSTITUTE OF SPEECH AND HEARING

Manasagangothri, Mysuru-570006

September 2021

CERTIFICATE

This is to certify that this dissertation entitled **"Effect of phonological and morphological factors on the frequency of stuttering in adults 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: 19SLP037. This has 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.

Mysuru

September 2021

Prof. M. Pushpavathi

Director

All India Institute of Speech and Hearing

Manasagangothri, Mysuru-570006

CERTIFICATE

This is to certify that this dissertation entitled **"Effect of phonological and morphological factors on the frequency of stuttering in adults 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.

Guide

Mysuru

September 2021

Dr. Santosh M.

Associate Professor

Department of Speech-Language Sciences

All India Institute of Speech and Hearing

Manasagangothri, Mysuru-570006

DECLARATION

This is to certify that this dissertation entitled **"Effect of phonological and morphological factors on the frequency of stuttering in adults 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.: 19SLP037**

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CHAPTER 1

INTRODUCTION

Stuttering refers to "disorder in the rhythm of speech in which an individual precisely knows about what he wishes to say but at the same time is unable to say because of an involuntary repetition, prolongation, or cessation of a sound (WHO, 1977)". Typically the onset of stuttering begins between 2-5 years of age (Andrews & Horris, 1964; Dworzynski et al., 2007; Yairi & Ambrose, 2004). It is more prevalent in males compared to females, with a ratio of 4:1 (Bloodstein, 1996). In approximately 50% of children who develop stuttering, it spontaneously resolves. Hence, a large majority of children develop persistent developmental stuttering.

Evidence from the literature suggests that stuttering is a multi-factorial disorder; factors such as cognitive, motor, linguistic, and environmental factors are responsible for the development and progression of the disorder (Smith & Weber, 2017; Smith & Kelly, 1997). Among the factors that influence the frequency of stuttering, several evidences support a strong connection between stuttering and linguistic factors at both the word and sentence levels (Anderson & Wagovich, 2010; Coulter et al., 2009; Howell & Au-Yeung, 2002; Richels et al., 2010; Seth & Maruthy, 2019; Weber-Fox et al., 2008).

1.1. Factors affecting stuttering

The earliest investigation (Brown, 1945) reported specific linguistic contexts are more prone to cause stuttering in the native speaker of English. The frequency of stuttering in adults who stutter (AWS) was more on initial utterance position than any other positions of a sentence, words with initial consonants than vowels, longer words than shorter words, and content words than function words. Further, the subsequent studies performed in English, Spanish, and Kannada language in AWS have confirmed

the findings by Brown(Au-Yeung et al., 2003; Dayalu et al., 2002; Dworzynski et al., 2003; Griggs & Still, 1979; Howell & Au-Yeung, 2007; Jayaram, 1983; Jayaram, 1981; Venkatagiri et al., 2016; Wingate, 1967). However, in languages like Germany, Arabic, Persian, these findings were contradicted (Abdalla et al., 2010; Al-Tamimi et al., 2013; Dworzynski et al., 2003; Dworzynski & Howell, 2004; Masumi et al., 2015; Phaal B; Robb, 2007).

1.1.1. Phonological factors

The variables investigated under phonological factors are phoneme category (words beginning with consonant/vowels), phoneme position (initial position/ final position of utterance), word length (monosyllable, bisyllable, trisyllable, or multi-syllable words), word shape, and phonological complexity. Studies have recorded higher stuttering rates in the initial position of the word, clause, and utterance in AWS in English, Kannada, and Spanish languages(Brown, 1938b; Griggs & Still, 1979; Hahn, 1942; Jayaram, 1984; Johnson & Brown, 1935; Soderberg, 1967; Taylor, 1966; Wingate, 1979). Similarly, the rate of stuttering was also increased on words with initial consonants than vowels in both AWS and CWS (Brown, 1938a; Hahn, 1942; Jayaram, 1983; Seth & Maruthy, 2019; Spencer & Weber-Fox, 2014; Taylor, 1966; Wingate, 1967) because the production of consonants require more precise movement of articulators making it more complicated. Researches in AWS in different languages that investigated the influence of word length have shown more stuttering on longer words (words with more than two syllables) (Al-Tamimi et al., 2013; Brown & Moren, 1942; Griggs & Still, 1979; Soderberg, 1966; Taylor, 1966; Venkatagiri et al., 2016; Wingate, 1967). Further, Howell, Au-Yeung and Sackin, (2000) described that in AWS, phonological complexity contributed to the factor for disfluency in the case of content words only. However, for Persian-speaking AWS, phonetic complexity and syllable

length did not significantly affect the stuttering rate (Masumi et al., 2015). Similarly, in German-speaking AWS, phoneme category and phonetic complexity were not responsible factors for disfluency (Dworzynski et al., 2003; Dworzynski & Howell, 2004).

1.1.2. Morphological factors

Word class is one of the majorly studied morphological factors. Grammatically word class can be categorized into content and function words. Content words include nouns, main verbs, adjectives, and adverbs, whereas pronouns, articles, prepositions, conjunctions, modals, auxiliary verbs, and inflections are function words (Brown & Fraser, 1964). The linguistic organization is found to be different in these word categories. Content words are dynamic and offer expansion, so they are labelled as an open linguistic set, while function words are a closed linguistic set because the addition of new words is rare in this category (Hartmann, 1972; Quirk, 1985).

In comparison, function words occur more frequently, have simple linguistic elements, and increased predictability with restricted information (Kucera & Francis, 1970; Quirk & Stein, 1990). Also, in terms of prosodic characteristics, function words are less stressed, have more flat contours of the fundamental frequency, and shorter vowel shifts (Bard & Anderson, 1983; Wingate, 2002). Moreover, the retrieval and encoding are accessed through the different systems as storage of content and function word occurs in different mental lexicons (Bock & Levelt, 1994; Levelt, 1992). The available evidences are mixed regarding the stuttering rate in content versus function words in AWS. Some studies have reported a high disfluency on content words (Au-Yeung et al., 1998; Brown, 1937; Dayalu et al., 2002; Eisenson & Horowitz, 1945; Jayram, 1981; Wingate, 1979). And few studies have found no significant differences

on either type (Abdalla et al., 2010; Dworzynski et al., 2003; Phaal & Robb, 2007). Mostly English, German and Spanish share many standard features as they belong to the Indo-European language family. Nonetheless, the distribution of stuttering in languages other than Indo-European languages is different. Besides content and function words in the grammatical class, hybrid content-function words are also present in Arabic, Persian, and Kannada. Among these languages as well, variations are observed regarding the rate of stuttering in different grammatical classes. A study by Abdalla et al., (2010) in Kuwaiti Arabic, speaking AWS, reported no significant effect in stuttering rate among content words, function words, and content-function words. Likewise, in the Kannada language, there was no variation in disfluency frequencies between content-function words and pure content words in AWS (Venkatagiri et al., 2016). Whereas, in the native speaker of Jordanian Arabic CWS and AWS, a significantly higher stuttering frequency was observed on hybrid function-content words than content and function words (Al-Tamimi et al., 2013). Hence, influencing factors of stuttering are highly determined by the linguistic feature of the language, which is varied among the world's languages. Similar to word class, inflectional morphology is also a factor studied under morphology. However, it is a less explored factor, and available literature is limited. Inflectional morphology includes free or bound forms. A study by (Marshall, 2005) reported no significant effect of word inflections in English-speaking AWS concerning the frequency of stuttering.

Need for the Study

Linguistic factors on stuttering frequency are well-documented for various languages, and variations are observed across the languages. Different languages have different structures. A vast amount of literature is available regarding the same; several studies discuss the influence of various phonological and morphological factors on the

frequency of disfluency in adults who stutter. There is a need for a systematic review to compile significant studies to understand the relation between these factors and their impact on adults who stutter.

Aim

To systematically review the literature on the effect of phonological and morphological factors on the frequency of speech disfluencies of adults who stutter.

CHAPTER 2

METHOD

A systematic literature search was conducted to review the literature on the effect of phonological and morphological factors on the frequency of speech disfluencies of adults who stutter. Using keywords related to phonological factor/s and morphological factor/s that influence the frequency of stuttering in adults using PubMed, Science Direct, J-Gate, and ERIC databases. A PICO (Population, Intervention, Control, and Outcome) was carried out to arrive at the following keywords. They were used in various combinations under various categories were: (a) domain terms (dependent variables): *stuttering, stutter, stammering, disfluencies, dysfluencies;* (b) population terms (address the participants involved in the study): *adult, individual, PWS (Person who stutter), AWS (Adults who stutter), stutterers;* and (c) skill terms (independent variables): *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.* Boolean operators AND or OR, along with the keywords, were used to create search strings for various databases. A two-step search procedure was carried out, which included (a) an electronic database search and (b) a snowball search where references to all relevant articles identified were reviewed.

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 "syllable shape" or "word category" or "word class" or "word ending" or "word inflections" or " word length" or "word position" or "loci of stuttering") AND ("person" or "adult" or "individual") AND ("Stutterers" or "stutter" or "PWS" or "disfluencies" or "dysfluencies" or "AWS" or "stuttering"))

2.1 Study selection

Articles collected from electronic databases were compiled together in Rayyan QCRI (Ouzzani et al., 2016). Rayyan software is a free, user-friendly web tool designed to conduct systematic reviews, scoping reviews, and other knowledge syntheses, which help researchers speed up screening and selecting studies. Regardless of the study design, all types of studies investigating the effect of phonological and morphological factors on the frequency of stuttering in adults were included in the review. A two-stage selection process was endorsed to narrow down to the final corpus of included studies. In Stage 1, the title and abstracts obtained during the database searches individually were further evaluated by the two authors independently. The studies were determined to be eligible to promote to Stage 2 if they met all of the following criteria in table 2.1.

Table 2.1

Inclusion and exclusion criteria for study selection

Inclusion criteria	Exclusion criteria
1. The study included participants as adults who stutter aged from 18-40 years. 2. Articles published till August 2020 were included. 3. Included the articles published in English only.	1. If the study included participants with psychogenic or neurogenic stuttering. 2. Articles that don't focus on factors considered, i.e., phonological factor(s) and morphological factor(s), were excluded. 3. Unpublished studies, reviews, and book chapters.

If the study title and abstracts seemed irrelevant for the review, the study was excluded from further screening. In Stage 2, the full-length study of the selected abstracts was done and was reviewed independently by the author. Only those studies which met all the criteria listed above (Table 2.1) were included in the final review. If there was any conflict in the selection process at any stage while screening titles, abstracts, and full-text, it was resolved by the guide. Figure 1 shows the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flowchart, which outlines the review's steps. The studies included in the present review aimed to address the following questions:

1. Do phonological factors influence the frequency of stuttering in adults?

2. Does the frequency of stuttering in adults vary on the influence of morphological factors?

Data extraction and management

The data extraction was conducted using a form developed based on existing systematic review studies (Gunjawate et al., 2018; Sugathan & Maruthy, 2021). The data extracted from the included studies were: publication details (author and year), study characteristics (study design, the factor studied, and the tools used for the study), participant characteristics (gender, sample size, and the age range in years), and results were obtained.

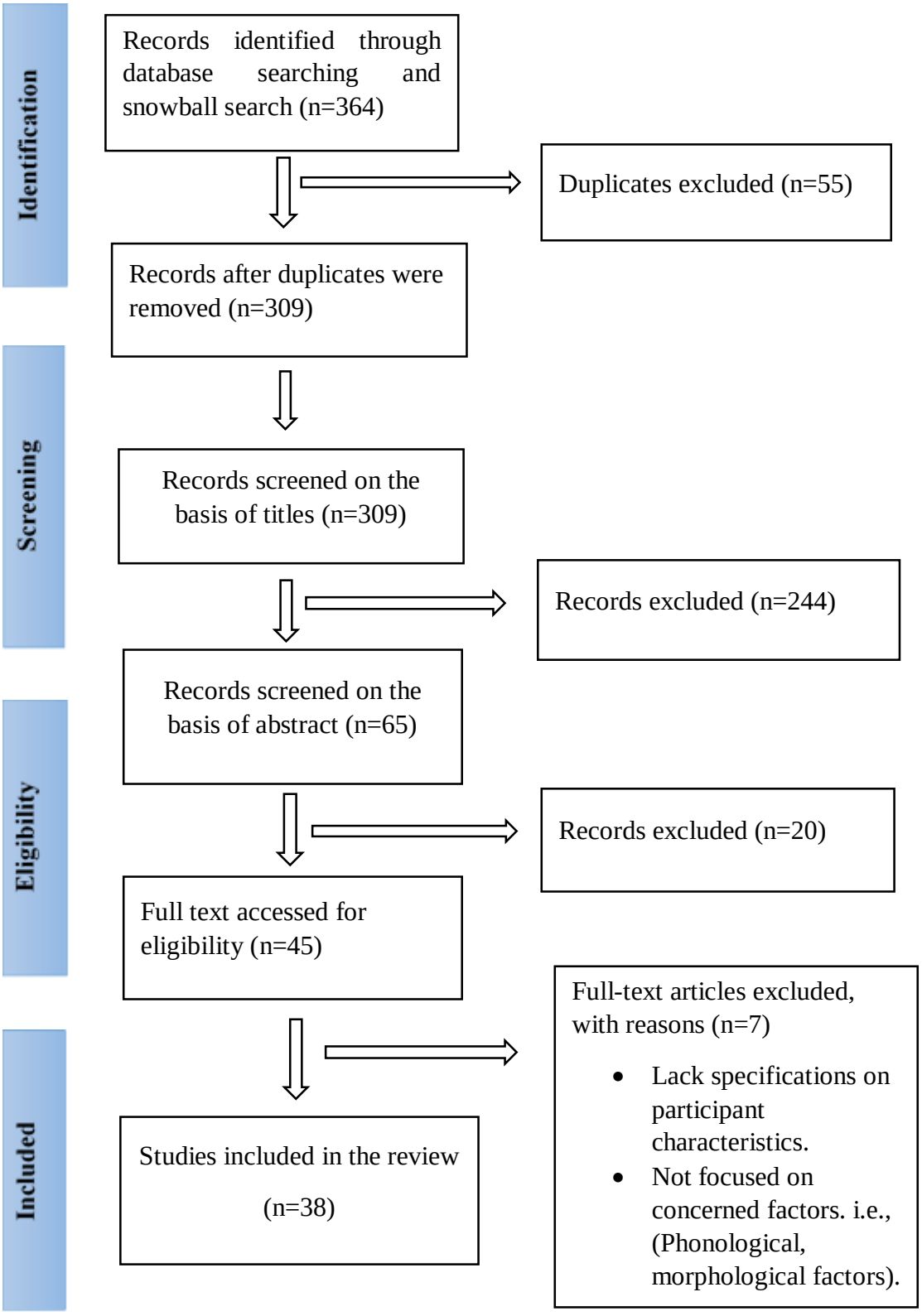


Figure1. The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flowchart outlines this review's steps.

Methodological Quality Appraisal

The methodological quality appraisal was conducted for included studies 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 percentage for each study was calculated by using the formula obtained score/total score × 100. The percentage was used to categorize the studies: as 1) weak (0–33.9%), 2) moderate (34%–66.9%), and 3) strong (above 67%) (Gunjawate et al., 2018). The author coded the quality appraisal of each study, and Table 2.2 displays the methodological quality appraisal tool and the rating obtained for each study. Based on the % score, 37 studies fell into the study category with strong methodological quality, whereas the remaining one study fell under the moderate category.

Table 2.2

Methodological quality appraisal and ratings for included studies.

Sl. No	Study ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Score (%)
1	Johnson and Brown (1935)	1	1	1	0	1	1	1	85.71%
2	Brown (1937)	1	0	1	0	1	1	1	71.42%
3	Brown (1938)	1	0	1	0	1	1	1	71.42%
4	Brown (1938)b	1	1	1	0	1	1	1	85.71%
5	Brown and Moren (1942)	1	1	1	0	1	1	1	85.71%
6	Hahn (1942)	1	0	0	0	1	1	1	57.14%
7	Hahn (1942)b	1	0	1	0	1	1	1	71.42%
8	Brown (1945)	1	1	0	0	1	1	1	71.42%

9	Eisenson and Horowitz (1945)	1	1	1	0	1	1	1	85.71%
10	Quarrington et al. (1962)	1	1	1	0	1	1	1	85.71%
11	Conway et al. (1963)	1	1	1	0	1	1	1	85.71%
12	Wingate (1967)	1	1	1	0	1	1	1	85.71%
13	Danzger and Halpern (1973)	1	1	1	0	1	1	1	85.71%
14	Tornick and Bloodstein (1976	1	1	1	0	1	1	1	85.71%
15	Griggs and Still (1979)	1	1	1	0	1	1	1	85.71%
16	Jayaram (1981)	1	1	1	0	1	1	1	85.71%
17	Jayaram (1983)	1	1	1	0	1	1	1	85.71%
18	Jayaram (1984)	1	1	1	0	1	1	1	85.71%
19	Au-Yeung, Howell and Pilgrim (1998)	1	1	1	0	1	1	1	85.71%
20	Carol and Hubbard (1998)	1	1	1	0	1	1	1	85.71%
21	Howell et al. (1999)	1	1	1	0	1	1	1	85.71%
22	Howell et al. (2000)	1	0	1	0	1	1	1	71.42%
23	Dayalu et al. (2002)	1	1	1	0	1	1	1	85.71%
24	Dworzynski, Howell and Natke (2003)	1	1	1	0	1	1	1	85.71%
25	Au-Yeung, Gomez and Howell (2003)	1	1	1	0	1	1	1	85.71%
26	Dworzynski, Howell, Au-Yeung and Rommel (2004)	1	1	1	0	1	1	1	85.71%
27	Dworzynski and Howell (2004)	1	1	1	0	1	1	1	85.71%

28	Howell, Au-Yeung, Yaruss and Eldrige (2006)	1	1	1	0	1	1	1	85.71%
29	Howell and Au-Yeung (2007)	1	1	1	0	1	1	1	85.71%
30	Phaal and Robb (2007)	1	1	1	0	1	1	1	85.71%
31	Blomgen and Goberman (2008)	1	1	1	0	1	1	1	85.71%
32	Abdalla et al. (2010)	1	1	1	0	1	1	1	85.71%
33	Juste et al. (2012)	1	1	1	0	1	1	1	85.71%
34	Schafer and Robb (2012)	1	0	1	0	1	1	1	71.42%
35	Al-Tamimi, Khamaisehz and Howell (2013)	1	1	1	0	1	1	1	85.71%
36	Maruthy et al. (2015)	1	1	1	0	1	1	1	85.71%
37	Venkatagiri et al. (2017)	1	1	1	0	1	1	1	85.71%
38	Max et al. (2019)	1	1	1	0	1	1	1	85.71%

Q1. Was the research topic or aim of the study stated clearly?

Q2. Was the research population defined and specified?

Q3. Did all of the participants come from the same or similar populations (during the same time period)? Were the study's inclusion and exclusion criteria predetermined and used similarly to all participants?

Q4: Was a sample size justification, power description, or variance and effect estimates provided?

Q5: Were the exposure measures (independent variables) well specified, valid, and reliable in all of the studies?

Q6: Were the outcome measurements (dependent variables) well stated, valid, and reliable in all of the studies?

Q7: Was the impact of potential confounding variables on the association between exposure(s) and outcome(s) quantified and statistically adjusted?

Note: Rating: 0 = no, 1= yes.

CHAPTER 3

RESULTS

The current review was conducted to systematically review the existing literature on the effect of phonological and morphological factors on the frequency of Stuttering in AWS. The search was conducted using five electronic databases (PUBMED, J-Gate, Science direct, and ERIC) and backreference of included articles. The electronic search yielded 364 citations, of which fifty-five were duplicates and were thus eliminated. The remaining 309 titles were screened, 244 articles were excluded, and 65 abstracts were screened based on the inclusion criteria as mentioned earlier and then progressed to a full-text retrieval stage. A total of 20 studies were excluded through abstract screening as they failed to meet the inclusion criteria. Majority of the citations were eliminated because (1) the study was done only on CWS, (2) methodology involved stuttering treatment. Full texts of the remaining 45 studies were reviewed and evaluated independently by the author as to whether or not the studies met all required inclusion criteria. Seven studies were excluded during stage two of review as they were lacking information specifically on participant characteristics (age, gender) and were not focused on the factor of interest. In this manner, 38 studies attained eligibility and were included in the current review.

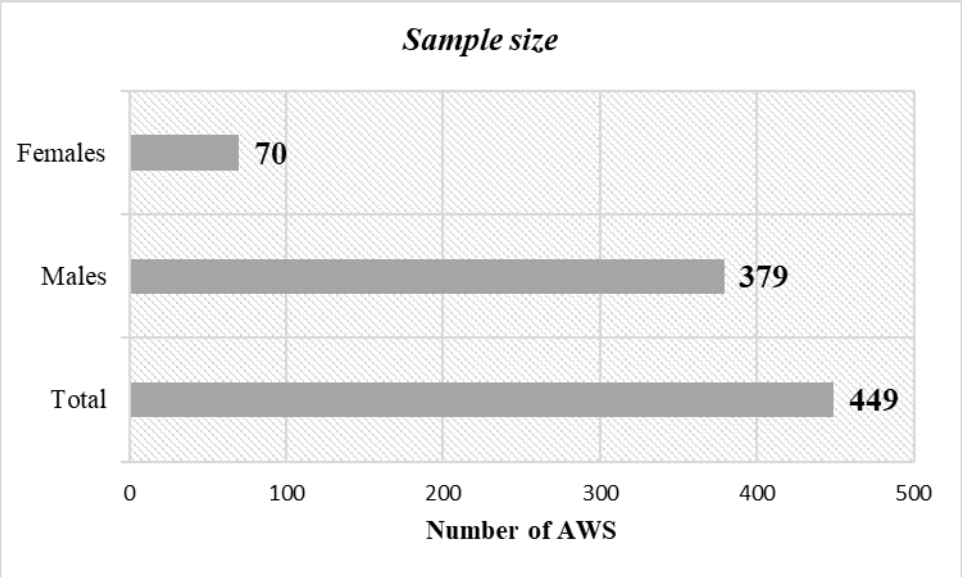
Extraction of data

All the data extracted, including study design, factor studied, participant characteristics, task or tool used, and findings, were tabulated in a summarised table (Appendix A and B). The studies qualified to be included in the review were conducted between 1935 to 2019. The sample size ranged from 2 participants (Griggs & Still,

1979) to 43 participants (Hahn, 1942). The total sample size of AWS across studies is 449, and there were 379 males and 70 females among them, as shown in (Figure 3.1).

Figure 3.1

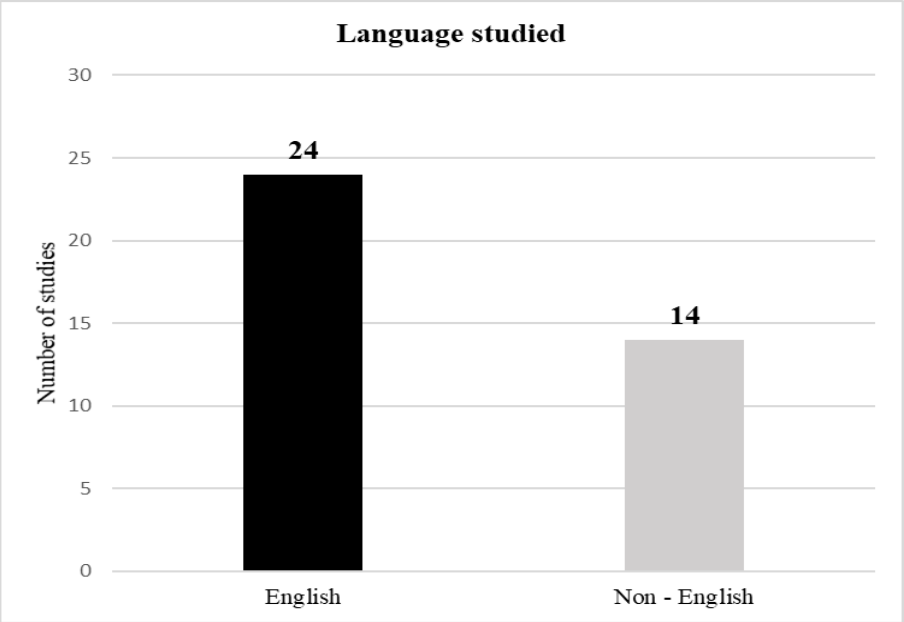
Total sample size and frequency of males and females across the studies



The current review yielded 38 studies conducted on various languages; there were 24 citations on the English language being the majority and 14 studies on Non-English literature, as shown in (Figure 3.2).

Figure 3.2

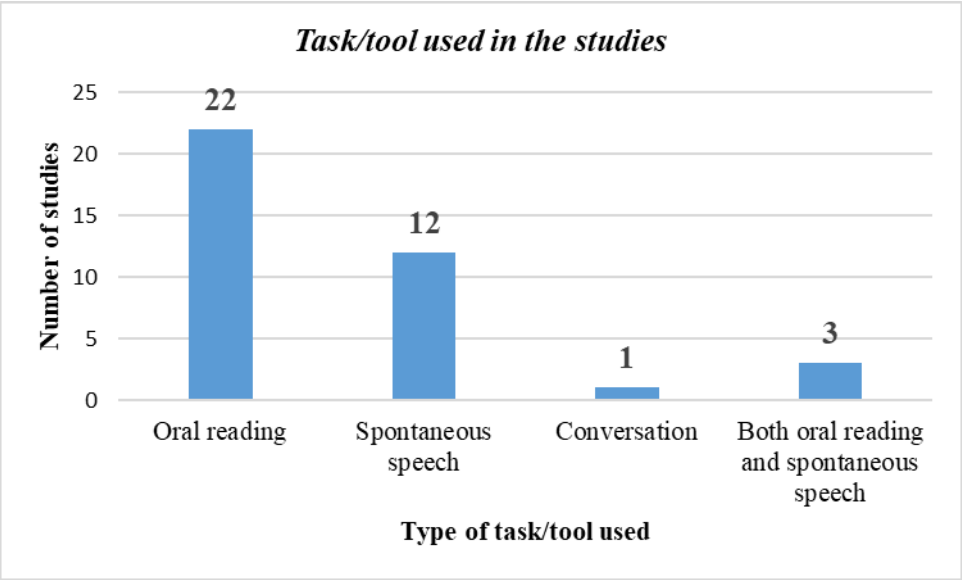
Frequency of various languages used across the studies



There were three tasks/tools utilized to derive the effect of phonological/morphological factor(s) on stuttering frequency. Those were 1) Oral reading, 2) Spontaneous speech, and 3) Conversational speech. Out of these, oral reading has been used in a majority of the citations, i.e., 22 studies, followed by a spontaneous speech in 12 citations; both Oral reading and Spontaneous speech in 3 citations and conversational speech were the least used in only one citation out of 38 studies included (Figure 3.3). All the included studies clearly defined the variables studied and explained the study findings.

Figure 3.3

Frequency of different Tasks/tools used across the studies

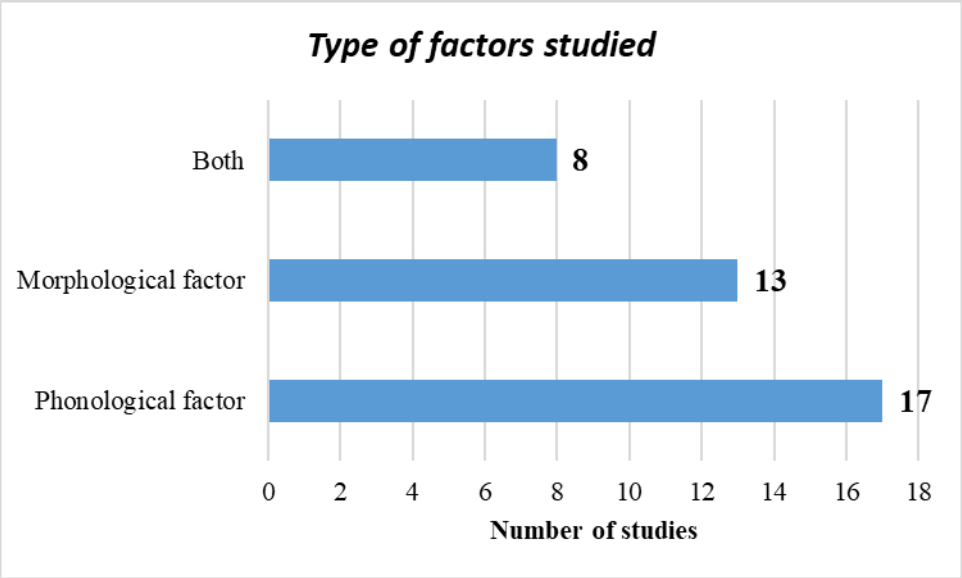


Factors that influence the frequency of stuttering

The current review examined two major linguistic factors influencing the frequency of disfluencies in AWS 1) Phonological and 2) Morphological factors. The phonological factors were further subdivided into four categories a) Phoneme category, b) Phoneme position, c) Word length, and d) Phonological complexity. Among morphological factors, there were two sub-factors, a) Word class and b) Word inflection, as mentioned earlier in the previous chapter. Among 38 studies included, 17 studies examined the effect of phonological factors solely being the majority, 13 studies dedicated only to morphological factors, and eight studies conducted on both phonological and morphological factors (Figure 3.4).

Figure 3.4

Frequency of studies which examined phonological, morphological, or both the factors



3.1 Phonological factors

As mentioned earlier, phonological factors were subdivided into four categories, namely, a) Phoneme category (Vowel v/s consonant), b) Phoneme position (Initial, medial or final position), c) Word length (shorter word v/s longer word), and d) Phonological complexity. The results of each sub-category will be discussed in detail below.

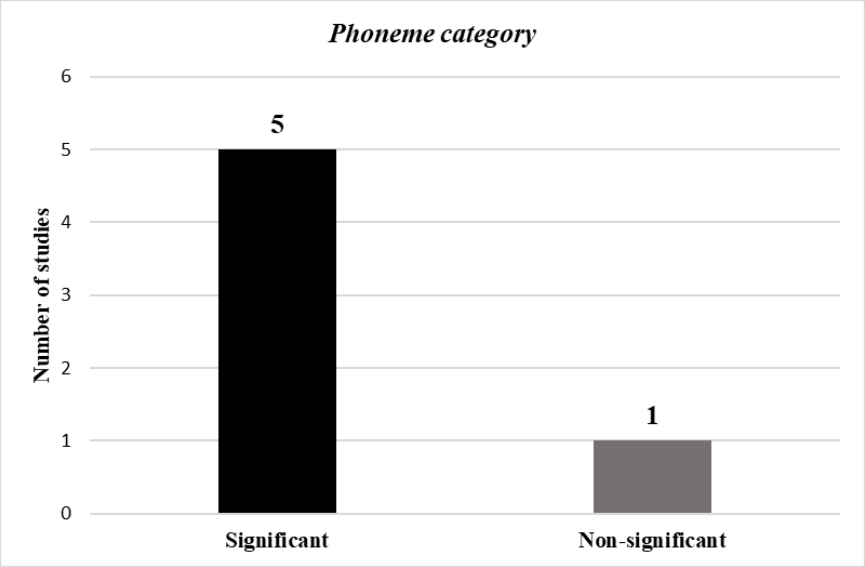
3.11 Phoneme category

The phoneme category included words beginning with vowels and consonants. From the current review, six studies which recruited a total of 145 AWS from five research labs, determined the effect of phoneme category variable; among these, five studies (n = 130) suggested that words beginning with consonants significantly increased stuttering frequency compared to vowels (Brown, 1938a; Hahn, 1942b;

Jayaram, 1983; Johnson & Brown, 1935; Max et al., 2019). And one study (n = 15) found this factor as not significant (Dworzynski et al., 2003), i.e., no significant difference was found between disfluencies on vowels and consonants (Figure 3.5). To conclude, words beginning with consonants produced more disfluencies than vowels.

Figure 3.5

Frequency of studies which investigated effect of phoneme category on stuttering rate in AWS



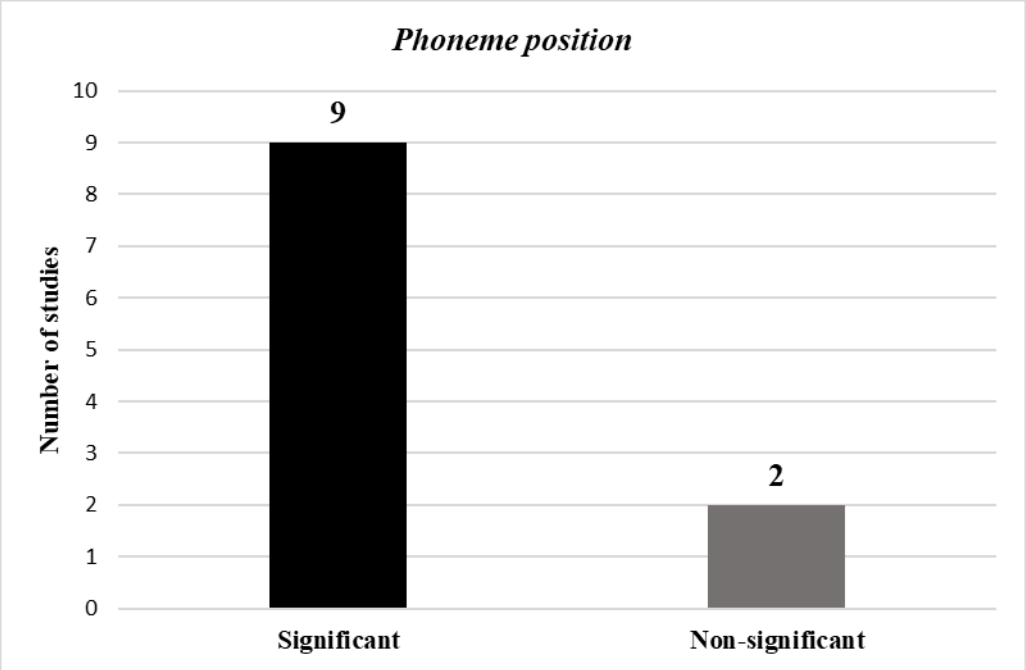
3.12 Phoneme position

Phoneme position included syllables/words with initial position, medial position, or terminal position. From the current review, 11 studies involving a total of 210 adults who stutter from seven labs determined the effect of the phoneme position variable. They found that syllables/words with initial position produced increased disfluencies than any other positions in a word/clause/sentence. Among those 11 studies, nine studies (n = 160) found that effect was significant (Au-Yeung et al., 1998; Brown, 1938b; Brown, 1945; Conway & Quarrington, 1963; Griggs & Still, 1979; Hahn, 1942; Hubbard, 1998; Jayaram, 1984; Quarrington et al., 1962) and two studies

which recruited fifty AWS, found it was not significant (Dworzynski et al., 2003; Max et al., 2019), i.e., there was no significant difference among all the positions of utterance. (Figure 3.6). To conclude, syllables/words with initial utterance position implement more stuttering than in any other utterance position within word/clause/sentence.

Figure 3.6

Frequency of studies which investigated effect of phoneme position on stuttering rate in AWS



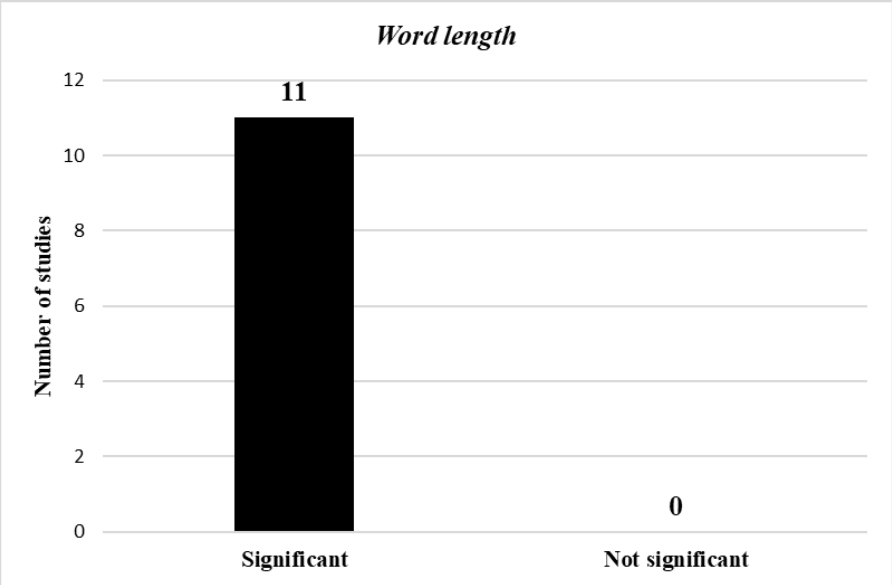
3.13 Word length

Word length factor included shorter words and longer words. It was found 11 studies that recruited a total of 177 adults who stutter from seven labs determined the word length effect on the frequency of stuttering from the current review, which revealed longer words produced increased disfluencies than shorter words in AWS (Al-Tamimi et al., 2013; Blomgren & Goberman, 2008; Brown, 1945; Brown & Moren,

1942; Danzger & Halpern, 1973; Dworzynski et al., 2003; Griggs & Still, 1979; Max et al., 2019; Tornick & Bloodstein, 1976; Venkatagiri et al., 2016; Wingate, 1967). All eleven studies found this factor as significant (Figure 3.7). To conclude, shorter words were less stuttered compared to longer words.

Figure 3.7

Frequency of studies which investigated effect of word length on stuttering rate in AWS

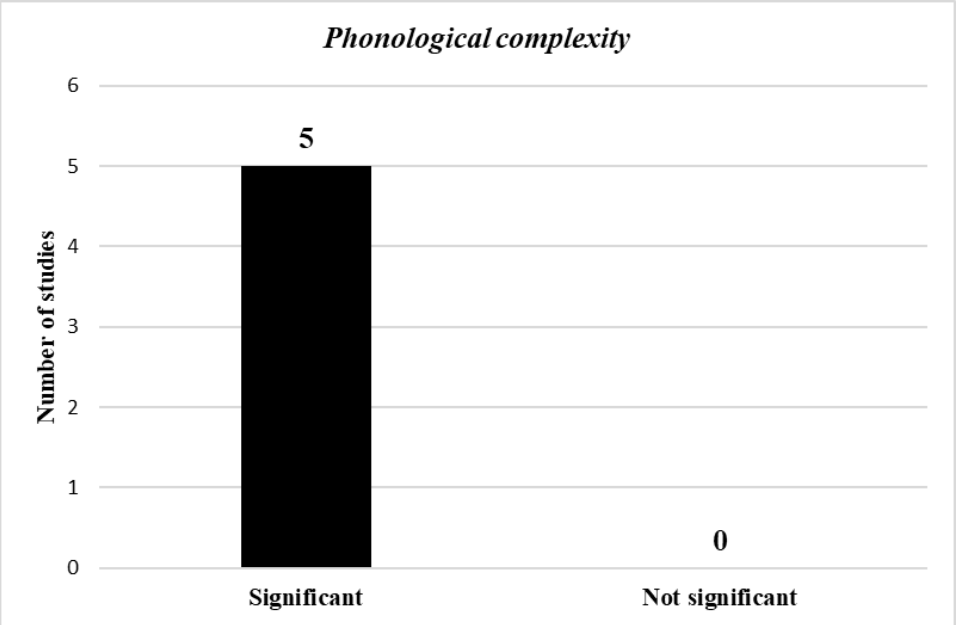


3.14 Phonological complexity

Phonological complexity was one of the factors among phonological factors, which included the IPC score (Index of phonetic complexity). The current review yielded five studies that recruited 68 adults who stutter from two research labs, which determined its effect on stuttering frequency. All five studies found significant effects (Figure 3.8), which revealed more the IPC scores, more complex the phonetic structure, and which lead to increased stuttering frequency (Dworzynski & Howell, 2004; Howell et al., 2000, 2006; Howell & Au-Yeung, 2007; Venkatagiri et al., 2016).

Figure 3.8

Frequency of studies which investigated effect of phonological complexity on stuttering rate in AWS



3.2 Morphological factors

As mentioned earlier, morphological factors were sub-grouped into a) word class (content word, function word, hybrid content-function words) and b) word inflection. The current review found 21 citations on the factor word class but didn't find any articles related to the word inflection factor.

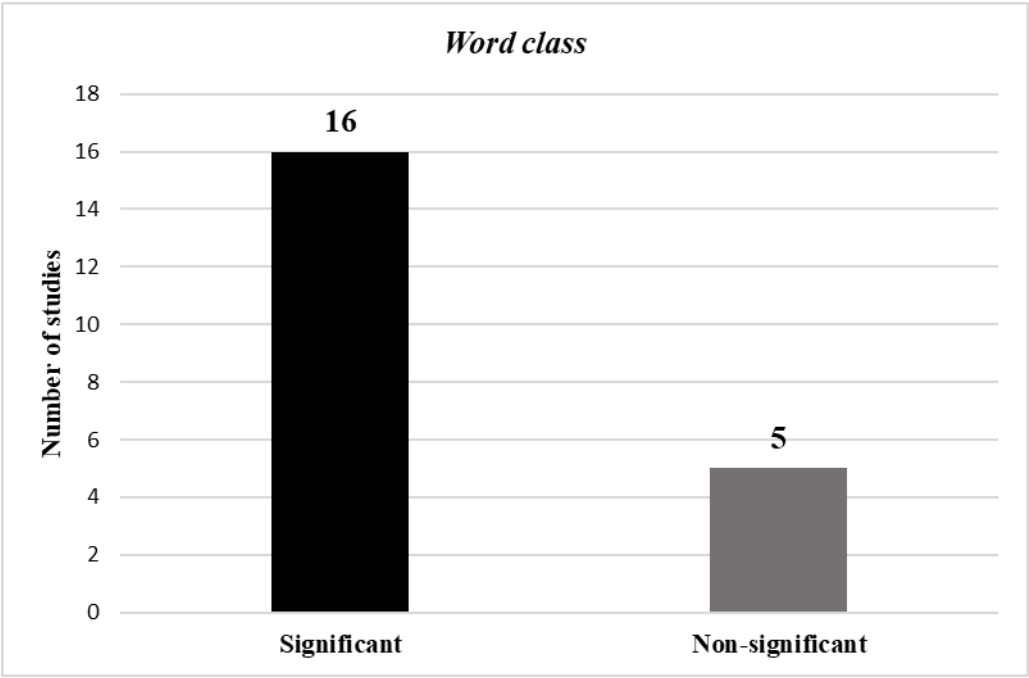
3.21 Word class

Word class was the most studied morphological factor, among 21 studies which recruited a total of 351 adults who stutter from 16 research labs, determined the effect of word class on stuttering frequency, 16 studies with 266 adults who stutter found significant effect which revealed content words produced increased disfluencies than function words in AWS (Au-Yeung et al., 1998, 2003; Brown, 1937, 1945; Dayalu et al., 2002; Dworzynski et al., 2003; Dworzynski et al., 2004; Eisenson & Horowitz,

1945; Hahn, 1942b; Howell et al., 1999; Jayaram, 1981; Juste et al., 2012; Maruthy et al., 2015; Max et al., 2019; Schäfer & Robb, 2012; Griggs & Still, 1979). And five studies (n = 85) found this effect was not significant (Abdalla et al., 2010; Danzger & Halpern, 1973; Phaal & Robb, 2007; Quarrington et al., 1962; Venkatagiri et al., 2016), i.e., there was no significant difference shown among content word, function word and content-function words on stuttering frequency (Figure 3.9). A study by Griggs and Still (1979) found a contradictory finding on one of the participants, i.e., content words were less stuttered than function words. To conclude, as most studies revealed, content words produced more stuttering than function words.

Figure 3.9

Frequency of studies which investigated effect of word class on stuttering rate in AWS



CHAPTER 4

DISCUSSION

The study aimed to summarize available literature and emphasize the overall trend found across phonological and morphological factors that influence stuttering frequency in adults who stutter. The current review yielded 38 articles through database search and snowball search that determined the effect of earlier mentioned factors. The findings have been categorized under each factor as follows;

4.1 Phonological factors

As mentioned in previous chapters, the phonological factors were subdivided into four categories a) Phoneme category, b) Phoneme position, c) Word length, and d) Phonological complexity.

4.11 Phoneme category

The phoneme category included words beginning with vowels and consonants. An overall trend is that words that begin with consonants produced higher disfluencies than words that start with a vowel. The possible explanation for this finding could be that the consonants' mechanism of articulation compared to vowels during their production can be considered to require more complex and challenging articulation (Hahn, 1942a; Johnson & Brown, 1935; Taylor, 1966). During the production of the vowels, only the tongue's position attributes primarily; wherein different positions such as bilabial, dental, palatal, etc., types plosives, nasals, fricatives, affricates, etc., and manners involve voiced, and unvoiced articulation are involved in producing consonants. Due to consonants' complex phonetic nature were significantly stuttered than vowels (Taylor, 1966).

4.12 Phoneme position

Phoneme position included syllables/words with initial position, medial position, or terminal position. An overall trend across the studies suggests that syllables/words with the initial position of a word/sentence had a greater frequency of disfluencies than any other position in an utterance. The possible explanation for this finding may be explained with the "tension and fragmentation hypothesis" by (Bloodstein, 1974) which suggests when a person perceives the elements of sound as too challenging to produce smoothly and automatically during the flow of speech, he may respond to it by attempting only the first part of it and might do this again and again until he gets the conviction to attempt all of it at once. According to Howell et al. (2004) EXPLAN theory, there is a premature initiation in the execution stage. Assuming that plan for a word is built from left to right, more difficulty will be seen on initial sounds more often in content words. Tornick and Bloodstein (1976) reported increased stuttering on the initial clause of long sentences than on the same clause in isolation due to the subjects' perception of or preparation for such sentences.

4.13 Word length

Word length factor included shorter words and longer words. The overall trend showed longer words produced increased disfluencies than shorter words. The possible explanation for this is as follows; There are various explanations on why stuttering occurs more on longer words. It could be due to lesser familiarity with the lengthy word's occurrence instead of the short one. It could be due to the psychological reaction of the speaker towards the long words because of their more significant duration. Starkweather and Gottwald (1990), according to their demands and capacities explanation of fluency breakdown, reports that longer utterances

exhibit challenging demands on the sources required for speech production and planning. Eisenson (1975) suggested that longer words may be anxiety-producing because stutters lack familiarity, leading to a lack of practice in getting a habitual articulatory set. According to Danzger and Halpern (1973), a stutterer's image of a longer word involves high possibilities of phoneme error than a shorter word's image, thereby accounting for the word length factor. And all eleven studies from the current review, which determined this factor, showed a significant effect that indicates word length to be the most potent phonological factor to influence stuttering frequency.

4.14 Phonological complexity

Phonological complexity was one of the phonological factors, which included the IPC score (Index of phonetic complexity). The current review yielded five studies that determined its effect on stuttering frequency. All five studies found a significant effect, which indicates this is an essential factor that affects stuttering frequency in AWS. The possible explanation for this could be, more complex phonological property of the material, which includes multiple factors acting upon the target words in a sentence, induced more IPC scores, and which lead to increased stuttering frequency (Howell et al., 2000; Dworzynski & Howell, 2004; Howell et al., 2006; Howell & Au-Yeung, 2007; Venkatagiri et al., 2017).

4.2 Morphological factors

As mentioned earlier, morphological factors were sub-grouped into a) word class (content word, function word, hybrid content-function words) and b) word inflection. The current review found 21 citations on the factor word class but didn't find any articles related to the word inflection factor.

4.21 Word class

Word class involved content words, function words, and hybrid content-function words. The overall trend across the studies on this factor revealed content words produced significantly higher stuttering frequency than function words in AWS. The possible explanations account for this factor are as follows; These content words have phonological properties that are complex (Howell et al., 2006), are less occurring words (Quirk & Stein, 1990), and have lexical stress (Wingate, 1984). The function words are usually shorter than lexical words, which induce less stuttering, as Wingate (1969) reported. The literature supports the fact that the amount of information in a word directly relates to the stuttering frequency, i.e., high information words produced more disfluencies than low information words. Since most of the words that carry high information are content words, they produce more disfluencies (Eisenson & Horowitz, 1945). Increased stuttering frequency on content words may also be explained based on the word fear or 'specific word anxiety ' feature impose advanced stuttering more than it does incipient stuttering. The individual who stutters is more likely to produce disfluencies on content words than function words as they try to anticipate or avoid difficulty on meaningful words, i.e., content words. A majority of content words begin with consonants than vowels. We can derive from the earlier mentioned phonetic factor, i.e., phoneme category that revealed increased stuttering frequency on consonants than on vowels, supporting the findings of increased stuttering on content words, implies phonetic factors may be responsible for higher stuttering. Howell et al. (1999) interprets that in AWS, mechanism of overriding the delaying on the function words might lead to attempt the production of not fully prepared content words which results in difficulty in the production of content words.

4.3 Frequency of various languages used across the studies.

The current review yielded 38 studies conducted on various languages; there were 24 citations on the English language being the majority and 14 studies on Non-English literature that included five studies on Kannada, four on German, three on Spanish, two on Arabic, and one on Brazilian-Portuguese. The majority of the English studies replicate their findings and strongly impact those factors in the English language. There is a need to conduct more studies across the languages similar to English studies, thereby accounting for cross-linguistic differences. The efficacy of these factors influencing stuttering on AWS can be determined.

4.4 Frequency of various tasks/tools used across the studies.

The three tasks/tools utilized to derive the effect of phonological/morphological factor(s) on stuttering frequency were 1) Oral reading, 2) Spontaneous speech, and 3) Conversational speech. Out of these, oral reading has been used in a majority of the citations, i.e., 22 studies, followed by a spontaneous speech in 12 citations; both Oral reading and Spontaneous speech in 3 citations and conversational speech were the least used in only one citation out of 38 studies included. Implies more studies to be conducted using spontaneous speech and conversational speech as the task if the results are consistent across the studies, which may play as an active variable in eliciting stuttering frequency independent of factors studied.

4.5 Other confounding variables

Apart from phonological and morphological factors considered in the current review, various factors induce increased stuttering frequency in AWS, whether it could be interdependent on available phonological or morphological factors in the current review or it can be a potential factor alone. The confounding variables found across the current review are as follows. Word frequency as an individual factor

(Danzger & Halpern, 1973) or can be combined with other leading phonological and morphological factors, Syllabic stress as interdependent on word position (Hubbard, 1998). Furthermore, language proficiency along with competent factors in this review especially on bilingual speakers can be studied as a factor influencing stuttering frequency (Jayaram, 1981, 1983, 1984; Maruthy et al., 2015; Schäfer & Robb, 2012).

CHAPTER 5

SUMMARY AND CONCLUSION

The present study aimed to review the available literature on the effect of phonological and morphological factors on the frequency of stuttering in AWS. Through electronic database search and snowball search, the current review yielded 38 articles that determined the effect of following phonological factors (phoneme category, phoneme position, word length, and phonological complexity) and Morphological factors (word class and word inflection), and the results are as follows;

1. In the phoneme category variable, words beginning with consonants produced greater disfluencies than vowels.
2. Phoneme position factor revealed increased stuttering frequency was found on the initial position of an utterance than on any other position.
3. In word length factor, longer words induced increased stuttering than shorter words in AWS.
4. Phonological complexity characterized by IPC (index of phonetic complexity) showed higher the IPC scores, more the disfluencies in AWS.
5. In morphological factors, word-class was the factor studied predominantly, and the current review didn't yield any citation on word inflection as it failed to meet the inclusion criteria. In word class, content words produced an increased frequency of disfluencies than function words.

To conclude, the current review provides a strong link between the linguistic factors influencing the frequency of stuttering in adults.

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APPENDIX – A

DATA EXTRACTION TABLE

Data Extraction Table								
Study ID	Participant Details (Age, Gender, No.)	Language	PF				MF	
			1) PC- C & V	2)PP - I, M, F	3) WL	4) PhC	1) WC- C, F, CF	2) WI
Johnson and Brown (1935)	32 – AWS 26- male 6 - female Age range: 18 to 30 years Mean age: 22 years	English						
Brown (1937)	32 – AWS 26- male 6 - female Age range: 18 to 30 years Mean age: 22 years	English						
Brown (1938)	32 – AWS 26- male 6 – female Age range: 18 to 30 years Mean age: 22 years	English						

Brown (1938)b	32 – AWS 26- male 6 - female Age range: 18 to 30 years Mean age: 22 years	English						
Brown and Moren (1942)	32 – AWS 26- male 6 - female Age range: 18 to 30 years Mean age: 22 years	English						
Hahn (1942)	43 – AWS 38 - male 5- female Age range:18 to 39 years.	English						
Hahn (1942)b	43 – AWS 38 - male 5- female Age range:18 to 39 years.	English						
Brown (1945)	31 – AWS 25 – male 6 - female Age range: 18 to 30 years. Mean age: 22 years	English						

Eisenson and Horowitz (1945)	18 – AWS 15 – male 3 - female Age range: 17 to 20 years Mean age range:18.4 years	English						
Quarrington et al. (1962)	27 – AWS 21 - male 6 - female Mean age range: 23.2 +/- 4.9 years	English						
Conway et al. (1963)	23 – AWS 17- male 6 - female Age range:15 to 40 years. Mean age:24 years	English						
Wingate (1967)	14 – AWS 14 - male Age range:16 to 36 years Mean age range: 25.2 years	English						
Danzger and Halpern (1973)	16 – AWS 12 – male 4 - female Age range: 15 to 41 years. Mean age: 24.11 years.	English						
Tornick and Bloodstein (1976	14 – AWS 12 – male 2 - female Age range:16 to 39 years.	English						

	Median age range: 20.7 years.							
Griggs and Still (1979)	2 – AWS 1 – male (S1) 1 – female(S2) Age: S1 – 25 years. S2 – 23 years.	English						
Jayaram (1981)	20 – AWS 10 - male (monolingual) 10 – males (bilingual). The age range of (monolingual) 17 to 34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean age of 25.6 years.	Kannada and Kannada-English speaking bilinguals						
Jayaram (1983)	20 – AWS 10 - male (monolingual) 10 – males (bilingual). The age range of (monolingual) 17 to 34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean age of 25.6 years.	Kannada and Kannada-English speaking bilinguals						

Jayaram (1984)	20 – AWS 10 - male (monolingual) 10 – males (bilingual). The age range of (monolingual) 17 to 34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean age of 25.6 years.	Kannada and Kannada-English speaking bilinguals						
Au-Yeung, Howell, and Pilgrim (1998)	12 - AWS 12 - male Age range: 20 to 40 years Mean age: 28.4 years	English						
Carol and Hubbard (1998)	10 - AWS 7 - male 3 - female Age range: 19 to 62 years. Mean age: 39 years	English						
Howell et al. (1999)	12 – AWS 12 – male 12 – control group (People who do not stutter) 12 - male The age range of AWS group: 20 to 40 years Mean age range: 28.4 years For control group:	English						

	Mean age: 29.5 years							
Howell et al. (2000)	12 – AWS (Group 3) Age range: 18+ years. Mean age: 28.3 years	English						
Dayalu et al. (2002)	10 – AWS 9 – male 1 – female Age range: 21 to 52 years. Mean age: 32.1 years; SD: 10.7	English						
Dworzynski, Howell and Natke (2003)	15 - AWS 10 – male 5 – female Age range:16.3 to 47 years Mean age: 29.8 years	German						
Au-Yeung, Gomez, and Howell (2003)	9 – AWS 7 – male 2 - female Age range: 20 to 68years	Spanish						
Dworzynski, Howell, Au-	German AWS: 15 10 - males 5 - female	German (monolingual) and English (monolingual) speakers						

Yeung, and Rommel (2004)	English AWS: 12 12 - male German AWS: Age range:16.3 to 47.1 years. Mean age 29.8 years. (English AWS): Age range: 20 to 40 years Mean age 28.4 years							
Dworzynski and Howell (2004)	German group: 15 – AWS 10 – Male 5 – female English group: 10 – AWS 10 – male German group: Mean age: 29.3 years and S.D. of 10.9 years. English group: Age :18+ years Mean age: 26.9 years, S.D. of 6.2 years.	German (monolingual) and English (monolingual) speakers						
Howell, Au- Yeung, Yaruss	10 – AWS (Group 3, G3) 10 – male	English						

and Eldrige (2006)	Age:18 plus years Mean age range: 26.9 years, SD of 6.2							
Howell and Au- Yeung (2007)	9 – AWS 7 – male 2 - female Age range:18 to 68 years. Mean age: 39.3 years, SD: 15.4.	Spanish-speaking monolinguals.						
Phaal and Robb (2007)	10 – AWS 8 – male 2 - female Age range:10 to 59 years. Mean age: 30 years.	English						
Blomgen and Goberman (2008)	22 – AWS and 22 – normal speakers. 44 – male in total. The age range of both groups: 18 to 62 years. Mean age range of stuttering speakers: 34 years and S.D.= 13 years. Mean age range of non-stuttering speakers: 31 years and S.D. = 11 years.	English						

Abdalla et al. (2010)	10 – AWS 8 – male 2 – female Age range:17 to 42 years Mean age: 22.4 years	Kuwaiti Arabic speakers.						
Juste et al. (2012)	AWS - 30 24 – male 6 – female AWNS (Adults who do not stutter) – 30 For both AWS and AWNS groups: Age range: 18 to 40.11 years. Mean age: 26.1 years.	Brazilian Portuguese speakers						
Schafer and Robb (2012)	15 – AWS 11 – male 4 – female Age range: 10 to 59 years. Mean age: 25 years.	German (L1) – English (L2) speakers. (Bilinguals)						
Al-Tamimi, Khamaisehz and Howell (2013)	5 – AWS (G3) - group3. 3 – male 2 – female Age: 18+ years	Arabic speakers.						

	Male: Mean age: 23.93 years, SD 1.75) Female: mean age: 24.15 years, SD 1.97)							
Maruthy et al. (2015)	25 – AWS 23 – male 2 – female Age range: 16 to 28 years. Mean age: 22.5 years	Kannada (L1) – English (L2) Bilinguals.						
Venkatagiri et al. (2017)	22 – AWS 22 – male Age range: 15 to 30 years. Mean age: 19.6 years.	Kannada						
Max et al. (2019)	35 – AWS 27 – male 8 – female Age range:19 to 49 years. Mean age: 30 years.	English						
PC- Phoneme Category; PP- Phoneme Position: I-Initial, M-Medial, F-Final; PhC - Phonological Complexity; WC- Word Class: C- Content, F-Function, CF- Content Function; WI- Word Inflection (Box filled darker shade represents significant effect of the factor and box with lighter shade represents non – significant effect of the factor)								

APPENDIX - B

DATA EXTRACTION TABLE

Data Extraction Table for Phonological Factors:

Study ID	Study design	Language studied	Participants	Age range (in years)	Phonological Factors studied	Task/tool used	Findings
Johnson and Brown (1935)	Cohort study	English	32 – AWS 26- male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Phoneme category (consonant or vowel)	Oral reading of five 1000 word lists. (contextual material)	Increased disfluencies found on consonants than vowels. But there were individual differences attributes to varying degree.
Brown (1938)	Cohort study	English	32 – AWS 26- male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Phoneme position (Initial, medial or final)	Oral reading of 698 sentences and 178 paragraphs, and 60 sections in total).	Results showed high stuttering rate in the initial position of the first word of a sentence (78), paragraph (81), and sections (72) than all other positions of the words. Note: (78) indicates the number of sentences had stuttering in the initial position.
Brown (1938)b	Cohort study	English	32 – AWS 26- male 6 - female	Age range: 18 to 30 years	Phoneme category (consonant or vowel)	Oral reading of 700 words, ten words beginning with	Among 32 AWS, 18 cases didn't stutter on non-contextual material but they had difficulty and produced disfluencies with

				Mean age: 22 years		each 23 consonant sounds, 29 consonant blends, and eighteen vowels (non-contextual material)	contextual material; only 14 stutterer's current results were compared with the results of previous contextual material. The correlation of rank of difficulty for the same 14 cases who read contextual material earlier was found to be .91 To summarize, the phonetic rank of difficulty corroborates previous reports of the study by Johnson & Brown (1935); i.e., consonants were more difficult than vowels. From contextual to non-contextual material individual patterns varied.
Brown and Moren (1942)	Cohort study	English	32 – AWS 26- male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Word length (longer words, shorter words, or mono/bi/three/four syllables)	Oral reading of five lists of 1000 words. (The word lists consist of only adjectives and prepositions to make the grammatical factor constant. The word length was quantified based on the	Results showed that for adjectives, the frequency of stuttering varied in proportion with the word length that is more stuttering for four syllabic words than three syllables than two syllables than one syllable. And this finding was the same for the number of syllables in prepositions. But concerning the number of letters, it was seen that stuttering percentage within any syllable group had

						number of syllables and letters. Adjectives were one to four-syllable and three to ten letters in length, while prepositions were mono and bisyllable with two to five letters.)	an indefinite pattern. For mono and bi-syllable adjectives, the stuttering rate was directly proportional to the number of letters. Still, the stuttering rate was indirectly proportional (i.e., nine-letter three-syllable adjectives with nine letters had less stuttering than seven-letter three-syllable adjectives). To summarize, words with multi-syllables increase the frequency of stuttering than mono/bi-syllables.
Hahn (1942)b	Cohort study	English	43 – AWS 38 - male 5- female	Age range: 18 to 39 years	Phoneme category and Phoneme position	Oral reading of reading material consisted of 550 words.	Stuttering frequency was found to be significant on words beginning with consonants and words occurring in initial utterance position that produced increased disfluencies.
Brown (1945)	Cohort study	English	31 – AWS 25 – male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Phoneme position (Words in the initial, second and third position of a sentence given as a plus rating	Oral reading of a passage.	Results showed that words in initial position and words that had more than five letters are correlated with increased stuttering. And the rank-order correlation of the degree of presence of the four factors considered was .99± .003 and it was consistent across the

					All other words were given a minus rating). And word length (was measured in the number of letters and words with >5 letters were given plus rating and words with < 4 letters were given minus rating).		subjects and amount of stuttering.
Quarrington et al. (1962)	Cohort study	English	27 – AWS 21 - male 6 - female	Mean age range: 23.2 +/- 4.9 years	Phoneme position (initial or terminal) And also, Phoneme class (high frequency and low-frequency phonemes)	Oral reading (A series of 64-six-word sentences)	Results showed that the mean stuttering for the words in initial utterance position was 14.52 (45.3%), compared to 7.72 (24.1%) for words in the final position. And for the high frequency and low frequency phonemes, words in initial position produced more disfluencies than final position. To conclude, a significant effect was seen for only word position, i.e., the initial position was stuttered more, as mentioned by the authors.

Conway et al. (1963)	Cohort study	English	23 – AWS 17- male 6 - female	Age range: 15 to 40 years. Mean age: 24 years	Phoneme position (initial, medial, and terminal)	Oral reading (Task was to read aloud the seven words 72 sequences. Eight critical words in three positions, so a total of 24 words. Three levels of contextual constraints).	Results reveal that for all levels of contextual constraint, the mean frequency of stuttering approaches a decrease in linear function of their position. i.e., more stuttering on initial position than medial and terminal position.
Wingate (1967)	Cohort study	English	14 – AWS 14 - male	Age range: 16 to 36 years Mean age range: 25.2 years	Word length	Oral reading (30 pairs of common and uncommon, monosyllabic meaningful words and 30 bi-syllabic meaningful words).	The Chi-square test showed that participants stuttered more in bi-syllable words and word-initial positions. Moreover, the stuttering frequency was identical for both common and uncommon bi-syllable words, whereas, on monosyllable words, the stuttering frequency was more in uncommon words than in common words.
Danzger and Halpern (1973)	Cohort study	English	16 – AWS 12 – male 4 - female	Age range: 15 to 41 years. Mean age: 24.11 years.	Word length (Long and short words, were measured based on the number of letters and	Oral reading (Stimulus material consisted of 72 words).	Results showed that word length factor yielded a significant effect i.e., longer words produced increased stuttering frequency compared to shorter words.

					syllables separately in each word. "Long" words had two or more syllables and six or more letters. "Short" words had one syllable of four or fewer letters).		
Tornick and Bloodstein (1976	Cohort study	English	14 – AWS 12 – male 2 - female	Age range: 16 to 39 years. Median age range: 20.7 years.	Word length (Short sentence: 3-5 words Long sentence: 11-12 words)	Oral reading (20 short sentences and 20 long sentences in random order)	Results showed that increased stuttering frequency on the initial words of long sentences than on short sentence with similar information on it. The stuttering on the similar portions of the long sentences was significantly more than the short sentences.
Griggs and Still (1979)	Case study	English	2 – AWS 1 – male (S1) 1 – female (S2)	Age: S1 – 25 years. S2 – 23 years.	Phoneme position and Word length	Oral reading (twenty-five passages with approximately 200 words)	Results revealed that both S1 and S2 stuttered on longer words and initial consonants.
Jayaram (1983)	Standard group comparison study	Kannada and Kannada-English	20 – AWS 10 - male (monolingual)	The age range of (monolingual) 17 to	Phoneme class (vowels and consonants)	Oral reading (Eight-word lists consisting total of 286	The outcome of the study displayed higher disfluency in voiceless stops and voiceless fricatives. A significant

		speaking bilinguals.	10 – males (bilingual).	34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean age of 25.6 years.		Kannada words and 297 English words). And spontaneous speech tasks.	difference was observed between the different sound categories in both tasks and languages to total stuttering for all the groups. There were few differences between stuttering frequency concerning tasks. In spontaneous speech, voiceless fricatives stuttered most, whereas voiceless stops in oral reading. Furthermore, the stuttering percentage was more considerable in reading tasks than in spontaneous speech. And compared to bilinguals, the monolingual stutterers exhibited more stuttering.
Jayaram (1984)	Standard group compariso n study	Kannada and Kannada-English speaking bilinguals.	20 – AWS 10 - male (monolingu al) 10 – males (bilingual).	The age range of (monoling ual) 17 to 34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean	Phoneme position.	Oral reading (10 monolinguals read 20 sets of sentences in Kannada. Ten bilinguals read 20 sets of sentences in Kannada and English each).	Results showed that initial word/clause in a clause/sentence respectively produced an increased amount of disfluencies than any other utterance position.

				age of 25.6 years.			
Au-Yeung, Howell, and Pilgrim (1998)	Cohort study	English	12 – AWS 12 - male	Age range: 20 to 40 years Mean age range: 28.4 years	Phoneme position (initial, medial and final)	Spontaneous speech	Results from the second analysis investigated the position effect concerning word classes on the stuttering rate. ANOVA and post-hoc-Tukey tests revealed higher disfluency on utterance initial (first two utterance positions) function and content words than other positions. In the third analysis, the stuttering frequency of function words and content words in different phonological word positions was computed, showing that the phonological word-initial position of function words produced more disfluencies than other positions. There was no significant influence of phonological word positions on disfluency frequency for content words than function words.

Carol and Hubbard (1998)	Cohort study	English	10 - AWS 7 - male 3 - female	Age range: 19 to 62 years. Mean age: 39 years	Phoneme position i.e. Word position	Oral reading	Results revealed significant stuttering on syllables of word initial position than syllables of word terminal position. A similar finding on word initial stressed syllable revealed increased stuttering. A total 186 stutter events produced, among those 184 (99%) were on syllables with word initial position. In comparison, only 90 (48%) were on stressed syllables.
Howell et al. (2000)	Standard group comparison study	English	12 – AWS (Group 3)	Age range: 18+ years. Mean age: 28.3 years	Phonological complexity (Internal structure of content words: LEC – late-emerging consonant and CS – Consonant string)	Spontaneous speech.	The amount of LEC and CS occurrence over age groups depends on whether these factors occurred in the content words; all nine combinations of no LEC, word-initial LEC, non-initial LEC with no CS, word-initial CS, and non-initial CS were examined. Results from Friedman statistic on the ratio of stuttering (proportion of stuttered words in a particular word class divided by the proportion of words in that particular word class) showed that the stuttering frequency remained high for adults in word-initial

							position when both CS and LEC appeared in the target word. To conclude, this study highlights the effect of phonological complexity and phoneme position in AWS.
Dworzynski, Howell and Natke (2003)	Cohort study	German	15 - AWS 10 – male 5 - female	Age range: 16.3 to 47 years Mean age: 29.8 years	Phoneme category (Vowel and consonants), Phoneme position (initial, medial and final), and Word length (longer words and shorter words)	Spontaneous speech	Results revealed adults stuttered more on longer words than on shorter words. However, for all other factors, no significant difference was observed in both age groups.
Dworzynski and Howell (2004)	Standard group compariso n study	German (monoling ual) and English (monoling ual) speakers	German group: 15 – AWS 10 – Male 5 – female English group: 10 – AWS 10 – male	German group: Mean age: 29.3 years and S.D. of 10.9 years. English group: Age :18+ years	Phonological complexity (IPC – index of phonetic complexity; authors analysed the eight IPC factors that includes consonant by place, consonant by manner, singleton	Spontaneous speech	Results are as follows: Analysis 1 used Paired t-tests to determine the effect of phonological complexity on word type across the age groups which revealed greater IPC scores for content words than function words that suggests complex phonetic structure of content word. Analysis two; revealed non stuttered had lesser IPC scores

				Mean age: 26.9 years, S.D. of 6.2 years.	consonants by place, vowel by class, word shape, word length, contiguous consonants, and cluster by place).		than stuttered content words, but this effect was not seen for function words. Analysis three; reported that content words of German language were more complex than English content words.
Howell, Au-Yeung, Yaruss and Eldrige (2006)	Standard group comparison study	English	10 – AWS (Group 3, G3) 10 – male	Age:18 plus years Mean age range: 26.9 years, SD of 6.2	Phonological complexity (The authors looked at the eight IPC (IPC – index of phonetic complexity). Consonant by place, consonant by manner, singleton consonants by place, vowel by class, word shape, word length, contiguous consonants, and cluster by place are among the	Spontaneous speech.	The following are the outcomes: In English, the IPC ratings of both content and function terms highlighted the complexity of content words, with content words having higher IPC values than function words. For adult speakers in G3, the IPC ratings for fluent words were lower than those for stuttering words and approached significance (p 5.085). In G3, the IPC values of stuttering content words were higher than fluent content word scores. There were no significant differences between stuttering and fluent function words

					eight IPC elements.		across age groups, according to the findings.
Howell and Au-Yeung (2007)	Standard group comparison study	Spanish-speaking monolinguals.	9 – AWS 7 – male 2 - female	Age range: 18 to 68 years. Mean age: 39.3 years, SD: 15.4.	Phonological complexity (IPC – index of phonetic complexity)	Spontaneous speech	Results showed that related t-tests on each age group revealed significantly increased IPC scores for content words across all ages and stuttered words for adults. And for fluent and disfluent function words across all age group found no difference in IPC scores. Thus it was suggested that higher stuttering is associated with a high IPC score, i.e., phonetic complexity.
Blomgen and Goberman (2008)	Standard group comparison study	English	22 – AWS And 22 – normal speakers. 44 – male in total.	The age range of both groups: 18 to 62 years. Mean age of AWS: Thirty-four years and S.D.= 13 years. Mean age of adults	Word length	Oral reading (Reading a list of 45 words and a list of 45 phrases, two times each).	Results revealed AWS, had increased stuttering on variable rate task than habitual. Overall, the results indicated that stuttering frequency in AWS affected by varying utterance length and temporal complexity. And the performance patterns were different across the tasks by groups. The severity of stuttering directly related to amount of stuttering and word length i.e., more severe group

	who do not stutter: 31 years and S.D. = 11 years.	had greater disfluencies with increased length of utterance and vice versa.

Al-Tamimi, Khamaisehz and Howell (2013)	Standard group compariso n study	Arabic speakers	5 – AWS (G3) - group3. 3 – male 2 – female	Age: 18+ years Male: Mean age 23.93 years, SD 1.75) Female: (Mean age 24.15 years, SD 1.97)	Phonetic complexity (Arabic index of phonetic complexity (AIPC) on content, function, and function-content words). The 9 AIPC factors considered were consonant by place, consonant by manner, singleton consonants by place, vowel by class, word shape, word length, contiguous consonants, cluster by place, and consonant by length)	Spontaneous speech.	Results from related t-tests by multiple comparisons with Bonferroni revealed the following: The overall AIPC scores of content words (content words versus function words for G3, n = 5, t = 17.51, p< 0.001) and of function-content words (Function-content words versus function words: G3, n = 5, T = 5.73, p< 0.001). were significantly higher than those of function words. The AIPC scores of function words those stuttered and not stuttered was not significant across the age groups. To conclude, G3(AWS) produced more disfluencies on content and function-content words than functions words.

Venkatagiri et al. (2017)	Cohort study	Kannada	22 – AWS 22 – male	Age range: 15 to 30 years. Mean age: 19.6 years.	Morpho-phonemic complexity (MPC). Those factors were the presence of sandhi, the presence of geminates, consonant clusters, and the number of morphemes. And Word length.	Oral reading (4 short stories consisting of a total of 192 words with 764 syllables).	Results showed that word length and morphophonemic complexity (MPC) significantly affected disfluency in reading tasks using linear regression analysis. Despite the significant direct relation of MPC and stuttering, the effect size of 7.5% suggested that MPC's impact is negligible in real-world scenarios. Therefore, the authors suggested word length as a potential factor in determining the disfluency rate compared to MPC. Further, multiple regression analyses to observe the interaction of these two factors on stuttering frequency displayed a reduction in the strength of word length. Moreover, the influence of sandhi and non-sandhi words, making word length a constant factor, revealed no significant difference.
Max et al. (2019)	Standard group comparison study	English	35 – AWS 27 – male 8 - female	Age range: 19 to 49 years. Mean age:	Phoneme category (consonant and vowel),	Oral reading	The effect of position on stuttering frequency was not significant, according to the findings. Other criteria, such as

	30 years.	Phoneme position (initial, medial and final), and word length.	the length factor (a word with five or more letters) and the phonetic component (a word that starts with a consonant), however, resulted in higher disfluencies.

Data Extraction Table for Morphological Factors:

Study ID	Study design	Language studied	Participants	Age range (In years)	Morphological Factors studied	Task/tool used	Findings
Brown (1937)	Cohort study	English	32 – AWS 26- male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Word class (nouns, adjectives, adverbs, verbs, articles, conjunctions, and prepositions)	Oral reading of five 1000-word lists.	The more relative difficulty was observed in adjectives and nouns, whereas lesser difficulty was in conjunctions, prepositions, and articles. So, we can conclude that stuttering frequency was more on content words than on function words.
Hahn (1942)	Cohort study	English	43 – AWS 38 - male 5- female	Age range: 18 to 39 years.	Word class (nouns, adjectives, adverbs, verbs, pronouns, prepositions, conjunctions, articles, and interjections).	Oral reading of reading material consisted of 550 words.	Results revealed adjectives, nouns, adverbs, and verbs produced significant difficulty. The ranking of difficulty of parts of speech is comparable to that formulated by Brown, (1937). To conclude, content words elicited more stuttering than function words.
Brown (1945)	Cohort study	English	31 – AWS 25 – male 6 - female	Age range: 18 to 30 years Mean age: 22 years	Grammatical function, i.e., Word class (Plus rating was given to adjectives,	Oral reading of a passage.	Results showed that presence of grammatical function factors influences the increase in the frequency of stuttering.

					adverbs, verbs, and nouns. Minus rating was given to prepositions, conjunctions, pronouns, and articles). To conclude, content words were given a plus rating, and function words were given a minus rating.		
Eisenson and Horowitz (1945)	Cohort study	English	18 – AWS 15 – male 3 - female	Age range: 17 to 20 years Mean age range: 18.4 years	Grammatical function based on propositional value, i.e., Word class (nouns, adjectives, adverbs, verbs, pronouns, prepositions, conjunctions, and articles)	Oral reading (Three types of reading materials with varying propositional value were used: a list of 130 words, a non-sense selection of 130 words, and a meaningful paragraph of 130 words).	Results revealed an increase in stuttering frequency from reading word lists to reading meaningful paragraphs on nouns, verbs, and adjectives. Adverbs and prepositions stuttered more in meaningful paragraphs, whereas pronouns and articles stuttered less in meaningful paragraphs than the other two. The authors concluded that the steady increase in stuttering in adjectives, nouns, and verbs indicated that higher propositional values cause an

							increase in stuttering. However, pronouns, prepositions, articles, and conjunctions, have less stuttering frequency. To conclude, high disfluencies in content words than function words.
Quarrington et al. (1962)	Cohort study	English	27 – AWS 21 - male 6 - female	Mean age range: 23.2 +/- 4.9 years	Grammatical form i.e. Word class (nouns, adjectives, adverbs, and verbs)	Oral reading (A series of 64-six-word sentences)	As examined in this study, the significance of word class is in some doubt due to the lack of control over word length.
Danzger and Halpern (1973)	Cohort study	English	16 – AWS 12 – male 4 - female	Age range: 15 to 41 years. Mean age: 24.11 years.	Word class (Nouns, verbs, and adjectives)	Oral reading (Stimulus material consisted of 72 words).	Results revealed among nouns, verbs, and adjectives there were no significant difference.
Griggs and Still (1979)	Case study	English	2 – AWS 1 – male (S1) 1 – female (S2)	Age: S1 – 25 years. S2 – 23 years.	Grammatical class, i.e., Word class (content word and function word).	Oral reading (twenty-five passages with approximately 200 words).	Results revealed that S1 produced increased stuttering frequency on content words than function words and vice-versa for S2.

Jayaram (1981)	Standard group comparison study	Kannada and Kannada-English speaking bilinguals.	20 – AWS 10 - male (monolingual) 10 – males (bilingual).	The age range of (monolingual) 17 to 34 years and mean age 24.8 years. And Age range of (bilingual) 19 to 32 years and the mean age of 25.6 years.	Word class (content words and function words)	Both oral reading (Reading material of 149 words English passage and 122 words Kannada passage). And spontaneous speech.	Results revealed significantly increased stuttering frequency on content words compared to function words in both the tasks and the monolingual and bilingual groups.
Au-Yeung, Howell, and Pilgrim (1998)	Standard group comparison study	English	12 - AWS 12 - male	Age range: 20 to 40 years Mean age: 28.4 years	Word class (Content words and function words)	Spontaneous speech	Results from first analysis compared the disfluencies between word classes across each age group using Wilcoxon signed-rank test; it revealed that participants from the adult group produced more disfluencies on content words compared to function words.
Howell et al. (1999)	Standard group comparison study	English	12 – AWS 12 – male	Age range: 20 to 40 years	Word class (Content words and function words)	Spontaneous speech	The results demonstrated that dysfluency was induced inside each phonological word by either the function word

			12 – control group (People who do not stutter) 12 - male	Mean age range: 28.4 years For control group: Mean age: 29.5 years			preceding the content word or the content word itself in both groups, but not both. For fluent speakers (control group) had increased frequency of stuttering on initial function words compared to content words. And increase in disfluencies on function words than content words were the same across all age groups. In PWS: function words were stuttered more in the initial age groups similar to the fluent group, but later it decreased on function words, and increased on content words in the adults' group. To conclude, for AWS, content words produced greater disfluencies than function words. For the PWS group, stuttering on function words decrease over age groups, and disfluencies on content words increase.
Dayalu et al. (2002)	Cohort study	English	10 – AWS 9 – male 1 – female	Age range: 21 to 52 years.	Word class (Content word and function words)	Oral reading (A list of 126 words containing the exact count of	One-way repeated measures of ANOVA revealed on content words. Result from the current study indicates that increased stuttering on content words

				Mean age: 32.1 years; SD: 10.7		content and function words of one grammatical category was given for reading tasks)	approached significance of 16% compared to function words when presented in isolation.
Dworzynski, Howell and Natke (2003)	Cohort study	German	15 - AWS 10 – male 5 - female	Age range: 16.3 to 47 years Mean age: 29.8 years	Word class (content word and function words)	Spontaneous speech	Results showed the adults who stutter produced significant stuttering frequency on content words compared to function words.
Au-Yeung, Gomez, and Howell (2003)	Standard group comparison study	Spanish	9 – AWS 7 – male 2 - female	Age range: 20 to 68years	Word class (Content word and function words)	Spontaneous speech	Results showed as follows: The disfluency rate of function words occurring in pre and post content words and disfluency across age groups was examined. First analysis performed through two-way ANCOVA revealed that pre-function words had a significantly increased stuttering frequency than the post-function word. In the second analysis, a significantly increased number of disfluencies was observed on

							the content word in the adult group than children.
Dworzynski, Howell, Au-Yeung, and Rommel (2004)	Standard group comparison study	German (monolingual) and English (monolingual) speakers	German AWS: 15 10 - males 5 - female English AWS: 12 12 - male	German AWS: Age range: 16.3 to 47.1 years and Mean age 29.8 years. English AWS: Age range: 20 to 40 years and mean age 28.4 years	Word class (Content word and function words)	Spontaneous speech	Results showed that function words that precede the content word in a PW (Phonological word) produced more disfluencies than those that succeed the content word. And young speakers exhibit increased stuttering frequency on function words, but this decreases with age, and the stuttering frequency of content words increases.
Phaal and Robb (2007)	Cohort study	English	10 – AWS 8 – male 2 - female	Age range: 10 to 59 years. Mean age: 30 years.	Word class (content word and function word)	Oral reading of 40 stimulus sentences.	A series of t-tests were performed. And the results showed no significant effect on disfluency due to grammatical class when other variables like phonetic composition, word length, sentence position, syllable stress, and utterance length were controlled. Also, the analysis indicated that the

							utterance length of content and function words did not affect speech disfluency. To conclude, In AWS the influence of content and function words was not significant.
Abdalla et al. (2010)	Cohort study	Kuwaiti Arabic speakers.	10 – AWS 8 – male 2 - female	Age range: 17 to 42 years Mean age: 22.4 years	Word class (content word and function words)	Oral reading, Spontaneous speech and single word naming task.	A series of t-tests displayed no significant influence of content and function words on disfluency across all three tasks. A significant difference wasn't observed in any of the word categories on spontaneous speech. However, there were significant differences in oral reading between content words and content-function words and between function words and content-function words. To conclude, the effect of word class was not significant.
Juste et al. (2012)	Standard group comparison study	Brazilian Portuguese speakers	AWS - 30 24 – male 6 – female	For both AWS and AWNS groups: Age range:	Word class (content words and function words)	Spontaneous speech.	Results showed that for AWS, there is an increase in stuttering frequency on content words (T= 66.50, p=0.001). Wherein, AWNS continues to produce greater disfluencies on

			AWNS (Adults who do not stutter) - 30	18 to 40.11 years. Mean age: 26.1 years.			function words. (T= 44.00, p=.013). For AWS the effect of word class (content word) was significant. (χ2(4) =84.37, p<0.001) and for AWNS (χ2(4) = 31.92, p<0.001). To conclude, AWS produced greater disfluencies on content words than function words across the age groups compared with AWNS.
Schafer and Robb (2012)	Standard group comparison study	German (L1) – English (L2) speakers. (Bilinguals)	15 – AWS 11 – male 4 – female	Age range: 10 to 59 years. Mean age: 25 years.	Word class (Content word and function words)	Conversational speech. (15-minutes sample)	Results revealed increased stuttering frequency on L2 compared to L1. Disfluencies occurred significantly on content words compared to function words in L1 and no effect of this observed in L2. An analysis on stuttering frequency of function words across L1 and L2 revealed increased disfluencies in L2 compared to L1 and vice versa for content words.
Maruthy et al. (2015)	Standard group comparison study	Kannada (L1) – English (L2)	25 – AWS 23 – male 2 - female	Age range: 16 to 28 years. Mean age:	Word class (Content word and function word)	Spontaneous speech.	Results showed that frequency of disfluencies differ between two languages. The current findings suggest that frequency

	Bilinguals.		22.5 years			of disfluencies was more significant in L2 than L1. Both content and function words, produced disfluencies in AWS, and content words produced greater disfluencies than function words in both the languages.
Venkatagiri et al. (2017)	Kannada	22 – AWS 22 – male	Age range: 15 to 30 years. Mean age: 19.6 years.	Word class (Content word, function words, and content – function words)	Oral reading (4 short stories consisting of a total of 192 words (764 syllables).	Results revealed content-function words and content words along with controlled word length factor, produced statistically equivalent disfluencies. To conclude no variation in stuttering frequency between content-function word and function words in AWS.
Max et al. (2019)	English	35 – AWS 27 – male 8 - female	Age range: 19 to 49 years. Mean age: 30 years.	Word class (Content word and function words)	Oral reading	Results showed that word class factor i.e., word that was a noun, adjective, adverb, or verb produced more disfluencies than function words. To conclude, content words produced increased stuttering frequency compared to function words.